

School of Earth & Environment

FACULTY OF ENVIRONMENT



UNIVERSITY OF LEEDS

Public acceptance of CCS and hydrogen

Report of research findings, October 2022

Produced for SSE Thermal by:

Dr James Van Alstine, University of Leeds, j.vanalstine@leeds.ac.uk

Dr Claire Bastin, Nifty Sustainability CIC, clairebastin@niftysustainability.org.uk

Prof Fiona Fylan, Brainbox Research, fiona@brainboxresearch.com

Contents

Figures and tables	4
Glossary.....	5
Executive summary	6
1 Introduction	7
1.1 Research aims and objectives.....	8
1.2 Our approach	8
1.3 Report Structure	9
2 Research findings	10
2.1 Interviews.....	10
2.2 Surveys	14
2.3 Survey 2.....	33
2.4 Focus groups	38
3 Summary	43
3.1 Public perception of CCS, hydrogen and UK Net Zero commitment	43
3.2 Issues relating to policy legitimisation	43
3.3 Message framing and implications for public acceptance.....	44
Appendices.....	45

Figures and tables

Box 1: Key takeaway messages from the interviews	10
Box 2: Key takeaway messages from the surveys.....	14
Table 1: Survey participants	15
Figure 1: Geographical distribution of participants	16
Figure 2: Participants' familiarity with Net Zero.....	17
Figure 3: Beliefs about climate change.....	18
Figure 4: Regional differences in beliefs about climate change.	18
Figure 5: Awareness of green technologies.....	19
Figure 6: Average (mean) awareness of green technologies.....	20
Figure 7: Acceptance of green technologies being used locally.	21
Figure 8: Beliefs about carbon capture and storage.....	22
Table 2: Beliefs about carbon capture and storage.....	23
Figure 9: Ranked importance of potential benefits from carbon capture and storage.	23
Figure 10: Participants' responses to a CCS facility opening in their local area.....	24
Figure 11: Participants' responses to a hydrogen power plant opening in their local area.....	30
Figure 12: Support for green and blue hydrogen.	30
Figure 13: Willingness to pay extra for decarbonised electricity.....	31
Table 3: Survey participants	33
Figure 14: Beliefs about climate change.....	34
Figure 15: how positive each statement makes people feel about carbon capture and storage.....	36
Figure 16: Preference for the amount of information.....	37
Figure 17: Support for a CCS facility generated by each cluster of statements.....	37
Box 3: Key takeaway messages from the focus groups	38

Glossary

Abbreviation/term	Description
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Usage, and Storage - group of technologies designed to reduce the amount of carbon dioxide (CO ₂) released into the atmosphere from coal and gas power stations as well as heavy industry including. Once captured, the CO ₂ can be either re-used in various products, such as cement or plastics (usage), or stored in geological formations deep underground (storage).
CO ₂	Carbon Dioxide
GHG	Greenhouse gas(es) - atmospheric gases such as carbon dioxide, methane, chlorofluorocarbons, nitrous oxide, ozone, and water vapour that absorb and emit infrared radiation emitted by the Earth's surface, the atmosphere, and clouds.
HGV	Heavy good vehicle
MtCO ₂	Megatonnes of carbon dioxide
SSE	Scottish and Southern Energy

Executive summary

This report summarises research commissioned by SSE to explore public acceptance of carbon capture and storage (CCS) and hydrogen in the UK. There were three research objectives: (RO1) to assess public understanding of the role of CCS and hydrogen in the UK's commitment to reach net zero by 2050; (RO2) to evaluate public perception of the impacts of this low carbon transition on the industrial heartlands across the UK, specifically in the Humber and Scotland; and (RO3) to explore public understanding of the opportunities, benefits and challenges associated with CCS and hydrogen and whether increased understanding has an impact on public acceptance.

The research was conducted between May and October 2022 and comprised: semi-structured interviews with experts and members of the public; two national surveys; six focus groups with residents of Peterhead and Keadby.

The interviews show that key stakeholders believe that the public are generally supportive of decarbonisation plans, especially around the potential for new jobs. There is a concern that government decarbonisation plans are complicated, and the public may disengage with them when given too much information on government policy. In Aberdeenshire, there is public disappointment that CCS funding has not been forthcoming. In both regions, just transition is about creating and retaining jobs as well as retraining employees. In Scotland, there were specific concerns about distribution of wealth, and wealth being retained in Scotland.

The surveys show that most people support taking action to tackle climate change, feel a responsibility to do so, and believe it is important to decarbonise, but do not feel well informed about the causes of climate change. The more awareness of green technologies people have, the more accepting of it they are, but awareness of CCS is currently low. People in Scotland and in Yorkshire and the Humber have particularly strong beliefs that investing in CCS will be good for their local area. People were broadly positive about a CCS facility opening in their local area, and the potential benefits they value the most are reducing carbon emissions and creating local jobs. There is a potential misperception that a CCS facility would produce cheaper energy and cleaner air. The major concerns people have are about the safety of stored carbon dioxide, building on green space, and that CCS is a short-term solution that delays efforts to reduce carbon production. Clear, simple statements about CCS generate positive feelings, especially statements about how CCS industries plan on recruiting and training local people and linking with local schools and colleges to provide training opportunities for young people.

The focus groups show that knowledge around CCS and hydrogen is at best mixed, and where people do know more about local development this is usually due to their own research rather than information provided during planning processes. People who know more about developments generally perceive more potential benefits. Regardless of previous awareness, people are hopeful that CCS and hydrogen developments will provide jobs and skill benefits and opportunities locally. They would like more and accessible information from 'trusted' sources, including balanced discussions on the risks as well as the benefits of low carbon developments. While there is a high level of support for Net Zero ambitions, there is some scepticism about whether Net Zero targets will be achieved.

We conclude with a summary of how the research findings could inform SSE's approach to public perception, policy legitimisation, and message framing.

1 Introduction

Carbon, capture, usage, and storage (CCUS or CCS) and hydrogen are critical to meeting the Government's Ten Point Plan for a Green Industrial Revolution as well as the Climate Change Committee's sixth carbon budget¹. Included in the Ten Point Plan is the ambition to capture 10Mt CO₂ a year by 2030 through the deployment of CCS in two industrial clusters by the mid-2020s (Track-1), and a further two clusters by 2030 (Track-2).

A package of government support announced in 2020 is being developed for the clusters. This includes a £1bn CCS Infrastructure Fund. The East Coast Cluster and Hynet were sequenced onto Track-1. The Scottish cluster was announced 'as a reserve in case a backup is needed'². SSE has important interests in the Scottish Cluster, and in Zero Carbon Humber as well as the extended East Coast Cluster. Given the ambition of the Humber Industrial Cluster Plan to achieve Net Zero by 2040, it is critical that public acceptance of CCS and hydrogen is understood, and public engagement strategies are crafted accordingly.

Previous research has identified several benefits and challenges associated with the public acceptance of CCS and hydrogen. The capacity of CCS to protect employment, promote new job opportunities, and provide community benefits in fossil dependent and industrial regions are core benefits perceived by the public in industrial and energy applications³. Unless contextualised carefully within broader decarbonisation processes, CCS tends to be perceived less favourably than renewable energy technologies (ibid). The public has been more accepting of CCS in bioenergy and industrial manufacturing applications, rather than fossil-based energy applications (Thomas et al 2018). The same researchers found that the public is largely unaware of CCS technologies and role CCS may play in climate and energy futures (ibid).

Trust is also a mediating factor in CCS acceptance (Thomas et al 2018). Past research has found the most trusted stakeholders to be researchers and NGO, with government less trusted and industry least trusted (S. L'Orange Seigo et al 2018). Of interest to this project, there is little research in communities where CCS projects have been cancelled (Thomas et al 2018).

CCS and hydrogen combine several elements known to involve public contention. How much contention will be influenced by a range of factors, events, and choices, many of which – but not all – will be controllable. Risk perceptions associated with carbon capture and hydrogen production plants are likely to be low if sited in existing industrial sites, but new pipelines will attract attention and could result in public rejection if not accompanied by appropriate communications. Negative attitudes may be associated with the use of fossil H₂, the perceived risk of extending fossil fuel lock-in, and the use of CCS. Our previous research⁴ demonstrated that the public is more concerned about the safety of CCS than of using hydrogen in their homes. However, this research did not explore ways of addressing CCS concerns. While negative attitudes may not be felt strongly on a widespread basis, concern about the financial cost being passed on to the consumer may be more prevalent. Indeed, our previous research showed that financial concerns, for self and vulnerable community members, are important predictors of acceptance. There also may be public uncertainty on the complementarity of CCS and hydrogen with other decarbonisation pathways, such as electrification, alternative fuels and/or process changes.

¹ [The Ten Point Plan for a Green Industrial Revolution](#). See POINT 8 on CCUS.

² [Cluster sequencing phase 2: eligible projects \(power, CCUS, hydrogen and ICC\)](#). March, 2022.

³ See [L'Orange Seigo et al 2014](#) and [Thomas et al 2018](#).

⁴ [Public perceptions of converting the gas network to hydrogen \(2020\), Northern Gas Networks](#).

1.1 Research aims and objectives

The overarching aim of this research was to review and report on public acceptance of CCS and hydrogen in the UK with a specific focus on industrial clusters in the Humber and Scotland as outlined in the scoping document. In order to achieve this, this report presents key findings to address three research objectives (RO). These are:

- RO1. To assess public understanding of the role of CCS and hydrogen in the UK's commitment to reach net zero by 2050;
- RO2. To evaluate public perception of the impacts of this low carbon transition on the industrial heartlands across the UK, specifically in the Humber and Scotland; and
- RO3. To explore public understanding of the opportunities, benefits and challenges associated with CCS and hydrogen and whether increased understanding has an impact on public acceptance.

1.2 Our approach

The report methods are designed to achieve these three objectives. Our interdisciplinary and multi-method approach draws from psychological and social theory, as well as emerging frameworks for the assessment of sustainable energy technology acceptance⁵. Our research design is triangulated by using both qualitative and quantitative methods, including desk-based analysis, interviews, surveys, and focus groups. Factors such as attitudes, trust, fairness, norms, awareness, knowledge, and context have informed research design throughout.

Similarly, a range of academic themes informed our analysis of the data as appropriate to the complexity of the context being explored. As a starting point, we reflected on our findings using three main lenses:

- *Public perception:* The combination of interviews, representative national and local surveys, with focus groups (online and face to face) with local communities in each area, has allowed us to identify the opinions, mental images and attitudes people have. A comparison of national versus local perceptions of and attitudes towards these technologies informs our analysis of public acceptance. As a result, we have been able to better understand how people perceive the deployment of CCS and hydrogen technologies within UK industrial clusters.
- *Policy legitimisation:* The extent to which the UK public knows about, and supports, key elements of the Government (and regional) CCS and hydrogen policies and plans has been explored through the nationally representative survey, with over-sampling in the Humber and Scotland industrial clusters. Our analysis tested for proximity effects and demographic associations. The focus groups explored headline findings from the survey in more depth.
- *Message framing:* How the key elements of industrial cluster decarbonisation are communicated will significantly influence attitudes toward CCS and hydrogen. We have considered the various conditions and types of information about CCS and hydrogen

⁵ See for example. [Huijts et al 2012](#); [Hydrogen Acceptance in the Transition Phase \(HYACINTH\) 2016](#); [Seigo et al 2014](#)

technologies and tested for their effects on attitudes, drawing on our characterisation of the context above.

During the research period, May to October 2022, research activities were conducted (see Appendix 1 for further details) as follows:

- Semi structured interviews with experts and members of the public
- Two national surveys
- Focus groups with local residents in Peterhead and Keadby

In addition, throughout the research activity we conducted a number of scoping and exploratory exercises in order to ensure that wider national and local contextual issues were considered in our analysis. These activities included:

- Desktop reviews
- Visit to Keadby (including conversations with nine local residents)
- Visit to Peterhead
- Media reviews of local social media (Facebook, Twitter) and comment sections of local media websites, reviewed for Peterhead and Keadby at the start and end of the research period

1.3 Report Structure

This report presents our analysis of the findings from the above research activity. Throughout we describe the specific dimensions of public acceptance (e.g., the levels of awareness, knowledge, trust and attitudes towards CCS and hydrogen technologies among the general public etc). We then explore and understand factors that influence levels of awareness and acceptance of CCS and hydrogen technologies across individuals, populations, social groups, and contexts/localities by investigating the association between various factors, for example, socio-demographics and attitudes. In Section 2 we present findings from the interviews, surveys, and focus groups as they relate to the research objectives. In each subsection we draw out key takeaway messages to highlight the relevance of the findings. In Section 3 we then build on and synthesise these key themes emerging from our research in terms of the lenses above and provide SSE with reflections on the relevance of these for SSE's important interests in the Scottish Cluster, and in the East Coast Cluster and the Humber. Finally, Section 4 presents a summary of the research and reflections of connections with the wider literature along with our thoughts on areas for further study.

2 Research findings

This section presents findings from the main research activities conducted: interviews, two national surveys, and focus groups with local residents.

2.1 Interviews

What the interviews tell us. Five key points.

ONE: There is a belief that **government decarbonisation plans are complicated**, and the public may disengage with them when give them too much information on government policy.

TWO: The public are **primarily concerned about costs and jobs**, but also question the effectiveness of decarbonisation technologies as well as the safety of CO₂ storage.

THREE: In Yorkshire and Humber, the **public sector could move more quickly** to fully advocate for the plans, and industry could do better to **speak as one voice** in the region. While communities are generally supportive of decarbonisation plans, it can be **difficult getting the public engaged**.

FOUR: In Aberdeenshire, the public are **generally supportive** of the plans at Peterhead and broader industrial decarbonisation plans, but there is **public disappointment** that CCS funding has not been forthcoming, and suspicion of **competition politics**.

FIVE: In both regions, **just transition is about creating and retaining jobs** as well as retraining employees. In Scotland, there were specific concerns about **distribution of wealth**, and wealth being retained in Scotland.

Box 1: Key takeaway messages from the interviews

RO1 Public understanding of the role of CCS and hydrogen in the UK's commitment to reach net zero by 2050

Areas of consensus

- There was broad consensus from the expert interviewees that the government cluster decarbonisation plans are complicated, and the public may disengage with them when give them too much information on government policy. One participant commented:

"If people are confident it won't cost them anymore then fine, they don't need to know the details."

- Most felt that the public are primarily concerned about costs and jobs, and there was general consensus in both regions to just 'get on with it' on progressing CCS projects.

Yorkshire and Humber

- In Yorkshire and Humber, it was felt that CCS is crucial as part of decarbonisation and energy transition for the region.

- While Yorkshire and Humber has higher emissions than Teesside, Yorkshire and Humber is not as high profile as Teesside within the cluster sequencing process given Teesside mayoral politics.

Aberdeenshire

- In Aberdeenshire, public understanding of CCS is stronger given the long history of engagement processes and employment in the oil and gas industry.
- Some interviewees felt that the cluster sequencing process in Scotland has become politicised.
- CCS is framed as an overall win/win for the Scottish region.

RO2 Public perception of the impacts of this low carbon transition on the industrial heartlands across the UK, specifically in the Humber and Scotland

Areas of consensus

- Expert interviewees generally felt the public supported the CCS and H2 industries within the two regions, given the low carbon energy transition will provide positive economic support to the regions.
- Our interviews with the public supported this: interviewees supported low carbon industries, with more awareness of low carbon transition in Peterhead than Keadby.
- Interviewees highlighted increasing interest in low carbon energy careers, e.g., referring to it as the “new IT”, the big new thing to move into.
- The general sentiment on just transition included the recommendations that jobs are kept in the industrial regions, keeping hold of the skills set and retraining employees if needed, better gender equity than old energy industry, and that local peoples’ voices are heard.

Yorkshire and Humber

- In Yorkshire and Humber, it was felt there is pride in their industrial heritage and broad public acceptance of industry.
- The public are generally supportive of decarbonising industry in the Yorkshire and Humber region given its carbon intensity.
- One industry insider noted the risk of the public viewing these plans for the Humber as greenwash if decarbonisation targets aren’t met. Others emphasised that acceptance of CCS and H2 will depend on job and cost ramifications.
- On public engagement, interviewees stressed the need for industry to be part of community, as opposed to only speaking to community when something is needed. Particularly related to Keadby, interviewees noted the high public acceptance of CCGT or H2 power station:

“They’ve got the heritage in the village...they’ve always lived next to a power station.”

- It was also highlighted that while communities are generally supportive of decarbonisation plans, it can be difficult to find the right message to the public/communities.
- On the relationship between industry and the public sector in the Yorkshire and Humber region, interviewees highlighted the potential mismatch between LEPS/local government and regional industrial decarbonisation plans. They suggested that the public sector could move more quickly to fully advocate for the plans.

- Industry could also do better to speak as one voice in the region, e.g. could all in the East Coast Cluster agree on key messages, and could there be a single point or source of information on the decarbonisation plans and networks?
- There were concerns that closures and Brexit have negatively affected the region; interviewees emphasised the need for a pragmatic approach to decarbonisation.

Aberdeenshire

- In Aberdeenshire, interviewees felt there was a huge opportunity for the region given CO₂ storage capacity and existing oil and gas infrastructure.
- While there was disappointment when previous CCS plans fell through, the public are generally supportive of the plans at Peterhead and broader industrial decarbonisation plans.
- There is a lot of interest in low carbon jobs/careers and retraining workers given there are fewer jobs in the oil and gas sector.
- Particularly in Aberdeenshire, there is an aging population of oil and gas workers, that may perceive that net zero does not affect them.
- Some interviewees suggested that the narrative of just transition was being used strategically by different actors, that there was a risk of it becoming a “buzz word” and politicised in the Scottish context.
- Just transition may allow more inclusion in planning processes, particularly in industrial areas. For Scotland more broadly, it is about distribution of wealth, and wealth being retained in Scotland.

RO3 Public understanding of the opportunities, benefits and challenges associated with CCS and hydrogen and whether increased understanding has an impact on public acceptance

Areas of consensus

- There was broad consensus that the public will be concerned about safety of CO₂ storage, the effectiveness of the technologies to reduce CO₂ emissions, cost, and if the industries provide secure jobs.

Yorkshire and Humber

- In Yorkshire and Humber, the challenge of getting the public engaged in decarbonisation projects was highlighted. There was a belief that most people only engage when construction has started, or when low carbon technologies have close proximity to their daily lives.
- Interviewees highlighted the need to better communicate the tangible benefits of the projects and raised concerns that there may be consultation fatigue.
- The challenge of fairness was also noted, ensuring that people on low incomes can have access to green energy and technology, as well as education and training.
- There was concern that the region was suffering from de-industrialisation, that new projects are needed to engage with public on education around low carbon industry.

Aberdeenshire

- In Aberdeenshire, multiple interviewees noted how people in the Peterhead area are already very supportive of CCS and hydrogen, particularly given Shell completed extensive consultation with the community for the previous CCS competition.
- Interviewees stressed that a key opportunity is jobs:

“What they're looking for is something that's going to replace the industry that they have. So, to secure those jobs to secure, decent paid technical jobs for people...”

- Disappointment was expressed that the Scottish CCUS cluster had not been chosen in Track-1 of the CCUS Cluster Sequencing process (although as the reserve cluster it will continue its development and planning through Phase-2).
- The public was suspicious of competition politics, that this was a political decision (not wanting to provide resources to Scotland) rather than one based on the merits of the project, but all were hopeful that it will eventually be funded.
- While NE Scotland has a significant history of oil and gas employment and the public is generally supportive for CCS and H2, some interviewees noted that there may be limits. Communities may feel they are disproportionately affected by low carbon energy assets, for example, if the landscape becomes too industrialised.
- Others also highlighted that the public knowledge on CCS is still quite low, that it is most likely higher for renewable energy.
- On safety, given people trust gas companies and are used to gas pipelines, interviewees felt the public are unlikely to be concerned about CO₂ pipelines:

“I think people are used to gas in the wider sense pipelines having been managed quite well. And there's a certain amount of trust in how that would be regulated and managed.”

- However, interviewees noted that some members of the public have expressed concern about the safety and efficacy of CO₂ storage.

2.2 Surveys

What the surveys tell us. Six key points.

ONE: Most people **support taking action to tackle climate change**, feel a responsibility to do so, and believe it is important to decarbonise. Despite this, many do not feel well informed about the causes of climate change.

TWO: Most people have heard of Net Zero, but awareness of CCS is much lower. There is strong support for green technologies, except for nuclear power. **The more awareness of green technologies people have, the more accepting of it they are.**

THREE: People in Scotland and in Yorkshire and the Humber in particular believe that investing in CCS will be good for their local area. **People were broadly positive about a CCS facility opening in their local area**, particularly about the positive environmental effects it might have. The potential benefits of CCS that people value the most are reducing carbon emissions and creating local jobs. Protecting local industries was rated as the lowest potential benefit, suggesting that people are unaware that local industries will also need to move towards Net Zero.

FOUR: Some people believe that a CCS facility would produce cheaper energy and cleaner air, and **it will be important that SSE identify any misperceptions about the benefits of the facility.** The **major concerns** people have are **about safety, particularly of the stored carbon dioxide.** They also had concerns about the environment, including building on green space, and that CCS is a short-term solution that delays efforts to reduce carbon production.

FIVE: There are **gender differences**, with males reporting they have heard more about net zero and green technologies and know more about the causes of climate change than females. Despite this, females more strongly agreed than males that the UK needs to take action to tackle climate change, that everybody has a responsibility to reduce climate change, and that it's really important that we move to energy sources that create less carbon. Males were more positive than females towards a CCS facility opening in their local area.

SIX: People would like to find out about a CCS facility through an information leaflet, web page, open day, local news, and public meetings. **Clear, simple statements about CCS generate positive feelings about it**, although less positive for how it is transported and stored. The most positive feelings were elicited by statements about how CCS industries plan on recruiting and training local people and linking with local schools and colleges to provide training opportunities for young people. Very few people reported that the clear, simple statements provided too much information. Most thought it was about right, although a large minority would like more information.

Box 2: Key takeaway messages from the surveys

The aim of survey 1 (national sample with over sampling for Scotland and Humber Industrial Clusters) is to assess the extent to which the UK public knows about, and supports, key elements of the Government and regional industrial cluster CCS and hydrogen policies and plans.

2.2.1 Survey 1 Participants

A total of 1000 participants were recruited⁶. Table 1 provides a summary of socio-demographic information participants is as follows:

Socio-demographic factor	Participants' characteristics
Gender	509 were female, 487 were male, 4 identified in another way.
Age	29% were aged 18-35; 39% aged 36-55; 28% aged 56-75; 4% aged 76+.
Employment pattern	64% were employed or self-employed, 17% were retired, 8% were not working and not looking for work, 4% were looking for work, 2% were students, and the remaining 4% were none of these.
Employment type	13% were managers, directors, or senior officials; 18% were in professional occupations; 6% in associate professional or technical occupations; 18% in administrative or secretarial occupations; 10% in skilled trades; 4% in caring, leisure or service occupations; 5% in sales or customer service occupations; 3% were process, plant, or machine operatives; and the remaining 23% in other occupations. 4% worked in the environmental industry, 3% gas or oil, 3% green energy.
Qualifications	4% reported having no formal qualification, 23% had Level 2 qualifications/GCSEs or equivalent; 25% had Level 3 qualifications/A levels or equivalent; 35% had Level 4 or 5 qualifications/a degree; and 13% had a postgraduate qualification.
Children at home	A third of participants (33%) had children under the age of 18.
Income	Participants varied in how comfortably they were managing on their income: 19% reported that they find it difficult to manage on their current income; 53% that they are just about managing; 25% that they are living comfortably; and 4% that they are living very comfortably.
Main source of heating	Most participants (77%) used gas as their main source of heating, with 17% using electric, 3% oil and 05% each on LPG, bottled gas, heat pumps, and wood.

Table 1: Survey participants

Participants lived in areas across Great Britain, with over-sampling in the two industrial clusters where SSE has power plants (Peterhead and Keadby). Figure 1 below shows the number of people living in each region, and there is a proportionately great number of participants in Scotland and the Yorkshire and the Humber. In several sections of the results we analyse geographical differences, in which we compare the responses of people in Scotland, in Yorkshire and the Humber, and the combined responses of participants in all other regions.

⁶ Participants were recruited through a UK panel organisation.

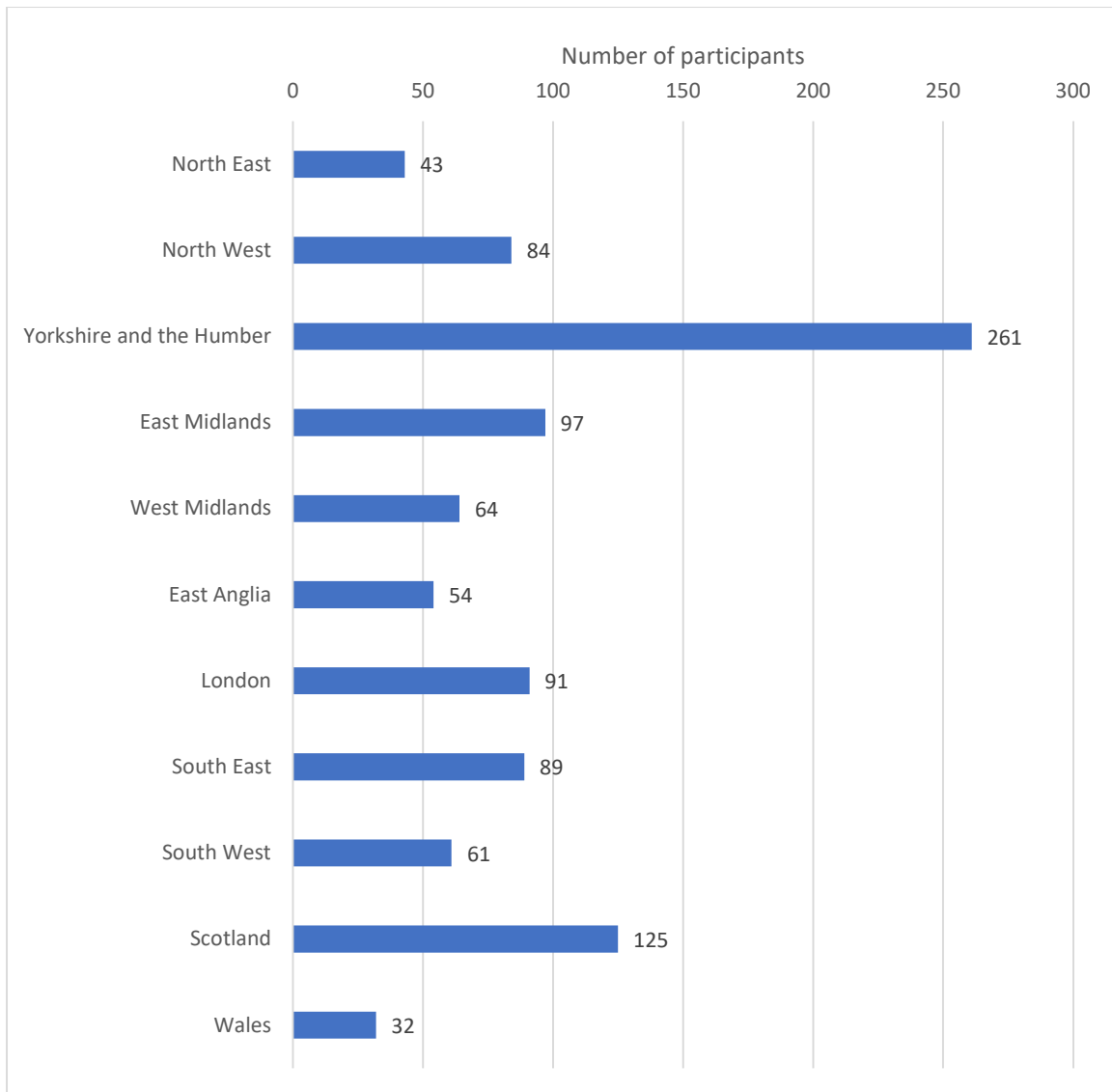


Figure 1: Geographical distribution of participants.

2.2.2 Survey 1 Results

The survey results are presented in four sections. The first reports participants' beliefs about net zero and green technologies. The second reports their beliefs about CCS. The third reports beliefs about hydrogen power plants, and the fourth section reports on our statistical analysis to identify which demographics and beliefs mean that people are most likely to support CCS and hydrogen.

2.2.2.1 Beliefs about climate change and green technologies.

Participants were given the following explanation of the UK's net zero policy:

“The UK government is aiming to reduce UK greenhouse gas emissions to 'Net Zero' by 2050. This involves significantly reducing emissions produced by our industries, transport, food, and homes. Any remaining emissions will be balanced by actions that reduce greenhouse gases already in the atmosphere, such as planting trees.”

They were asked, how much they knew about the concept of Net Zero ‘before today’. They could choose from never having heard of it, to having heard a lot about it. Their responses are shown in Figure 2. This shows most people reported having heard a little (38%) or a fair amount about it (28%), with only a minority having heard nothing (8%) or very little (18%). Males reported having heard more about it than females ($t=9.01, p<0.001$). There was no difference based on where participants live.

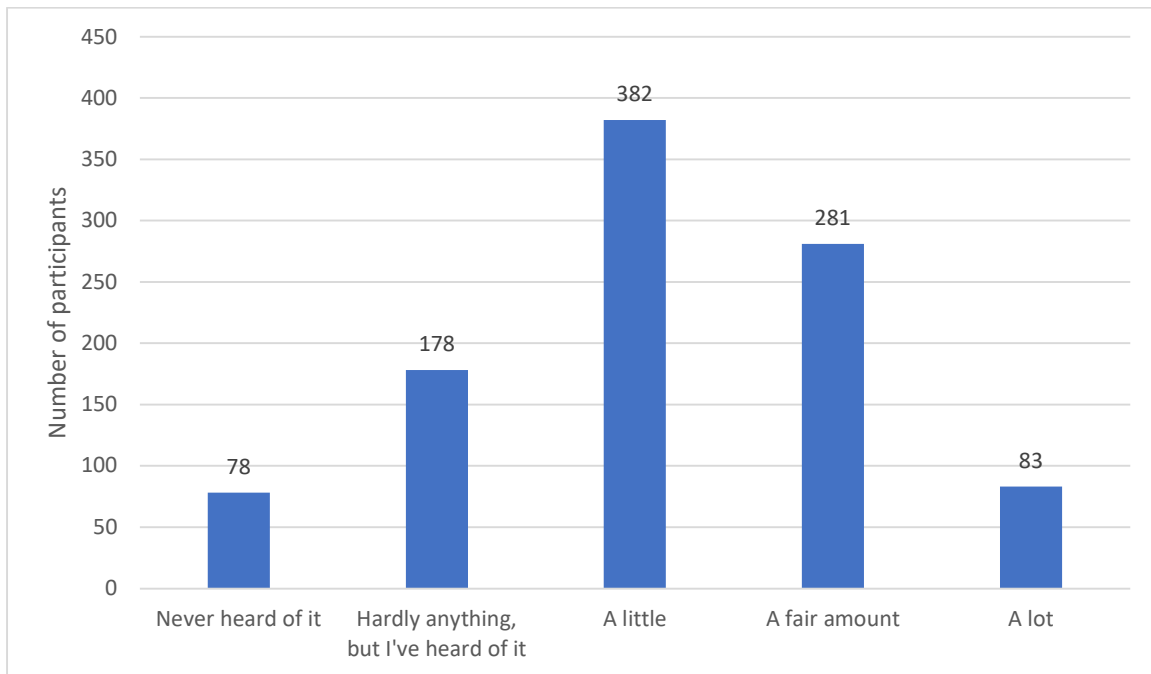


Figure 2: Participants’ familiarity with Net Zero.

Participants were asked how much they agreed or disagreed with a series of statements about climate change:

1. The UK needs to take action to tackle climate change
2. I feel well informed about the causes of climate change
3. Everybody has a responsibility to reduce climate change
4. It’s really important that we move to energy sources that create less carbon.

Their responses are shown in Figure 3. The results show that most people agree or strongly agree with the need to take action to tackle climate change and that everybody has a responsibility to do so, and that it’s important we decarbonise energy. Despite this, many people do not feel well informed about the causes of climate change.

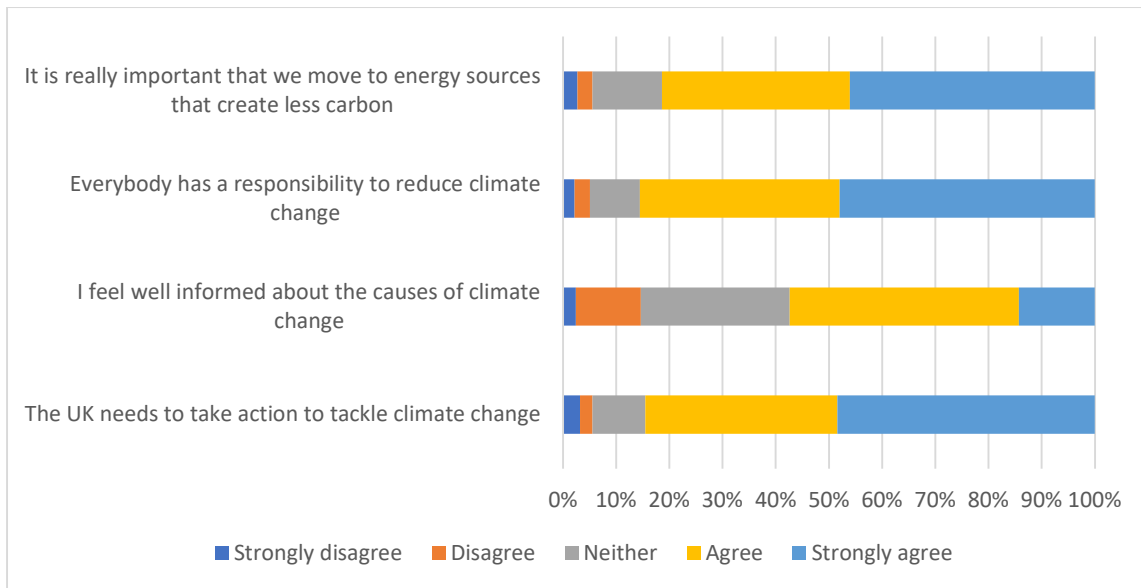


Figure 3: Beliefs about climate change.

Responses were scored so that higher numbers indicate greater agreement and scores compared between males and females. There were significant differences on all the items: females more strongly agreed than males (all $p < 0.05$) that the UK needs to take action to tackle climate change, that everybody has a responsibility to reduce climate change, and that it's really important that we move to energy sources that create less carbon. Males more strongly believed than females that they feel well informed about the causes of climate change ($t = 5.0$, $p < 0.001$).

We compared responses based on where participants live: Scotland, Yorkshire and the Humber and the rest of Great Britain. The mean scores for the four different questions are shown in Figure 4.

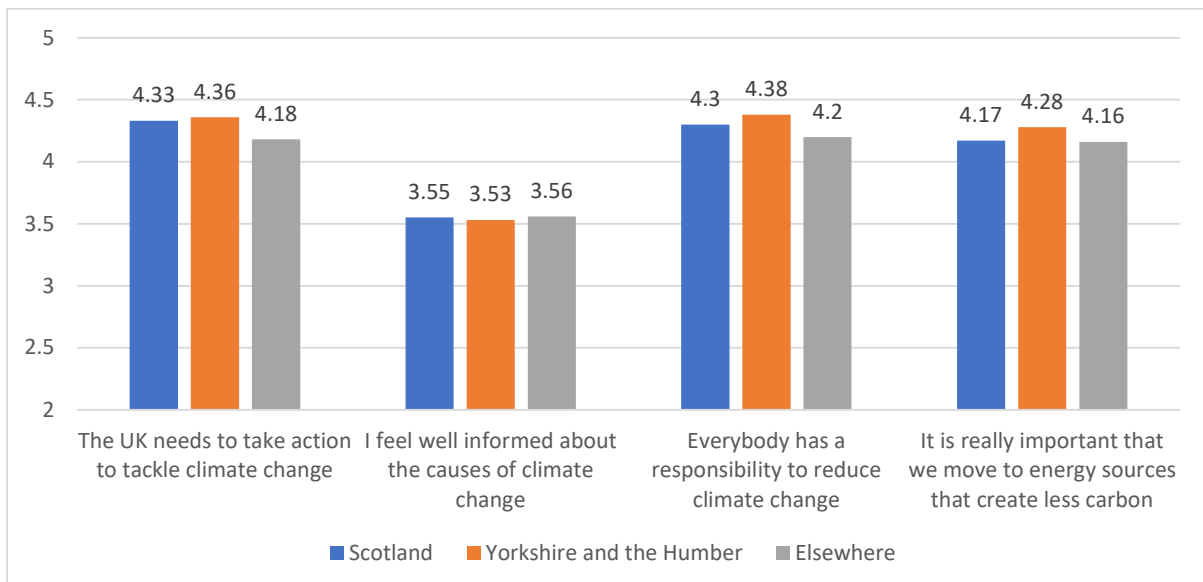


Figure 4: Regional differences in beliefs about climate change.

The median score was compared for each group (using non-parametric medians test due to the non-normal distribution of scores), which showed that people in Yorkshire and the Humber are more

likely to agree strongly with the three beliefs about tackling climate change (all $p < 0.02$), and there was no difference in how well informed they believed they are about the causes of climate change.

Participants were asked about how much they know about a series of green technologies. They could choose from never having heard of it, hardly anything, but they have heard of it, a little, a fair amount, and a lot. The range of responses for each technology is shown in Figure 5 and the mean score (where higher scores indicate greater awareness) in Figure 6. Relatively few participants were aware of direct air capture, biomass or CCS. Slightly more were aware of hydrogen. They were most aware of solar power, wind power and nuclear energy. We tested for gender differences in awareness of the technologies, and males reported greater awareness than females across all the technologies (all $p < 0.05$). There were no geographical differences.

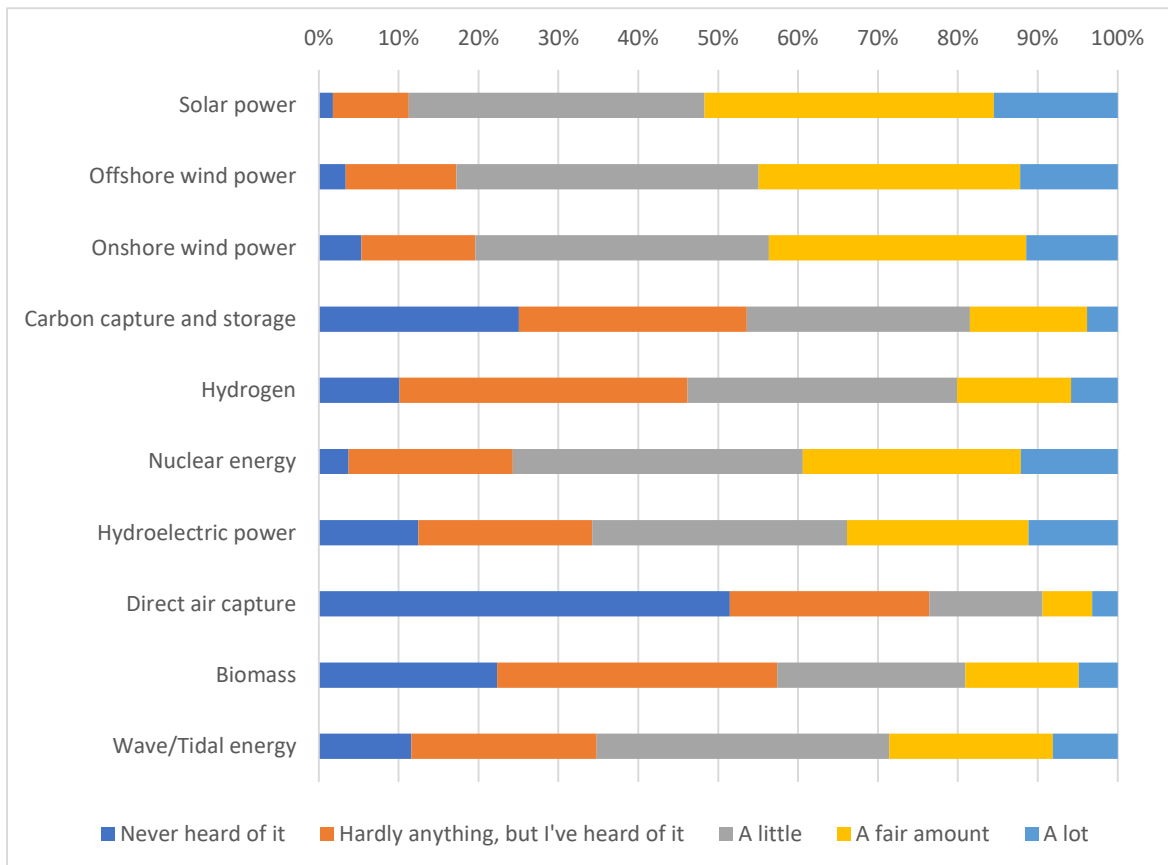


Figure 5: Awareness of green technologies.

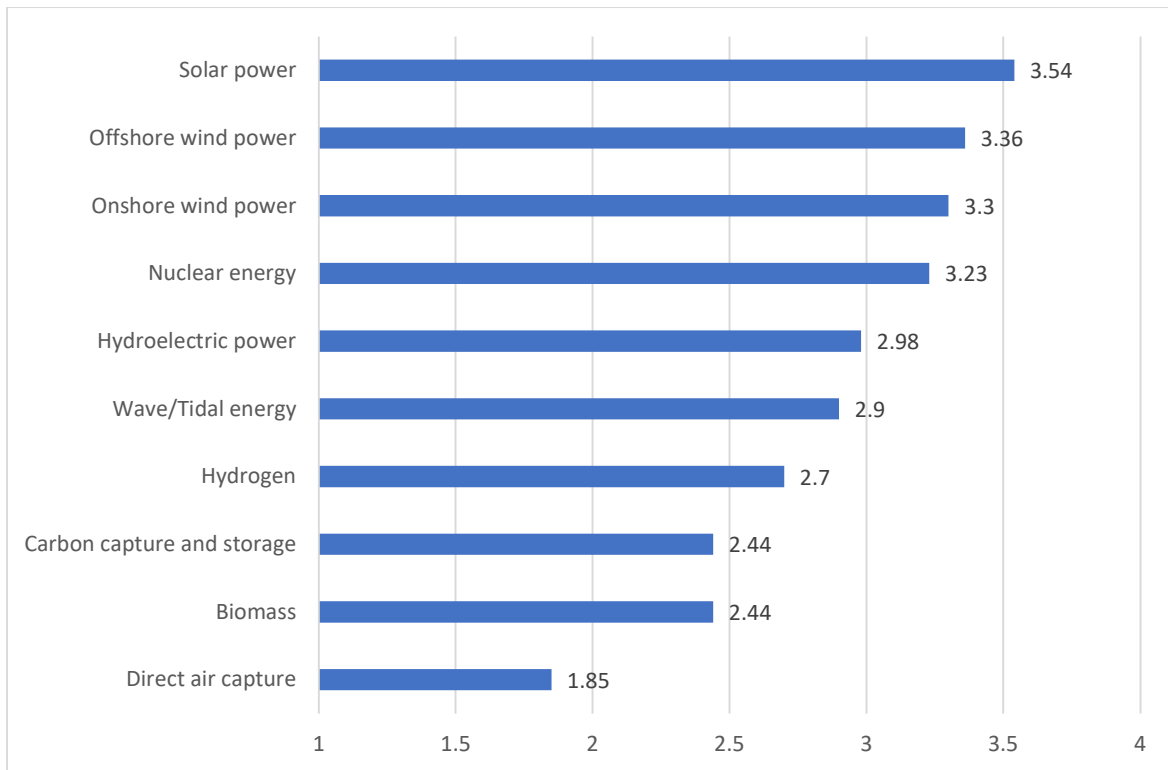


Figure 6: Average (mean) awareness of green technologies.

Participants were also asked how they would feel about these technologies being used in their local area. They could choose from being very unhappy, fairly unhappy, they wouldn't mind either way, fairly happy or very happy. Their average (mean) responses are shown in Figure 7. The results show strongest acceptance for solar power, and support for all other technologies except nuclear power.

It is worth noting that there is a significant correlation between awareness of technology and acceptance of it being used locally for both CCS ($r = 0.26$, $p < 0.001$) and for hydrogen ($r = 0.3$, $p < 0.001$).

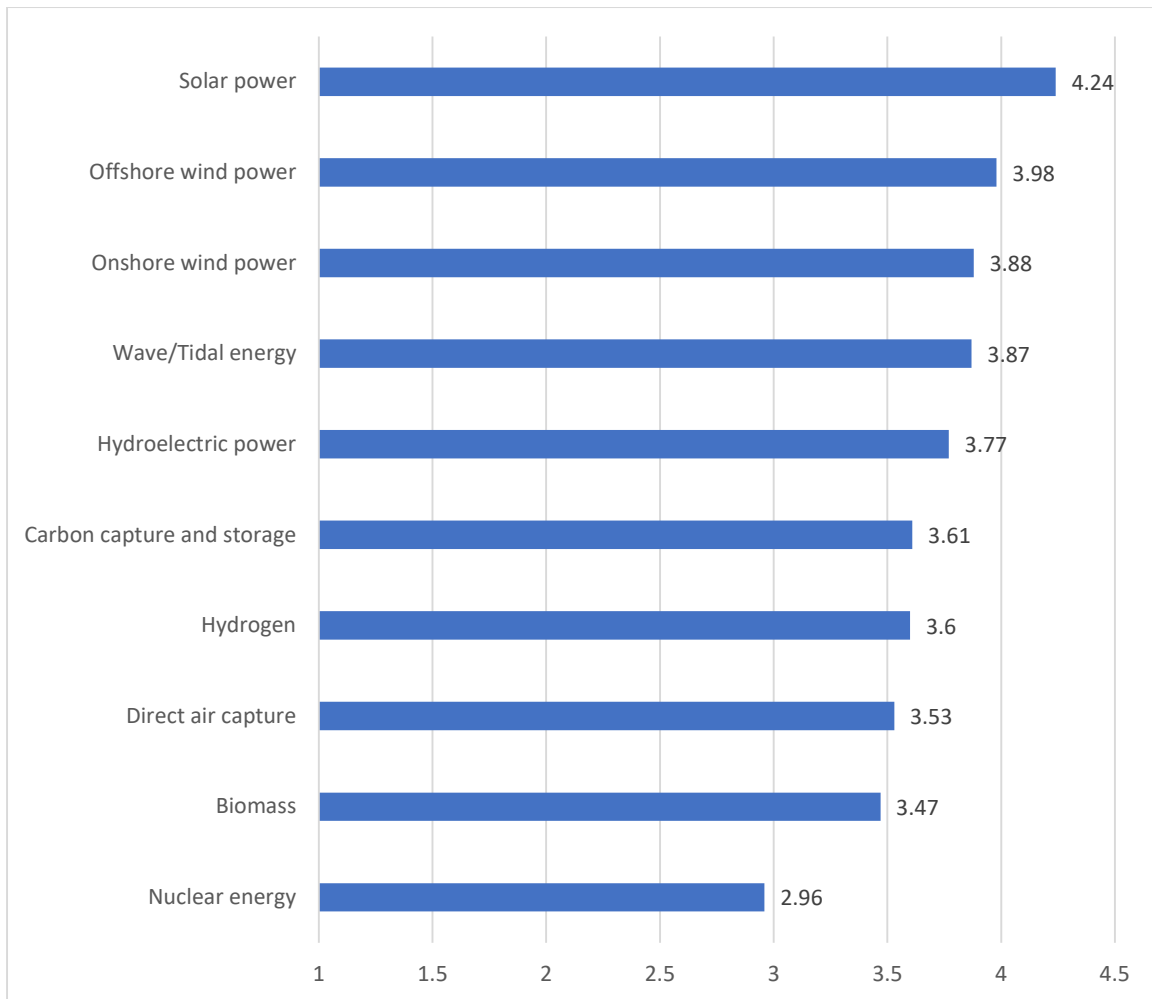


Figure 7: Acceptance of green technologies being used locally.

2.2.2.2 Beliefs about carbon capture and storage

Participants were told that

“Carbon capture and storage is a technology that stops greenhouse gases entering the atmosphere. It typically involves capturing carbon dioxide (CO₂) emissions from power stations or industrial facilities where emissions are high. The CO₂ is then piped to offshore underground storage sites, where it can be safely and permanently stored.”

They were asked how much they had known about CCS before today.

- 35% had never heard of it
- 28% had heard hardly anything
- 23% had heard a little
- 11% had heard a fair amount
- 3% had heard a lot.

Awareness of CCS is low, with over half (63%) having heard nothing or hardly anything about it before the survey. This corresponds with findings in the focus groups (see Section 2.5). They were then asked a series of questions to measure their beliefs about CCS. They could choose that they

strongly agree, agree, neither agree nor disagree, disagree, strongly disagree, or that they do not know. Their responses are shown in Figure 8. A relatively high proportion of people responded that they don't know, reflecting the lack of awareness of this technology. Even people who had a view about CCS were often uncertain about whether they agreed or disagreed; typically around 30%. The results show that overall, people disagree that UK investment in CCS is a waste of money, they agree that it is a good way to help meet net zero, that it will create good jobs, and it will be good for the local area.

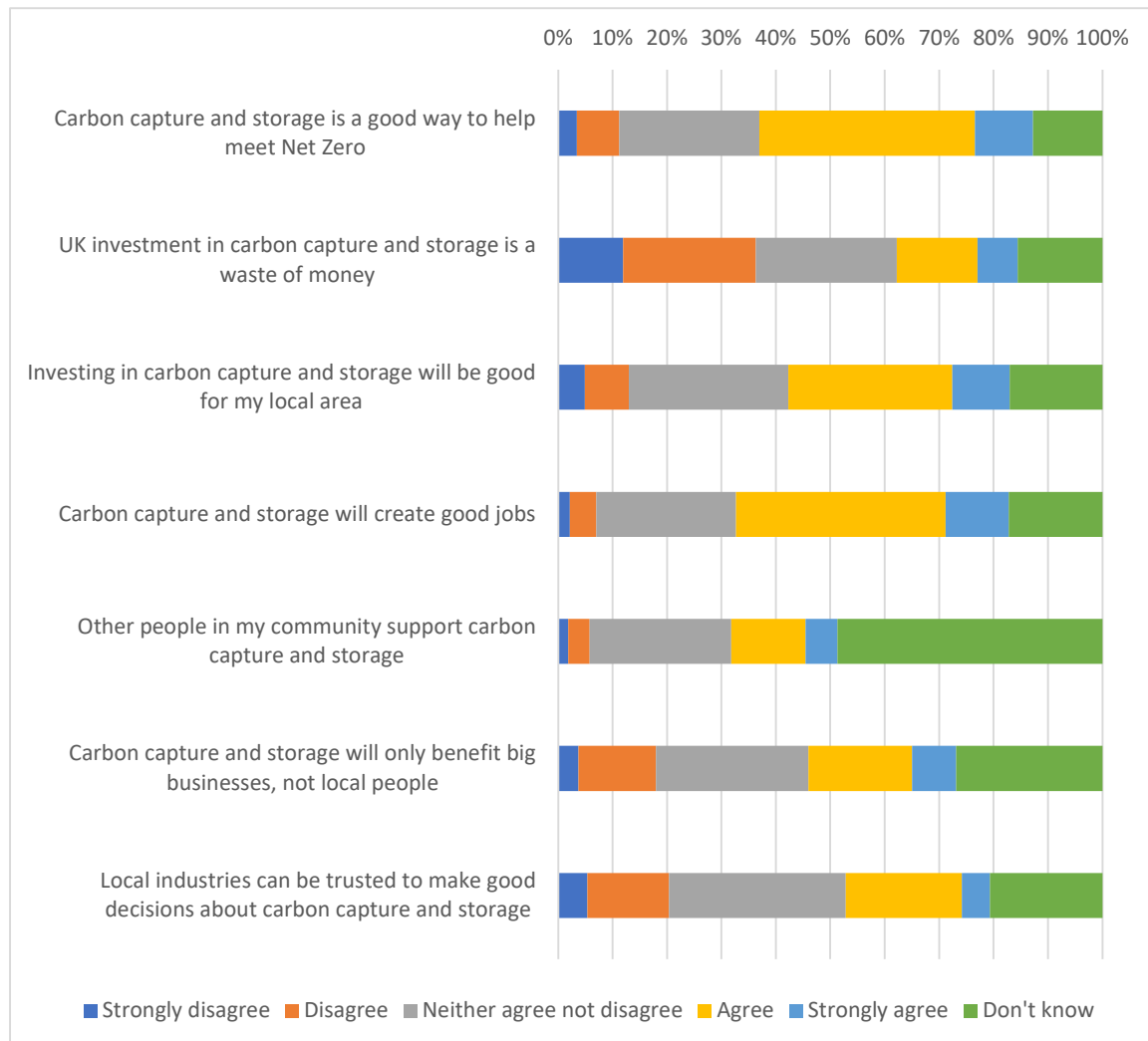


Figure 8: Beliefs about carbon capture and storage.

Responses were scored between 1 (strongly disagree) and 5 (strongly agree) so that higher scores indicate stronger beliefs in each statement. Average (mean) scores are shown in Table 2 below, along with the percentage of people who did not know (who were not included in the average score). There were no differences based on gender, and only one difference based on geography: people in Scotland and in Yorkshire and the Humber have stronger beliefs that investing in CCS will be good for their local area ($F=4.6, p = 0.01$).

Statement	Mean score	Don't know
Carbon capture and storage is a good way to help meet Net Zero	3.53	13%
UK investment in carbon capture and storage is a waste of money	2.78	16%
Investing in carbon capture and storage will be good for my local area	3.4	17%
Carbon capture and storage will create good jobs	3.64	17%
Other people in my community support carbon capture and storage	3.35	49%
Carbon capture and storage will only benefit big businesses, not local people	3.18	27%
Local industries can be trusted to make good decisions about carbon capture and storage	3.08	21%

Table 2: Beliefs about carbon capture and storage.

Participants were given a list of five potential ways in which communities could benefit from CCS and asked to rank them from most important (1) to least important (5). The average (mean) ranks are shown in Figure 9. Reducing carbon emissions was perceived as the most important benefit, followed by creating local jobs. Protecting local industries was rated as the lowest potential benefit. There were no geographical differences in this pattern of results, but males ranked protecting local industries as being more important than females, and females ranked becoming a global leader as being more important than males.

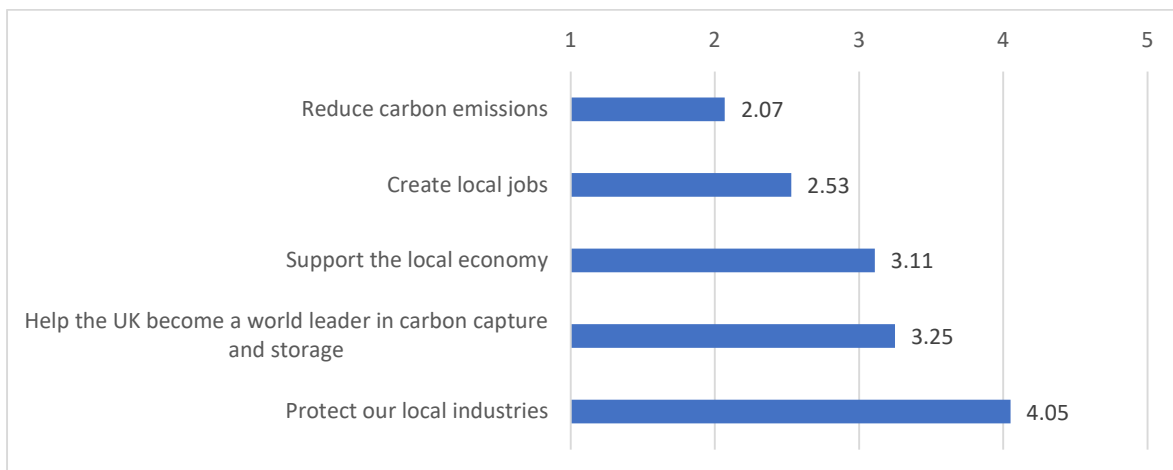


Figure 9: Ranked importance of potential benefits from carbon capture and storage.

Participants were asked to imagine that within the next five years a CCS facility were set up in their local area. They were asked to rate, using a scale from 0-100, how they would feel about:

- how safe it is (very dangerous to very safe);
- how it affects the environment (bad for the environment to good for the environment);
- how worried they would feel (very worried to not worried at all);

- whether they would support it (strongly against it to strongly for it).

Average (mean) responses are shown in Figure 10, where higher scores indicate a more positive response to a CCS facility opening in their local area. Participants were most positive about the environmental effects and had slightly positive beliefs about all aspects. Males had higher scores on all of these questions ($p < 0.001$) indicating that they believe a CCS facility in their area would be safer, better for the environment, they would be less worried, and they would support it more than females. There was one geographical difference: participants in Scotland would support it more.

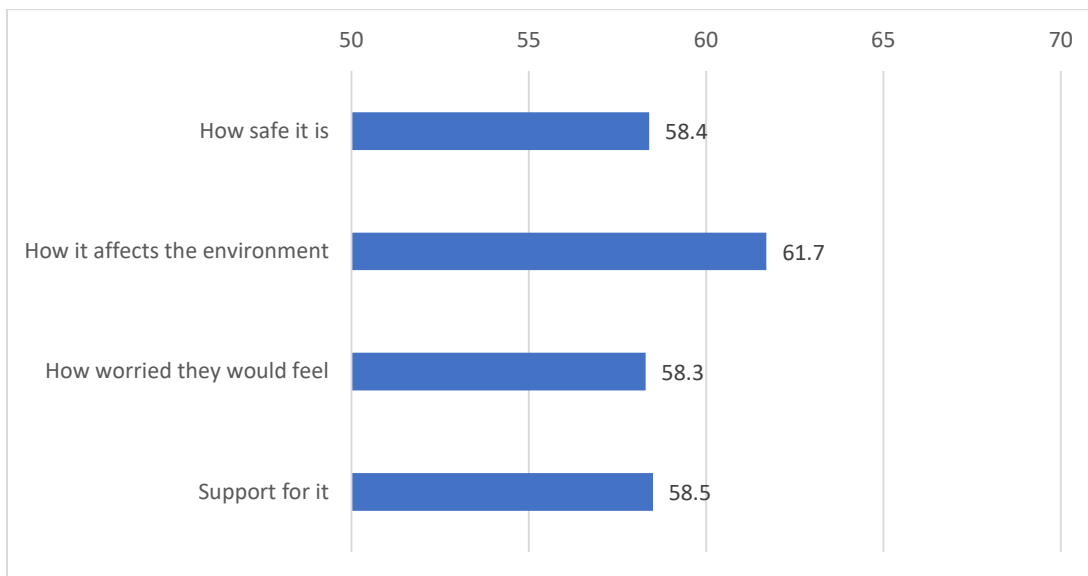


Figure 10: Participants' responses to a CCS facility opening in their local area.

Participants were asked whether a CCS facility in their area should store CO₂ from other areas of the UK. They could select from three options:

- 25% selected yes, it should
- 25% selected no, it shouldn't
- 50% selected yes, if our local area benefits

They were asked how they would like to find out about a CCS facility opening in their local area.

- 52% would like an information leaflet
- 38% would like a webpage
- 34% would like an Open Day
- 22% would like social media
- 21% would like a video
- 6% suggested alternative ways of finding out, mainly through television news, local newspapers, through the local council, public meetings, and word of mouth. A few reported that they would not be interested.

Participants were also asked two open questions about the benefits *they would like to see* if a CCS facility were to open in their local area, and about any disadvantages that there might be.

Benefits

We identified five groups of participants' responses, these were:

- Benefits for the local economy
- Benefits for the environment
- Cheaper energy
- Don't know
- CCS will not bring benefits

Benefits for the local economy

The most common response was that they would like to see a CCS facility in their local area benefitting the local economy, with many participants commenting that they would like it to offer employment opportunities. The scale of this, along with specific details of the jobs, varied, with some commenting that they would like the facility to offer a few jobs, and others that they would like a specific type of job or that the jobs are well paid. Several talked about they would like it to provide training opportunities. A few commented about how they would like local industry from a supply of decarbonised energy or that they would like it to bring new businesses or investment into the area. A few commented that they would like it to bring better infrastructure (e.g., roads) into the area, or new amenities.

"A boost to the local economy and jobs market."

"I would like to see new local jobs being created and the facility to help support the local economy."

"Create jobs for local people."

"A high number of well-paid part-time work made available."

"Boost local economy, better paying jobs, innovation."

"Better infrastructure."

"Bring wealth to the local area."

"Investment in leading technology and expertise in my local area."

"Community payback, better regular infrastructure i.e., roads, etc."

"Creating new jobs, it would also help industries be able to open up without worrying so much about their carbon footprint."

Benefits for the environment

Many participants hoped that a CCS facility would bring environmental benefits. Some simply stated that they would like it to improve the environment, while some were more specific, for example that they would like it to tackle global warming, result in less pollution, improved air quality, or that the wider population would benefit because of becoming carbon neutral. Several commented that they would like CCS to produce cleaner energy. A few thought that it would become more efficient too. A few gave more specific responses, such as they would like it to enable us to use fossil fuels for longer.

"If it helps the environment to recover it must be a really good thing."

"Better air quality in my community."

"Reduce pollution."

"Cleaner and fresher air in the locality."

"Cleaner and healthier air."

"It would be a benefit to know that it is just helping the planet."

"Greener energy"

"Clean and efficient energy source."

"Energy needs to get greener."

Cheaper energy

A few of the comments were about how participants would like CCS to reduce the cost of energy, either generally or for local people. One commented that there would be cheaper carbon dioxide for local businesses.

"Cheaper energy prices."

"Cheaper bills."

"Discounts for locals on energy bills."

"Cheaper CO2 gas supply for pub drink dispense."

Don't know

A large number of participants simply commented that they don't know.

"Don't know."

"Don't know enough about this to have an opinion."

"Do not know enough about it to know if it would benefit or not."

Carbon capture and storage will not bring benefits

A small number of participants were negative about a CCS facility, and commented that they do not anticipate any benefits, or it is an inappropriate technology. A very small number had concerns about safety.

"None."

"I don't see any real benefits. It seems to be a technology which just hides a problem and consumes resources without creating any tangible benefits."

"I have no interest in such political propaganda, which IS what THIS really IS...nothing more!!"

"I'm not sure this is safe at all and cannot see any benefits."

"It will help in the short-term to reduce carbon emissions. For the record, I am against the idea. Carbon capture & storage is a hasty and short-term intervention for a massive problem which exists only due to previous complacency and inaction. This sort of stopgap intervention

only gives industries more time for inaction and passes the problem onto future generations in the interests of making short term profit.”

Disadvantages

We also asked participants about what disadvantages there might be if a CCS facility were to open in their local area. We identified five categories of answer, described below. These are:

- Don't know
- Safety concerns
- Environmental concerns
- Making their area a less desirable place to live
- Expensive or unnecessary

Don't know

The most common response was that people don't know enough about CCS to think about any disadvantages.

“Do not know enough about it to understand what disadvantages it might bring.”

“I don't think there would be any disadvantages.”

Safety concerns

The next most common response was about safety concerns. Most concerns were about the safety of the stored carbon dioxide. Some were worried about the consequences of any leaks, and others were concerned that we are creating problems for future generations. One pointed to media reports of a carbon dioxide leak.

“Having a carbon storage facility under my feet and not knowing how safe it is.”

“Does anyone know how safe it truly is storing it underground.”

“How safe is it? What happens if there is a leak?”

“Health effects if storage facilities fail or malfunction.”

“Don't know, but what happens to the co2 for future generations?”

“In February 2020, a leak from a carbon dioxide pipeline in Mississippi had hospitalized 49 people.”

Environmental concerns

Many of the comments were about concerns about what would happen to the environment. These were commonly about building on green space, and the loss of natural and wildlife habitat. Concerns about disruption arising from construction works were also common. These included increased traffic, noise, and inconvenience. Some were concerned that the facility might appear unattractive. Some were concerned that CCS is a short-term solution and adopting it could delay efforts to reduce carbon production.

“Loss of green space.”

“More building, spoiling our countryside.”

“Environmental destruction when building it with continuing local degradation of the landscape and natural resources.”

“Eyesore building.”

“If it was overground, then a large green belt area would have to be built on. If underground then minimum building on greenbelt would be acceptable to me, for the wider good.”

“It seems to be greenwashing, hiding away the CO2 when you should be using it for something else - disposing of it appropriately or not producing it at all. Like burying rubbish underground hasn't solved the problem.”

“It doesn't solve the problem of the fact that our lifestyles are responsible for so much in the way of CO2 emissions. It cannot be sustainable in the long term.”

“It doesn't encourage companies to reduce their carbon footprint.”

A less desirable place to live

A few of the comments were about not wanting to live near a CCS facility in case it made the area a less desirable place to live. Several commented that it might produce a lot of noise or pollution. Several expressed concerns about a potential increase in traffic. Several were about house prices dropping.

“Heavy machinery traffic pollution. Not loads of jobs as I feel it is an automated process”

“Fumes from all the machines they use.”

“More traffic and congestion.”

“Noise, road disruption, less safe, dirty.”

“It will probably be an eyesore and may affect the prices of local homes.”

“House prices might fall.”

“Increase in traffic moving containers to the coast for disposal/storage road traffic.”

Expensive or unnecessary

A few comments were about the cost of creating the facility, both in terms of constructing it and operating it. A few were about not believing that climate change is happening.

“Expensive to run so taxes might increase as a result.”

“It is just a huge waste of public money. Net zero policies should be scrapped as they are just costing too much money and pushing people into poverty as they struggle to pay their energy bills. The whole area of climate change is bad science based on short term observation and poor computer models.”

2.2.1.3 Beliefs about Hydrogen

Participants were told:

“Hydrogen is used as a fuel in some industrial processes. When produced in an environmentally friendly way, hydrogen can help reduce carbon emissions.”

They were asked: before today how much did you know about hydrogen being used as a fuel in some industrial processes in the UK?

- 21% had never heard of it
- 34% had heard hardly anything
- 30% had heard a little
- 12% had heard a fair amount
- 3% had heard a lot.

Awareness of hydrogen was a little higher than that of CCS, with 55% having heard nothing or hardly anything about it before the survey (compared with 63% for CCS). Males reported knowing more about hydrogen than females ($t=9.6$, $p<0.001$). There were no significant geographical differences.

Participants were asked to imagine that within the next five years a hydrogen power plant were set up in their local area. They were asked to rate how they would feel about it, using a scale from 0-100:

- how safe it is (very dangerous to very safe);
- how it affects the environment (bad for the environment to good for the environment);
- how worried they would feel (very worried to not worried at all);
- whether they would support it (strongly against it to strongly for it).

Average (mean) responses are shown in Figure 11, where higher scores indicate greater support. Beliefs are all positive, although less positive than CCS for safety ($t=3.04$, $p=0.002$) and how it affects the environment ($t=2.57$, $p=0.01$). As with the CCS results, males had higher scores on all of these questions ($p<0.001$) indicating that they believe a hydrogen power plant in their area would be safer, better for the environment, they would be less worried, and they would support it more than females.

There were no geographical differences.

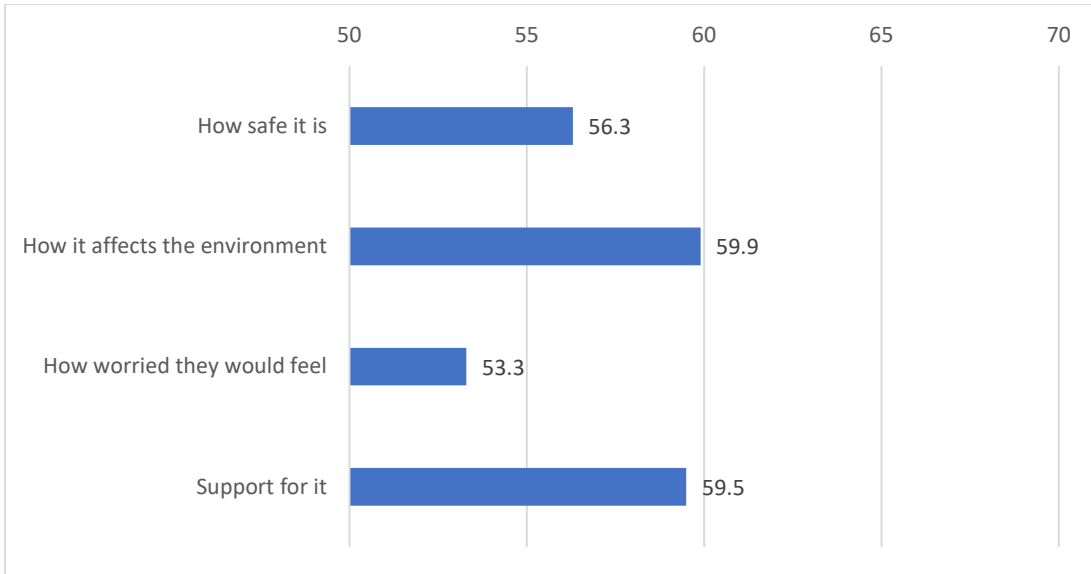


Figure 11: Participants' responses to a hydrogen power plant opening in their local area.

Participants were asked to choose which type of fuel the power station should use, choosing one or more from the following three options. The percentage selecting each type of hydrogen is shown in Figure 12.

- Hydrogen created from water (green hydrogen). This is currently expensive, but no carbon is involved.
- Hydrogen created from natural gas (blue hydrogen). The carbon is captured and stored.
- Neither - power stations should not use hydrogen.

The results show strong support for hydrogen, 83% believing that some form of hydrogen should be used. There was stronger support for green hydrogen than for blue hydrogen, despite participants being told that it is currently expensive.

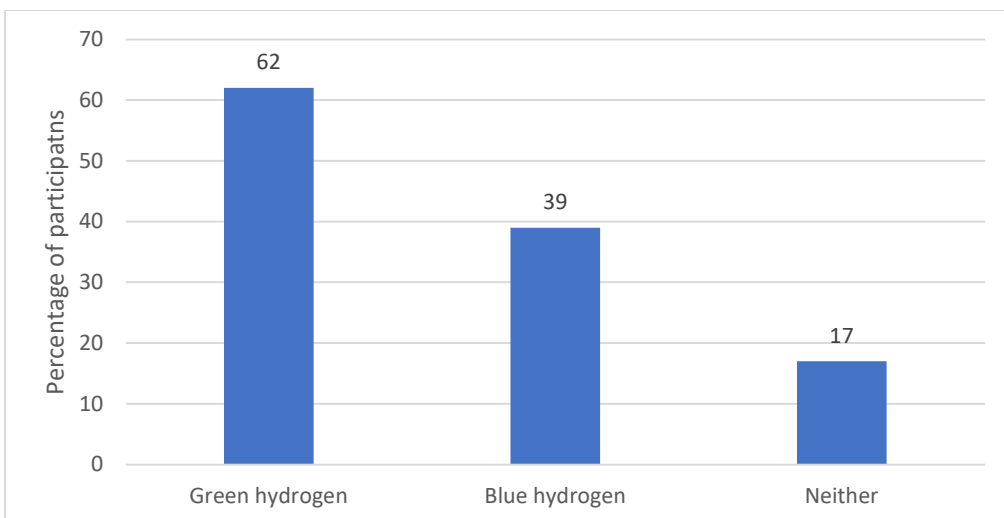


Figure 12: Support for green and blue hydrogen.

Participants were told:

“We don’t know how much it will cost to decarbonise the electricity grid.”

They were asked for every £100 they spend on electricity at the moment, how much extra they would be prepared to pay if the CO₂ emissions were removed using three different: creating electricity from blue hydrogen (using CCS of natural gas); creating electricity from green hydrogen; and creating electricity from renewable energy, e.g., wind and solar power. The amount they would be prepared to pay is shown in Figure 13. Participants would be prepared to pay more for decarbonised electricity. They would be prepared to pay just under 10% more for electricity from blue hydrogen, just over 11% for electricity from green hydrogen, and the most – nearly 13% for electricity from renewable sources.

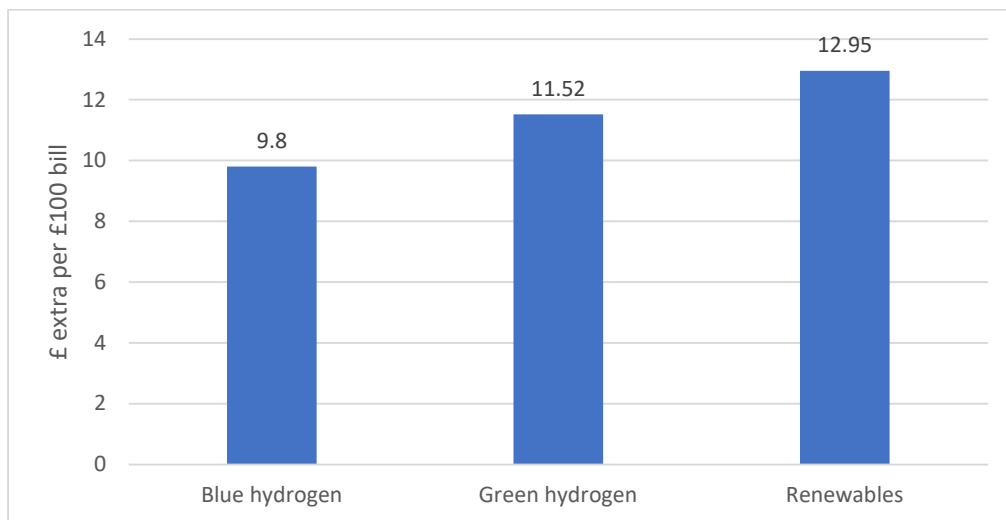


Figure 13: Willingness to pay extra for decarbonised electricity.

2.2.2.4. What beliefs and demographics predict support for carbon capture and storage and hydrogen?

We created a series of linear regression models to identify beliefs that predict support of CCS and hydrogen power plants.

Beliefs

The following beliefs were predictive of support for CCS.

- Previous awareness of CCS (standardised Beta = .16⁷)
- Believing CCS is a good way to meet net zero (standardised Beta = .29)
- Not believing UK investment in CCS is a waste of money (standardised Beta = -.26)
- Not believing CCS will only benefit big businesses, not local people (standardised Beta = -.27)

Believing local businesses can be trusted to make good decisions about CCS was not a significant predictor. There was insufficient variability in the data to identify whether believing CCS will create

⁷ The statistic reported – standardised Beta – indicates the predictive strength, with higher values indicating greater predictive strength.

good jobs and believing others in the community will support it were predictive. Most participants believed that it would create good jobs, and most did not know whether others would support it.

The following beliefs were predictive of support for hydrogen power plant.

- Previous awareness of hydrogen as a fuel in industrial processes (standardised B = .06)
- Believing it is safe (standardised Beta = .47)
- Believing it will have a positive environmental effect (standardised Beta = -.36)
- Not feeling worried about it (standardised Beta = .09)

Demographics

We also examined the demographics that predict support. The following were predictors of CCS:

- Gender (males more than females)
- Age (18-35 more than 56-75)
- Household income (living comfortably more than those finding it difficult to live or coping on current income)

Neither qualifications nor having children under the age of 18 were predictors.

The following demographics were predictive of support for hydrogen:

- Gender (males more than females)
- Age (18-35 more than 36-55)
- Household income (living comfortably more than those finding it difficult to live or coping on current income)

Neither qualifications nor having children under the age of 18 were predictors.

2.3 Survey 2

Following the focus groups, we conducted a second survey to find out more about the information that people want about CCS and how it might bring a CCS facility in the local area could bring jobs to the community, and how it affects their support for CCS.

2.3.1 Survey 2 participants

A total of 604 participants were recruited⁸ for Survey 2 which was above our target (500). This was a national survey, with no over-sampling in Yorkshire and Humber and Scotland. Table 3 provides a summary of socio-demographic information participants.

Socio-demographic factor	Participants' characteristics
Gender	298 female, 305 male and 1 who identified in another way.
Age	There was a good range of ages, although a little older than in Survey 1: 18% were age 18-35; 38% age 36-55; 38% 56-75; 6% age 76+.
Employment pattern	58% were employed or self-employed, 24% were retired, 7% were not working and not looking for work, 4% were looking for work, 3% were students, and the remaining 4% were none of these.
Employment type	12% were managers, directors, or senior officials; 22% were in professional occupations; 7% in associate professional or technical occupations; 13% in administrative or secretarial occupations; 10% in skilled trades; 5% in caring, leisure or service occupations; 6% in sales or customer service occupations; 2% were process, plant, or machine operatives; and the remaining 23% in other occupations. Of these, 2% worked in the environmental industry, 2% gas or oil, 1% green energy
Qualifications	There was a wide range of qualifications: 5% reported having no formal qualification, 22% had Level 2 qualifications/GCSEs or equivalent; 24% had Level 3 qualifications/A levels or equivalent; 38% had Level 4 or 5 qualifications/a degree; and 11% had a postgraduate qualification.
Children at home	A quarter of participants (25%) had children under the age of 18. ⁹
Income	Participants varied in how comfortably they were managing on their income: 19% reported that they find it difficult to manage on their current income; 58% that they are just about managing; 19% that they are living comfortably; and 4% that they are living very comfortably.
Main source of heating	Most participants (78%) used gas as their main source of heating, with 14% using electric, 3% oil, 2% heat pump, 1% wood, 1% LPG, and 0.7% on bottled gas.

Table 3: Survey participants

⁸ Participants were recruited through a UK panel organisation.

⁹ This is lower than in Survey 1 and may be reflective of the sample being older.

2.3.2 Survey 2 results

Participants were asked how much they agreed or disagreed with a series of statements about climate change:

1. The UK needs to take action to tackle climate change.
2. I feel well informed about the causes of climate change.
3. Everybody has a responsibility to reduce climate change.
4. It's really important that we move to energy sources that create less carbon.

Their responses are shown in Figure 14. As in Survey 1, the results show that most people agree or strongly agree with the need to take action to tackle climate change and that everybody has a responsibility to do so, and that it's important we decarbonise energy. Despite this, many people do not feel well informed about the causes of climate change.

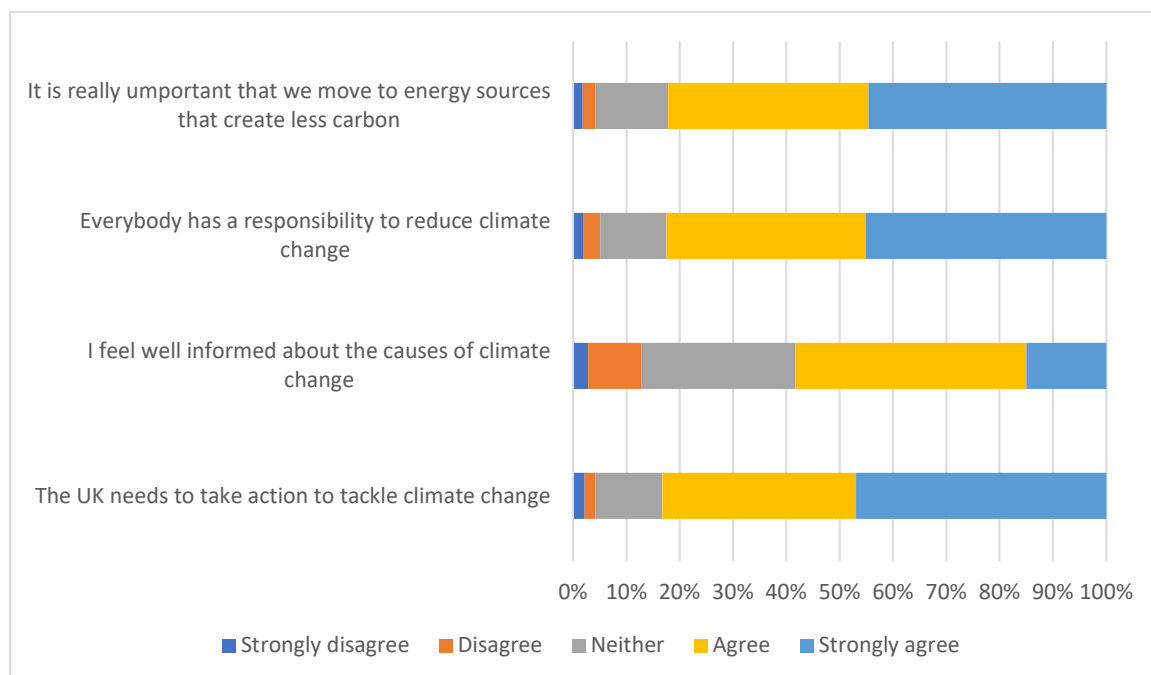


Figure 14: Beliefs about climate change.

We designed 12 statements – clustered into four groups each with three statements. The first cluster provided information about what CCS is, the second cluster about what it is used for, the third cluster about the industrial strategy for CCS, and the fourth cluster was about local jobs. The statements are shown below.

Cluster 1: What is carbon capture and storage?

1. Carbon capture and storage is a technology designed to reduce the amount of carbon dioxide (CO₂) from entering the atmosphere.
2. Carbon capture and storage typically involves capturing CO₂ emissions from coal and gas power stations or industrial facilities where emissions are high, for example from cement

and steel production.

3. The captured CO₂ is compressed, piped offshore, and stored deep underground in, for example, depleted oil and gas reservoirs. This prevents it from being released into the atmosphere.

Cluster 2: Why use carbon capture and storage?

4. Carbon capture and storage helps tackle climate change by reducing carbon emissions when electricity is generated from fossil fuels.
5. Carbon capture and storage involves removing carbon dioxide from the electricity generator flue gases so that it's not released into the atmosphere.
6. Using carbon capture and storage in power stations that generate electricity using gas would mean we can continue to use gas to generate electricity without increasing CO₂ emissions.

Cluster 3: How does carbon capture and storage relate to industrial strategy?

7. The Government Climate Committee estimates that carbon capture and storage can remove 90% of current carbon emissions (from power plants and industrial facilities).
8. Carbon capture and storage is seen as crucial for the UK to meet its Net Zero targets.
9. Carbon capture and storage will help meet global carbon reduction targets.

Cluster 4: What jobs might a carbon capture and storage facility bring?

10. Carbon capture and storage developments aim to create new green, low carbon jobs in areas of UK that currently have high carbon emissions.
11. Carbon capture and storage industries plan on recruiting and training local people.
12. Carbon capture and storage industries plan on working with local schools and colleges to provide training opportunities for young people.

After each statement, participants were asked to rate how it made them feel about CCS, using a scale from 0 (very negative) to 100 (very positive). The average (mean) positivity is shown in Figure 15, where higher numbers indicate greater positivity. The results show that all the statements generate positive feelings about CCS, although Statement 3 about how it is transported and stored generates less positivity, indicating the results from the focus groups that people are concerned about how the carbon is stored are generalisable. The most positive feelings were elicited by statements about the jobs CCS might generate, in particular that CCS industries plan on recruiting and training local people and linking with local schools and colleges to provide training opportunities for young people.

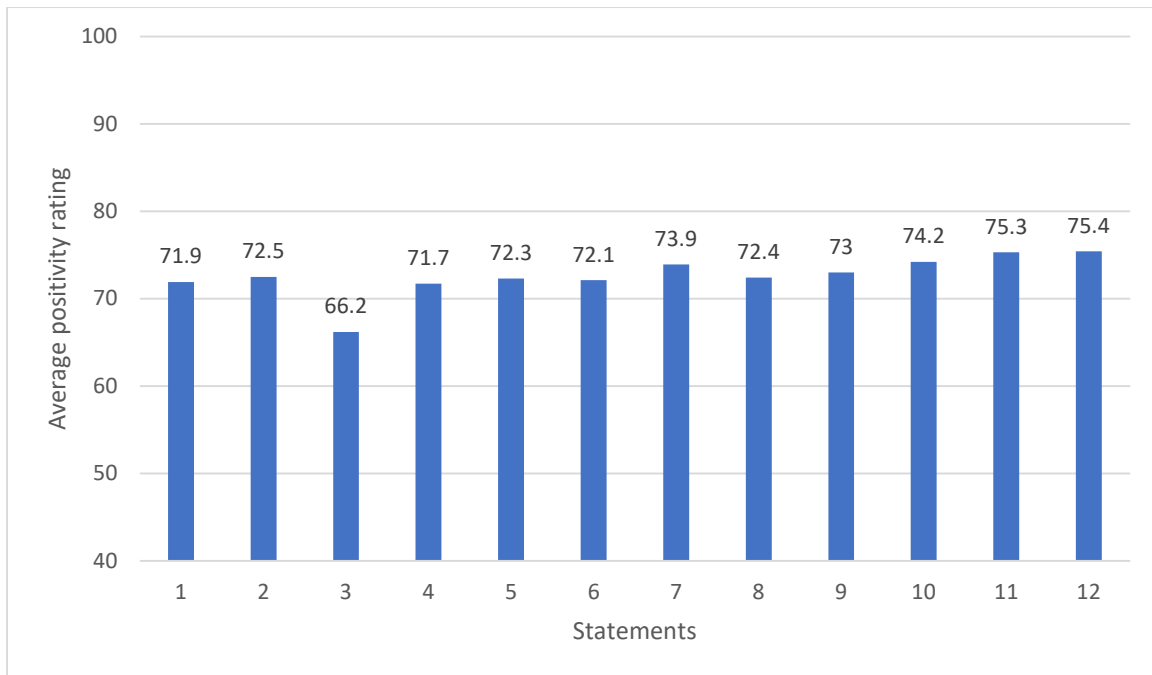


Figure 15: how positive each statement makes people feel about carbon capture and storage.

After each cluster of three statements participants were asked two additional questions. The first was about the amount of information:

- There wasn't enough – it left me with questions
- About right – it told me what I need to know
- There was too much information

The second was whether they would support a CCS facility in their local area. They were asked to rate their support from 0 (definitely not) to 100 (definitely yes).

Their views on the amount of information in each cluster are summarised in Figure 16. The results show that very few people reported that there was too much information. Most thought it was about right, although a large minority would like more. There were no differences based on gender, age, or household income. There was only one significant difference based on qualifications: people with a postgraduate degree wanted more information than those with GCSEs about industrial strategy.

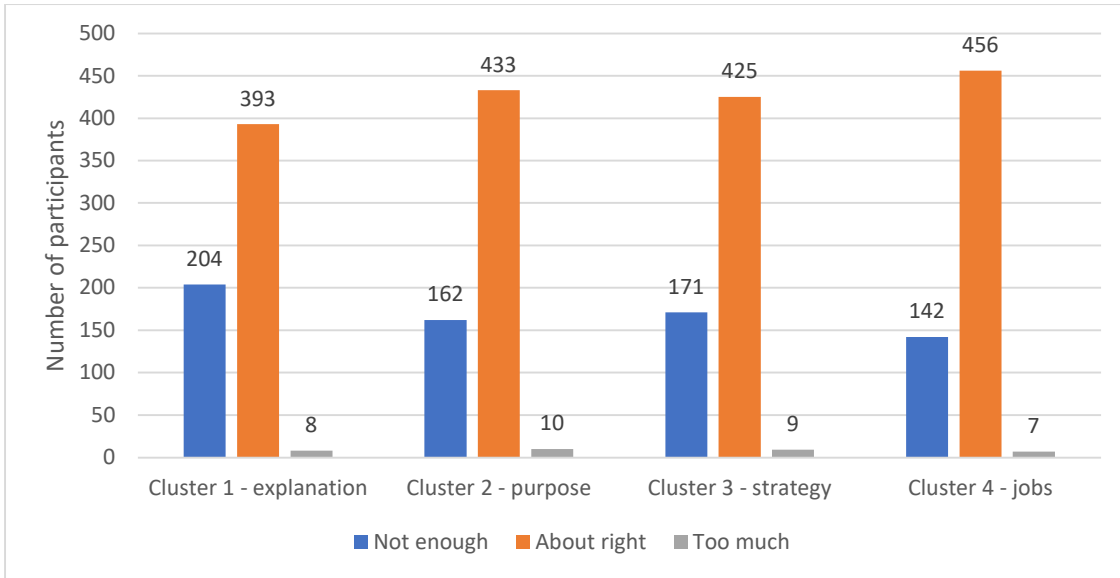


Figure 16: Preference for the amount of information.

Average (mean) scores for how much people would support a CCS facility in their local area after seeing each cluster of statements is shown in Figure 17. They used a scale from 0 (definitely not) to 100 (definitely yes). The more information participants received, the more they support it. This supports the finding from Survey 1 that the more awareness people had about CCS, the more they supported it. The biggest jump in support came after the information about jobs and training. This reinforces the focus group results, that people perceived real benefits in CCS industries engaging with the local community to provide skilled work and training for employees and young people in schools and colleges. Interestingly, none of the demographics predicted the support scores. It may be that the provision of clear and concise information about CCS overcomes the gender, age and income differences observed in Survey 1.

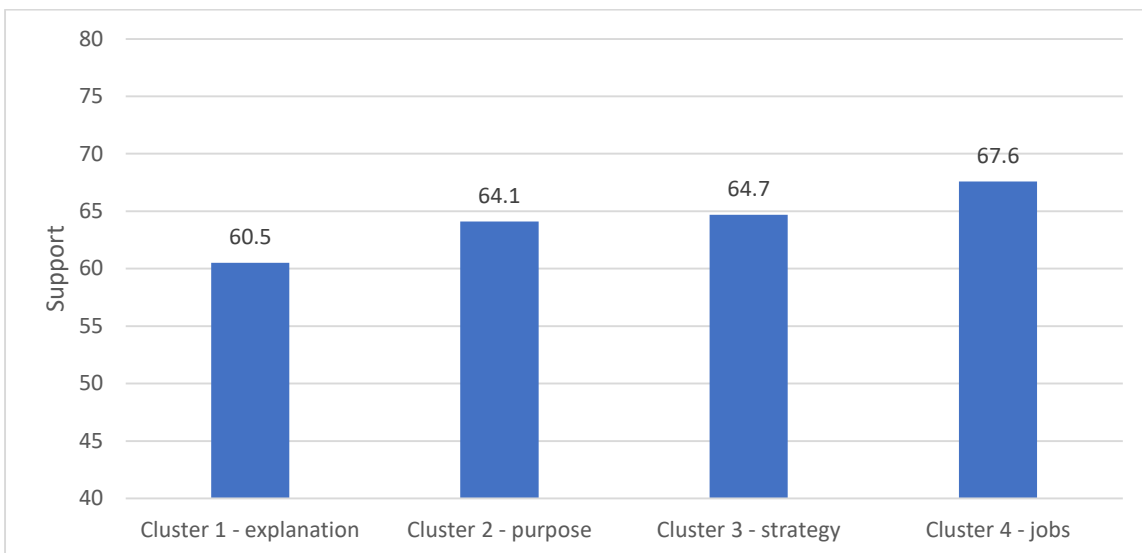


Figure 17: Support for a CCS facility generated by each cluster of statements.

2.4 Focus groups

What the focus groups tell us. Five key points.

ONE: Knowledge around CCS and hydrogen was at best *mixed*, and where participants did know more about local development this was usually due to their own research rather than, for example, information given as part of planning process.

TWO: Whilst increased knowledge and understanding about the technical/engineering aspects of the technologies was seen to have a positive impact on acceptance, and participants suggested it would be important to find out more about CCS and hydrogen developments, this is quite nuanced and place based, and it was **not clear that increased knowledge about developments led to increased acceptance.**

THREE: Participants **would like more and accessible information from ‘trusted’ sources.** This should include balanced discussions on the risks as well as the benefits of low carbon developments.

FOUR: There is a *high level of support for Net Zero ambitions*, but some reticence about whether Net Zero targets will be achieved.

FIVE: Where people know more about developments, they **recognise the potential benefits.** Those who know less *and* those who know more express hope that CCS and hydrogen developments will provide benefits and opportunities locally including **high level skills** development and **new low carbon employment.**

Box 3: Key takeaway messages from the focus groups

The focus groups provided an opportunity to explore some of the key issues raised in interviews and in Survey 1 around public understanding of CCS and hydrogen and the UK’s plans for Net Zero, with participants who live close to SSE sites within two industrial clusters.

- A total of six focus groups were held in September 2022 with one online and two in person in each location (an outline of the focus group discussion structure in Appendix 2)
- Participants were recruited from within a radius of 15km of Peterhead or Keadby sites (see Appendix 3 for socio-demographic details of participants from each location)
- A range of ages, incomes and house types were recruited
- Venues were accessible and recommended by local recruiters
- Incentives (£35) were paid to participants

Focus group questions were structured around the research objectives. Findings for each RO are presented below in terms of the key themes identified in the data.

RO1 Public understanding of the role of CCS and hydrogen in the UK's commitment to reach net zero by 2050

Mixed knowledge of CCS and hydrogen:

- Where people had previously heard of CCS, most had come across the term but did not know more about the technology.
- Participants who knew more about CCS had either done some research on the technology because they had a personal interest, or because they or a family member worked in energy, or oil and gas sector.
- Participants were more familiar with hydrogen as having a role in low carbon transport than in electricity generation.
- It was not clear whether participants had views on the *role* of either CCS or hydrogen in UK's commitment to reach net zero. Some participants had questions around how/to what extent CCS and/or hydrogen will reduce CO₂ sufficiently to meet (or make a significant contribution to) Net Zero targets. In particular there were some interesting questions raised about whether CCS has any other environmental benefits beyond reducing CO₂ for example cleaner air, which reinforces some of the survey responses on perceived benefits.
- There were questions over why it was necessary to develop CCS when other low carbon energy solutions exist and are well tested. Participants in a number of groups discussed tidal, hydro, on- and off-shore wind as being preferable to extending electricity generation at gas fired plants. One participant commented:

'I thought we were supposed to be getting rid of gas. I'd rather the power station wasn't there at all never mind expanding it'

However, this was caveated by a discussion around gas with CCS being preferable to gas without CCS.

Broad support for Net Zero

- Overall, there was broad support for net zero and the need for the UK to reduce its GHG emissions in order to tackle climate change.

'We have to do something for the next generation'

- Most participants (just over half across the groups) had heard the term and understood it to be related to reducing carbon dioxide with UK targets for becoming net zero in place. However, there was little knowledge on the detail of the UK's Net Zero commitments. Where there was knowledge, people had heard about it via national and local news, or through their work.
- Where participants did know more about Net Zero plans, we observed a degree of scepticism about whether targets will be achieved or are achievable. This appeared to be for one of two main reasons: a general lack of trust in UK Government to deliver on commitments, and/or participants' own observations of, in their view, failed projects such as introducing electric cars on mass.
- Whilst most were in support of Net Zero, where participants were less supportive of UK commitments, it was described as being:

'A waste of time when our emissions are tiny compared to Russia or China or America'

Or too complicated to manage or too expensive:

'I don't understand why the costs of these sort of projects end up in the billions of pounds'

Place-based differences

- Participants in Peterhead had greater awareness of CCS because of previous plans and public awareness raising campaigns. However, contrary to findings in the survey, this had a somewhat negative impact on public understanding of CCS with many participants saying they had been 'promised' benefits (for example jobs in the area) which had not materialised. This led to general support for Net Zero, but lack of trust around whether low carbon developments would ever happen. In addition, a number of participants in each group suggested:

'They tell you what they want you to hear' (i.e., in order to get planning approval)

When exploring these comments, participants noted that they had been told about potential jobs and investment coming to the area, but not, for example, any risks or examples of where CCS is currently in use.

- Participants in Keadby (Gunness) had little knowledge of CCS other than individuals who had worked in energy/construction. As a result, in the focus groups, discussions moved to the impacts of other developments in the area such as the energy from waste plant and onshore wind at Keadby. Similarly in Keadby, there was less awareness of or interest in specific developments at the power station. Here it appears participants are less concerned with the gas fired power station than (as above) other developments and the impact of multiple industrial developments (see RO3).

RO2 Public perception of the impacts of this low carbon transition on the industrial heartlands across the UK, specifically in the Humber and Scotland

Environmental (and health) impacts

- A strong theme was that participants believed low carbon developments to have positive environmental impacts in terms of reduced carbon, however it was less clear whether they consider these benefits as being felt specifically in the Humber and Scotland. Discussions in both places raised questions around whether CCS would have a positive impact on local environments, for example due to improved air quality. One participant noted that air quality had already been improved through cleaning flue gas, and another asking whether there would be less grey smoke from the power station. There was recognition that the transition needs to happen and that there have already been positive impacts over time in terms of, for example, air quality.
- An interesting theme identified from discussions in both places, discussed mostly by participants who had more knowledge about CCS, was whether using CCS to reduce carbon emissions might lead to future negative or unknown environmental impacts in the area such

as issues with leaks from pipelines or storage facilities. However, other participants who had less knowledge of CCS (or hydrogen) also questioned the potential for negative impacts, such as impacts on marine life.

Economic impacts

- Participants expressed broadly positive views on the low carbon transition and what this means for the regions. There was recognition that the transition needs to happen but that there would be costs associated with this (discussed further in RO3).
- Concerns were expressed over impacts of industrial agglomeration (including green energy) with, for example, energy from waste plant, wind turbines and housing developments locally.
- There was also interest and discussions relating to the transition from high carbon to low carbon economies and what this will mean for, for example, local employment. This was particularly related to the importance of economic benefits being felt locally.

Place-based differences

- Whilst both places discussed impacts in terms of potential for employment in each area, this was a particularly strong feature of discussions in Peterhead, and at the centre of issues relating to participants' perceptions of what a just or fair transition to low carbon might involve. This manifested in two main ways: 1) the need for new jobs and skills especially for young people, and 2) the need to support people working in high carbon industries to transition to new low carbon jobs. There was considerable discussion around the need to develop more (and better paid) apprenticeships. Several participants pointed out that apprentices at the power plant were considering leaving to take better paid jobs at local supermarkets.
- In Keadby, some discussions focused on potential safety issues associated with CCS with questions around transport and storage of CO₂. As discussed below, these discussions were not about rejecting developments, rather participants wanted to know how issues would be discussed and decided, for example where pipelines would be located. It was interesting that participants with more knowledge of CCS, and those who were involved in e.g., local governance, shared their knowledge on technology and policy during the focus group and that other participants found this interesting and useful.

RO3 Public understanding of the opportunities, benefits and challenges associated with CCS and hydrogen and whether increased understanding has an impact on public acceptance

Across both locations, opportunities, benefits, and challenges were discussed in terms of local peoples' understanding.

Opportunities and benefits

- Environmental benefits associated with reduced CO₂ emissions and the need to tackle climate change were understood well in most groups.
- Where people had some knowledge of CCS, it was discussed as an opportunity to continue using gas in electricity generation.

- Clear opportunities and benefits in terms of potential for jobs, low carbon skills, education, and local economic development, but these were only seen as benefits if they happened locally, obtained through e.g., working with schools and colleges to develop high levels skills, supporting people currently working in oil and gas to move to low carbon jobs, and investing in UK companies and local workers rather than overseas workers.

Challenges

- There was a clear message that jobs created should mainly benefit local people and this is a key part of considerations of fairness and justice. There was considerable awareness locally of developments and opportunities being awarded to international companies (Norway and China were mentioned) and (in Peterhead in particular) the impact of large numbers of overseas workers coming to the area.
- Cost and who pays. Participants recognised that CCS and hydrogen developments would be costly and that ultimately as consumers or tax payers they would pay for the transition to low carbon. There were differences between participants on whether this was perceived as fair, and a common thread in discussions was that businesses and shareholders will profit either from Government investment or from longer profits associated with electricity generation. There was some concern that CCS and hydrogen developments would cost a lot but yield few benefits in terms of either emissions reduction or local benefits such as jobs when compared to other options such as renewables (especially tidal and offshore wind).
- An interesting thread in the discussions in focus groups in Peterhead in particular, but also to a lesser extent in Keadby related to the challenges associated with actually developing and delivering complex projects. In Peterhead, this was grounded in the fact that local people felt 'let down' at having 'missed out' on funding.
- In both places there were discussions about existing skills and/or infrastructure not being ready for developments and there being real challenges around skills development in time to develop the technologies to meet carbon reduction requirements.
- Also in both places, there were concerns about local, place-based issues such as proximity of developments to housing and disruption to local traffic. Additional concerns associated with unknowns e.g., where pipelines would be located, safety, risks to health, and increases in noise and disruption from works traffic including heavy good vehicles.

Influencing public acceptance

- Participants were broadly accepting of plans in their local areas but with some clear caveats around being informed of the risks as well as benefits. Participants were clear that they would rather have 'balanced' information with details of risks and benefits.

Information provided should be accessible in terms of language used, level of detail and where information is available from. Participants suggested 'independent' trusted sources should provide information rather than businesses or 'the Government' although many participants suggested leaflets they had seen from (they believed) powerplants had been useful. Trusted sources included, local and national news, some social media, libraries, and universities. Some specific well known people were mentioned as being trusted for example David Attenborough, Martin Lewis and Greta Thunberg.

3 Summary

In this section we summarise and synthesise findings to present the key themes identified in our research. We do this using three lenses to provide SSE with reflections on the relevance for SSE's important interests in the Scottish Cluster, the East Coast Cluster, and the Humber.

3.1 Public perception of CCS, hydrogen and UK Net Zero commitment

A consistent finding in our research is that *most people support taking action to tackle climate change*, feel a responsibility to do so, and believe it is important to decarbonise. People are *broadly accepting* of CCS and hydrogen.

Most people have heard of Net Zero, but awareness of CCS is much lower. There is a *lack of awareness* of specific technologies and policy to achieve targets, and many people do not feel well informed about the causes of climate change. Some question the effectiveness of decarbonisation technologies as well as the safety of CO₂ storage. There is *strong support for low carbon technologies* generally with the exception of nuclear power. The more aware people are of green technologies, the more accepting of it they are. There is, however, reticence about whether net zero targets will be achieved.

Where people know more about CCS and hydrogen, *they recognise the potential benefits* and many hope that CCS and hydrogen developments will provide benefits and opportunities locally including reducing carbon emissions, high-level skills development and new low-carbon employment.

We see differences between places and at different levels which suggests that specific *place-based issues influence public acceptance*. Increased knowledge and understanding of the technical/engineering aspects of the technologies was seen to have a positive impact on acceptance in Survey two, and participants suggested it would be important to find out more about CCS and hydrogen developments. However, this is quite nuanced and place based, and it was not clear that increased knowledge about specific local developments led to increased acceptance. In Keadby for example, local residents are generally unconcerned about development at the power plant, whereas in Aberdeenshire, the public are generally well informed and supportive of the plans at Peterhead and broader industrial decarbonisation plans, but there is *public disappointment that CCS funding has not been forthcoming, and suspicion of competition politics*.

3.2 Issues relating to policy legitimisation

As above, there is a *high level of support for Net Zero ambitions*, but considerable scepticism about whether Net Zero targets will be achieved. We witnessed a *lack of trust in government* and in particular concerns that developments would not go ahead for political reasons despite broad public and industrial support.

There is a *lack of awareness of policy detail* or what people need to know about planning. Knowledge around CCS and hydrogen is at best mixed, and where participants do know more about local development this is usually due to their own research rather than, for example, information given as part of planning process. Amongst experts, there is a broad feeling that *government decarbonisation plans are complicated*, and the public may disengage with them when given too much information on government policy.

There is *concern around who pays and who profits*. Survey and focus group results suggest people accept the need to pay for decarbonisation but have concerns about high costs being met by consumers and tax payers, rather than energy companies. Additional concerns discussed in less

detail include whether it is necessary to develop CCS to extend use of gas rather than invest in existing/known low carbon energy technologies such as wind and solar.

3.3 Message framing and implications for public acceptance

For many people, a *just transition to Net Zero* is about *creating low carbon and retaining jobs* as well as retraining employees. Qualitative findings in both locations as well as survey findings suggest that it is important to guarantee local economic and environmental benefits from developments. In Scotland in particular, where previous investment in energy development has gone overseas, there are specific concerns about distribution of wealth, and wealth being retained in Scotland.

Some people believe that a CCS facility would produce cheaper energy and cleaner air, and it will be important that SSE identify any misperceptions about the benefits of the facility. The *major concerns people have are about safety, particularly of the stored carbon dioxide*. They also have concerns about the environment, including building on green space, and that CCS is a short-term solution that delays efforts to reduce carbon production.

People *want to be informed of and understand the risks*. This was an important feature of discussions, with participants in focus groups saying they would rather know the risks so they can make informed decisions. People would also like *more and accessible information from locally 'trusted' sources*. Information should include balanced discussions on the risks and costs as well as the benefits of low carbon developments. *Straightforward, non-technical language is important*.

There are *local differences* in what matters to people. People in Scotland and in Yorkshire and the Humber in particular believe that investing in CCS will be good for their local area. People are broadly positive about a CCS facility opening in their local area, particularly about the positive environmental effects it might have. The potential benefits of CCS that people value the most are reducing carbon emissions and creating local jobs. Protecting local industries is rated as the lowest potential benefit, suggesting that people are unaware that local industries will also need to move towards Net Zero.

Across the board, *most people support taking action to tackle climate change*, feel a responsibility to do so, and *believe it is important to decarbonise*.

Appendices

1. **Summary of research activities** conducted between May 2022 and October 2022

- Interviews – 13 semi structured interviews with experts with place-based knowledge of relevance to CCS and/or hydrogen
- Surveys – 2 national surveys:
 - Survey one (n=1000) completed August 2022
 - Survey two (n=604) to further explore themes from qualitative research completed in October 2022
- Focus groups – total of 6 focus groups in September 2022, 3 in Peterhead, 3 in Keadby (Guinness)
- Advisory group meetings throughout for oversight and steering

2. Online focus group example outline

Time	Activity	Who/Resource
-0.10 to 0.00	Welcome participants and settling in Check consent	Recruitment host to facilitate
0.00 to 0.05	Hello and brief introduction to research and facilitator(s)	Start recording
0.05 to 0.15	<p>Have you heard of these technologies before this focus group? Follow up: If so, do you know where heard about them from?</p> <p>SSE CCS video Scroll screen to link Mute participants</p> <ul style="list-style-type: none"> Did you find anything surprising about what you just saw? 	<p>Voting poll in Zoom Round room?</p> <p>Facilitator to share link to video in chat</p> <p>https://www.ssethermal.com/flexible-generation/development/peterhead-carbon-capture/</p>
0.15 to 0.20	<p>Voting options:</p> <ul style="list-style-type: none"> How would you describe your views on? Broadly positive/negative, neither positive nor negative, undecided. <p>Check box/scales</p> <ul style="list-style-type: none"> CCS Hydrogen UK's Net Zero plans 	<p>Voting poll in Zoom</p> <p>Share screen with results</p>
0.20 to 0.35	Discussion around results – round robin	Start with anyone who wants to add
0.35 to 0.55	<p>Thinking about what a 'just' or 'fair' transition to net zero carbon might be. What are your thoughts on potential:</p> <ul style="list-style-type: none"> Benefits/opportunities – local focus Challenges/concerns – local focus Pick out comments on e.g.: <ul style="list-style-type: none"> Fair transition? A good way to meet net zero? Jobs? Cost? How much would you pay? Who should fund this who should be responsible? 	<p>Discussion around results – round robin</p> <p>Start with anyone who wants to speak</p> <p>Add to chat if you have a point to add or reactions to a comment</p>

3. Focus group participants

	Peterhead		
	Group 1	Group 2	Group 3
Online/F2F	Online	F2F	F2F
Total attendees	7	8	8
Age range	23-55	19-77	20-71
Gender	4 female, 3 male	4 female, 4 male	4 female, 4 male
Income range	>£15k-£66k+	£10k-£36k	£11k-£50k+
	Keadby		
	Group 4	Group 5	Group 6
Online/F2F	Online	F2F	F2F
Total attendees	8	8	7
Age range	34-69	21-70	26-62
Gender	5 female, 3 male	3 female, 5 male	5 female, 2 male