Humber Industrial Cluster Plan - Societal and Cultural Challenges and Social Innovation Study

Final Report

30 January 2023

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30 January 2023

Humber Industrial Cluster Plan

Societal and Cultural Challenges and Social Innovation Study
Final Report

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Acronyms and Abbreviations

Name	Description
BECCS	Bioenergy with Carbon Capture and Storage
CATCH	Centre for Assessment of Technical Competence Humber
CCUS	Carbon capture utilisation and storage
CREESA	The Centre for Research into Electrical Energy Storage & Applications
DWP	Department for Work and Pensions
ERM	Environmental Resources Management
H2H	Hydrogen to Humber
HEY LEP	Hull and East Yorkshire Local Enterprise Partnership
HICP	Humber Industrial Cluster Plan
GL LEP	Greater Lincolnshire Local Enterprise Partnership
JCP	Jobcentre Plus
LA	Local Authority
LEP	Local Enterprise Partnership
NRW	North Rhine-Westphalia
OECD	Organisation for Economic Co-operation and Development
SME's	Small and medium enterprises
Societal Study	Societal and Cultural Challenges and Social Innovation Study
UKRI	UK Research and Innovation
UKTI	UK Trade and Investment
VCSE	Voluntary, Community and Social Enterprise

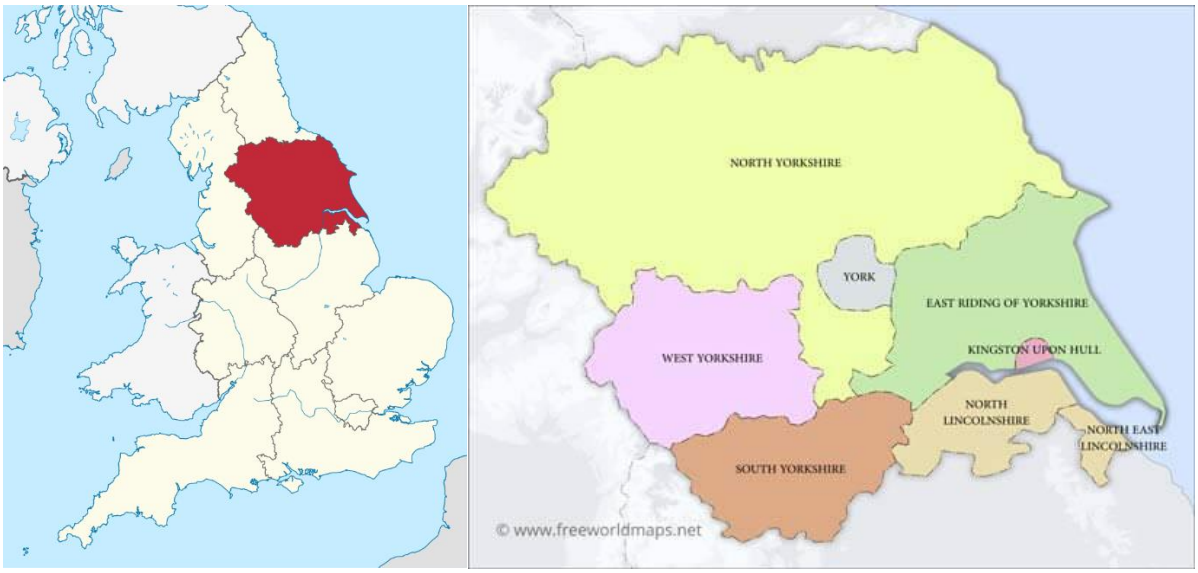
1. EXECUTIVE SUMMARY

1.1 Context

The Net Zero by 2050 legal target adopted by the UK Government will require an ambitious reduction of emissions across all sectors of the UK economy, including industry and power, and therefore needs rapid deployment of key decarbonisation technologies. Industrial Clusters (i.e. geographical concentrations of related firms, suppliers and industries) are seen as a key area for decarbonisation due to their contribution to the UK economy and their pivotal role in initiating hydrogen and CCUS infrastructure.

There are six UK Industrial Clusters that are developing plans to reduce their carbon emissions as part of the UK Government's Industrial Decarbonisation Challenge. Of these six Industrial Clusters, the Humber Industrial Cluster is by far the largest emitter of emissions in the UK. The Humber Industrial Cluster is located on the east coast of Northern England and is composed of Kingston Upon Hull, East Riding of Yorkshire, East Lincolnshire and North East Lincolnshire local authorities (Figure 1-1). The strategic positioning, size and complexity of the Cluster prompts an urgent need to develop a clear regional decarbonisation strategy for it to be decarbonised.

Figure 1-1 The Yorkshire and Humber region and local authorities[1]



The Humber region has signalled its strong intent to be at the forefront of the UK decarbonisation agenda, recognising the potential which the Humber offers to roll out first-of-a-kind technology solutions. This can only be achieved by bringing local people on the net zero journey. The route to achieving public buy-in therefore needs to be rooted in an understanding of the socio-cultural and economic barriers and opportunities and founded on community-level dialogue.

1.2 The Study and Objectives

The Humber Industrial Cluster Plan (HICP) was established in January 2021 to set out a strategic plan for the Humber Industrial Cluster to reach net zero emissions by 2040. The Societal and Cultural Challenges and Social Innovation Study is one of the HICP outputs and was led by Environmental Resources Management (ERM) in close collaboration with The Centre for Research into Electrical Energy Storage and Applications (CREESA).

The study aims to understand the societal and cultural challenges and innovations required to support the deployment of industrial decarbonisation in the region through the deployment of fuel switching,

[1] Source: Free World Maps

carbon capture utilisation and storage, greenhouse gas removal, provision of emissions offsets to other regions, and CO_2 imports from other regions.

The central research questions of the study were as follows:

1. What are the societal & cultural opportunities, barriers and challenges presented by industrial decarbonisation in the Humber as perceived by local stakeholders?
2. How do these opportunities, barriers and challenges vary across the different HICP-related decarbonisation technologies?
3. What steps and potential innovations are required to engender public support to deliver, and maximise the potential social and cultural opportunity offered by, the significant transformational changes needed to achieve deep decarbonisation by 2030 and net zero by 2040?

The study is based on both primary and secondary data research, including a literature review of academic publications and stakeholder mapping to guide engagement activities with representatives from industry, small and medium sized entities, public sector and local community members.

1.3 Findings

1.3.1 Societal Opportunities, Barriers and Challenges

The literature review yielded a number of valuable insights on societal opportunities, barriers and challenges related to achieving transformational changes. Key findings highlighted the complexity of accurately measuring the economic impact and benefits of industrial decarbonisation, and the long timeframe over which benefits and impacts may occur, which can make securing support difficult. Evidence from previous industrial transitions (e.g. industrial revolution) shows that economic interest is a far bigger driver for public support than public policy. While a shift towards decarbonisation will require regulatory changes, there is a risk of backlash if the distributional economic effects of energy and climate policies are not adequately assessed or addressed.

The literature highlighted that the accelerated speed of the industrial transition is likely to create skills and labour shortage. Stakeholders highlighted that opportunities should be advertised across relevant sectors to support the demand for skills and labour from industry and support a just transition for the region. International climate agreements mean that there will be export opportunities for UK skills and small and medium enterprises (SMEs) to address industrial decarbonisation abroad. Accelerating national competitiveness and developing best practice expertise, both in terms of skills development and SME growth, is therefore a significant opportunity.

Engagement activities highlighted the Humber's unique sense of place and strong industrial identity, which stakeholders perceived to be undervalued. Stakeholders largely support the concept of the Humber acting as an exemplar for industrial decarbonisation nationally and globally, recognising the potential significant opportunities of being a leader in industrial decarbonisation, including the need for a large and skilled labour force and export opportunities for UK skilled workers and SMEs to support industrial decarbonisation abroad.

Concerns about a rapid growth and subsequent rapid decline experienced in previous industrial transitions were raised repeatedly. Stakeholders voiced their desire for clear and transparent communication around local employment opportunities, particularly for SMEs. Strong, cohesive and consistent political support and clearly defined administrative responsibility will help to underpin public confidence in the transition.

1.3.2 Responses to Different Technologies

Concerning the technology used within industrial decarbonisation, the literature review found evidence that the legitimacy of industrial decarbonisation is strengthened when clearly linked to renewable energy and sector-specific strategies for green products. Companies with an oil and gas heritage may face lower public support when taking forward industrial decarbonisation projects due to

concerns around carbon lock-in (i.e. whereby fossil fuel intensive systems delay a transition to low carbon alternatives). Stakeholders participating in engagement activities did not identify different challenges for different decarbonisation technologies and instead suggested that challenges were shared across technologies.

1.3.3 Actions to Engender Public Support

With regards to gaining public support for industrial decarbonisation, the literature review raised the complexity, uncertainty, long timescales and interconnectedness of policy making around decarbonisation. Whole systems thinking will be required to persuade the public that industrial decarbonisation is deliverable and worthwhile. Communication efforts need reframing to emphasise long-term alliance building through participation and joint goals instead of focussing on short-term persuasion tactics and simple strategies of building acceptance particularly for fossil fuelled technologies. Engagement and communication will also need to consider different stakeholder groups and ideologies. Subsequent public support will depend on a fair and transparent distribution of costs and benefits across these stakeholder groups.

Engagement activities further highlighted the importance of timely engagement across demographic groups and with a particular focus on voluntary and community sector organisations to create co-design interventions. In order to do this, the public need access to a single source of accurate, impartial and non-technical information that clearly sets out investment required (public and private), community and individual-level benefits and costs (e.g. employment, skills development, infrastructure, transport) as well as the environmental benefits gained through the prioritised use of nature-based solution design principles in new developments.

1.4 Recommendations

The findings from the literature review and stakeholder engagement have been synthesised into a series of recommendations for action. The recommendations are provided with the context of this study being a first-of-a-kind study on public perception of industrial decarbonisation in the Humber and the recognition that the financial scope of the study did not facilitate an exhaustive programme of engagement across the Humber's large geography and significant socio-economic diversity. Rather, engagement was conducted with representative organisations and a broad but relatively small sample of local individuals. The results are a starting point, with further scope for expansion described below.

The recommended activities are based on a theory of change model that seeks to take us from a series of inputs or enabling factors (such as financial investments) through to the four outcomes in a way that supports a just transition to net zero industry and creates the best conditions for public support for industrial decarbonisation in the Humber. These four key outcomes, shaped by local stakeholders through a visioning exercise, are as follows:

- The Humber becomes a global leader and exemplar for industrial decarbonisation.
- Planning and placemaking across the Humber delivers community benefits from industrial decarbonisation and enhances industrial heritage.
- The Humber has thriving businesses and supports many highly skilled, highly paid jobs, including those necessary to enable industrial decarbonisation.
- Industrial decarbonisation is 'nature positive' and strengthens ecosystems services provision.

The recommendations are also guided by four delivery strands, which are the key processes by which outcomes should be achieved. These were identified from the literature on community engagement on industrial decarbonisation and reinforced by stakeholders during engagement activities. These delivery strands are as follows:

- Public participation in decision making.
- Provision of information and signposting.

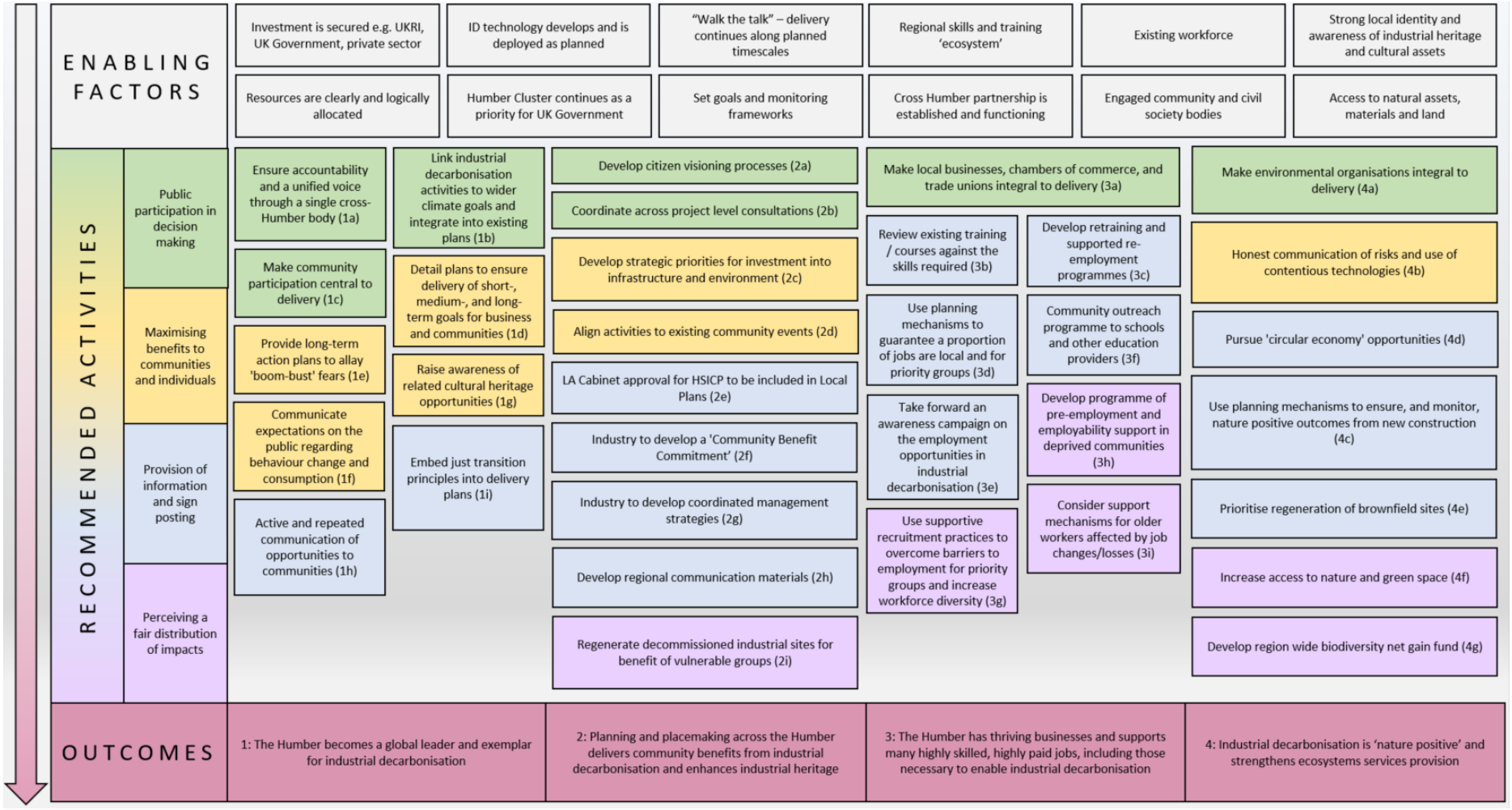
- Visible benefits to communities and individuals.
- Perceiving a fair distribution of impacts and benefits.

The theory of change-style summary shown in Figure 1-2 presents outcomes, delivery strands, enabling factors and recommended actions. It is noted that the enabling factors that are shown in this figure, along with enabling factors from other elements of the HICP, should be routinely interrogated and tested to highlight if any critical enabling actions need to be implemented.

As noted above, the recommendations provided in this report are subject to certain limitations, which also present opportunities for further work to be undertaken. One key limitation was that the financial and timescale parameters of the study constrained the level and depth of demographic research and stakeholder engagement activity that could be conducted. To widen and deepen participation, it would be beneficial to engage with a greater diversity of young and disadvantaged groups, as well as with local voluntary and community infrastructure organisations, with appropriate funding to enable these organisations to canvas and engage with their members. Moreover, in future research, additional time could be designated to explain the different decarbonisation technologies and more effectively canvas stakeholders' technology-specific viewpoints. Additional work would benefit from expanding on the scope of this study by exploring the policy context that could help the Humber influence broader regional and national industrial and environmental policy.

Given these limitations, the findings of this report should be used as a starting point to shape a longer-term programme of collaborative work with local communities to engender public support and maximise the social and cultural opportunities offered by the net zero industrial transition.

Figure 1-2: Theory of Change[2]



[2] Also included in main report as Figure 4-2.

2. INTRODUCTION

2.1 The Humber Industrial Cluster Plan

A program of work to develop a Humber Industrial Cluster Plan (HICP) was established in January 2021 with match funding from UK Research and Innovation (UKRI) and industry partners. The HICP team includes the Hull and East Yorkshire Local Enterprise Partnership (HEY LEP), Centre for Assessment of Technical Competence Humber (CATCH), and eight industry partners (Phillips 66, British Steel, Centrica Storage, Drax, Equinor, National Grid Ventures, SSE Thermal, and VPI) with additional support from Greater Lincolnshire Local Enterprise Partnership (GL LEP) and other strategic observers (Harbour Energy, EP SHB, Singleton Birch, Uniper and PRAX). These partners are working together to develop the HICP, which will set out the strategic roadmap for the Humber Cluster to achieve net zero by 2040.

This Societal and Cultural Challenges and Social Innovation Study (herein referred to as the Societal Study) forms part of the HICP development and was led by Environmental Resources Management (ERM), working in collaboration with The Centre for Research into Electrical Energy Storage & Applications (CREESA). This report presents a summary of the Societal Study and a set of recommendations which will be integrated into the overarching HICP.

2.2 Objectives for the Societal Study

The overarching objective for the Societal Study is to address the societal & cultural challenges and social innovations required to support the successful deployment of the five technology themes that are central to industrial decarbonisation in the Humber, namely:

- Fuel switching.
- Carbon capture utilisation and storage (CCUS).
- Greenhouse gas removal.
- Provision of emissions offsets to other regions; and
- CO_2 imports from other regions.

The following research questions were identified as central to meeting the overarching objective of the Societal Study:

1. What are the societal & cultural opportunities, barriers and challenges presented by industrial decarbonisation in the Humber as perceived by local stakeholders?
2. How do these opportunities, barriers and challenges vary across the different HICP-related decarbonisation technologies?
3. What steps and potential innovations are required to engender public support to deliver, and maximise the potential social and cultural opportunity offered by, the significant transformational changes needed to achieve deep decarbonisation by 2030 and net zero by 2040?

2.3 Approach

The Societal Study comprised seven tasks, which were undertaken between November 2021 and November 2022. These tasks, including a summary of the underlying approach, is summarized in Table 2-1. It is noted that whilst the Societal Study emphasized engagement with local organisations and individuals, the scope of the work necessarily constrained the range of voices that could be heard. Consequently, it is noted that the findings and recommendations in this Report should be considered a foundation from which to build during the launch and delivery of the HICP.

Table 2-1: Study Approach

Task	Duration	Objectives	Activities and Output
1: Project Inception	October 2021 – November 2021	■ Refine objectives of the Study. ■ Determine key engagement processes. ■ Design criteria for the outputs; and ■ Coordinate engagement with other HICP outputs.	■ Kick off workshop. ■ Project action plan.
2: Literature Review	November 2021 – January 2022	■ Address the following research questions to provide necessary context for subsequent engagement activities: - What examples are there of transformational change through industrial transition, and what social challenges and opportunities can be identified? - What are the root causes of public support or resistance to industrial transformations? - What do stakeholders in industrial transition view as positive outcomes (and who are those key stakeholders in different contexts)?	■ The academic literature search yielded 136 papers, of which 65 were of high quality and relevance, with 23 being reviewed in more detail[3]. A supplementary review of 15 policy documents was also conducted. These documents are shown in Annex A. ■ Literature review report.
3: Stakeholder Mapping, Analysis and Planning	December 2021 – February 2022	■ Profile the stakeholder landscape in the Humber, understanding the sociocultural characteristics of the area. ■ Identify the key stakeholders across public sector, private sector and non-governmental sectors that may have an influence or interest in the industrial decarbonisation of the region; and ■ Plan the engagements to be taken forward during later stages of the work.	■ Demographic research was conducted using Office of National Statistic 2011 Census data to determine the following characteristics at the regional and local authority-level: age, population, birthplace, ethnic background, religion, qualification level, and economic activity. ■ A stakeholder identification exercise was conducted and screened for local relevance, resulting in a final listing of 146 stakeholders. To create a listing of high priority stakeholders, these stakeholders were mapped using the following criteria: - Ideology: a) the strength of support or opposition of the stakeholder for the decarbonisation of heavy industry and b) the strength of public opinion in relation to the stakeholder (scored 1-10); and - Impact: the consequences for the stakeholder of the Project in relation to their environment, socio-economic and cultural context, as well as the power that the stakeholders have in relation to decisions either taken by or affecting the Project (scored 1-10).

[3] References of sources used in the literature review are provided in the footnotes. Where there is reference to "(note X)" this refers to the footnote that the source was first referenced in, and where there is are numbers ", Y", this refers to the page number(s) within the source material that are particularly pertinent to the point being made.

Task	Duration	Objectives	Activities and Output
			■ The stakeholder mapping identified a range of key informant stakeholders (15 community-based organisations, five public sector organisations, two academic networks and 19 business stakeholders) who were approached to be involved in the first round of engagement (Task 4). These were business-related stakeholders that scored more than 8 on the impact scale and non-business-related stakeholders that scored at least 8 on both scales. From this listing, 37 individuals representing 28 stakeholder organisations responded to the study's invitation and participated in engagement activities on behalf of their organisations and those they represent. The names of these stakeholder organisations are provided in Annex B. A further 12 locally-based individuals responded to the focus group invitation to provide their personal views. ■ In addition, a listing of key engagement events of relevance to industrial decarbonisation was developed, consisting of events that had taken place during 2021 or were planned for 2022, in order to consider any overlaps with previous or planned events.
4: Engagement – Key Informant Workshop	February 2022 – March 2022	■ Fill knowledge gaps around Humber-specific characteristics and social and cultural factors which would influence the public's perception and attitudes towards industrial decarbonisation. The task aimed to address the following research questions: - What are the societal & cultural opportunities, barriers and challenges presented by decarbonization in the Humber? - How do these opportunities, barriers and challenges vary across the different HICP-related decarbonization technologies? - What are the social and cultural factors that may influence how different segments of the public perceive industrial decarbonization in the Humber? - What existing mechanisms / networks / organisations can we utilize to hear and incorporate diverse community voices into the study? - Are all social and cultural groups represented within these mechanisms, and what cultural and societal barriers and opportunities influence their participation?	■ The Task 4 aims were addressed by two sets of tailored engagement activities, including: - Interviews with key informant organisations identified as priority stakeholders as they had a strong connection to the key questions we were researching; and - A workshop involving 22 organisations across public, private and third sectors which was held at the Aura Innovation Centre in Hessle, near Hull on 23 March 2022. ■ Annex B provides a list of the 22 attendees.

Task	Duration	Objectives	Activities and Output
5: Interim Findings	April 2022	■ Present interim findings to the Project team and other HICP output teams for feedback.	■ Interim Findings Report, final issue September 2022. ■ Presentation to HICP and UKRI teams.
6: Engagement – Community Focus Groups	April 2022 – June 2022	■ To understand the individual perspectives of local stakeholders on the opportunities and challenges around industrial decarbonization, as well as their vision for the Humber in the next 20 years.	■ Three focus groups were convened following extensive enrollment activity. ■ Two groups were focused on the natural environment and local community perspective (8 attendees across the two groups) and one with a focus on local energy-intensive sector and SME perspectives (4 attendees). ■ Annex B provides a breakdown of the 12 attendees.
7. Prioritization and Reporting	June 2022 – November 2022	■ Thematically synthesize results from Tasks 2-6 and hold a workshop with key HICP stakeholders to test and prioritize recommendations for inclusion in the final report.	■ Workshop to discuss preliminary recommendations. ■ 12 participants (excluding the study team) from HICP, private sector, the public sector and the third sector attended the workshop. ■ Annex B provides a list of the 12 attendees. ■ Final report.

3. KEY FINDINGS

3.1 Key Findings from the Literature Review

3.1.1 Societal opportunities, barriers and challenges

The industrial transition literature covered a wide range of industrial sectors and different geographical scales, but was mainly focused on the United Kingdom (UK) and Europe and on the use of CCUS and pathways for decarbonising heavy industries, such as iron and steel, cement, and glass (see Table 3-1). There were also regional strategies in the UK for South Yorkshire[4] and the Midlands[5] as well as an analysis of benefits, specifically for the Humber, linked to Bioenergy with Carbon Capture and Storage (BECCS) at Drax.[6] In total the academic literature search yielded 136 papers, of which 65 were of high quality and relevance, with 23 being reviewed in more detail. A supplementary review of 15 policy documents was also conducted. A breakdown of the papers reviewed is provided in Table 3-1.

Table 3-1: Region and sectors of papers identified

Region	% Of papers	Sectors	% Of papers
UK	39%	Carbon Capture, Utilisation and Storage (CCUS)	19%
Europe	17%	Heavy industries (iron and steel, cement, glass, and paper and pulp, meat and dairy, refinery)	19%
Germany	7%	Energy (general)	9%
Estonia	5%	Hydrogen	9%
Netherlands	5%	Mining	6%
Australia, Denmark, DRC, Ghana, Finland, India, Italy, Japan, Norway, Poland, Canada, US	2% each	Oil and gas	6%
		Chemicals	4%
		Coal	4%
		Decarbonisation (general)	4%
		Maritime	4%

The reviewed literature on industrial transition was rich in technical case studies, modelling, and comparisons of the potential low carbon technologies[7,8,9] and these studies often analysed the

[4] Arup (2020) *Establishing a regional hydrogen economy: Accelerating the carbon transition in South Yorkshire, UK*. Arup, available at https://www.arup.com/-/media/arup/files/publications/h/hydrogen-sheffield.pdf.
[5] Midlands Engine (2021) *Hydrogen Technologies Strategy*. Midlands Engine, available at https://www.midlandsengine.org/wp-content/uploads/2021/12/Hydrogen-Technologies-Strategy-Dec-21.pdf.
[6] Vivid Economics (2020) *Capturing Carbon at Drax: Delivering Jobs, Clean growth and Levelling up the Humber – Report prepared for Drax*. Vivid Economics, available at https://www.vivideconomics.com/casestudy/capturing-carbon-at-drax-delivering-jobs-clean-growth-and-levelling-up-the-humber/.
[7] Griffin P.W., Hammond G.P. (2021) *The prospects for 'green steel' making in a net-zero economy: A UK perspective*. Global Transitions, 3(Apr), 72-86, https://doi.org/10.1016/j.glt.2021.03.001.
[8] Griffin P.W., Hammond G.P., Norman J.B. (2018) *Industrial decarbonisation of the pulp and paper sector: A UK perspective*. Applied Thermal Engineering, 134(Apr), 152-162, https://doi.org/10.1016/j.applthermaleng.2018.01.126.
[9] Espegren K., Damman S., Pisciella P., Graabak I., Tomasgard A. (2021) *The role of hydrogen in the transition from a petroleum economy to a low-carbon society*. International Journal of Hydrogen Energy, 46(45), 23125-23138, https://doi.org/10.1016/j.ijhydene.2021.04.143.

different decarbonisation pathways for a single sector (e.g. iron and steel) or group of sectors (e.g. energy intensive or high emitting industries). There was also research outlining national policy and regulatory recommendations[10,11,12]. Whilst some articles did infer social impacts based on the technical changes needed for a transition[13], there was little targeting social and cultural impacts specifically and these were often limited to economic costs and opportunities[14,15.] Many of the studies discussed the importance of public engagement and/or participation in industrial transitions, but the literature was very limited in the detail on how the public are engaged in practice or what the root causes of support and resistance may be. The focus for public engagement is largely limited to gaining acceptance for a new technology or to avoid opposition to new construction/operations.

Despite the relatively limited literature, the review yielded a number of valuable insights on societal challenges and opportunities related to achieving transformational changes, which are summarised in Table 3-2. Further findings specific to different decarbonisation technologies and recommendations related to securing and maintaining public support for decarbonisation are provided in subsequent sections.

Table 3-2: Societal opportunities, barriers and challenges from the literature review

#	Finding	Context	Insight relevant to the Societal Study
F1	Consider the economic impacts of decarbonisation on households and businesses.	The complexity of accurately measuring the impact and benefits of industrial transition, and the long timeframe over which benefits and impacts may occur, can make securing support difficult. Evidence from previous transitions (e.g. the Industrial Revolution) shows that economic interest is a far bigger driver for public support than public policy. It is also evident that the public may consider that, as decarbonisation is a response to the problem of climate change, decarbonising pathways will be economically inferior when compared to the current system, requiring increased short-term investments by both businesses and households even if there is strong agreement on the long-term benefits.	Make the economic case at a national, regional and community level and provide incentives that motivate people to invest in the short-term for long-term benefits.
F2	Consider the distributional effects of energy and climate policies.	A shift towards decarbonisation will require regulatory changes, but there is a risk of backlash if the distributional effects of energy and climate policies are not adequately assessed or addressed.	Assess and address distributional effects of industrial decarbonisation.

[10] Turner K., Race J., Alabi O., Katris A., Swales J.K. (2021) *Policy options for funding carbon capture in regional industrial clusters: What are the impacts and trade-offs involved in compensating industry competitiveness loss?* Ecological Economics, 184(Jun), 106978, https://doi.org/10.1016/j.ecolecon.2021.106978.
[11] Tagliapietra S., Zachmann G., Edenhofer O., Glachant J.-M., Linares P., Loeschel A. (2019) *The European union energy transition: Key priorities for the next five years*. Energy Policy, 132(Sep), 950-954, https://doi.org/10.1016/j.enpol.2019.06.060.
[12] Zenghelis D. (2019) *Securing Decarbonisation and Growth*. National Institute Economic Review, 250(1), R54-R60, https://doi.org/10.1177/002795011925000118.
[13] Barrett J., Cooper T., Hammond G.P., Pidgeon N. (2018) *Industrial energy, materials and products: UK decarbonisation challenges and opportunities*. Applied Thermal Engineering, 136(May), 643-656, https://doi.org/10.1016/j.applthermaleng.2018.03.049.
[14] Budinis S., Krevor S., Dowell N.M., Brandon N., Hawkes A. (2018) *An assessment of CCS costs, barriers and potential*. Energy Strategy Reviews, 22(Nov), 61-81, https://doi.org/10.1016/j.esr.2018.08.003.
[15] Nurdiawati A., Urban F. (2022) *Decarbonising the refinery sector: A socio-technical analysis of advanced biofuels, green hydrogen and carbon capture and storage developments in Sweden*. Energy Research and Social Science, 84(Feb)102358, https://doi.org/10.1016/j.erss.2021.102358.

#	Finding	Context	Insight relevant to the Societal Study
F3	Ensure that there is sufficient skilled labour to address the acceleration of industrial decarbonisation.	The accelerated speed of the industrial transition is likely to create skills and labour shortage.	Highlight the opportunities in relevant sectors to support the demand for skills and labour for industrial decarbonisation.
F4	Consider demand side as well as supply side.	Among the debates over which technological pathways will need to be taken forward, it is assumed that supply side changes will occur and that they will result in, or be complemented by, demand side changes. These changes will have direct social implications that need to be considered.	Communications need to set out the expectations on the public, regarding behaviour change and consumption, while also clearly setting out long-term and short-term impacts.
F5	Accelerate national competitiveness and best practice.	International climate agreements mean that there will be export opportunities for UK skills and SMEs to address industrial decarbonisation abroad. Accelerating national competitiveness and developing best practice expertise, both in terms of skills development and SME growth, is therefore a significant opportunity.	Highlight opportunities for export to local people and businesses, working with UK Trade and Investment (UKTI) to identify countries and supply chains in need of decarbonisation expertise.

3.1.2 Responses to Different Technologies

The literature review found evidence that the legitimacy of industrial decarbonisation is strengthened when clearly linked to renewable energy and sector-specific strategies for green products.

In contrast, a systematic review of 115 articles looking specifically at communication practices in CCUS projects[16] noted that: "*The 'dominant justification' of CCS relies on arguments that have not been discussed with the public, since there is no deliberation that starts with framing climate change, connects it to CCS as mitigation strategy and debates its role in different scenarios*"[17]. The review argues that communication efforts need reframing to emphasise long-term alliance building through participation and joint goals instead of focussing on short-term persuasion tactics and simple strategies of raising acceptance.

This approach was backed up by a study analysing data on the Acorn CCUS project in Scotland[18], which emphasised the strong role for local and regional government in CCUS to help overcome concerns about the role of fossil fuel industry operators in a low-carbon transition:

> *"Stakeholders that are unlikely to be formally engaged in the project can still have significant influence on the societal support of the project through actions such as granting planning permission or influencing public opinion ... those responsible for CCS deployment - especially local and regional government who may be viewed as leading on*

[16] Otto D., Gross M. (2021) *Stuck on coal and persuasion? A critical review of carbon capture and storage communication*. Energy Research & Social Science, 82(Dec), 102306, https://doi.org/10.1016/j.erss.2021.102306.

[17] Ibid, 9

[18] Alcalde J., Heinemann N., Mabon L., Worden R.H., de Coninck H., Robertson H., Maver M., Ghanbari S., Swennenhuis F., Mann I., Walker T., Gomersal S., Bond C.E., Allen M.J., Haszeldine R.S., James A., Mackay E.J., Brownsort P.A., Faulkner D.R., Murphy S. (2019) *Acorn: Developing full-chain industrial carbon capture and storage in a resource- and infrastructure-rich hydrocarbon province*. Journal of Cleaner Production, 233 (Oct), 963-971, https://doi.org/10.1016/j.jclepro.2019.06.087.

a local low-carbon transition - must create a compelling case for how CCS can undertake climate change mitigation in the public interest. This is particularly significant in carbon-intensive regions, where CCS could be framed as facilitating a just transition for workers in high-emitting industries"[19].

Addressing the role of fossil fuel industries in the transition, one report highlights that the public's negative perception of the oil and gas industry can be a challenge for mobilising public support. The report states that "the oil and gas industry is perceived as an outdated industry that only slowly adopts new low carbon technologies, stalling a rapid transition to a carbon–neutral economy"[20]. That said, previous UK consultations related to industrial decarbonisation planning and infrastructure[21,22] have suggested that the majority of the public are currently ambivalent on the issue – as referenced by low response rates – but that improved access to information has resulted, or is likely to result, in greater support[23]. Key findings related to the public response to those technologies related to fossil fuels, specifically CCUS, are provided in Table 3-3.

Table 3-3: Technology Specific Findings from the Literature Review

#	Finding	Context	Insight relevant to the Societal Study
F6	Public acceptance may be a determining barrier for the development of CCUS due to the association with fossil fuel companies and concern related to carbon lock-in (i.e. whereby fossil fuel intensive systems delay the transition to low-carbon alternatives).	Addressing the role of fossil fuel industries in the transition, one report highlights that "the oil and gas industry is perceived as an outdated industry that only slowly adopts new low carbon technologies, stalling a rapid transition to a carbon–neutral economy"[24].	Companies with an oil and gas heritage or that utilise oil and gas as a feedstock may face lower public support when taking forward industrial decarbonisation projects.
F7	Legitimacy is strengthened when clearly linked to renewable energy and sector specific strategies for green products.	As part of an analysis of the oil refinery sector in Sweden, one paper looked at how new technologies "create legitimacy"[25]. The three proposed decarbonisation pathways examined - advanced biofuel, green hydrogen and CCUS - focussed on lobbying and building a reputation as a sustainable technology, attempting to change negative attitudes to the related oil and gas industries and continuing carbon lock-in. Hydrogen was found to carry high legitimacy thanks to a clear national	Legitimacy is strengthened when linked to a clear national strategy. Legitimacy is increased when linked to renewable energy and sector-specific strategies for green product.

[19] Ibid, 970.

[20] Nurdiawati and Urban (note 13), 5.

[21] NZT (2020) *Stage 2 consultation*. Net Zero Teesside, available online at https://netzeroteesside.consultation.ai/.

[22] Scott K. (2021) *HyNet North West Carbon Dioxide Pipeline: Non-Statutory Consultation Report*. WSP UK Ltd, available at https://hynethub.co.uk/consultationreport.pdf.

[23] Scott, M., Powells, G. (2019) *Blended Hydrogen: The UK Public's Perspective*. Newcastle: Newcastle University, available at https://eprints.ncl.ac.uk/file_store/production/261762/77656234-5E46-460F-8A9C-211C0458E36D.pdf.

[24] Nurdiawati and Urban (note 13), 5.

[25] Nurdiawati and Urban (note 13).

#	Finding	Context	Insight relevant to the Societal Study
		hydrogen strategy that highlights the benefits but also links the technology to parallel developments in renewable energy and decarbonising steel.	

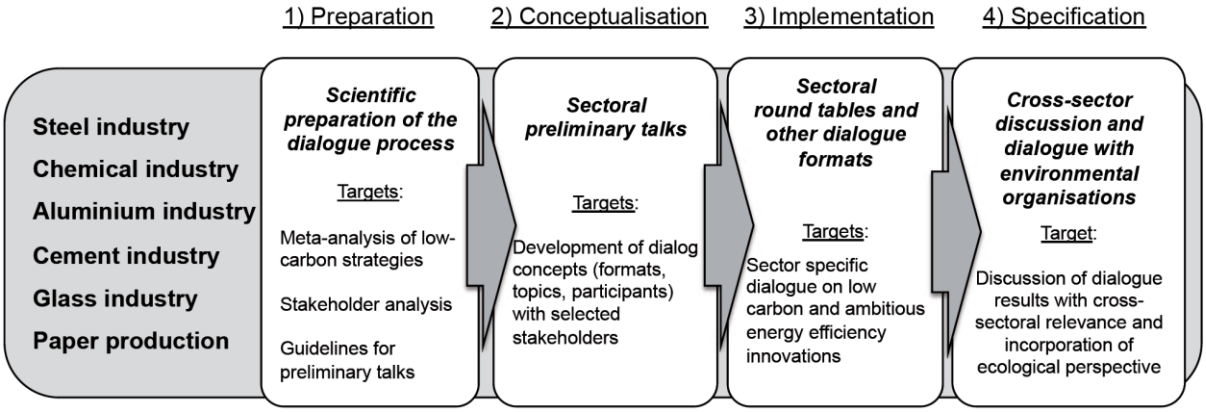
3.1.3 Actions to engender public support

In relation to the question of how to engage with the public and what topics will be of high importance, a detailed approach can be found in Espert et al[26], who outline a participatory, multi-stakeholder approach used in the North Rhine-Westphalia (NRW) region of Germany. The approach was used to identify and develop the necessary far-reaching low-carbon innovation strategies for energy intensive industries. They outline a dialogue process to address specific targets for innovation and industrial contributions to climate protection. Their approach is grounded in the assumption that:

> *"Technological solutions to sustainability challenges call for integrated and comprehensive planning approaches in order to stimulate innovation. They often involve a large set of heterogeneous stakeholders from the scientific arena as well as from the private and public sectors. Consequently, tackling sustainability challenges successfully requires new collaborative approaches"*[27].

The process outlined involved over 150 single actors from six energy intensive sectors, including steel, chemicals, aluminium, cement, glass and paper. While wholly focussed on industry and technology, the dialogue process could be applied to social and community stakeholders by adapting the aims and stakeholders involved in their four-phase process (Figure 3-1).

Figure 3-1: Structure of the dialogue process with energy intensive industries in NRW.



Source: Espert et al[28]

By selecting targets related to understanding public support or resistance, and identifying the relevant social and community stakeholders, this process could help identify the key issues and the underlying

[26] Espert et al (note 35).
[27] Ibid, 312.
[28] Ibid, 314.

factors that lead to positive or negative perceptions. By developing these findings with industry and public sector stakeholders, one can identify the social innovations needed to change behaviour.

Considering what positive outcomes may look like for broader stakeholders, the Organisation for Economic Co-operation and Development (OECD)[29] have produced a toolkit to assess policy responses under five headings (see Table 3-4). These headings recognise that "public acceptability and the success of transition depends on a fair and transparent distribution of costs and benefits".

Table 3-4: Policy responses to assess for industrial transition. Source: OECD[30]

Preparing for the future of work	Lack of skilled workers to move into new and emerging activities
	Spatially concentrated lack of job opportunities for low- and middle-skilled workers
	Limited investment in new sources of employment and productivity growth
	Lack of co-ordination and financing mechanisms
Broadening and diffusing innovation	Creating and sustaining comprehensive innovation ecosystems
	Lack of (small) business capabilities for innovation
	Territorial disparities in innovation diffusion
Promoting entrepreneurship and private sector engagement	Limited access to finance for start-ups and scale ups
	Limited access to entrepreneurship skills and networks for start-ups and scale-ups
	Improving the entrepreneurial enabling environment
Transitioning towards a climate-neutral economy	Creating job opportunities for the transition to the climate neutral economy
	Lack of business opportunities for green innovations
	Reconciling the long-term strategic dimensions of a climate neutral transition with short-term action
Promoting inclusive growth	Strengthening regional well-being
	Spatial discrepancies and territorial linkages
	Improving inclusive growth governance

The OECD's toolkit provides further actions to achieve each priority and can be tailored and used to measure success for industrial transition specifically. This tailoring can follow just transition principles and target the groups most impacted by the transition in the Humber to ensure that the distribution of opportunities and costs is equitable for all those living and working in the Humber. This and other findings related to how to engage with the public in the Humber are provided in Table 3-5.

[29] OECD (2019) *Regions in Industrial Transition: Policies for People and Places*. Paris: OECD Publishing, available at https://www.oecd.org/cfe/regionaldevelopment/Draft_policy_highlights_RIT_FINAL.pdf.
[30] Ibid, 16-17.

Table 3-5: Non-technology specific communication findings from the literature review

#	Finding	Context	Insight relevant to the Societal Study
F8	Industrial decarbonisation is inherently complex, uncertain, interconnected and associated with long timescales.	Work by Nick Pidgeon and Catherine Cherry[31,32,33,34] on engaging the public on energy policy, low-carbon housing, waste, and material use acknowledges the complexity, uncertainty, long time scales and interconnectedness of this kind of policy making. Their work advocates for facilitators to engage the public on "'whole systems' thinking at the problem scale, provide balanced information and policy framings, and use different approaches that encourage participants to reflect and deliberate on the issues"[35.] This "public view" can then be delivered back to industry and public sector decision makers through further workshops and interviews.	Public engagement should address the complexity, uncertainty, long time scales and interconnectedness of this kind of policymaking and demonstrate "'whole systems' thinking to persuade the public that industrial decarbonisation is deliverable and worthwhile.
F9	Provision of clear and unbiased information.	Some factors that need to be addressed to engender support include demonstrating clear economic benefits; overcoming the perception that some countries may do nothing and benefit from another country's sacrifices (the free-rider problem); concern about job losses from the old industries; the perception of carbon lock-in and regime resistance when working with fossil fuel firms; and ensuring an equitable transition. Even if able to address these complex concerns, the difficulty grasping the long timeframes involved (often up to 2050 and beyond) makes developing concrete actions for the	Reframe communication efforts on long-term alliance building and joint goals instead of short-term persuasion tactics and simple strategies of avoiding opposition.

[31] Pidgeon N., Cherry C. (2017) *Achieving transitions in UK energy and material use: public deliberations of a low material future*, in: Proc. 4th Sustainable Thermal Energy Management (SusTEM2017) International Conference, Alkmaar, The Netherlands, 28–30 June, 193–197.
[32] Cherry C., Pidgeon N. (2017) *The citizen and new business models*, in: From Waste to Resource Productivity: Evidence and case studies, Ch. 9 – Citizens, 127–132. London: Government Office for Science, available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/667480/from-waste-to-resource-productivity-evidence-case-studies.pdf.
[33] Pidgeon N., Demski C., Butler C., Parkhill K., Spence A. (2014) *Creating a national citizen engagement process for energy policy.* Proc. Natl. Acad. Sci., 111 (Supplement 4), 13606–13613, https://doi.org/10.1073/pnas.1317512111.
[34] Cherry C., Hopfe C., MacGillivray B., Pidgeon N., (2017) *Homes as machines: Exploring expert and public imaginaries of low carbon housing futures in the United Kingdom*. Energy Res. Social Sci, 23(Jan), 36–45, https://doi.org/10.1016/j.erss.2016.10.011.
[35] Barrett et al (note 11), 654.

#	Finding	Context	Insight relevant to the Societal Study
		short and medium term that much harder[36].	
F10	Public acceptability and the success of transition depends on a fair and transparent distribution of costs and benefits.	Multi-stakeholder processes can help to identify the key issues and underlying factors that lead to positive or negative perceptions. By developing these findings with industry and public sector stakeholders, the social innovations needed to change behaviour can be identified. Just transition frameworks and toolkits have been developed to consider the distribution of opportunities and costs related to energy transition.	Just transition frameworks can be applied by public and private sector to target the groups most impacted by the transition in the Humber, and to ensure that the transition is equitable for all those living and working in the Humber.
F11	Messages needs to consider different stakeholder groups and ideologies.	Understanding and appealing to different impacted and ideological stakeholders can help to target future discussions to better understand what is perceived as a positive outcome. Climate Outreach[37] uses a 'Core Beliefs Model' to identify seven segments of the British public when it comes to discussing climate change.	To bring communities on the net zero journey, they need to be engaged with on the basis of what is important to them. Communication and messaging needs to reflect the differing concerns and aspirations of different stakeholder groups.

3.2 Key Findings from Engagement Activities

3.2.1 Societal opportunities, barriers and challenges

The key informant interviewees were enthusiastic, keen to contribute to a cohesive consideration of the social and cultural dimensions of industrial decarbonisation in the Humber. Although coming from a range of organisations with varied strategic aims, there were no major areas of disagreement between interviewees and there were a number of common areas of consensus, as follows:

- The Humber has a unique sense of place, due to its geography and history. At the same time, its place in the national context – perceived as making a huge but undervalued economic contribution – has also led to it being isolated from the rest of the country.
- Industrial heritage is an important aspect of the region's culture. This can result in individuals being more accepting of heavy industrial infrastructure and innovation.
- Previous transitions have challenged individuals and communities in the Humber, without necessarily delivering benefits for them and this has created a level of caution around the potential effects of the low carbon energy transition on industry in the Humber.

[36] Espert V., Arnold K., Vallentin D., Lechtenböhmer S., Schneider C. (2016) *Platform climate protection and industry north-rhine westphalia - A multi stakeholder process for the advancement of energy efficiency and low carbon technologies in energy intensive industries*. ECEEE Industrial Summer Study proceedings; 12-14 September, Berlin, Germany, 311-320, https://nbn-resolving.org/urn:nbn:de:bsz:wup4-opus-69003.

[37] Climate Outreach (2020) *Britain Talks Climate: A toolkit for engaging the British public on climate change*. Oxford: Climate Outreach, available at https://climateoutreach.org/reports/britain-talks-climate/.

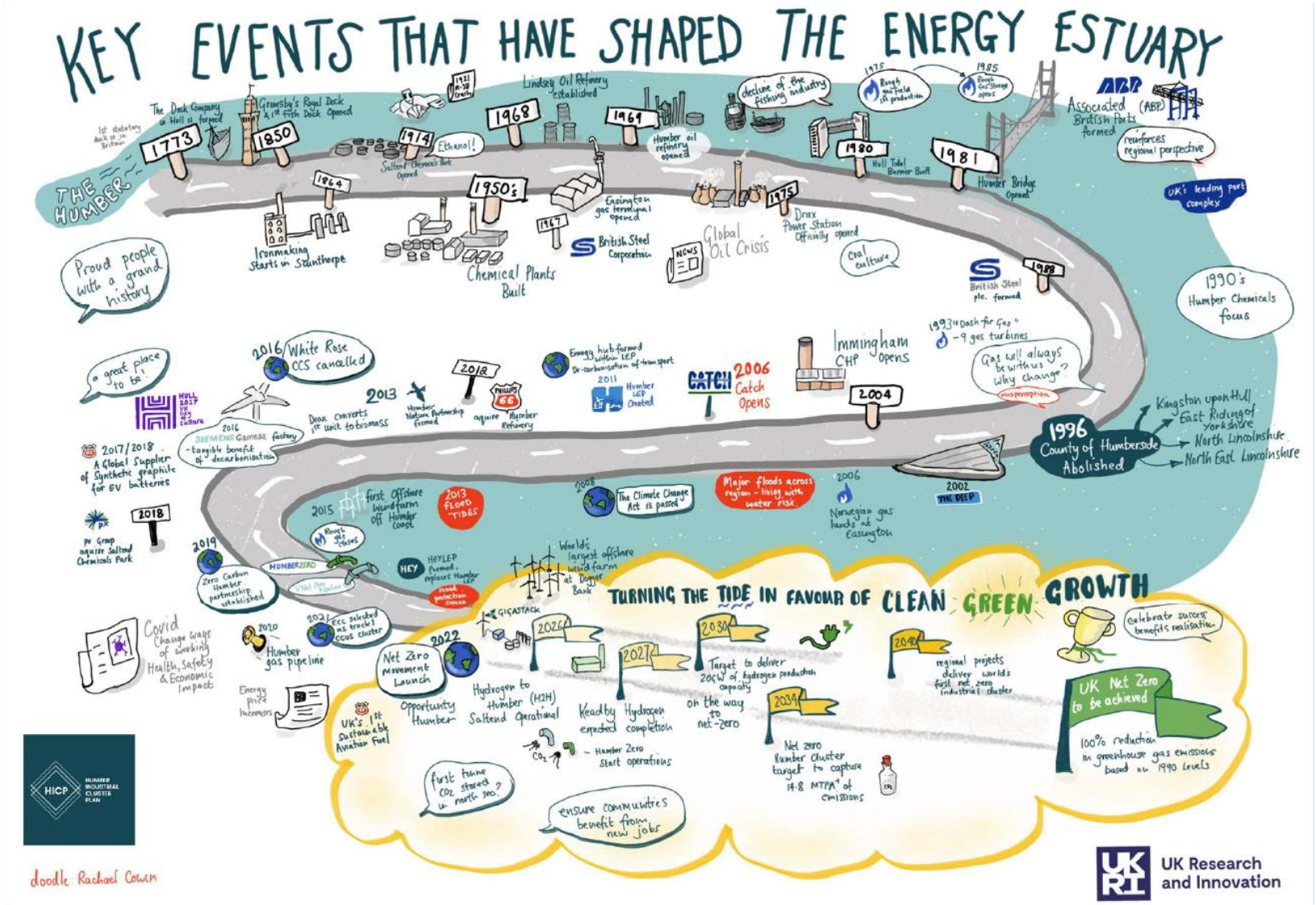
- Regional economic sustainability and employment opportunities are a key concern for individuals and communities in the region.
- Individuals and communities in the Humber are engaged and want to be informed when it comes to industrial changes taking place in the region.
- SMEs are vital to enabling industrial decarbonisation in the Humber – both through supply chain development, and because of the number of SMEs which are currently operating in the Humber.
- There are divisions in the Humber, both at a political level, and at an institutional level. There is an opportunity for cross-political collaboration, as well as an opportunity for greater partnership working across the institutions in the Humber region.

In addition to the areas of agreement, individual interviewees also highlighted the following key issues.

- Young people are vital to the low carbon energy transition. They have grown up with the messaging that climate change is dangerous and must be dealt with.
- Community and third sector organisations are already mobilising themselves, because they are not satisfied by actions being taken by government, business, and industry.

The themes raised by the interviewees supported the preparation of the Key Informant Organisation Workshop where it was possible to go deeper into many of the topics raised. Time in the Key Informant Workshop was devoted to gaining a common understanding of the past, present and potential future of the Humber, with particular emphasis on the industrial decarbonisation projects in the region and using this to identify key challenges and opportunities. The following web-link provides a detailed map of the 2030 vision for industrial decarbonisation in the Humber regions: https://humberindustrialclusterplan.co.uk/files/A_2030_Vision_AW090222.pdf. Participants were particularly engaged around contributing to a timeline of the Humber, the outputs of which fed into the illustration provided in Figure 3-2.

Figure 3-2: Timeline of the Humber. Source: HICP, Marketing Humber and UKRI



The timeline highlighted key events in the region, including industrial and technological milestones, political and governance changes, and planned activities and targets related to decarbonisation in the Humber, highlighting the creation of the Zero Carbon Humber, Humber Zero, and V Net Zero partnerships, along with specific projects, such as the Hydrogen to Humber (H2H) Saltend and Keadby Carbon Capture Power Station. From the comments posted, a number of themes emerged:

- A strong local pride and awareness of industrial heritage assets;
- A strong regional identity;
- Fears around rapid growth and a subsequent rapid decline;
- Uncertainty over the positive environmental impacts of decarbonisation; and
- A feeling that much information has not been properly communicated.

The pride in the local area and awareness of the rich industrial heritage was clear from the many additions that were made, highlighting assets which were missing from the timeline, such as the tidal barrier and Rough gas storage. This perspective acknowledges how the region and its people have been shaped by heavy industry and underlines that people are generally supportive of the organisations and activities in the region. However, it was also clear from the workshop that this support should not be taken for granted or exploited.

Pride in place was also an important theme that came out clearly in the Community Focus Groups that were hosted after the Key Informant Workshop. It was clear that many of the participants wanted to see the strong cultural identity of the Humber further strengthened through the new transition. Participants were energised by the potential that the Humber could act as a UK and world leader in industrial decarbonisation.

Another point of pride, though with a little more contention, was regional identity and the creation of Humberside or The Humber. There were mixed views around the former title, but what was clear was that people think that the region is better off united and collaborating than competing in territorial politics. There were also many discussions about the value of a regional mayor with comparisons being made to the role of the mayor of Teesside. A suggestion was made that low carbon could be the new regional identity for the Humber.

A more contentious issue was around the speed of transformation, with concern around a repeat of the rapid growth and rapid decline of past waves of industrialisation. Some participants did not want to see the current economic opportunity lost or risked by slowing down activity; whilst some voices strongly expressed that there have been periods of rapid growth in the past, only to see little or no benefit for their community or local people. Again, the atmosphere was still generally supportive and acknowledged the potential opportunity here, but there were calls for more clarity or certainty around what job or local economic opportunities could be guaranteed and how they could be accessed. The important topics of local benefits and economic opportunities are expanded upon in Section 3.1.3 below.

Accountability for delivery and clarity of roles and tasks (i.e. who is delivering the transition, how and when) were raised at both the Key Informant Workshop and within the Community Focus Groups. To increase public buy-in, participants considered it necessary to ensure that delivery is visible, and the key actors who have been assigned tasks are accountable for their delivery.

The insights related to key societal challenges and opportunities from the Key Informant Interviews, Workshop and the Community Focus Groups are summarised in Table 3-6, noting that a number of items have instead been included in Section 3.1.3 due to their connection with key topics of public concern and public engagement.

Table 3-6: Societal Opportunities, Barriers and Challenges as identified through Engagement

#	Finding	Context	Insight relevant to the Societal Study
F12	The Humber has a unique sense of place and a strong industrial identity.	The Humber has a strong regional identity. There is a pride in its industrial heritage and its important economic contribution to the country, which is perceived to be undervalued. People are generally supportive of the organisations and activities in the region, but this support should not be taken for granted or exploited.	There is potentially strong local support for industrial infrastructure and innovation in the Humber. The leading role of Humber, acting as an exemplar for industrial decarbonisation, is important for many local stakeholders.
F13	Economic sustainability and employment opportunities are a key concern.	There is a sense that the Humber is quite isolated from the rest of the country, and fears that industrial decarbonisation could bring about rapid growth and a subsequent rapid decline, as has been experienced in previous industrial transformations.	Plans should be long term to allay fears over economic 'boom and bust'. Plans should include clarity around local economic and employment opportunities and how local people can access them.
F14	Small and medium enterprises are a vital part of the journey.	SMEs are a vital component to ensuring strong local employment as well as wider economic benefits.	SMEs are critical in delivering local jobs and economic development and need to be central to any strategy for ensuring a strong and diverse local economy, skills and jobs.
F15	Transparency and accountability of administrative responsibility is a key concern.	There are seen to be divisions in the Humber, both at a political level, and at an administrative level. There is an opportunity for cross-political collaboration, as well as an opportunity for greater partnership working across the institutions in the Humber region.	Strong, cohesive and consistent political support for industrial energy transition in the Humber and clearly defined administrative responsibility will underpin public confidence. A single body to drive actions related to climate change across the Humber would provide a valuable single voice and help to define the region and its response to the challenge, in the absence of a unified administration.

3.2.2 Responses to Different Technologies

Although there is generally a high acceptance of heavy industry in the Humber, many participants were still unsure about the efficacy of technologies like CCUS, and the fact that many of the activities are still reliant on fossil fuels. This mirrored the challenges identified through the literature review (see Section 3.2.1 above).

However, when invited to differentiate the challenges related to industrial decarbonisation by technologies during the Key Informant Workshop, participants indicated that the challenges are

shared across all technologies. This may have been due time limitations that could have prevented some participants from gaining a detailed understanding of each of the technologies as part of the workshop.

3.2.3 Actions to Engender Public Support

3.2.3.1 Key Topics of Public Concern

An issue that was raised repeatedly through the engagement activities was that the industrial transition needed to deliver direct community-level and regional-level benefits to make the Humber a more attractive region for individuals and businesses. Alongside investment in the Humber, skills, employment and education were the most discussed topics in both the Key Informant Workshop and the Community Focus Groups.

One of the key challenges identified in both the Key Informant Workshop and the Community Focus Groups was that jobs might be lost as a result of transitioning away from the energy intensive industry in the Humber. Participants considered it necessary to ensure that the transition delivers additional job opportunities and upskills the existing workforce in the Humber, while ensuring that older generations of the workforce are not disadvantaged. To address these challenges, participants emphasised the need for skills development of the existing workforce and the need to attract young people both to the Humber and to careers in low-carbon energy sectors. Engaging young people in these careers needs to be done at an early point in their education and should be delivered through a range of means and channels in the most creative way possible.

There was also discussion on opportunities related to local infrastructure and connectivity. While participants were very welcoming of new job creation, they also recognised that this would put pressure on existing infrastructure, unless also maintained and upgraded and emphasised the importance of the Humber being an attractive place to live as well as work. Participants considered that infrastructure related to green industry and green mobility would generate wider economic and social benefits for the Humber in the following ways:

- Connectivity with other regions, allowing increased domestic and international trade;
- Connectivity with other regions allows easier transport of skilled workers between different parts of the country;
- Improved industrial infrastructure may attract new businesses to the region;
- Opportunity for modern placemaking approaches with strong community input;
- Improved mobility for all to take part in society.

It was discussed during the Community Focus Groups that any land which might be liberated through the industrial energy transition should be used to maximise community benefit, instead of being reallocated towards alternative uses, such as biomass production.

More broadly, the natural environment was seen as a concern for participants of both the Focus Groups and the Key Informant Workshop. There was recognition of the opportunity for a cleaner, less polluted environment, and improved health for the population as a result. Participants saw biodiversity-related risks and opportunities surrounding industrial transition, including potential flood risks, availability of a sustainable water supply, and impact to wetland habitat, as well as the opportunity to implement nature-based solutions as part of new developments. Enhanced collaboration between developers and organisations such as the Humber Nature Partnership was noted during the Key Informant Workshop as a way to achieve a coherent nature-related vision for the Humber.

3.2.3.2 How to Engage the Public

Workshop participants were enthusiastic to discuss how the public should be engaged to bring them on the journey to a net-zero Humber Industrial Cluster. Participants discussed the importance of the public being able to form opinions on the energy transition based on accurate information. Without such information, the public are unable to gauge the importance of transitioning away from carbon-intensive industries, the urgency of doing so, or the technology options to enable that transition. It was felt that these were likely to be key factors in securing buy-in for the HICP.

The Key Informant Workshop identified several factors which impede the public from currently accessing information:

- Firstly, it is currently unclear where the public can source a 'single point of truth', about the industrial decarbonisation of the Humber Industrial Cluster. This is partly due to the public not knowing which sources of information they can trust or where they will get the 'full story'. One participant noted that it was important to be upfront with the public about the 'short term pain for long term gain' which would be required to enable the industrial decarbonisation.
- Secondly, it was felt that industrial decarbonisation encompasses so many different issues, industries, and technologies, which the public are struggling to differentiate between. Participants also felt that the public struggle to differentiate industrial decarbonisation from separate issues such as fracking.
- Thirdly, but linked to the second point, is the complexity of the issues which the public need to understand in order to make an informed response. Publicly available information is often written from a technical industry perspective, which may not be accessible to lay people looking to understand industrial decarbonisation.

It was agreed by participants of the Key Informant Workshop that institutional collaboration is needed to enable industrial decarbonisation and broader energy transition. Currently the perception is that there are competing and contradictory messages and initiatives in place from across industry and government. A strong message was that it would be positive to have one voice on climate change for the Humber; a centralised organisation for the region that could advocate for Humber's climate change progress on the national stage and drive cohesive action that is more aligned to the public's vision for the Humber. There were also calls in the Community Focus Groups for greater collaboration across the public, regional environmental groups and industry.

Many participants highlighted the opportunity for directly involving communities in the co-design of the energy transition. A key aspect of this opportunity which was highlighted in the workshops was that the transition should be done 'with, not to' communities. Participants felt this would help to secure buy-in and strengthen the overall design of the transition. Within this point, it was also suggested that a citizen's jury for climate change may be a good way to facilitate input and co-design. The idea is that communities will not be brought on the transition journey by only demonstrating the benefits to business, industries, or to the region as a whole. Rather, it is also necessary to demonstrate benefit to communities and individuals themselves, and how these benefits link with other strategic elements of the zero carbon transition (e.g. housing retrofits). This principle should be closely linked to making the case for investing in the Humber, particularly in relation to community benefits.

One innovative opportunity identified in the Key Informant Workshop related to the broader energy transition was that communities, especially those who have been negatively impacted by austerity, could be directly empowered through sustainable technology required for industrial decarbonisation and wider net zero transition plans. An example provide was community ownership in renewable energy infrastructure such as wind turbines. The concept of empowered communities was also raised in the Community Focus Groups, where participants thought that it would be positive to see communities who are empowered and who had a strong voice.

Linked to this were a number of comments about better communication or awareness raising of what is taking place and the need for this information to be simple and independent, including noting that

the term 'decarbonisation' was not clear to many people. These comments underline the need to distribute existing and future information more widely and in a digestible format. It was further raised that communication needs to be balanced, providing both the potential challenges as well as benefits. For example, without a clear communication of the cost to taxpayers, it was considered by participants of the Community Focus Groups to be difficult to make the case for public investment, with resultant implications on public buy-in. It was noted that understanding the balance of public and private sector investment could also help to secure public support.

3.2.3.3 Summary Findings and Insights

The insights related to key topics of public concern from the Key Informant Interviews and Workshop and the Community Focus Groups are summarised in Table 3-7.

Table 3-7: Innovations to engender public support as identified by Key Informants

#	Finding	Context	Insight relevant to the Societal Study
F16	Importance of timely engagement.	The voluntary and community sector organisations are already mobilising themselves, because they do not acknowledge the actions that are being taken by government, business, and industry.	Overall, it is critical to engage with the voluntary and community sector, as part of the delivery of the HICP, to bring them on the journey and to engage with their concerns in order to reduce resistance to, and accelerate the delivery of, the industrial energy transition.
F17	Provision of information is key.	Individuals and communities in the Humber are engaged and want to be informed when it comes to industrial changes taking place in the region. It is important that there is a single point of detailed, informative and non-technical information.	The public must have access to accurate, impartial, and unbiased information, which can provide accurate, evidence-based information free of vested interests. This information must be non-technical and enable individuals to understand and be able to differentiate between the different technologies. Communications should clearly set out the overall investment (public and private) needed for the delivery of industrial decarbonisation in the region and any consequences of that, positive or negative.
F18	Strong regional vision and leadership.	Currently the perception is that there are competing and contradictory messages and initiatives in place from across industry and government.	Institutional collaboration is needed to enable the energy transition. A decarbonisation champion (i.e. body of accountability) for

#	Finding	Context	Insight relevant to the Societal Study
			the region could advocate for Humber's climate change progress on the national stage and drive cohesive action. A regional energy transition vision, aligned to the public's vision for the Humber, would provide greater cohesion across the public, environmental-related organisations, and industry.
F19	Community engagement is fundamental to generating buy-in.	The energy transition should be done 'with, not to' communities to secure buy-in and strengthen the overall design of the transition. Young people are vital to the transition. They have grown up with the messaging that climate change is dangerous and must be dealt with.	Community engagement should not only focus on informing or consulting the public, but should actively seek to generate ideas and co-design interventions. All sectors of the public should be invited into the discussion, including young people.
F20	Demonstrating community benefit.	In addition to demonstrating the benefits to business, industries, or to the region as a whole, it is necessary to demonstrate benefit to communities and individuals themselves. The Humber should become a more attractive region for individuals and businesses, with better infrastructure and transportation.	Develop clear messaging around community and individual benefits in the area of employment, jobs, skills development, infrastructure, transport and other areas of local economic and cultural value in order to engage the public on the basis of their priorities. This is currently the role of the Local Enterprise Partnerships (LEPs), Local Authorities (LAs) and other partners. Opportunity for modern place making approaches with strong community input.
F21	Realising positive environmental impacts	Industrial decarbonisation is an opportunity for a cleaner, less polluted environment, and improved health for the population. There may be risks and opportunities related to biodiversity, flood risk, water availability and sense of place.	There is an opportunity to imbed nature-based solution design principles into new developments for the benefit of people and nature. Collaboration between developers and organisations such as the Humber Nature Partnership can help to achieve a coherent nature positive vision for the Humber.

3.3 Overall Vision for the Humber

As part of the Community Focus Groups, an exercise was carried out where participants were asked, "what should the Humber look like in twenty years?". This exercise aimed to understand what was most important to participants when thinking about the future of the region, so that communications could be aligned to their priorities.

Within this exercise, three key themes emerged. When trying to organise the outputs of the focus groups, it became clear that these three themes underpinned all the aforementioned changes that participants wanted to see. When comparing the outputs from the Community Focus Groups with the outputs of the Key Informant Workshop, it was clear that there were significant overlaps in the overall vision for the Humber between both groups. A brief summary of each of these three themes is set out below.

3.3.1 The Humber will be a better place to live and work

The desire for the Humber to be a better place to live and work was an overarching social theme which came out of the Key Informant Workshop and the Community Focus Groups. Fundamentally, participants wanted to see the experiences of people living in the Humber improved over the next twenty years. Within this, many participants accepted that to deliver the Humber they wanted to see, the region needed to be a more attractive area, both in terms of retaining existing residents (particularly young people) and attracting new and diverse people to the area. Improved healthcare provision was one of the aspects that was identified by focus group participants, who noted that the Humber would therefore also need to be an attractive place for healthcare providers to live and work. Effective placemaking facilitated through investments made by industrial decarbonisation initiatives towards people and nature could help to make the Humber a desirable place to live.

It was also discussed, that while it is important for the industrial energy transition to provide opportunities for local people and reduce inequality, the region needs to attract more workers with green skills to successfully deliver the transition. The desire to attract workers with green skills is closely linked to the aspiration expressed by many focus group members for the Humber to become an exemplar for decarbonisation and build on their strong industrial heritage.

3.3.2 The Humber will have a vibrant economy

The aspiration for the Humber to have a vibrant (i.e. both prosperous and diverse) economy was an overarching economic theme identified by study participants. Participants voiced their desire for a thriving economy which supports many highly skilled jobs (particularly in green industries) and plenty of skills development opportunities. Economic growth in the region would then attract wider business who could benefit from the expanded workforce, as well as service providers (e.g. in healthcare, hospitality and other sectors) who could contribute to an overall better standard of living for both existing and new residents in the Humber. Closely linked to this was the idea that the Humber would attract investment from new businesses, particularly into the region's infrastructure.

It is clear that in order to bring the public on the Humber's energy transition journey, the economic benefit case for the transition must be made convincingly and credible actions must be taken to enable economic growth alongside the transition.

3.3.3 The Humber will be an exemplar for CO_2 Reduction

Participants of the Community Focus Groups expressed their desire to see the Humber's climate impact reduced in the next 20 years. There is an awareness among study participants that the region has a significant impact on the UK's CO_2 emissions and a general desire to live somewhere that is reducing its impact on climate change.

This theme builds upon discussions both in the Key Informant Workshop and the Community Focus Groups that the Humber could be a leader in industrial decarbonisation at a UK and global level. This

links to the sense of regional pride and cultural identity that came out clearly in each stage of engagement based around the Humber's industrial heritage, alongside the recognition of the opportunity that the Humber has to take a lead role in climate action on a national and global scale.

4. RECOMMENDATIONS FOR ACTION

Returning to the project objectives and the goal to address the social and cultural challenges that would enable the successful deployment of industrial decarbonisation in the Humber, the findings from the literature review and stakeholder engagement have been synthesised into a series of recommendations for action. The generation of recommendations are aligned with *key outcomes* that have been shaped by the voices of the local stakeholders that were engaged during the Societal Study, including the visioning exercise. The recommendations have also been guided by four *delivery strands* which were identified from the literature and reinforced by the local stakeholders that were engaged. These delivery stands emphasise the importance of the process by which outcomes are achieved in relation to gaining and maintaining public support.

This section presents the desired outcomes and the delivery strands before providing the recommendations for consideration in the HICP.

4.1 Key Outcomes: What is the vision?

Figure 4-1 shows outcomes listed by participants during the stakeholder engagement process. These statements coalesced around four outcome related themes:

- The Humber becomes a global leader and exemplar for Industrial Decarbonisation;
- Planning and placemaking across the Humber delivers community benefits from industrial decarbonisation and enhances industrial heritage;
- The Humber has thriving businesses and supports many highly skilled, highly paid jobs, including those necessary to enable industrial decarbonisation;
- Industrial decarbonisation is ‘nature positive’ and strengthens ecosystems services provision.

Figure 4-1: Synthesised outcomes from stakeholder engagement

**An overlap between findings indicates a connection.*

These outcomes can also be cross-referenced against the findings in this report (see Table 4-1).

Table 4-1: Vision outcomes cross referenced by report findings

	Vision Outcome	Relevant Findings in Report
1	The Humber becomes a global leader and exemplar for Industrial Decarbonisation	1, 3, 12, 13, 15, 18
2	Planning and placemaking across the Humber delivers community benefits from industrial decarbonisation and enhances industrial heritage	2, 4, 12, 19, 20
3	The Humber has thriving businesses and supports many highly skilled, highly paid jobs, including those necessary to enable industrial decarbonisation	1, 2, 3, 5, 13, 14, 20
4	Industrial decarbonisation is 'nature positive' and strengthens ecosystems services provision	6, 7, 21

4.2 Delivery Strands: How can the vision be achieved?

From the literature on community engagement on industrial decarbonisation, four strands through which action needs to be taken to engender public support and ensure maximum community benefit, were identified:

- Public participation in decision making;
- Provision of information and signposting;
- Visible benefits to communities and individuals;
- Perceiving a fair distribution of impacts and benefits.

These delivery strands are common across each outcome and align with the findings outlined in this report (see Table 4-2).

Table 4-2: Outcome delivery strands cross referenced by report findings

	Delivery Strand	Relevant Findings in Report
a	Public participation in decision making	6, 8, 15, 16, 19
b	Provision of information and signposting	3, 4, 5, 6, 8, 9, 11, 17
c	Visible benefits to communities and individuals	1, 5, 13, 14, 20, 21
d	Perceiving a fair distribution of impacts and benefits	1, 2, 4, 7, 10

4.3 Recommendations

The outcomes set out above are used to frame a series of recommended actions that consider each delivery strand. These activities are based on a theory of change model that seeks to take us from a series of inputs or enabling factors (such as financial investments) through to the four outcomes in a way that supports a just transition to net zero industry and creates the best conditions for public support for industrial decarbonisation in the Humber.

The recommendations are set out in Table 4-3 below with suggested action parties. At the time of writing the report, the constituents of the HICP legacy delivery body is not known. The HICP team are working with the Humber Energy Board to determine approach to the HICP legacy delivery.

Figure 4-2 then provides a theory of change-style summary of enabling factors, recommended actions and outcomes. It is noted that the enabling factors that are shown in Figure 4-2, along with enabling factors from other elements of the HICP, should be routinely interrogated and tested to highlight if any critical enabling actions need to be implemented.

It is important to note that these recommendations are based on relatively limited engagement with different sets of stakeholders. A key overarching recommendation from the study team is that further in-depth engagement with communities across the Humber is routinely undertaken to ensure that outcomes address the needs of those communities, and that public support for industrial decarbonisation in the region is built, maintained and tracked. Any future studies should also include more detailed public engagement at the 'problem-formulation' stage to feed into strategic aims and objectives of studies, rather than initiating this at or after the more detailed plan development stage.

Table 4-3: Summary of Recommendations & Actions

OUTCOME 1: The Humber becomes a global leader and exemplar for industrial decarbonisation

	Recommendation	Suggested Action Party	Priority
a	Ensure that there is clear responsibility for delivery of HICP activities across the Humber once the initial plan has been finalised, led by a suitable cross-Humber body, providing accountability for delivery of benefits and a unified voice for the region.	HICP legacy delivery body	Urgent *now is the time to act*
b	Ensure that industrial decarbonisation activities are clearly tied into wider climate action goals and activities for the region, to support public understanding and engagement; this includes integrating HICP actions into local or LEP energy, climate change, planning and other relevant strategies and plans.	HICP delivery body, LAs, LEPs	Urgent *now is the time to act*
c	Ensure that community participation is central to the next stages of HICP finalisation and delivery. This community participation should include young people and disadvantaged communities, and should actively seek to generate ideas, and co-design interventions.	HICP legacy delivery body	Urgent *now is the time to act*
d	Building from HICP, develop detailed action plans which ensure that benefits to the Humber businesses and communities are delivered in the short, medium and longer term.	HICP legacy delivery body	Low-hanging fruit *easy way to make some progress*
e	Final HICP and future action plans to deliver HICP should be long term to allay fears over a 'boom-bust' in relation to economic sustainability and employment.	HICP legacy delivery body	Critical *Risk to public support*
f	Communications to the public need to set out industrial decarbonisation in the context of the overall journey to net zero including the expectations on the public regarding behaviour change and consumption.	HICP legacy delivery body	Low-hanging fruit *easy way to make some progress*
g	Work with arts and cultural institutions to build on the legacy of Hull City of Culture 2017 and use creative activities and events to raise awareness of the Humber's cultural heritage and opportunities related to industrial decarbonisation: "Humber Lighthouse".	HICP legacy delivery body, LAs, LEPs	Low-hanging fruit *easy way to make some progress*

	Recommendation	Suggested Action Party	Priority
h	Ensure that opportunities related to HICP are actively and repeatedly communicated to local communities and priority groups, and set within wider opportunities of climate action and net zero economy.	HICP legacy delivery body	 **Low-hanging fruit** *easy way to make some progress*
i	Embed Just Transition principles into final HICP and HICP delivery plans to ensure that investment and action is brought to disadvantaged and/or impacted communities.	HICP legacy delivery body	 **Critical** *Risk to public support*

OUTCOME 2: Planning and placemaking across the Humber delivers community benefits from industrial decarbonisation and enhances industrial heritage

	Recommendation	Suggested Action Party	Priority
a	Develop citizen visioning processes - such as a citizens climate assembly - to bring the public's ideas into future place-making for the Humber, reflecting cultural identity alongside social, economic and environmental goals.	HICP legacy delivery body, LAs, LEPs, civil society	 **Critical** *Risk to public support*
b	Coordinate across project level consultation events to reduce stakeholder fatigue, providing consistent, clear, honest communication with local residents at or near development sites in an ongoing manner (beyond the end of the planning process).	Industry	 **Low-hanging fruit** *easy way to make some progress*
c	Develop strategic priorities for investment into local infrastructure and the natural environment. These priorities, which will include elements related to industrial heritage, can then be translated into Local Plans and implemented consistently through planning agreements and obligations (e.g. Statement of Common Ground (DCO), Community Infrastructure Levy, Section 106 Agreements, Biodiversity Net Gain Agreements). Ensure these agreements are properly monitored against delivery and that progress is publicly reported.	LAs, LEPs	 **Urgent** *now is the time to act*
d	Align activities to the existing calendar of community events to reach people where they already are.	HICP legacy delivery body	 **Low-hanging fruit** *easy way to make some progress*
e	HICP gains Cabinet Approval by the local authorities such this the HICP is required to be a consideration in the drafting of local plans and guidance documents.	HICP legacy delivery body, LAs	 **Low-hanging fruit** *easy way to make some progress*
f	Industry to develop an industrial decarbonisation Community Benefit Commitment to deliver coordinated action between companies and with government, the public and the third sector.	Industry	 **Critical** *Risk to public support*
g	Industry to work collaboratively on cumulative issues of key regulator and public interest (e.g. skills and local employment, sector diversity, use of local businesses and services, traffic and	Industry	 **Urgent** *now is the time to act*

	Recommendation	Suggested Action Party	Priority
	disturbance, biodiversity, air quality) to develop coordinated management strategies.		
h	Develop regional communication materials that provides consistent information related to the HICP and related community and individual benefits (employment, jobs, skills development, infrastructure, transport and other areas of local economic and cultural value, alignment to climate action plans and net zero) that can be used in all consultation events (including project specific consultation).	HICP legacy delivery body, Industry, LEPs	
i	Regenerate industrial sites that are decommissioned to disproportionally advantage more vulnerable individuals, e.g. providing green space, affordable housing, public leisure facilities etc.	Industry, LAs	

OUTCOME 3: The Humber has thriving businesses and supports many highly skilled, highly paid jobs, including those necessary to enable industrial decarbonisation

	Recommendation	Suggested Action Party	Priority
a	Local businesses, chambers of commerce and trade unions to be integral to HICP delivery, ensuring it considers how development impacts on their interests, incorporating measures to support them to manage and benefit from the transition.	LAs, LEPs	
b	With the involvement of education and training institutions, review the range of existing training / academic courses against the skills required for industrial decarbonisation.	LEPs, training providers, universities, colleges	
c	Develop retraining programmes and supported re-employment for any jobs that will change or disappear through decarbonisation.	Industry, Further and Higher Education, LAs, LEPs	
d	Use planning mechanisms including planning gain (e.g. S106 where relevant or securing voluntary agreements) to guarantee a proportion of local jobs and ensure opportunities for priority groups who would otherwise be disadvantaged in recruitment. Ensure these agreements are monitored against delivery.	LAs	
e	Working with community intermediaries, take forward a concerted awareness campaign around the significant potential employment in industrial decarbonisation, including information days, briefing educational providers, and organising recruitment fairs, including in deprived or marginalised communities.	LEPs, Industry, HICP delivery body	
f	Deliver community outreach programmes to schools and other education providers to raise awareness of what opportunities are available.	HICP delivery body, LEPs	

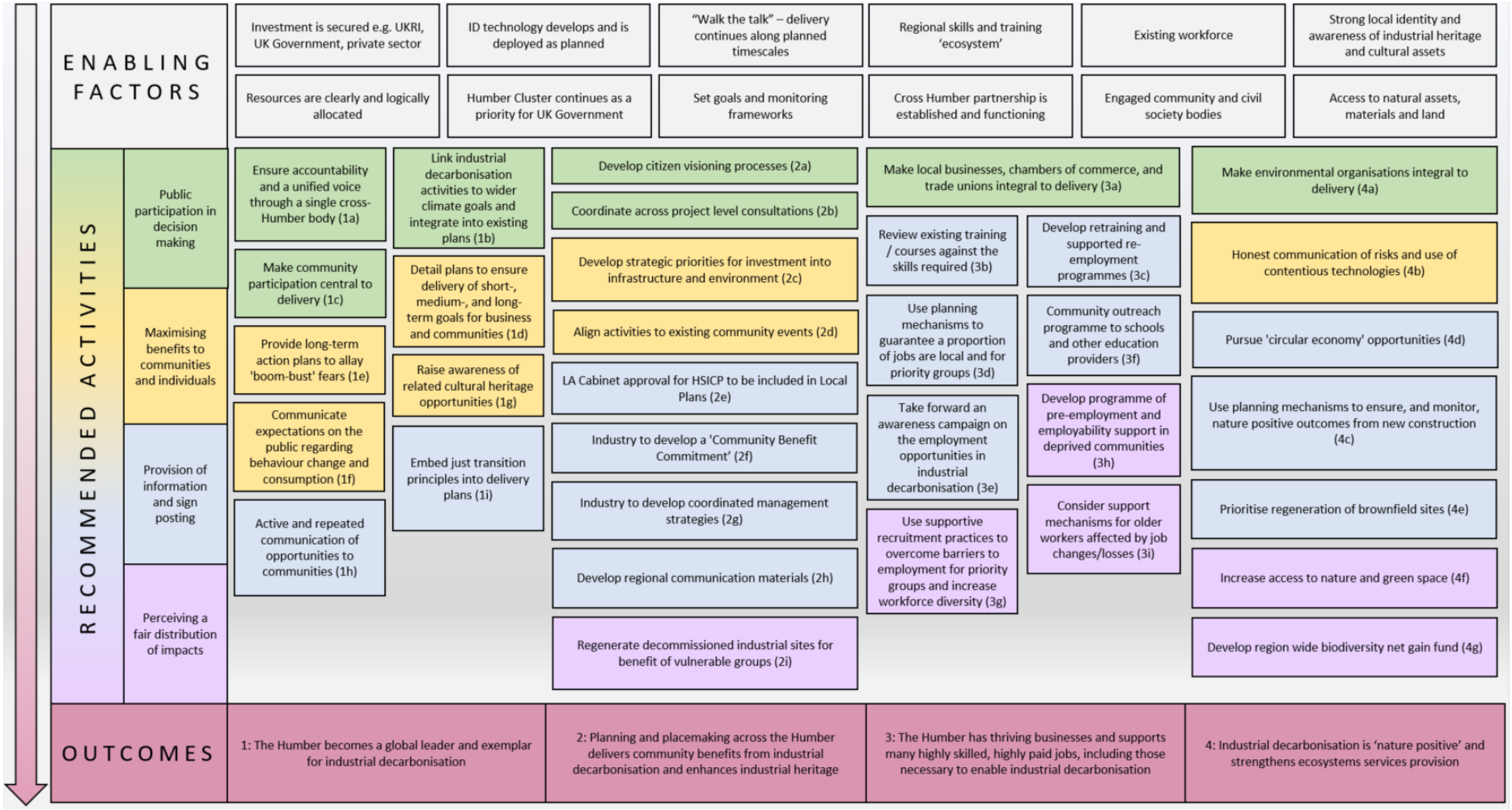
	Recommendation	Suggested Action Party	Priority
g	Use supportive recruitment practices, transitional employment support and shared apprenticeship schemes to help overcome barriers to employment for priority groups, including focus on increasing workplace diversity.	Industry, LEPs, LAs	Low-hanging fruit *easy way to make some progress*
h	Develop bespoke programme of pre-employment and employability support in deprived communities focused on potential opportunities in industrial decarbonisation projects.	Industry, LAs, LEPs, Voluntary, Community, and Social Enterprise (VCSE)	Critical *Risk to public support*
i	Consider implications and specific support mechanisms for older workers affected by job changes/losses.	Industry, Trade Unions, Job Centre Plus (JCP), Department for Work and Pensions (DWP)	Critical *Risk to public support*

OUTCOME 4: Industrial decarbonisation is 'nature positive' and strengthens ecosystems services provision

	Recommendation	Suggested Action Party	Priority
a	Environmental organisations to be integral to HICP delivery to understand biodiversity and ecosystem service needs and to ensure that this is integrated into the Plan.	HICP delivery body	Critical *Risk to public support*
b	Clear, ongoing and honest communication with communities about risks and safeguarding for innovative technologies like BECCS and blue hydrogen.	HICP delivery body, Industry	Low-hanging fruit *easy way to make some progress*
c	Use planning requirements and work with developers to ensure that new construction is nature positive and considers regenerative principles. Ensure these are effectively monitored.	LAs, Industry	Critical *Risk to public support*
d	Pursue 'circular economy' opportunities through industrial decarbonisation projects e.g. connection of waste industrial heat to district heating systems.	Industry, LAs, LEPs	Urgent *now is the time to act*
e	Industrial decarbonisation projects to prioritise regeneration of brownfield sites.	Industry, LAs, HICP delivery body	Low-hanging fruit *easy way to make some progress*
f	Ensure industrial decarbonisation developments increase access to nature and green space, especially in areas with poor access to greenspace.	LAs, Industry, Local Nature Partnerships	Low-hanging fruit *easy way to make some progress*

	Recommendation	Suggested Action Party	Priority
g	Develop pooled HICP biodiversity net gain fund to ensure region-wide rather than site-by-site approach.	HICP delivery body, LAs, Industry	 **Critical** *Risk to public support*

Figure 4-2: Theory of Change



4.4 Conclusion and Next Steps

The stakeholder engagement undertaken and synthesised under this lot provides the social and cultural foundations for decarbonisation to progress in the Humber. It highlights support from local communities for decarbonisation to take place, providing a social licence to operate, and for a continued improvement of this highly regarded Industrial Cluster. However, it also outlines a number of caveats upon which this licence hinges and which are vital to ensuring a just transition and the continued support of local communities.

This requires commitment to a vision for the Humber that creates the opportunity for the Humber to:

1. Become a global leader and exemplar for industrial decarbonisation;
2. Deliver community benefits through related planning and placemaking, enhancing the existing industrial heritage;
3. Create thriving local businesses that support highly skilled and highly paid jobs, both within and outside of the industrial decarbonisation supply chain; and
4. Strengthen ecosystem services through nature positive development.

To deliver the vision, this report offers 34 recommendations across these four outcomes, breaking down the activities into four strands:

1. Public participation in decision making;
2. Provision of information and signposting;
3. Visible benefits to communities and individuals; and
4. Perceiving a fair distribution of impacts and benefits.

By focussing on these strands of activity, the Humber Industrial Cluster can maximise community engagement and benefit and reduce risks related to community resistance to the changes needed for industrial decarbonisation to occur.

These recommendations, along with all findings in this report, are subject to a number of limitations, which themselves pose opportunities for further work to be undertaken. These limitations include the financial and timescale parameters set out in the original scope of work that has meant a constraint on the level and depth of stakeholder engagement possible. To widen and deepen participation, it would be beneficial to bring local voluntary and community infrastructure organisations on board as partners, with funding provided to allow them to properly canvass and engage with their members. Furthermore, the terms of reference did not include a demographic research element, and whilst a high level demographic framing was included as part of the stakeholder analysis, further work would be beneficial to better understand the cultural and social groups in the Humber and the social challenges, opportunities and innovations that may be beneficial in relation to these groups. This should include young people and groups that may be more vulnerable, or less able to benefit from, the upcoming transformational changes, who were not expressly heard from during this research.

There was also limited ability to understand the technology specific barriers, due in part to the additional complexity that this involved. Whilst efforts were made to outline the different decarbonising technologies being employed in the Humber, there was insufficient time to interrogate each technology individually. Where opportunities were included to provide a technology specific view, as in the stakeholder workshop, stakeholder comments remained focussed on industrial decarbonisation more broadly. This does not mean that there are no technology specific barriers, and it would be beneficial to understand what these barriers might be through subsequent research, but this will need to appreciate the additional complexity required to communicate the pros and cons of each technology to a community audience.

The nature of the stakeholder engagement carried out and the participants involved led to a focus on actions primarily for local industrial and public sector partners, who are best placed to deliver on the

outcomes identified in the vision. Additional work to explore the wider policy context could help to increase the influence of the Humber cluster on broader regional and national industrial and environmental policy, and help to evolve the relationship with the local community by leveraging further benefits.

Due to these limitations and the need for further research, the findings of this Report should therefore be taken as a starting place that can help to shape the longer term programme of collaborative work with local communities that will engender the necessary public support to deliver, and maximise the potential social and cultural opportunities offered by the industrial transition to net zero.

ANNEX A – LITERATURE REVIEW REFERENCES

Academic Literature

Author(s)	Year	Title	Source
Ala-Rämi K., Taipale-Erävala K., Väänänen M.	2020	Structural change as an opportunity for a post-mining region: The case of Pyhäjärvi, Finland	Nordia Geographical Publications
Alcalde J., Heinemann N., Mabon L., Worden R.H., de Coninck H., Robertson H., Maver M., Ghanbari S., Swennenhuis F., Mann I., Walker T., Gomersal S., Bond C.E., Allen M.J., Haszeldine R.S., James A., Mackay E.J., Brownsort P.A., Faulkner D.R., Murphy S.	2019	Acorn: Developing full-chain industrial carbon capture and storage in a resource- and infrastructure-rich hydrocarbon province	Journal of Cleaner Production
Barrett J., Cooper T., Hammond G.P., Pidgeon N.	2018	Industrial energy, materials and products: UK decarbonisation challenges and opportunities	Applied Thermal Engineering
Boyd, R., Green, F. and Stern N.	2015	The road to Paris and beyond	Centre for Climate Change Economics and Policy and Grantham Research Institute on Climate Change and the Environment
Budinis S., Krevor S., Dowell N.M., Brandon N., Hawkes A.	2018	An assessment of CCS costs, barriers and potential	Energy Strategy Reviews
Chilvers J., Bellamy R., Pallett H., Hargreaves, T.	2021	A systemic approach to mapping participation with energy transitions	Nature Energy
Espert V., Arnold K., Vallentin D., Lechtenböhmer S., Schneider C.	2016	Platform climate protection and industry north-rhine westphalia - A multi stakeholder process for the advancement of energy efficiency and low carbon technologies in energy intensive industries	Eceee Industrial Summer Study Proceedings
Fouquet R., Pearson, P.J.G.	2012	Past and prospective energy transitions: Insights from history	Energy Policy
Griffin P.W., Hammond G.P.	2021	The prospects for ‘green steel’ making in a net-zero economy: A UK perspective	Global Transitions
Griffin P.W., Hammond G.P., Norman J.B.	2018	Industrial decarbonisation of the pulp and paper sector: A UK perspective	Applied Thermal Engineering
Kretschmann J.	2020	Post-mining - A holistic approach	2020 SME Annual Conference and Expo

Author(s)	Year	Title	Source
Millot A., Maïzi N.	2021	From open-loop energy revolutions to closed-loop transition: What drives carbon neutrality?	Technological Forecasting and Social Change
Nurdiawati A., Urban F.	2022	Decarbonising the refinery sector: A socio-technical analysis of advanced biofuels, green hydrogen and carbon capture and storage developments in Sweden	Energy Research and Social Science
Nurdiawati A., Urban F.	2021	Towards deep decarbonisation of energy-intensive industries: A review of current status, technologies and policies	Energies
Öhman A., Karakaya E., Urban F.	2022	Enabling the transition to a fossil-free steel sector: The conditions for technology transfer for hydrogen-based steelmaking in Europe	Energy Research and Social Science
Otto D., Gross M.	2021	Stuck on coal and persuasion? A critical review of carbon capture and storage communication	Energy Research & Social Science
Pianta S., Rinscheid A., Weber E.U.	2021	Carbon Capture and Storage in the United States: Perceptions, preferences, and lessons for policy	Energy Policy
Tagliapietra S., Zachmann G., Edenhofer O., Glachant J.-M., Linares P., Loeschel A.	2019	The European union energy transition: Key priorities for the next five years	Energy Policy
Turner K., Race J., Alabi O., Calvillo C., Katris A., Stewart J., Swales K.	2021	Could a new Scottish CO2 transport and storage industry deliver employment multiplier and other wider economy benefits to the UK economy?	Local Economy
Turner K., Race J., Alabi O., Katris A., Swales J.K.	2021	Policy options for funding carbon capture in regional industrial clusters: What are the impacts and trade-offs involved in compensating industry competitiveness loss?	Ecological Economics
While A., Eadson W.	2021	Zero carbon as economic restructuring spatial divisions of labour and just transition	New Political Economy
While A., Eadson W.	2019	Households in place: socio-spatial (dis)advantage in energy-carbon restructuring	European Planning Studies
Zenghelis D.	2019	Securing Decarbonisation and Growth	National Institute Economic Review

Policy Literature

Author(s)	Year	Title	Publisher
Arup	2020	Establishing a regional hydrogen economy: Accelerating the carbon transition in South Yorkshire, UK	Arup
BEIS	2021	Industrial Decarbonisation Strategy	Department for Business, Energy and Industrial Strategy
BEIS	2021	UK Hydrogen Strategy	Department for Business, Energy and Industrial Strategy
Cherry C. Pidgeon N.	2017	The citizen and new business models, in: From Waste to Resource Productivity: Evidence and case studies	Government Office for Science
Copper	2021	Public attitudes to low carbon energy generation	Copper Consultancy
Midlands Engine	2021	Hydrogen Technologies Strategy	Midlands Engine
OECD	2019	Regions in Industrial Transition: Policies for People and Places	Organisation for Economic Co-operation and Development
OGCI	2021	OGCI position on policies to scale up carbon capture, use and storage (CCUS)	Oil and Gas Climate Initiative
NZT	2020	Stage 2 Consultation	Net Zero Teesside
Scott K.	2021	HyNet North West Carbon Dioxide Pipeline: Non-Statutory Consultation Report	WSP UK Ltd
Scott M. Powells G.	2019	Blended Hydrogen: The UK Public's Perspective	Newcastle University, Cadent, National Centre for Energy Systems Integration, Northern Gas Networks
Summit Power	2018	Caledonia Clean Energy Project Feasibility Study Phase 2 Final Report	Summit Power Caledonia UK Ltd
Vivid Economics	2020	Capturing Carbon at Drax: Delivering Jobs, Clean growth and Levelling up the Humber – Report prepared for Drax	Vivid Economics
Wang S. Corner A. Nicholls J.	2020	Britain Talks Climate: A toolkit for engaging the British public on climate change	Climate Outreach
Webb J.	2021	Forging the future: a vision for Northern steel's net zero transformation.	Institute for Public Policy Research (IPPR)

ANNEX B – SUMMARY OF ENGAGEMENT

Expert Interviews

A total of 6 expert interviews were conducted with Humber based key informants that were identified as having a strong connection to the study's research questions. These included representatives from two academic organisations, two public/private partnerships and two industry organisations, which are listed below:

- Greater Lincolnshire LEP
- HEY LEP
- Humber Leadership Board
- Marketing Humber
- The Industrial Decarbonisation Research and Innovation Centre (IDRIC).
- University of Hull, Aura

Workshop

The workshop consisted of the following representatives from 22 organisations that were based, or with active projects, in the Humber, including community, academic and public sector organisations as well as businesses:

- Anonymous public sector stakeholder
- Arup
- CATCH
- East Riding Voluntary Action Services (ERVAS)
- Environment Agency
- Equinor
- For Entrepreneurs Only
- Friends of the Earth Hull
- Groundwork
- HEY LEP
- Hull City Council
- Humber nature Partnership
- IDRIC
- Positive Activities
- SSE Thermal
- Townsend and Turner
- University of Hull
- University of Hull, Aura
- University of Manchester
- Voluntary Action North Lincolnshire Limited
- Yorkshire and Humber Association of Civic Societies

- Yorkshire and Humber Climate Commission

Focus Groups

In total, there were 11 Humber based attendees across the three-focus groups and one individual who sent their responses to the focus group questions via email. Five individuals attended the first Natural Environment / Local Community Perspective session, three individuals attended the Local Energy Intensive Sector Perspective Session, with one sending responses via email, and three individuals attended the second Natural Environment and Local Community perspective.

ID	Gender	Age	Local Authority	Employment Status	Sector	Session
# 1	Female	55-64	East Riding	Retired	-	Local community / natural environment perspective Session 1
# 2	Male	25-34	-	Unemployed	-	Local community / natural environment perspective Session 1
# 3	Female	35-44	East Riding	Employed	Heath	Local community / natural environment perspective Session 1
# 4	Male	55-64	East Riding	Retired	Prior to retirement - Principal Engineer, Department of Health	Local community / natural environment perspective Session 1
# 5	Male	25-34	-	Employed	-	Local community / natural environment perspective Session 1
# 6	Male	35-44	Hull City	Self Employed	Risk Manager	Local energy intensive sector perspective
# 7	Male	25-34	-	Student	-	Local energy intensive sector perspective
# 8	Male	25-34	-	Employed	Chemist	Local energy intensive sector perspective
# 9	Female	-	-	-	-	Local energy intensive sector perspective
# 10	Female	45-54	East Riding	Employed	Voluntary/ non-profit	Local community / natural environment perspective Session 2
# 11	Male	65+	Hull City	Retired		Local community / natural environment perspective Session 2
# 12	Male	45-54	Lives in East Riding but works across the Humber	Employed	Nature Conservation charity	Local community / natural environment perspective Session 2

Recommendations Validation Workshop

The following 12 organisations attended the recommendations validation workshop (excluding the report writing team):

- Arup
- National Grid
- East Riding of Yorkshire Council
- Marketing Humber
- BeaconTech Consulting
- Drax
- HEYLEP
- CATCH
- Hull City Council
- VPI Power
- HEY LEP
- ERVAS

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