



The Public Perceptions of Carbon Capture and Storage

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Summary

The key aims of this paper are two fold. Firstly to explore the public perceptions of carbon capture & storage (CCS), both when first presented with the idea and when more background information is provided. Secondly to explore and understand perceptions of the key risks and concerns surrounding CCS and what information, policies and processes would make CCS more and less acceptable to the public. In order to achieve these aims two citizen panels were held in late 2002 / early 2003 to explore public perceptions of carbon capture and storage (CCS). Each panel met 5 times for 2 hours and heard from a variety of technical experts. In addition, a face-to-face survey of 212 individuals was conducted during August 2003. Note, however, that the present questionnaire sample size is not large enough for the responses to be statistically representative of the UK population or a segment thereof.

Research on perceptions of CCS is challenging because of: a) the relatively technical and ‘remote’ nature of the issue, meaning that there are few immediate points of connection in the lay public’s frame of reference to many of the key concepts; b) the early stage of the technology, with very few examples and experiences in the public domain to draw upon as illustrations. These issues are discussed, and the research methodology is explained in terms of managing these difficulties.

On first hearing about carbon storage in the absence of information as to its purpose, we found that the majority of people either do not have an opinion at all or are somewhat sceptical. Once (even limited) information is provided on the role of carbon storage in reducing CO₂ emissions to the atmosphere, opinion shifts considerably towards slight support for the concept. Support depends, however, upon concern about human-caused climate change, plus recognition of the need for major CO₂ emission reductions. It also depends upon CCS being seen as one part of a wider strategy for achieving significant cuts in CO₂ emissions. A portfolio including renewable energy technologies, energy efficiency and lifestyle change to reduce demand, was generally favoured. CCS can be part of such a portfolio but wind, wave, tidal, solar and energy efficiency were generally preferred as options. As a stand alone option, it was felt that CCS might delay more far-reaching and necessary long-term changes in society’s use of energy. The notion of CCS as a ‘bridging strategy’ to a hydrogen-based energy system was welcomed.

It was felt that uncertainties concerning the risks of CCS had to be better addressed and reduced, in particular the risks of leakage, of accidents, or environmental and ecosystem impacts, and any human health impacts.

The results are reasonably encouraging vis-à-vis potential public reactions to CCS provided that its purpose is well understood and that the key risks are acknowledged. The need for CCS should be put clearly into the context of climate change and the need for large long-term reductions in CO₂ emissions to the atmosphere. The use of CCS as part of a portfolio of decarbonisation options which range from new technologies, to lifestyle change, should be stressed, rather than presenting CCS as a ‘stand alone’ option. A partnership approach to control and regulation of CCS would be generally welcomed, in which government, industry and environmental NGOs each have a role to play.

Recommendations for future research are made.

1.Introduction

The potential public perceptions of carbon capture & storage (CCS) in the United Kingdom have been recognized as a vital aspect which may hinder (or possibly even facilitate) the future development of the option (e.g. the Energy White Paper 2003). In order to investigate public perceptions two distinct research methods were used.

- 1) Two Citizen Panels (five, 2 hour sessions in each panel)
- 2) A questionnaire which was administered face-to-face to over 200 individuals.

The initial list of key questions which were addressed in the research is shown in Box 1 below.

Box 1: Questions Addressed in the Research

- (i) What do the public think about carbon sequestration when the idea is initially presented to them?
- (ii) How do their opinions change when provided with more information on CCS and the problem of climate change?
- (iii) Is there a difference in perception depending upon standard demographic variables (age, socio-economic status, gender, education, etc.)?
- (iv) Is there a difference in perception depending upon peoples' values and beliefs?
- (v) Is there a difference in perception depending upon what people think about climate change?
- (vi) Does (carefully presented) information on alternatives (behavioural change, energy prices, renewables, etc.) influence the perception of carbon sequestration?
- (vii) What policies and processes would make carbon sequestration more acceptable?
- (viii) What policies and processes would make carbon sequestration less acceptable?

The underlying rationale for the research questions is discussed below. The method used to address the question is indicated in brackets at the end of each question.

- (i) What do the public think about carbon sequestration when the idea is initially presented to them?
(questionnaire)

Do people have an immediate 'like or 'dislike' to the idea of CCS or do they simply not know? This question is perhaps the closest we get to a lay, cursory contact with the idea of CCS, as might be experienced through a brief news item, informal conversation with a friend or half-listened to media report.

(ii) How do their opinions change when provided with more information on CCS and the problem of climate change? (citizen panels & questionnaire)

Does a small amount of information on CCS, climate change and the challenge of reducing greenhouse gas emissions by 60%, affect people's perception of CCS? We might expect that as the purpose of CCS is revealed, i.e. to tackle the problem of global climate change by contributing to a reduction of carbon emissions by 60%, there would be a certain proportion of respondents who might express greater support for the concept. We have explored this issue of opinion-change in the survey, whilst in the citizen panels we have explored the underlying reasons *why* people's opinions change as more information is provided, and as group discussions are undertaken.

(iii) Is there a difference in perception depending upon standard demographic variables (age, socio-economic status, gender, education, etc.)? (questionnaire)

There is no strong *a priori* reason why we would expect CCS to be more or less preferred according to the standard demographic variables, yet it is important that we at least check if this is the case. The evidence about age-related effects, education and socio-economic status in previous surveys of sustainability is less clear, with contradictory findings in past work.

(iv) Is there a difference in perception depending upon peoples' values and beliefs? (citizen panels, and to an extent questionnaire)

Previous research on the underlying reasons for different perceptions of sustainability suggest that values, beliefs and 'world views' are a more important determinant than standard demographic variables (e.g. Pendergraft 1998). Attempting to address values and beliefs is notoriously difficult, whether in surveys or focus groups, and in this work we were not able to explore this issue in any depth. In the citizen panels, we were able to infer different values and beliefs from extended discussions with the participants, at least to a limited extent. In the questionnaire we attempted to ascertain beliefs about the role of experts in making decisions about how to respond to climate change, and several other questions provide clues as to the underlying world views of the respondents.

(v) Is there a difference in perception depending upon what people think about climate change and its seriousness? (citizen panels and questionnaire)

A sub-set of beliefs relates to the respondents beliefs about whether climate change is a real problem to be concerned about and whether it is caused by human activities. The hypothesis is that if the respondents are concerned about climate change and its human causes, then they may be more favourably inclined towards CCS. Certainly, if the respondents do not believe that climate change is human-caused and/or a problem, then it is more difficult to imagine why they might lend strong support to CCS, since there is no other reason why CCS should be undertaken. The only partial exception relates to the use of CO₂ for enhanced oil recovery (EOR) and we explored whether this possibility might change opinion on CCS.

(vi) Does (carefully presented) information on alternatives (behavioural change, energy prices, renewables, etc.) influence the perception of CCS? (citizen panels and questionnaire)

Since CCS is one of a range of options being considered as a route towards decarbonisation, a comparative approach is necessary. We therefore asked about perceptions of the main other contending routes towards decarbonisation: demand reduction, energy efficiency and the range of renewable energy sources.

(vii) What policies and processes would make CCS more acceptable? (citizen panels)

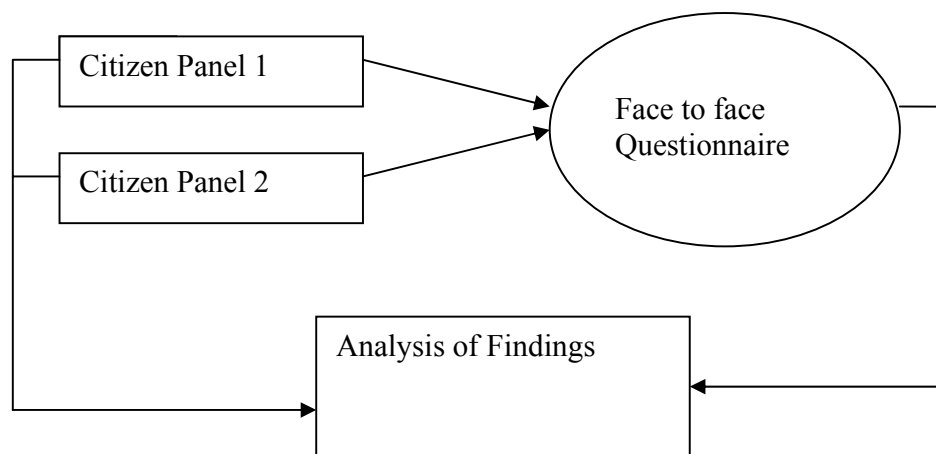
This slightly more free-ranging discussion focused upon what types of changes (technical, risk, environmental, social, economic, policy, etc.) might influence peoples' perceptions of CCS.

(viii) What policies and processes would make CCS less acceptable? (citizen panels)

Once again, this free-ranging discussion focused upon what types of changes (technical, risk, environmental, social, economic, policy, etc.) might influence peoples' perceptions of CCS .

2.Methodology

We used two complimentary methods to address the questions raised in Chapter One. We ran two Citizen Panels over two five week periods in the last quarter of 2002 and the first quarter of 2003. Each Panel met for ten hours in total. We then devised a questionnaire based upon the findings of the Citizen Panels which we then administered through face-to-face interviews to 212 respondents. Each method is shown diagrammatically below and then described and discussed in more detail.



2.1. Citizen Panels

A Citizen's Panel is a moderated group of between eight and ten individuals who meet over an extended period to discuss a set of related issues and who provide an informed opinion on those issues at the end of the Panel. Similar to a focus group, the key differences are that there is a gradual build-up of information on the particular topic of discussion, usually with expert witnesses, whom the Panel has the opportunity to question. The methods are described in detail in Kasemir et al. (2003). We recruited two distinctive Citizen Panels as shown in Table 2.1. A professional recruiter was employed to assemble the panels and the standard rate of pay was extended to the participants.

The intention was to provide a clear and interesting contrast between the two Citizen Panels. The groups differed in gender, place of residence and in socio-economic status. The discussion and activities undertaken in each group are provided in Table 2.2. We recorded the discussion in each panel using a Marantz tape recorder and transcribed the tapes in full.

Table 2.1. The Composition of the Two Citizen Panels

Manchester Citizen Panel	York Citizen Panel
All Female	All male
8 participants for all meetings	9 participants for all meetings
Five two hour meetings	Five two hour meetings
Socio-economic groups C1, B	Socio-economic groups A, B
Occupations: Secretarial, administrative, public sector	Occupations: managerial, self-employed, public sector
Held in November & December 2002	Held in January, February & March 2003
Facilitator: Clair Gough	Facilitator: Dr Simon Shackley

Table 2.2. Programme for Each Panel

Manchester Citizen Panel	York Citizen Panel
<i>Session 1:</i> Warm-up discussion on quality of life	<i>Session 1:</i> Expert presentation on climate change & round-table discussion
<i>Session 2:</i> Expert presentation on climate change & round-table discussion	<i>Session 2:</i> Expert presentation on CCS & initial discussion
<i>Session 3:</i> Expert presentation on CCS & initial discussion	<i>Session 3:</i> Two contrasting expert perspectives on CCS & discussion
<i>Session 4:</i> Two contrasting expert perspectives on CCS & discussion	<i>Session 4:</i> Criteria Weighting for selection of storage sites
<i>Session 5:</i> Participants summing-up	<i>Session 5:</i> Weighting of different decarbonisation options

2.1.1. Manchester Citizen Panel

We now discuss the proceedings of each Panel in a little more detail.

Session 1, 7 November, 2002:

Warm up session. The main purpose of this session was for the group to get to know each other and to establish a relaxed environment to facilitate the discussions. The main topic for discussion revolved around "quality of life" and what it means to the participants, how it is different for children today, how

it is changing. A few slides of extreme weather events were shown and participants discussed their reactions to these, leading into a general discussion of environmental issues.

Session 2, 14 November, 2002:

Introduction to climate change. A guest speaker (Dorian Speakman from UMIST) made a brief presentation of the evidence for, and implications of, climate change and how it might be addressed (covering the Kyoto protocol etc). Participants were given the opportunity to ask questions of the speaker for up to half an hour, the speaker was then asked to leave the room in order that the discussion could continue within the group.

Session 3, 21 November 2002:

Introduction to carbon storage. A guest speaker (Dr Michelle Brook from BGS) made a brief presentation on geological carbon storage, followed by questions. The speaker was asked to leave the room and the discussion continued. During the discussions a list of questions were drawn up about which participants would like to know more. These questions would be put to two guest speakers, an 'environmentalist' and a representative of a major oil company in the subsequent session.

Session 4, 28 November, 2002:

Two invited experts (Dr Kevin Anderson from the Tyndall Centre and Bill Senior, Manager of the CO₂ Management Programme at BP) were each given an hour in which they made brief introductions to their perspective on carbon storage followed by detailed questions from the group.

Session 5, 5 December 2002:

Final session. Following a brief discussion to clarify issues raised the previous week and brief reflection on the experts' messages, the participants were invited to make 'statements' summarising their main concerns/opinions from the discussions and to prepare 'messages' to send to their chosen audiences (government, public, industry etc).

2.1.2. York Citizen Panel

The format for this panel was adapted from that of the Manchester Panel. As we got to know the York Panel, we decided that we could 'fast-forward' the agenda somewhat and try some more challenging exercises in the last two sessions. This is further described below.

Session 1, 30 January, 2003

The warm-up session focused on the issue of flooding, following a serious flood event experienced in York during 2000. This discussion allowed the group to get to know one another in a relaxed way and on a topic which everyone could say something about. Dorian Speakman, from UMIST, raised a set of specific questions relating to the participants' experiences of the floods and their management. This discussion was followed by a short presentation on climate change (as for the Manchester panel) and brief discussion.

Session 2, 6 February, 2003

Following a very brief follow-up on issues raised during the previous week, Dr Michelle Brook (BGS) introduced carbon capture and storage and joined in the group discussion.

Session 3, 13 February, 2003

Guy Wallbanks (Friends of the Earth) and Paul Freund (IEA GHG R&D programme) were each invited to make a short presentation on CCS and answer questions. The format was slightly different to the Manchester Panel in that the two experts were each present for the entire meeting enabling them to respond to each other's points.

Session 4, 27 February 2003

Following a week's break for half term, the penultimate session involved the participants in a criteria weighting exercise. Using a set of evaluation criteria designed during the Tyndall pilot study¹, participants were asked to allocate points to criteria according to how important they consider them to be in the assessment of potential carbon storage reservoirs. The criteria are: rate of leakage of CO₂, storage timescale, potential storage capacity, proven storage security, monitoring/verification, public opposition, planning or legal barriers, costs, adverse impacts - human health, adverse impacts - ecosystems, reversibility.

The nine participants were split up into three groups of three, and each small group allocated their own weightings and discussed the reasoning behind their chosen weights. The reason for using three smaller break-out groups was that there was a diversity of perspectives within the panel. Attempting to derive a single criteria weighting from the group would have effectively cancelled-out the diversity of perspective. Based upon discussions in the earlier three sessions, we therefore allocated individuals to one of three groups - more favourably disposed, ambivalent and less favourably disposed to CCS - depending on their generally expressed views. The weightings procedure was undertaken by providing each sub-group with 100 tokens, and asking them to allocate them to the criteria written on an A1 chart. Each sub-group was also at liberty to add additional criteria to the ones mentioned above, receiving ten additional tokens to each new criterion added. The criteria weighting 'experiment' in sub-groups worked very well and has provided considerable new information on the potential diversity of criteria weightings for assessment of carbon capture and storage options by a well-informed sample of the public.

Session 5, 6 March 2003

Following the success of the weighting experiment in Session 4, it was decided to modify Session 5 to allow a further criteria weighting experiment to be performed. In this case, the same three sub-groups as convened in session 4, considered the allocation of public monies for RD&D and for public information campaigns across a range of low-carbon energy technologies and options. We asked each sub-group to allocate 100 tokens across a range of options which could receive support from government, where one token represented a quantity of money such as £1 million. The reason that we chose to do this was because an issue which emerged repeatedly in both Citizen Panels was the role of CCS in a portfolio of low-carbon energy technologies and options. Hence, we felt that it would be interesting to see how much financial resource each sub-group would consider desirable for CCS compared to the other major areas where public monies could be allocated to sustainable energy options and technologies.

¹ The final report from this study, detailing the multi criteria methodology, can be found at http://www.tyndall.ac.uk/publications/tech_reports/tech_reports.shtml

2.2. The Questionnaire

It is clearly not possible for small citizen panels to be representative of the entire population of the UK. A large-scale survey would, in principle, permit public perceptions to be measured that would be statistically representative. However, because of the novelty of CCS and the lack of familiarity with the technology, a large postal survey would not, in our view, be appropriate at this stage – we would anticipate very poor response rates and potentially misleading results (we would have little guarantee that the respondents would interpret the questions in the way that is intended). We therefore decided on a strategy of face-to-face survey work as the most appropriate means of understanding the reactions of the lay public to this new technology. We designed a questionnaire by drawing upon the citizen panel findings, as well as drawing upon other climate change questionnaires (e.g. Lorenzoni 2003). We tested the design of the questionnaire with a small sample (5 people) and modified it in the light of their comments and suggestions.

We initially proposed that the survey would be conducted within the departure area at Manchester Airport. Unfortunately, Manchester Airport were unable to help us on this occasion because their ‘survey quota’ was full-up. We therefore approached the Liverpool John Lennon International Airport with the same request and were allowed to conduct our survey in the departure area of the airport. The advantages of this were:

- a reasonably high response rate can be expected from passengers waiting for their flight to board;
- the topic can be related to the activity of air travel, presenting a possible solution to offset significant levels of CO₂ emissions;
- we can expect a reasonable cross section of society, including the business and leisure sectors, covering a range of ages, occupations, lifestyles and so on.

The actual questionnaire was administered by 6 individuals, all of whom are staff or graduate students of UMIST. A training session was held to ensure that all 6 surveyors were fully familiar with the questionnaire design and how it should be administered. On the first day of the administration of the survey itself several meetings were held between the surveyors to check for problems and to ensure consistent approaches to implementation.

Two hundred and twelve interviews were conducted on the 18th and 20th August. We found that people were generally willing to help us, with a ‘rejection rate’ of perhaps 40 to 50% of those asked. The interview lasted between 10 and 20 minutes, depending on the level of interest of the interviewee. It should be borne in mind that the survey was conducted towards the end of the heat wave of August 2003, just after the UK’s highest ever temperature had been recorded. During the two days we undertook the survey at Liverpool, however, temperatures were not exceptionally high.

The full survey is provided as Appendix A. In practice we used a set of sheets with the interviewee, which displayed the questions in the survey in large font in order to allow the respondent to comprehend the question and the options available to them. More information on the survey will be provided in chapter 5.

The survey results were entered in SPSS (Statistical Package for Social Sciences) and basic statistical analyses of the questionnaire responses undertaken. We have not attempted to undertake any complex statistical analysis of the responses (e.g. regression analyses) though we intend to do this in future work.

3. Literature review of public perceptions and acceptability of carbon capture and storage

Very little research has been conducted to date on public perceptions and perceived acceptability of carbon capture and storage (CCS), with a few completed or on-going studies in north European countries and the USA. Research on perceptions of CCS is challenging because of: a) the relatively technical and ‘remote’ nature of the issue, meaning that there are few immediate points of connection in the lay public’s frame of reference to many of the key concepts; b) the early stage of the technology, with very few examples and experiences in the public domain to draw upon as illustrations. A more in-depth research approach is typically required in such circumstances, whereby technical information is provided in an incremental fashion to the target public sample. Methodologically, focus groups and in-depth discussion groups are likely to be more suitable than structured questionnaires, at least as a first step in the research process. The disadvantage is that only small samples can be surveyed using in-depth methods, as opposed to surveys which can be statistically representative.

3.1. Underground Geological Storage of CO₂

Two Focus Groups were conducted in the UK in 2001 in order to test possible public reactions to carbon sequestration (Gough *et al.*, 2002). Whilst not representative samples of the population these groups do provide useful insights:

- Ocean sequestration is not likely to be well received due to the perception of high risk and uncertainty;
- Geological storage is seen as a viable option if adopted alongside other low- or zero-carbon approaches such as energy efficiency, demand reduction and renewables;
- It is useful to consider analogues such as Brent Spar, nuclear power and GM technologies – for which public opinion has strongly influenced their implementation;
- Levels of trust in key institutions and the role of the media were perceived to have a major influence on how CCS will be received by the public.

An important difference which emerged when comparing geological storage of CO₂ with Genetically Modified (GM) crops and the proposed disposal of the Brent Spa oil platform in the North Sea is that geological storage of CO₂ was widely regarded as a potential “solution” to the problem of global climate change. The risks associated with Brent Spa disposal and GM crops were not likewise regarded as solving a real and pressing problem, and/or much better options for tackling the problems of oil rig disposal and food production were identified. An intuitive cost-benefit framework was possibly being employed in which the potential risks of CO₂ storage are assessed relative to the potential benefits of reducing the problem of climate change.

From this highly limited research, it appears likely that two conditions may have to be met before the CCS option is considered alongside other options: a) anthropogenic global climate change has to be regarded as a reasonably serious problem; b) acceptance of the need for large reductions in CO₂ emissions to reduce the threat of global climate change. Many existing surveys from Europe and North America have indicated fairly widespread concern over the problem of global climate change, and a prevailing feeling that the negative impacts outweigh any positive effects (e.g. Kempton *et al.* 1995, Poortinga & Pidgeon 2003, Eurobarometer 2003, Hargreaves *et al.* 2003, Shackley *et al.* 2001). On the

other hand, some survey and focus group research suggests that widespread acceptance of the above two factors amongst the public (in particular the need for large reduction in CO₂ emissions (Hargreaves et al. 2003)) is sporadic and heterogeneous within and between national populations. Lorenzoni (2003), for example, identified statistically robust public samples, which varied in the extent to which they accepted that climate change was a) caused by human activities; b) a cause for concern. The implication is that unequivocal consensus on the problem of climate change and the need for carbon reduction is unlikely to be forthcoming, hence public opinion on carbon capture in the absence of a focused process of information provision (as in the panels reported on above) is also likely to be mixed.

UK Energy White Paper consultation

Although not explicitly addressing CCS as part of the preparation of the recent Energy White Paper produced by the UK Government a small review of public attitudes to energy policy has been conducted (DTI, 2002). The consultation involved five one-off focus groups in four locations, 2-day community workshops, and a web-based consultation drawing comments from invited experts. Responses were categorised into issues of:

1. Low or no consensus: role of nuclear power, role of increases in energy costs in delivering behavioural change, targets for new technologies;
2. Emerging consensus: tax incentives in favour of energy efficiency, need for Government to amend incentives in favour of energy efficiency and low carbon options;
3. Solid consensus: importance of supply security, greater role for renewables and support to achieve this, environmental policy as driver of energy strategy, improved communication and education from government to public, strong leadership from government to expose challenges and set out potential solutions.

3.2. Role of other Stakeholder Groups and the Media in Shaping Public Perceptions

Zaller (1992) argues that the lay public does not have well formed opinions on most issues which are not of immediate salience or relevance to their everyday life and livelihood. Opinions and perceptions are, instead, shaped by the media and other marketing efforts of stakeholders. There are several very good examples of such shaping having taken place, e.g. in the case of disposal of the Brent Spa platform, Greenpeace was successful in convincing the media, and consequently the general public, that disposal at sea would incur unacceptable environmental risks (Smith 2000). A further example is the role of the media and campaign groups in shaping perceptions of GMOs in Europe in the late 1990s. Feedbacks between the media and public opinion are also documented, and have been formalised in the theory of risk amplification (Jaeger et al. 2001), which maintains that risk perceptions can become amplified through media presentations, and subsequent stakeholder responses. The implication of such theory and real-cases is that public opinion on carbon storage could, at some future stage, be strongly shaped by stakeholder groups, including the media, who come to formulate a strong opinion. As Wynne (1996) notes, bereft of sufficient technical knowledge, the public may come to rely upon their sense of trust in the organisations involved, and in their past institutional performance, when assessing CCS. Research is not able to anticipate how public perceptions might change, possibly dramatically and rapidly, in response to pro-active stakeholder and media interventions and real-world events, though it can provide lessons from the past and guidance on ‘good practice’ in the communication of risks and uncertainty.

3.3. Underground storage of other fluids

Public perception of the storage of other wastes and substances in rock formations (e.g. nuclear and other toxic waste disposal schemes) has not been subject to much publicly-accessible research, though experts have identified similar potential public concerns to those discussed above. Proposals for underground natural gas storage schemes have generated public opposition in some localities, despite similar facilities operating very close by without apparent concern (Gough et al. 2002). Concern regarding the effects of natural gas storage underground upon local property prices and difficult-to-assess risks appear in one case to have been taken up and possibly amplified by the local media. Public opposition to below ground storage is likely to be heightened by accidents such as the two deaths from explosions in 2001 in Hutchinson, Kansas (USA), when compressed natural gas escaped from salt cavern storage facilities (Gas Utility Manager 2001).

4. Citizen Panel Findings

4.1. Introduction

In this chapter we describe the main findings from the two Citizen Panels. The first section discusses the Manchester Panel and the second the York Panel. We then compare the findings from the two groups and provide some conclusions in the final section. Throughout we use quotes from participants to better convey the sentiments expressed. We have changed the names of the respondents to protect their identity. The code at the end of the quote refers to the panel, session and page number in the typed transcript, i.e. MS2:15, means Manchester Panel Session number 2, page 15 of typed transcript.

4.2. Analysis of the Manchester Citizens Panel

4.2.1. Importance and Seriousness of Global Climate Change

The first session of the Manchester panel identified waste and recycling as the most immediate environmental issue that arose from the participants own experience and understanding. Global environmental issues were barely mentioned spontaneously. This confirms the general finding of focus group research that the local and visible issues such as waste are those which are most evident in everyday experiences (Darier et al. 1999). The Manchester group did respond, however, with surprise and concern at the account of climate change, and its possible impacts from the global to the local scales, which was provided in the second session. Throughout the remaining weeks, participants returned to this topic:

**“I certainly didn’t know, I was obviously aware of global warming, greenhouse effect, but I wasn’t aware that it was just such an extreme. I don’t think a lot of people do”
(Samantha, MS5:6)**

Once the expert presentation had been made in session 2, there was no questioning or scepticism about the reality of human-induced climate change nor of its potential seriousness to society. The panel seemed to accept the account of the expert speaker with few, if any, reservations.

4.2.2. Initial Positive Perceptions of CCS

The Manchester panel was generally quite positive about the idea of CCS after session 3, when it was presented by a British Geological Survey (BGS) scientist. There are a number of different underlying reasons for their positive perception.

Confidence in Governance

There seemed at the session 3 stage to be a fairly high degree of confidence from some participants in the ability of government to undertake appropriate assessment and regulation.

“They [government] never go in blind do they. They never just do things just for the sake of doing things” (Sarah, MS3:18)

Avoidance of “NIMBYism” (Not in My Back Yard) through Off-shore Storage

During discussion in session 3, some participants could not see any real negatives associated with CCS, in part because the location of the carbon storage off-shore meant that local opposition was unlikely.

“... It [CCS] just seems a nice little neat way of doing it. Cause you know it’s ‘not in my back yard’ is it? That would get round all the critical NIMBYs like me wouldn’t it?” (Elizabeth, MS3:19)

“Its not in anyone’s backyard” (Jo, MS3:19)

Possible Damage from CCS Compared to Damage from Climate Change

Several Manchester participants assessed CCS in terms of its potential risks relative to the risks of climate change itself.

Sara: “You just look at the costs and benefits and Greenpeace will weight them up for themselves but my personal opinion from what I’ve seen is that it [CCS] is more beneficial than ...”

Sue: “We’re doing more damage by not doing anything”

(MS3:19)

Note, however, that the other options for reducing CO₂ had not been presented to the group at this point. Some participants struggled during session 3 to see why CCS would be opposed:

“why would Greenpeace oppose it? I just don’t see why they would” (Samantha, MS3:18)

Yet, during session 3 some concerns over the impacts of CCS were discussed, which we now turn to in the next section.

4.2.3. Emergence of Some Concerns about CCS

During session three, various concerns began to emerge about CCS which are considered below. These concerns tended to be expressed by a few participants, rather than by the whole panel, suggesting a more critical, or at least enquiring, minority within the group.

Integrity of Reservoir Sinks

Various technical questions emerged during the geologist's presentation regarding the nature of the geological sinks. For example, it was asked where the water in an aquifer would be displaced to. The possible effect of past human utilization of fossil fuel reservoirs was also raised as a problem for their future integrity (MS3:5). After the geologist had left, Samantha commented that:

".... Yeah it [oil & gas field] does store it for all these years but then drilling into it when they get the oil out you just don't know where The holes have been filled, but she [the geologist] said the cement wasn't that great So they need to research into it that or

..... they were saying that with some of the sites ... they can't be 100% sure if there is a fault or not, so what if they start pumping all the CO₂ down there? (Samantha, MS3:13-14).

One participant picked up upon the geologist's use of the term 'bubble' to describe the CO₂ storage in the underground aquifer. This participant, Sue, was concerned that a large bubble of CO₂ might burst with catastrophic consequences.

Sue: " ... you mentioned the world 'bubble' ... its looking for an escape ...

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If it's that large, that much of an area that its [the CO₂] going to be in, its going to be more than just catastrophic isn't it really? [if it bursts]**

Geologist: ".... Well it's not explosive Underground it's not a bubble and I probably shouldn't have used that word.

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.... We term it the CO₂ bubble but its not really a bubble because its not existing on its own its actually in the rock pore spaces there will be dissolving in some of the water, it will be reacting with some of the minerals in the rock".**

(MS3:6,7,8)

Sue later returned to the issue when the geologist had left the room:

"... me saying bubble! She scared the living daylight out of me, [saying] there's this bubble" (MS3:24).

This exchange indicates the importance of the terminology which is used by experts in communicating with the public. Associated with this dialogue were questions about the fate of the CO₂ in the Sleipner field aquifer, seismic images of which had been shown by the geologist. One participant was concerned that the CO₂ in the aquifer appeared to have "risen quite a lot" (MS3:7), raising a concern for her about long-term integrity. Such movement in just 5 years led her to wonder what would happen to the CO₂ in 200 years. Samantha picked up on the time scale issue to return to her concern about the integrity of large geological structures over hundreds of years:

“... they can’t possibly foresee whether it’s going to ... whether something else might happen ... I mean they won’t have done a seismographic on the whole of the section because it’s too expensive... they’ll have only done it on a few parts” (Samantha, MS3:15).

Questions were also asked about the subsurface potentially changing and its subsequent impact on storage integrity. These questions were, in general, not answered in detail due to a lack of time, a change of focus in the conversation or simply that the expert speaker could not address all the points raised. Samantha, in particular, expressed concerned over the level of uncertainty and the difficulty of extrapolating findings from small test sites over small time periods to potentially huge sites over hundreds of years.

Capacity of Sinks

There was a general interest in how important CCS could be in reducing the UK’s CO₂ emissions. Storage of between 20 and 40% of the UK’s CO₂ emissions were quoted by the geologist and this seemed to satisfy the panel participants, viz:

“I suppose with all the other thing going on [e.g. renewables] it’s quite a lot 20% isn’t it?” (Melanie, MS3:11).

Environmental Impacts

In session 3, the positive perception of CCS was tempered by some participants who raised questions over the possible environmental impacts upon the sea and sea-life. There was, however, little information which could be discussed regarding such impacts, so the discussion moved on to other concerns.

Infrastructure and Visual Impacts

As participants thought more about CCS, the issue of infrastructure and pipelines emerged as an issue of concern. Questions were asked about how large and visible the pipelines and rigs would be. The possible adverse effects of large structures upon the landscape and tourism were raised. The possible sabotage of pipelines was also mentioned post the terrorist attack upon the World Trade Center in New York City which took place on the 11th of September 2001. Again discussion was limited by lack of detailed information.

Technical Fix Approach Reducing Incentive for Other Activities

An area of concern which did emerge more strongly, however, was the wider societal consequences of CCS as a ‘technical fix’. Several participants were concerned that CCS would result in society becoming complacent in addressing other ways of reducing CO₂ emissions because the problem would be perceived as having been ‘fixed’. The group returned to the general low level of recycling as evidence of ‘laziness’ in responding to environmental problems. Any ‘solution’ which meant that individuals or other sections of society did not have to make wider changes would allow such ‘laziness’ to continue. It was widely felt in the panel that CCS was such a ‘technical fix’ that would stop or delay other desirable actions and steps.

Sue: “..... if we decide that we were going to do this [CCS] it would be easier because we’re lazy to an extent aren’t we? We don’t recycle enough It’s been taken out of our hands and somebody else is doing it for us then”

Facilitator: “Is that good or bad?”

Sue: “It’s a bad thing because that’s us being lazy”.

Heather: “Because people would just think, like a quick fix think, ‘oh, they’ve fixed it, so I don’t have to do anything’”. (MS3:20)

A further development of this argument was that CCS might even create a ‘false sense of security’ in our ability to cope with climate change and carbon abatement and that this could, perversely, result in an increase in CO₂ emissions.

Elizabeth: “....people will just think, ‘oh, well that’s alright then, that’s kind of been fixed.... There’s this invisible body out there that’s taking care of it I’ll just shove my carbon emissions We’d become more blasé wouldn’t we just like the car drivers? [driving more dangerously in response to safer design & seat belts]. We’d think, well, this has all been sorted”.

Heather: “Maybe we just shouldn’t tell anyone about it then. Maybe it should be a secret?”

Samantha: “..... can you imagine if there was a leak or something and everyone would go, ‘oh my god, the government are hiding this’”

(MS:21-22)

This above exchange shows a ‘risk compensation’ type argument being used, whereby as peoples’ perceptions of the risks of carbon emissions are potentially reduced due to application of CCS, they may compensate by higher CO₂ emitting behaviours and lifestyles. The idea of withholding information from the public to avoid such CO₂ compensation was seen by many other participants as highly risky for the government’s image. It was generally agreed within the groups that individuals were partly to blame for CO₂ emissions and therefore had to share some of the responsibility for reducing CO₂ emissions into the atmosphere. It was also felt that individuals *could* make a change in their lifestyles, but that some sort of ‘crisis mentality’ might be required before they would be prepared to do so.

4.2.4. More Uncertain and Ambiguous Perceptions

A shift to more negative perceptions of CCS within the panel more generally emerged after a critical presentation by an independent academic energy expert in session 4. This presentation came after one by an industry expert, which was generally more favourable to CCS. In subsequent questioning, the panel raised many of the critical points with the industry expert (MS4:4). The panel tended to view the industry speaker as having a vested interest in the technology, whereas the academic was perceived as independent. The panel repeatedly questioned the industry expert about the wider motivations of his company in adopting greenhouse gas emission reduction targets and in looking at the possibility of CCS. The research team's own evaluation is that both experts presented fairly balanced views of the need for the technology. There was also a presentational difference between the academic and the industrialist which appears to have influenced their reception by the panel. The academic relied more upon facts and figures than the industrialist, and was willing to provide seemingly 'harder' and quantitative answers to questions from the panel.

The difference in reception illustrates the way in which opinion can be shaped through presentational devices, persuasion and engagement with an audience, in addition to the trust imbued upon 'independent' experts in universities, and the corresponding lack of trust in industry experts (a common finding in survey research, e.g. Poortinga & Pidgeon 2003). Nevertheless, by the end of the session, the initial scepticism of the industrialist appears to have subsided and his perspectives taken more at face value. The critical presentation by the academic challenged the panel members to re-think their earlier generally positive endorsement of CCS. For example:

“Last week to me it [CCS] sounded really good , it sounded like the only option (...) and then this week it just sounds as though there's more options, (...) and then are we prepared, as a day to day person doing your day to day job are we prepared to make sacrifices we would have to make, like you say if we want to reduce that 60%, we're not going to be able to do it are we?” (Sue, MS4:10)

This comment was elicited in response to the academic's analysis of the benefits of greater energy efficiency compared to CCS (including the energy penalty associated with the latter), a perspective which was not appreciated by all the panel until then. The second part of the quote refers to the extent to which individuals would be prepared to change their lifestyles, possibly dramatically, in order to reduce CO₂ emissions, and hence avoid the need for extensive reliance on CCS. This need for lifestyle change had been an implicit part of the academic's preferred approach. The industrialist had stressed that achieving a 60% reduction in CO₂ emissions was a huge challenge and had made the argument that people had to decide between options such as nuclear, CCS or everyone changing their energy use quite radically. He asked the panel whether they could envisage reducing CO₂ emissions arising from their lifestyles by 50%. Several participants, e.g. Sue in the above quote, acknowledged in response that such lifestyle changes could be difficult to envisage. Such doubts about the feasibility of lifestyle changes made the comparison of options more complex and uncertain. In effect, the industrialist raised an uncertainty about how effective household or individual actions to reduce CO₂ emissions by a large percentage would be *in reality*, achievement of which the panel itself had recognized as problematic in session 3.

As a consequence of having been presented with an assessment of the alternatives to CCS, together with their unknown effectiveness at the present time, the panel was left more uncertain and undecided than they had been after session 3, when there was a reasonably positive position on CCS. Furthermore,

the fact that both experts were open-minded and not overtly pushing a single option also made an assessment of CCS more difficult.

“I think we all expected these guys to come in and go ‘right its green, green, green, green’,and you to come and go ‘you’ve got to do it this way there’s no other way’. I think that’s what we expected , I know I did, I didn’t expect anything else but its more of an option” (Sue, MS4:10)

Towards the end of session 4, a ‘rapprochement’ between CCS and lifestyle change as options for reducing CO₂ emissions appeared to emerge in the thinking of several participants.

“..... if we were going to do the storage way [i.e. CCS], could we not do both? Could we, as the general public, do more [in reducing energy use] so that you wouldn’t have to dig up as much ground [for laying CO₂ pipes]” (Sue, MS4:9)

“.....that would be a bit of a sight wouldn’t it? Everyone working together we’ll have 50% of it [CCS], we’ll have 50% of that [demand reduction]” (Sue, MS4:11)

The industrialist certainly encouraged such a consensual approach, but Sue herself, and other panel members, recognized the practical difficulties associated with such ‘joined-up’ thinking and working.

“..... they’re usually working against each other aren’t they Greenpeace against whoever, but then it would be nice for all to work together and say well if we do it together we’ll get more out of it” (Sue: MS4:11)

4.2.5. Final Thoughts from the Manchester Panel: Three Positions

In the final session 5, having reflected for a week upon the discussion, the panel members summed-up their overall thoughts on CCS and its role in reducing CO₂ emissions. For most members, the extent of the challenge had impressed upon them the difficulty of achieving a 60% reduction by lifestyle change alone.

“I certainly thought about it a lot this week, really I’ve had a lot of discussions with (...) but it seemed interesting to me, people who’re not involved in it - I’ve had the same reaction, I changed my view (...), once I’d listened to [the industrialist], and then it came across that we’re not all going to be able to do it on our own, we’ve gone that far”

“I don’t think you’re going to get as dramatic change in everyone’s lifestyle as we want to [get] each household [to reduce CO₂] by 60% (Sue, MS5:2).

Whilst most participants shared this somewhat negative assessment of public responsiveness, there were perhaps three categories of response to it.

- (i) The view that because of the reasonably long timescales involved, it would still be possible for the 60% reduction to come from lifestyle change and introduction of energy efficiency and renewable energy technologies. This group was not in favour of CCS, because it was placing CO₂ out of effective control and taking an unnecessary risk if the 60% reduction could be done through safer means.

“I would prefer to do it ourselves rather than store anything underground that I can’t see and can’t control, don’t know what’s happening with it” (Sue, MS5:6)

This group was in favour of measures imposed upon companies, councils and, ultimately, households to make sure that emissions of CO₂ were steadily brought under control, i.e. incentives, fines, taxation instruments, etc.

- (ii) Against this argument was the position that control is in any case ‘in your head’ and that you do not need to see something to have an understanding of it, or confidence in it. In this group, the participants saw the benefits of CCS as outweighing the risks. A worst case-scenario, for this group, would involve CO₂ escaping from storage reservoirs, but it was argued that this CO₂ would have been in the atmosphere in any case.
- (iii) A third group was more ambiguous about the role of CCS. Like group (1) there was strong support for government to take more action on energy efficiency, demand reduction and renewable energy. Any support for CCS is tempered by the perception that fossil fuels are, in any case, running out, hence other sources of energy are going to be required. In addition, it was felt that the risks of CCS are somewhat too high and uncertain at the current time and that there need to be more definitive answers to questions about the various risks encountered. However, a possible role for CCS as part of a wider package of decarbonisation measures was identified, provided that some of the key questions about the risks could be better addressed.

4.3. Analysis of the York Citizens Panel

As with the Manchester group it is helpful to first examine the panel’s attitude to climate change in a general sense.

4.3.1. Is Climate Change a Problem?

A few members of the group voiced concern that the climate change debate was very one sided and that those experts that thought that climate change was part of a natural cycle did not get enough attention. These members promoted a scepticism about the human influence upon the global climate which led to a considerable debate with the invited expert and carried through to session 2.

“Isn’t the problem that what is fact to one person is fiction to another?” (David YS2:6)

A few members of the group stressed that they felt there was a need to “separate the wheat from the chaff” when it came to the claims that people made about climate change. This focus on getting the “right” answer was echoed throughout by some members.

“We need people who can actually distribute the true facts” (John YS5:6)

The sceptical elements ‘went along’ with the dominant scientific view in session 2 and subsequent sessions, however, for the sake of moving the discussion forward.

4.3.2. Need for an Integrated Approach

Throughout the meetings, the members assumed that the ultimate goal of decarbonisation technologies is to solve the problem of *global* climate change rather than to meet nation specific targets. This indicates that integrated plans that demonstrate the impact that UK actions have on the wider problem of climate change may foster more public support than target focused ones. In particular, CCS was associated with avoiding the “real” problem and a reluctance to change. In order for the impact of CCS (and indeed any climate change technology) to be significant it was generally felt that it would need to be adopted internationally.

**“It’s not what we [the UK] do that’s actually going to change climate change”
(Mark YS2:17)**

The need for a portfolio of emissions reductions approaches to be adopted and the need to be able to compare them rather than consider each in isolation was stressed throughout the meetings. The need to continue expenditure on other, often longer term, solutions was also stressed.

“as long as they are putting as much effort in to figuring out ways of bringing it [CO₂] down, that is the main issue and also ways of dealing with the CO₂” (David YS2:24)

4.3.3. Reasons for Supporting CCS

The concept of using CCS as a “bridging strategy” to more renewable energy was presented by one of the expert witnesses and well understood and fairly well supported by the panel. However the need for longer term solutions was also stressed.

“It just bides time to figure out, if it doesn’t work or if we get a bit more time hopefully get some more ideas about how to sort it out... it just does buy a bit more time doesn’t it even if we don’t put much [CO₂] down there?” (Andrew YS2:18)

The majority of the group were reasonably supportive of CCS due to the significant impact it could have over a short period of time, and to the fact that no other technology could do this.

“Its not an ideal solution but it looks like a solution that can achieve drastic reductions in the short term” (Russell YS5:6).

When one of the expert speakers discussed the link that many people draw between CO₂ storage and nuclear waste storage, it was met with some agreement from the group, though it was generally thought that CCS would be more acceptable than nuclear.

“You could just say it was non-nuclear [storage] and that would make it acceptable” (George YS2:30)

Safety issues were ranked consistently highly by the entire group, and it was agreed that minimum standards would need to be met before any project was undertaken.

“If you can lock it [the CO₂], fine, I can understand why they are putting so much time in to this technology. If you can’t, if there’s still potential of it leaking, that strikes me as a bomb, because if it goes pop...” (Mark YS2:18)

Images of explosions such as this were common throughout the panel discussions despite the inert nature of CO₂. A closer analogy than nuclear waste storage might be the potential risks of natural gas or of industrial gases which have caused explosions in the past.

4.3.5. Reasons for Opposition to CCS

As End of pipe technology

CCS was perceived as an “end of pipe” technology and this was discussed frequently as a negative attribute by the panel.

“We are treating the symptoms not the causes [of] doing this” (Mark YS2:21)

Long-term Implications and Uncertainties

The uncertainty associated with this technology as it has not been used on a long term basis or on a wide scale before generated a number of concerns throughout the meetings.

“In one hundred, two hundred years time we may actually be paying the penalty for putting a pollutant back in to the earth It could do anything couldn’t it? ... but that is the risk that we’re taking today isn’t it, doing all of this?” (John YS2:15)

This uncertainty and long term implication conjures-up analogies with previous events.

“... that’s what they did with asbestos... suddenly they did a test for it and it has become catastrophic really... we have used lots of chemical products that we’ve found out after the time – we shouldn’t have done it.” (John YS2:15)

It was stressed by one participant that the idea of CCS needs to be very carefully and thoroughly explained if it is to be supported. If it is not properly assessed with local participation then he suggests that there could be serious consequences:

“I can imagine if it was discussed quite widely in the community there would be a lot of alarm. These things do provoke that sort of reaction.” (Andrew YS2:15)

Not Sufficiently Radical

CCS (in particular) and also the Government’s approach to climate change (in general), were frequently criticised for not being radical enough, though the panel was not well informed about what government is actually doing.

“Have the government tried to sell any green issues apart from a few silly adverts about filling your kettle? They don’t seem to do much” (Graeme YS2:4)

“They don’t seem to be thinking outside the box do they? They are actually trying to find somewhere to store it, to keep it , when surely can we not try to use it [CO₂] as another form of energy that dissipates naturally creating heat or whatever” (John YS2:22)

This is a prime example of how this, rather technically minded group were very keen to suggest end solutions to problems but were not actually able to explain exactly how this would be achieved. They tended to assume that technologies or approaches that they thought about were feasible but had simply not been thought of by others, or had not been the subject of sufficient research activity. The idea of using CO₂ in the process of making something else was often discussed by the panel. This technological optimism demonstrates a “utilitarian” type approach, preferring to re-use and recycle CO₂, rather than just storing it.

Limited Ability to Tackle Sources of CO₂ Emissions

The fact that CCS could not be used to capture the CO₂ emissions from cars (given the present energy system) is seen to be a limiting factor:

“This isn’t going to save much because there is no way that you’re going to sequester it from your Land Rover is there?” (Graeme YS2:21)

Moral & Emotional Objections

A number of moral and emotional arguments against CCS are expressed.

“Our deep irrational fears, I think you’ve come up with deep irrational fears about injecting mother earth. I think that is an irrational fear but I feel it as well.” (Graeme YS2:25)

These concerns are often linked with a sense of responsibility to not cause problems for future generations.

“I just don’t like the idea about pumping another pollutant back in to the earth, we’re doing it all the time aren’t we? We are storing up another problem for the future” (John YS2:23)

Distrust of Business Motivations

There was a general distrust and scepticism of the motives and behaviour of business.

“If there is money to be made associated with it, people will not trust them”.
(Mark YS2:27)

When discussing the possibility of hydrogen fuels for cars...

“That wouldn’t be acceptable to the oil industry would it? It would be squashed straight away because there is too much political pressure from that sector”
(John YS3:19)

The discussion on Enhanced Oil Recovery (EOR) met with a largely negative reaction as the extraction of more oil seemed to contradict the aim of limiting future CO₂ emissions. The support of America for CCS and EOR also led to scepticism in the group as the USA was seen to be environmentally unfriendly. Deep felt scepticism of any actions by the USA was expressed throughout.

Distrust of the Media

Many of the group supported the idea that the media would control what the public would think of CCS if it were introduced. There was a great deal of scepticism of the media in this group, especially in their ability to understand and communicate scientific information to the public. This seemed to be due to the belief held by many of the panel members that they had more reliable scientific knowledge (or ways of obtaining such knowledge) than the media.

Lack of Trusted Source of Information

In reference to the Greenpeace campaign to stop the sinking of the Brent Spar and the controversy over some of the claims made about the negative environmental impacts the following comment was made:

“The people feeding us policy, who are trying to make us feel good, get it wrong on a big thing [i.e. the Brent Spa], so what should we believe next?” (Mark YS3:4)

There was widespread support for an “encyclopaedia of facts” that would be presented in a digestible format for the public and the media. Some members of the group suggested the encyclopaedia could include different opinions on the same issue to allow for inevitable disagreement and uncertainty. The groups were asked to consider how trust in the information presented in the encyclopaedia could be developed. One suggestion was that it would be a ‘living document’ where the encyclopaedia could be “challenged” by lay members of the public or experts. Information would have to be given to defend an entry in the encyclopaedia or that entry would have to be altered. It was stressed that this needed to be a very visible process if the public was to be convinced that the encyclopaedia was a reliable and unbiased source of information. How this “challenging process” could actually be carried out was also discussed. Some support for using the internet was expressed, as was some severe scepticism of the internet as it is not felt to include everybody. The use of moderated web-based discussion fora was also strongly supported by one member of the group.

4.3.6. Participation in Climate Change Policy Decision-Making

The York panel engaged in a lengthy discussion of the decision-making process itself and how it could become more open and transparent. This discussion was very much ‘bottom-up’ from the participants themselves, rather than having been promoted by the facilitator, and indicates a high degree of interest in participatory approaches by at least some of the panel members. There was some scepticism from members of the group regarding existing forms of participation:

“You’ve got things like local agenda 21.... That’s nonsense, its not making a difference and they... ‘oh, little people making a difference’. No! ... [it is] Government policy which is driving agendas nationally....[that will] make a difference” (Mark YS3:4)

However, it was accepted by most of the panel that encouraging participation is a very difficult task. Some of the members supported the need for financial incentives to encourage participation; others believe that the provision of more information would be incentive enough. The distinction between participation and empowerment was also raised. It was generally agreed that stakeholder groups discussing CCS need **“to have teeth”** (John YS4:10). The need for members of the public to not just be included but to actually have an impact upon the final outcome of the policy making process was stressed. There was also support for meetings that were a variation of the citizen panels themselves but included politicians and civil servants and thereby would have a greater impact upon policy. However, the desire for greater public involvement was balanced by general agreement of a high level of public apathy in the UK. When asked about what the general public would think about CCS, the following responses were elicited:

“They probably don’t give a [damn] to be honest” (John YS2:25)

“The only time people will complain is when the energy bill goes up as a result of this policy” (Mark YS2:25)

“The first thing the public will say is (...) its going to cost me more on my electricity bill. And the next reaction from another part of the population will be “that’s shoving more yuck into the earth” (Mark YS2:27)

It is interesting that this is a very different reaction from that which the majority of the panel themselves offered i.e. many of them stressed that they would not mind paying somewhat more for their energy to support CCS. This reflects a more general finding of citizen panel research (Gough et al. 2002), namely that participants often start with some views which they then develop collectively through successive meetings, and by means of gaining new knowledge and perspectives from the expert witnesses. Such a distinctive, informed position comes to set the panel members (often individually and as a group) apart from the ‘lay public’ which the panel is intended to, in some ways, represent.

The Need for Greater Awareness and Education

The need for education about the problem of climate change and abatement strategies that people could adopt themselves was stressed throughout by many members of the group.

“I think a big problem is awareness. I don’t think that the general public is aware of the seriousness of the situation” (Andrew YS3:21)

It is suggested that education would result in behavioural and attitude change.

“They would [then] be more inclined to help fund or support things” (Andrew YS3:21)

The idea of focusing education campaigns specifically at children also met with approval.

“... its school kids who I think often get their parents .. just on a small basis, in terms of recycling, it’s the youngest generation” (Oliver YS3:20)

Lessons from Previous Campaigns

The recent NSPCC campaigns involving animated children and the noise levels of babies crying were praised in terms of effective marketing and raising awareness. The idea of private sector advertising agencies being used by the government in order to communicate environmental messages was discussed. Another member of the group suggested that advertising of any sort was not the best way to educate and that instead factual Television programmes should be made, in which the government played a considerable role. Some felt that the government needed to be completely divorced from any campaign as they would “bottle out” from more hard-hitting presentation styles. The success of the independent Monetary Policy Committee at the Bank of England was used as a potential analogy for the separation of the government from advertising related decisions.

“The government doesn’t take all the flack for interest rates like it used to. They don’t get ‘you got that all wrong’” (Graeme YS5:27)

Distrust and Trust in Experts

Many of the group used information that they have gained from watching television programmes, or else applied scientific principles and ideas that they were familiar with, to question the expert witnesses who came before the panel. Several panel members used what knowledge they did have with a great deal of authority even when they could not fully remember its source. There was a strong preference amongst some participants for “exact” figures rather than expert opinion, with some even trying to work out numbers by themselves on the basis of what the expert speakers had told them. However other members of the group were far more amenable to accepting the expert opinion on an issue and believed that others would do likewise:

“To be honest as long as it’s been researched by people who really know what they’re doing... I’m not scientific at all... as long as the people who are scientific, who know what they are talking about, as long as they agree with it I am prepared to go along with it as far as [CO₂] storing “ (Tony YS3:20)

Even those sceptical of “expert” opinion themselves, tended to believe that the general public would be persuaded by experts, if convincing arguments could be made:

“If it can be proven scientifically [and], there’s enough people to argue that it is a good thing I think it will be accepted” (Mark YS2:29)

4.3.7 Multi-Criteria Scoring of Storage Site Evaluation Criteria within Sub-Groups

As noted in Chapter 2, the York panel broke into three sub-groups in sessions 4 and 5, during which two scoring exercise were carried out. One related to the relative weights given to a set of criteria for evaluation of CO₂ storage sites, which were derived from an earlier Tyndall Centre project (Gough, Shackley & Cannell, 2002). The results for each group (series 1 – 3) are shown in Figure 4.1.

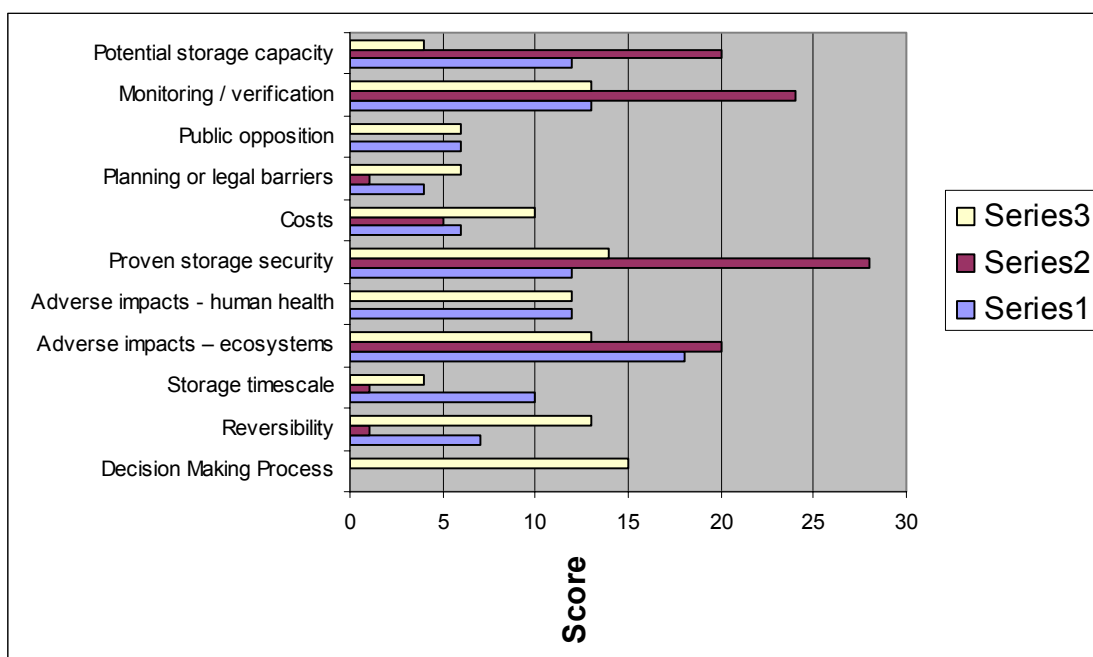


Figure 4.1

Potential Storage Capacity

Potential storage capacity was rated fairly highly by both groups one and two. The first group did not rate it highly, suggesting that all the possible sites would probably have a fairly high capacity. Hence, they interpreted the weighting differently, rather than lacking concern about storage capacity.

Monitoring and Verification

It was generally felt that there was a substantial public interest in this aspect of safety and that it was a good way of showing the public that the system was operating safely.

Public Opposition

The impact of public opposition was considered to be fairly low by all groups. However, the explanation for low weighting was not that the sub-groups necessarily regarded public opposition as unimportant, but rather that opposition was seen by all three sub-groups as politically insignificant.

“Public opposition was something that we thought would be there but could be managed” (George YS4:2)

“Being cynical we felt that public opinion could be swept aside, as recent examples show [referring to the large demonstrations against the war in Iraq]” (David YS5:5)

Planning and Legal

Again, it was generally thought that planning and legal barriers and obstacles could be “managed” by the government, e.g. by changing the law or guidance, and hence was given a low weighting.

Costs

One group noted that whilst the actual nominal amounts would be very high, it was not thought to be a terribly important factor. However another group felt that if the public had to pay for CCS directly then cost would seriously affect the way the public felt about CCS. The need to protect those on lower incomes from taxation to pay for CCS was also noted. Compared to the extensive interest in costs in the policy debate, it is interesting to note that this aspect does not feature very highly in importance with the Panel. This might, however, be a consequence of the perception that costs would be spread across a large number of consumers, and so appear fairly small to the individual householder. It could also be an artefact arising from the hypothetical nature of the proposal, as has been found in some contingent valuation (Willingness to Pay) studies.

Storage Security

Safety issues were discussed by all the groups as being highly important. Security, verification and impacts on human health were scored most highly by one group. This is because these were the factors which were felt by that group to have most impact on people’s every day lives.

Human Health Impact

It was suggested that although the likely human impact was small it would have to be demonstrated clearly to the public that:

“you had paid due regard to human health aspects”. (George YS4:3)

Ecosystems

As the perceived purpose of the technology is to protect ecosystems, damage to them resulting from the technology was ranked reasonably highly by all three groups.

Storage Timescales

The weighting for timescale was not increased above the initial (default) allocation of ten given to all the categories by any group.

“we didn’t see that as overly important as long as it was sufficient” (George YS4:2)

Reversibility

This was generally not thought to be of high importance.

“If there were faults with it one would just stop doing it rather than actually try and extract it” (George YS4:3)

Even the group that supported the idea of periodic ice ages as the main explanation of climate change did not think that reversibility was important, since they felt that it would be easy enough to produce more CO₂ in the future.

Decision-Making Process

One group added this category to the list provided to reflect the importance they placed on including the public in the decision making process and the need for it to be transparent.

In summary, it is interesting to note that all three sub-groups rated the security, safety and risk criteria most highly. This suggests that the public perception of CCS will be strongly influenced by the extent to which potential risks and hazards have been seen to be properly identified, assessed and appropriate responses and safety measures implemented.

4.3.8 Assessment of Energy Options within Sub-Groups

The three groups were asked to weight the level of funding they would support for each of the following technologies (Figure 4.2). This was used as a surrogate indicator for the technology options which they would most like to see developed in order to reduce future CO₂ emissions.

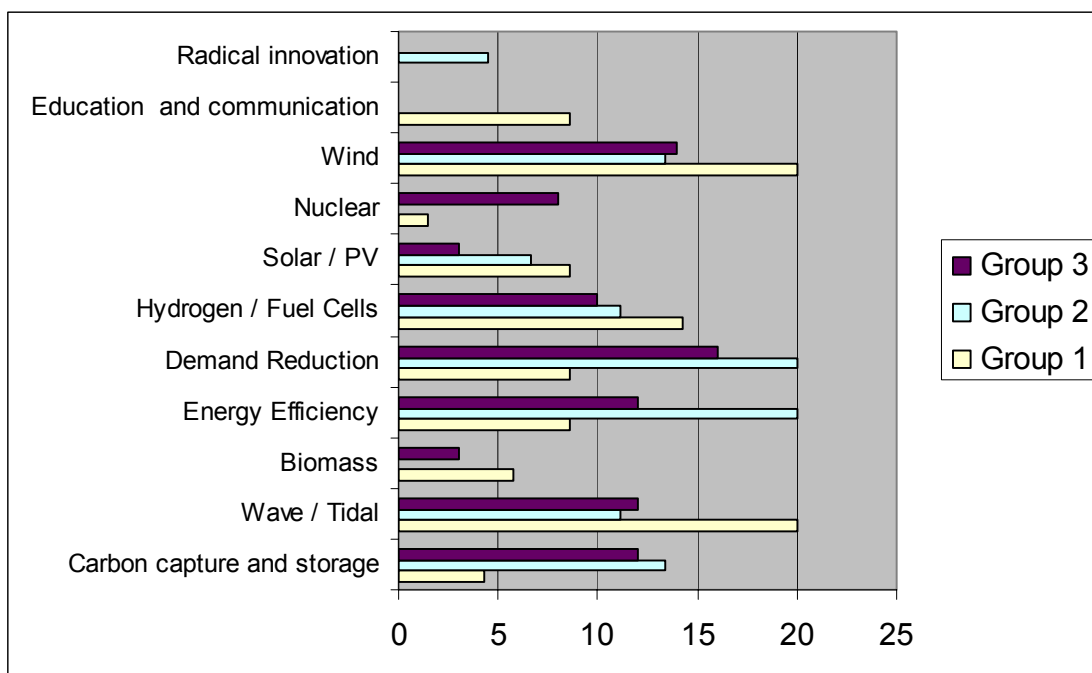


Figure 4.2

The “radical innovation” category was added by one group, thus reinforcing the idea that current R&D efforts are perhaps not seen as being radical enough. As discussed previously, education and communication were felt to be of utmost importance. Therefore one group created this separate category whilst the others included it implicitly under energy efficiency and demand reduction.

Wind power met with unanimous support. The use of **nuclear power** was met with some disapproval. The only expenditure on nuclear that was widely supported was that to close down the industry or to develop fusion related technology. However one of the subgroups also noted that nuclear may have to provide the long term solution to climate change if no other technological developments are made, though it was hoped that it would be made “cleaner”. **Solar power** was supported in principle; however, two of the groups did not consider that it would have a significant impact in the UK. There was widespread support for **hydrogen**, especially in relation to transport. **Demand reduction** and **energy efficiency** were strongly supported throughout all the groups. The groups were all of the opinion that **biomass** had not yet been proven to be effective (The strength of this opinion may be stronger in the York area due to its proximity to the recently closed Arbre project). **Wave and tidal power**, although generally less well understood than other renewables, were supported. **Carbon capture and storage** received fairly high ratings from groups two and three. It is promising for the development of CCS that all groups supported some level of expenditure on it. One sub-group was noticeably less keen on CCS than other options - this was the “doubters group” and so was an expected response.

Although we selected the sub-groups with the view that we had relatively pro-, agnostic and anti-CCS ‘camps’, it turned out that the weightings for most of the other decarbonisation options are generally similar in pattern, if not in magnitude. This suggests that there was greater consensus on the role of wind, energy efficiency, demand reduction and wave & tidal than on the possible role of CCS. This is perhaps to be expected given that knowledge of CCS is much less than that of wind, energy efficiency, etc., and the associated risks are far more difficult to ascertain and evaluate, even with an extended discussion with experts. This simply reflects the novelty of CCS and the lack of experience with it. It is noticeable that two of the sub-groups did weight CCS at approximately the same level as hydrogen and wave & tidal, two other technologies which are future oriented, about which less is known and with which we have less experience.

4.4. Comparison between Manchester and York Citizen Panels

4.4.1. Different Degrees of Scepticism about Underlying Climate Change Science

There were some strong differences between the two groups in respect of the acceptance of the basic underlying science of climate change, and of the seriousness of the potential threat of climate change impacts to life in the UK and more generally. The York group was in general more critical and enquiring of the underlying science of climate change. Whilst the Manchester group accepted the presentation of the climate change scientist, this was much less so in the case of the York group, where probing questions were asked about: the timescale of the analysis, natural variation on very long timescales, the role of natural feedbacks and the role of sunspot cycles. For example, the 100 year global temperature record was not accepted as a sufficiently long enough timescale to make strong claims about anthropogenic change, so the following week we presented a 1000 year temperature record for the Northern Hemisphere. Even this was rejected by several participants as not long enough! We suspect that the York group was more sceptical of the underlying science for three reasons:

- i) More specialized knowledge (through further education, the media, etc.)
- ii) Gender
- iii) Socio-economic status

Previous survey research in the UK has shown that men are better informed about climate change science than women (Hargreaves et al. 2003). ‘Better informed’ might also translate into ‘better able to disagree’ and contest the information that is being provided by the expert witness. The York participants included several individuals with degree-level qualifications in scientific subjects and they augmented their existing knowledge with information from television programmes such as ‘Horizon’, the written media and through searching the web.

4.4.2. Change in Energy Systems Versus Lifestyle change

There was, in general, a more technological and scientific orientation in the York group, which may reflect gender, the background of several participants on the York panel, as well as educational qualifications and higher socio-economic status. This resulted in a stronger focus in the York panel upon the various technologies associated with CCS, as well as other low or zero-carbon technologies. The York panel were also interested in finding a **use** for CO₂, rather than just storing it as a waste by-

product of utilizing fossil fuels. The hydrogen economy, whereby CO₂ and hydrogen would be extracted from fossil fuels was a notion which appealed to many of the York group. The York panel focused upon transformation of systems and large-scale organizational response that involved coordinated action from government, companies and public agencies.

The Manchester panel, by contrast, focused more upon the challenge of reducing energy consumption through lifestyle change, of changing ‘hearts and minds’ by urging on people the severity of climate change and its impacts. The panel were more ready to take personal responsibility for the climate change problem and in identifying solutions to it than their York counterpart. The Manchester panel was also preoccupied with how to effectively communicate the message about the need for decarbonisation. Their interest in communication appears to have been the result of their own surprise at hearing first hand about the scale and potential severity of climate change and its impacts. The panel seems to have come to a collective view that the public needed to become much more aware of climate change and that the panel itself could provide some useful ideas on how to achieve more effective communication.

4.4.3. Safety and Risks

The York panel was in general more concerned about the safety aspects of CCS than the Manchester panel, and somewhat more sceptical about whether CCS could be implemented in a way which would eliminate risks, or at least reduce risks to a very low level. This reflects the greater focus of the York panel on technology and large-system change, in part a consequence of the group’s perception that energy demand reduction through lifestyle change was not a realistic option. The panel tended to take it for granted that decarbonisation would not occur through voluntary lifestyle and behavioural change and did not express support for taxation or other coercive approaches to effect change, hence the greater reliance on technological solutions. The York panel also seemed to be more familiar with the past history of industrial risks and accidents, and more inclined to view any major new system change as potentially creating risks which were inevitably uncertain. The panel did not particularly single out the risks of CCS as necessarily worse or less than the risks of other large-scale energy technologies; they were, instead, aware that such risks occurred in respect of many other options.

4.4.4. General Consensus on CCS as One Option Within the Portfolio of Decarbonisation Options

Yet, despite the differences between the Manchester and York panels, the qualified acceptance of CCS, and the readiness to include CCS as one of the decarbonisation options which needed to be assessed, was similar in both groups. In other words, CCS was regarded as one of the necessary options in a portfolio of decarbonisation technologies, policies and measures and lifestyle changes. In both groups the underlying reasons for the acceptance of CCS within the portfolio were broadly as follows:

- (i) No single measure or technology would be sufficient to meet the challenge of a 60% reduction in CO₂ emissions.
- (ii) Lifestyle change to reduce demand for energy, whilst in many respects the most attractive option, was not considered to be sufficiently reliable as the basis for decarbonisation on the scale required.
- (iii) The risks of CCS were considered to be something of an unknown at the present time, but generally the panels were reassured by the geologist’s interpretation of the potential risks.

(iv) Therefore CCS was accepted as one of the options.

4.4.5. Minority Positions Against or in Favour of CCS

A *minority* in both groups regarded the concept and practice of CCS as either morally questionable, or as posing too great a risk in terms of geological integrity. The moral argument was based on the sentiment that CCS is an ‘end of pipe’ approach to tackling decarbonisation and allows society to continue without making significant changes. The problem could then be regarded as having been ‘solved’ and attention would move away from the long-term need to transform the energy system and lifestyles, including significant long-term reduction in energy demand. A *further minority* expressed a more positive view of CCS. Whilst the majority view regarded CCS as a possibly necessary option, but were at best ‘luke warm’ about it, one or two individuals in each panel saw CCS as a positively beneficial option.

Whilst we could identify majority and minority viewpoints, there was also considerable ambiguity in the responses of the participants. Some individuals would express general support for CCS on technical and economic grounds, but then in other contexts they would express moral concerns about CCS, or else express distrust of the intentions of governments or businesses in promoting CCS. Others who were less supportive of CCS would, on other occasions, express scepticism about the efficacy of other decarbonisation technologies, policies and measures, seeming to then lend more support to the possible need for CCS. Such ambiguity has been identified in much work on public perceptions, especially when complex and uncertain science, technologies and social and economic change are involved (e.g. Kasemir et al. 2003).

5. Survey Results

5.1. Basic Characteristics Of The Sample

The number of respondents in the sample was 212, It is not possible on the basis of this small sample to make claims about whether the perceptions recorded here are representative of the UK population more widely. The present survey could be repeated at a number of other airports around the UK. This would allow the present sample to be compared to one or more samples. Statistical confidence levels between such samples could then be measured which would allow some conclusions to be drawn about whether the results are more widely representative. Although confidence intervals could be calculated for this sample alone, the value of this would be questionable and it would be more sensible do this once more data had been gathered. Quota sampling, in which the population is broken down into demographic groups and a target number of respondents from each group sought, would be another method that could be used and would allow for some wider claims about representativeness in future research. This approach would require a much larger sample.

The sample included more male than female respondents (58% to 42%). Just over a third of the sample had degree level qualifications or equivalent. There was a fairly even distribution of ages within the sample and a reasonably even distribution of household incomes beyond the £10,000 per annum figure. Respondents from households with below £10,000 per annum were not as well represented, presumably because members of such low-income households are less likely to be travelling by air. Two thirds of the sample were travelling for holiday or leisure purposes, with only 9% travelling for business. This reflects the principal business of Liverpool John Lennon International Airport as serving the needs of holiday-makers. A broadly (though not statistically) representative sample of the UK public (in terms of age, qualifications, household income and gender) has been obtained, though with an under-representation of low-income households and individuals with no qualifications. The full details of the sample are provided in the Appendix B.

5.2. Beliefs And Concern About Climate Change

The large majority of our sample believed that human activities are causing climate change, as shown in Figure 5.1. Only 7.5% of the sample disagreed or did not express a view either way. There was also a generally moderate to high concern about climate change, as shown in Figure 5.2, though there was also a substantial number (22%) who did not express a view either way, and a further 15% who were not concerned about climate change. This suggests that whilst many people now accept that human activities are a major cause of climate change, there is less consensus on whether climate change is a problem, though still over 60% who are “very concerned” or “concerned”. Figure 5.3 plots concern about climate change against belief in human-caused climate change. It shows that those who believe most strongly in anthropogenic climate change (ACC) are also the most concerned about the effects of climate change. Those with a lower or no belief in ACC tend also to be less concerned about the effects of climate change.

The majority of the sample believed that climate change is not given enough attention at the present time by politicians (Figure 5.4). Furthermore, there was overwhelming support for pro-active public participation in responding to climate change (Figure 5.5), although over 60% of the sample still look to government experts and scientists to decide on the most appropriate policies.

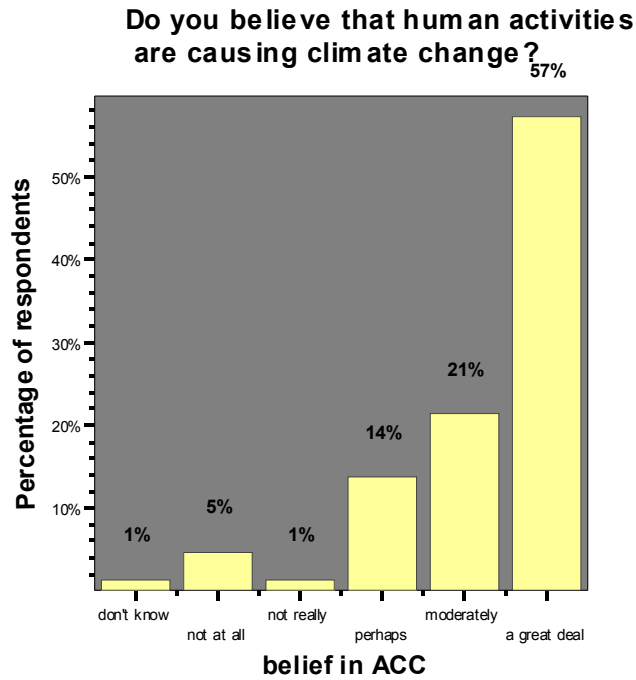


Figure 5.1: Belief in Anthropogenic Climate Change

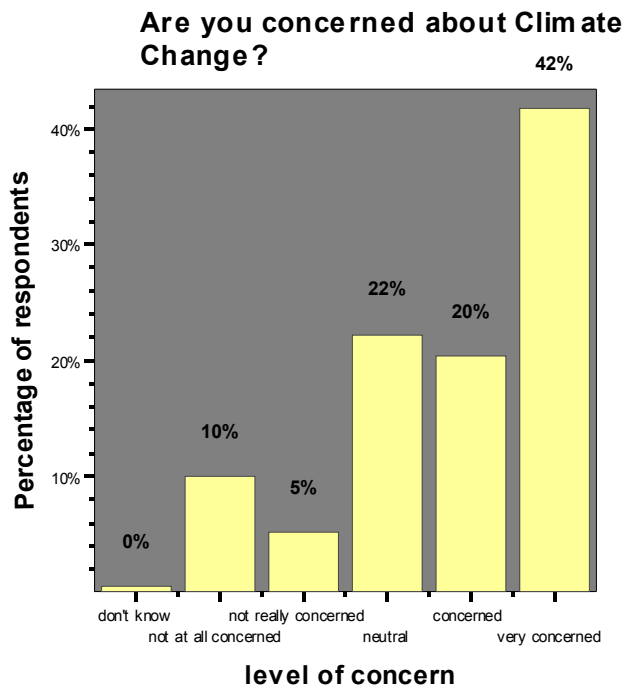


Figure 5.2: Concern about Climate Change

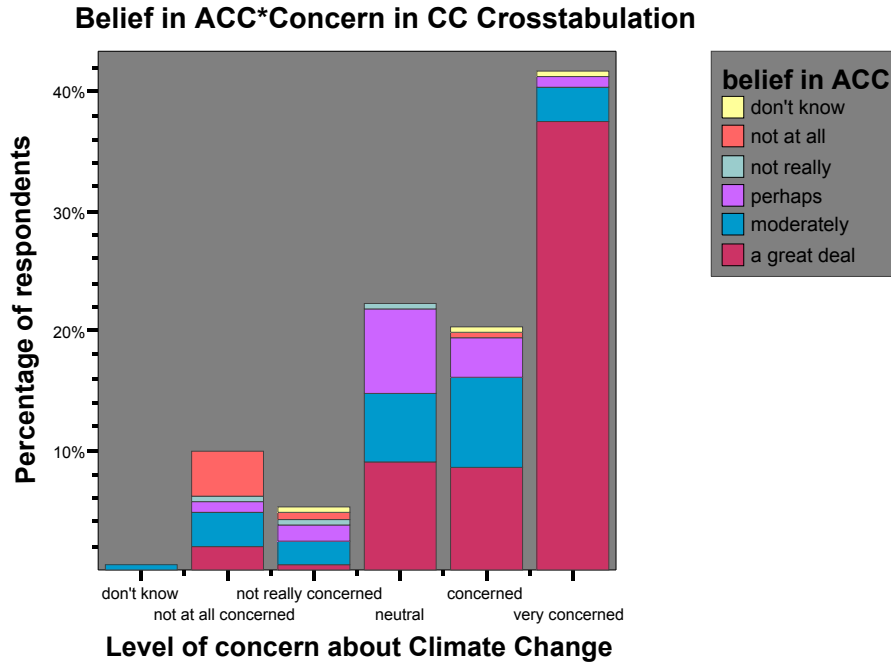


Figure 5.3: Concern about Climate Change Plotted Against Belief in Human Cause of Climate Change

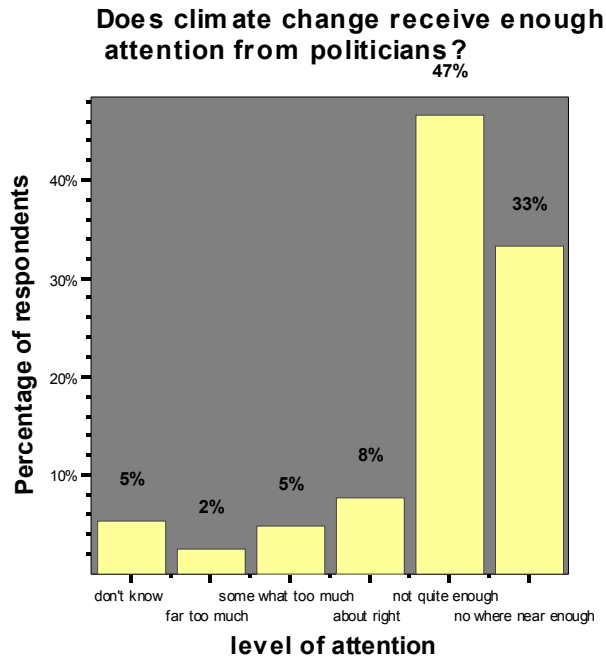


Figure 5.4: Does Climate Change receive enough attention from politicians?

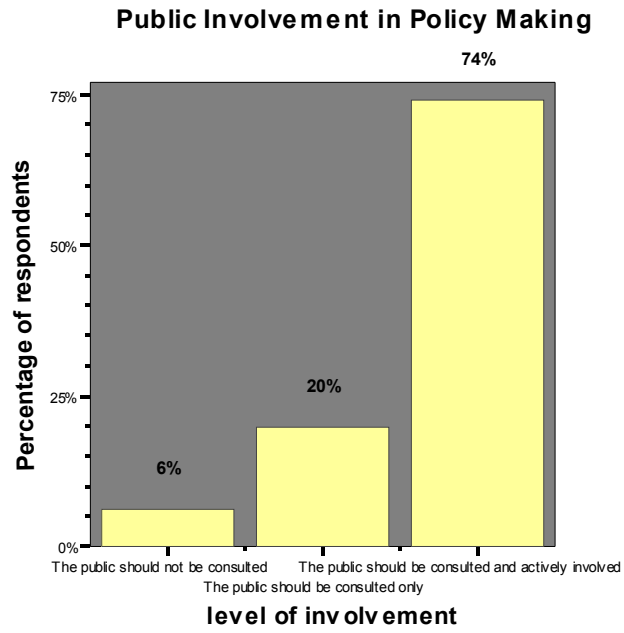


Figure 5.5: How Actively Should the Public be Involved in Policy Making?

5.3 Initial Reaction To CCS

Respondents were asked their opinion of CCS after a very brief introduction to the technology, i.e. they were told that it would store CO₂ under the ground but not the reason for doing this. Figure 5.6 shows that positive responses were not widespread. It was often stated by respondents that they had to know *why* it was being done and what the risks were before they could make a judgement. About 25% of the sample stated that they did not know, whilst 23% stated that they were neither for nor against. In other words, nearly half of the respondents were undecided in what they thought of CCS. Most of the other respondents were against CCS, with 14% stating that they did not like CCS at all, whilst 24% said they did not like it, or 38% against in total. Only 13% of the sample said that they supported CCS.

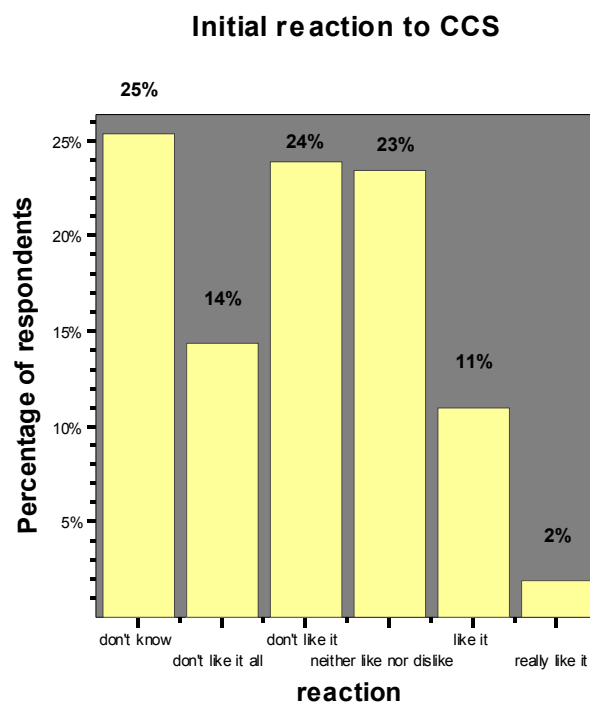


Figure 5.6: initial reaction to CCS

5.4 Perceived Attributes Of CCS

When asked, **unprompted**, if they could think of any negative effects of CCS (Figure 5.7) respondents' most frequent answer was leakage (49%). The next most frequently mentioned were ecosystems (31%), the new and untested nature of the technology (23%) and human health impacts (18%). Although these practical, physical risks were the most frequently mentioned, there were also a number of negative attributes mentioned in relation to CCS as a part of climate change abatement policy. Avoiding the real problem (13%), short termism (12%) and the policy demonstrating reluctance to change from government (11%) were all mentioned regularly. Grouping these last three responses into a general concern that CCS is treating the symptoms not the cause of excessive CO₂ emissions, this would constitute, at 36%, the second most frequently mentioned negative aspect of CCS.

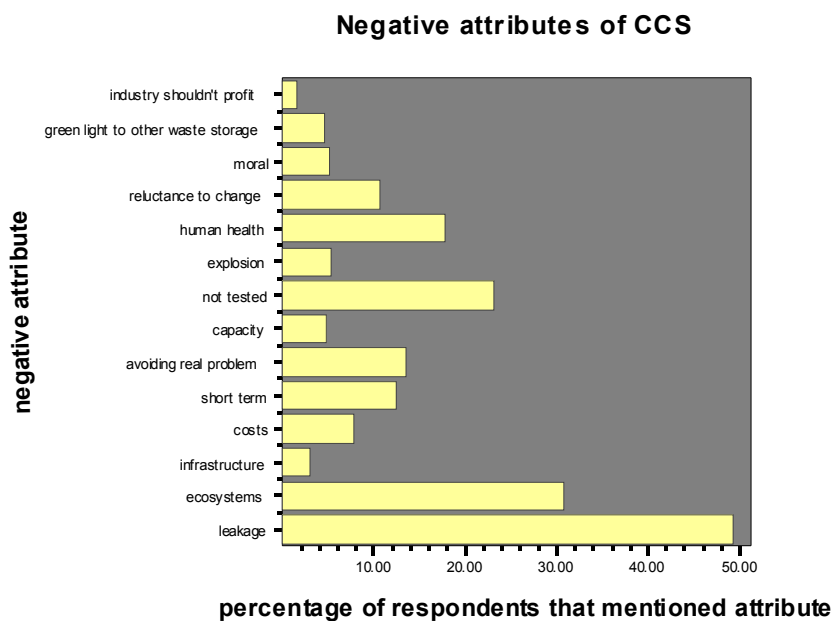


Figure 5.7: Negative attributes of CCS mentioned by respondents

When asked, **unprompted**, if they could think of any positive effects of CCS (Figure 5.8), by far the most frequent response was abating climate change (58%). The notion that using CCS could “buy time” to develop other solutions was the next most frequently mentioned at 7%. Definitions of the attribute labels can be found in Appendix C.

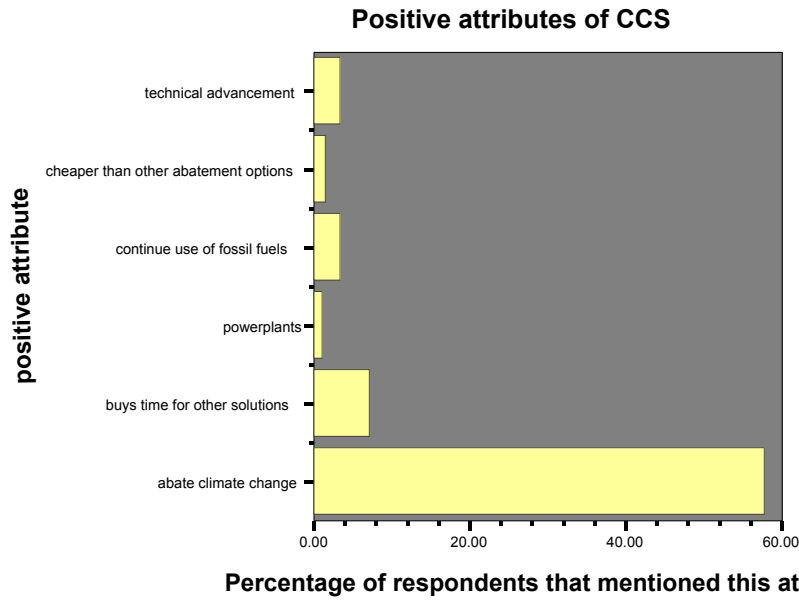


Figure 5.8: Positive attributes of CCS mentioned by respondents

5.5 Enhanced Oil Recovery (EOR)

The possibility of CCS being used to increase the amount of oil that could be extracted made no difference to their perception of CCS for a large number of respondents (47%) (Figure 5.9). However a similarly large percentage (43%) became **more favourable** toward the idea of CCS. Less than five percent became less favourable after being given this information. This suggests that EOR will, in general, be regarded as an additional reason in support of CCS, rather than counting as a reason against.

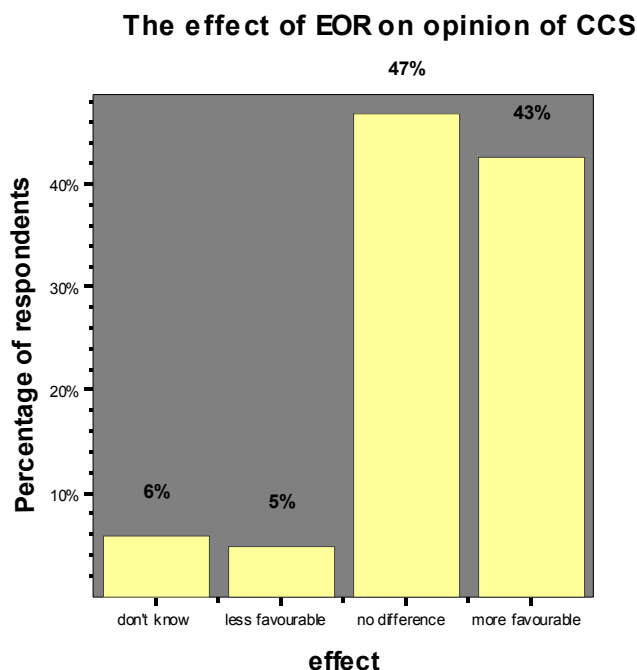


Figure 5.9: Effect of EOR on opinion of CCS

5.6 Support For Other Climate Change Abatement Techniques

Wind power, wave and tidal power, solar power and energy efficiency were all very well supported by the respondents (figure 5.10). Only nuclear power and higher energy bills received strongly negative reactions. Carbon storage, as a way of tackling climate change, met with a range of reactions, but the most frequent response was “slightly support”. Carbon storage was strongly or slightly supported by 55% of respondents. A further 22% of the sample were either slightly or strongly against CCS. Compared to some of the other options, there is higher uncertainty surrounding CCS and its potential impacts, and this may explain the moderate support that is the most common response. The level of slight and strong support for CCS at 55% is, however, notably higher than the 13% elicited without any information on why CCS was being proposed. There was a marked migration to the slight support category from the ‘slightly against’, ‘don’t know’ and ‘neither support nor not support’ categories.

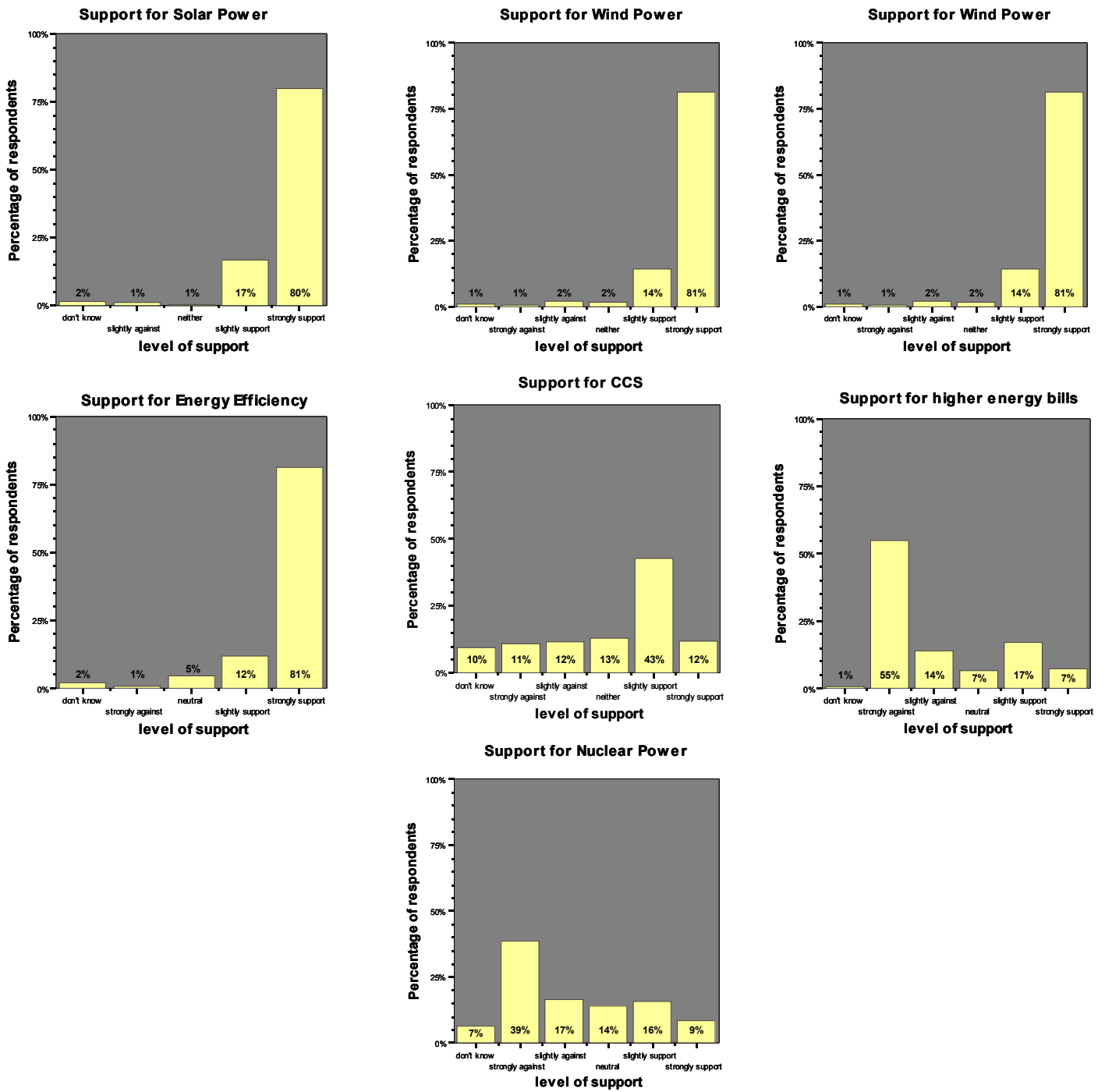


Figure 5.10: support for other climate change abatement options

5.7 Responsibility For Funding And Regulating CCS

The prevalent answer for who should fund CCS (when prompted) was the oil industry (71%) (Figure 5.11). This was followed by Government (54%). It should be noted that respondents were allowed to select as many of the categories as they wished. Hence, in most cases respondents have selected more than a single category as the funder (or regulator). It is also interesting to note that many of the respondents selected “consumers” because they felt they would end up paying for it no matter who was selected from the list, rather than because they felt that they *should* pay for it.

With regards to regulating CCS, Government was the most common answer (46%) (see Figure 5.12). This was fairly closely followed by the Environment Agency (43%), Environmental groups (34%) and the oil industry (32%). The suggestion of a completely new independent body to regulate CCS was supported by a few respondents. It is interesting that environmental NGOs were regarded by many respondents as an important part of the regulatory system, in many cases along with government, the Environment Agency and the oil industry.

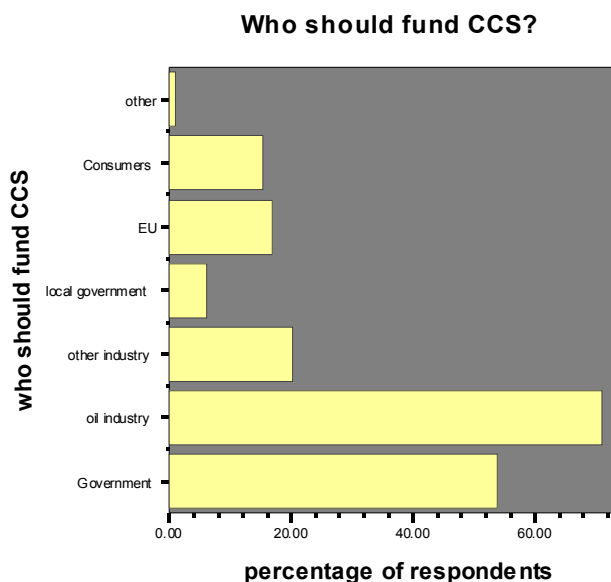


Figure 5.11: responsibility for funding CCS

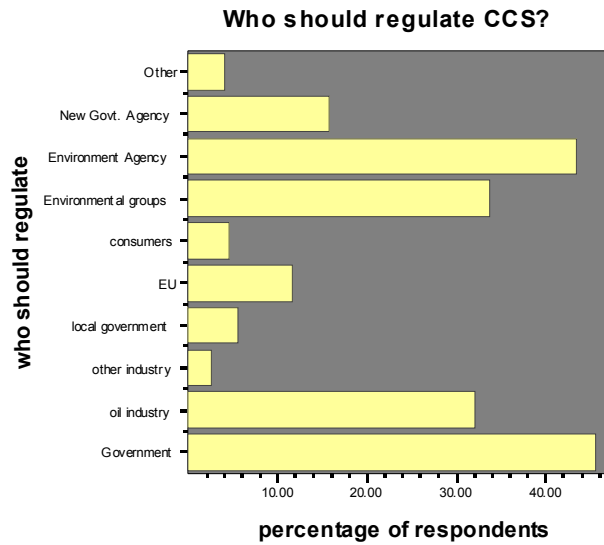


Figure 5.12: responsibility for monitoring and controlling the development of CCS

5.8 Opinion of CCS at the end of the survey

As can be seen from Figure 5.13, by the end of the survey, when more information regarding CCS had been presented to the respondents, the distribution of responses changed considerably. As would be expected, now that more information had been given to respondents, the “don’t know” category fell significantly. Positive responses increased significantly from the initial reactions (Figure 5.6). Negative responses fell substantially. The direction of opinion change is discussed in the next section.

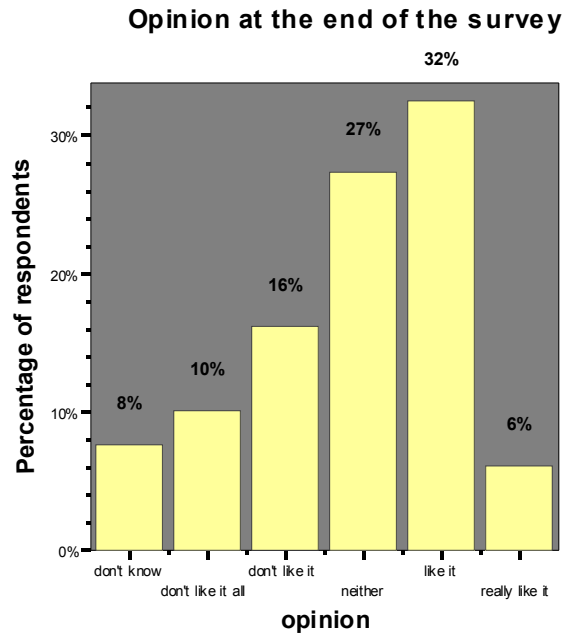


Figure 5.13: Opinion of CCS at the end of the survey

5.9 Opinion Changes As A Result Of Information

Half of the respondents developed a more positive attitude towards carbon storage once more information regarding its purpose and the practicalities of its use had been disclosed to them (Figure 5.14). The respondents were also made aware of the other major decarbonisation options available. A considerable proportion (35%) did not alter their opinion, however, whilst 16% developed a more negative attitude. The positive impact that a limited amount of information can have on public perceptions of CCS indicates the need for the concept and aims of CCS to be well understood early in the dissemination process if it is to be received well by the general public.

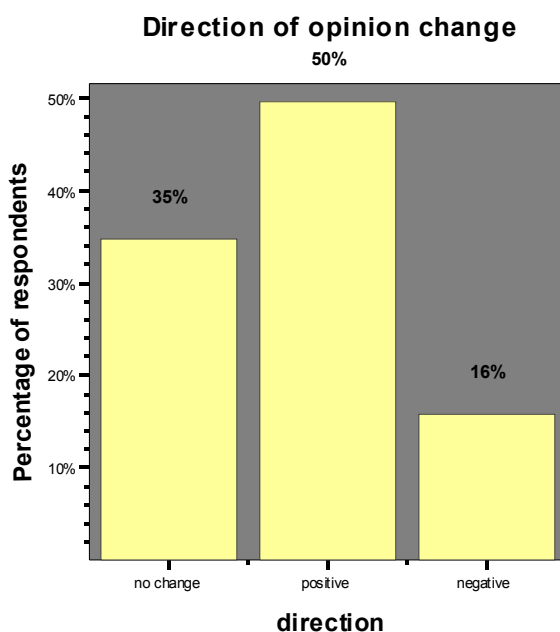


Figure 5.14: opinion change as a result of more information

5.10 Gender And Opinion Of CCS

As can be seen in Figures 5.15 and 5.16, although there was not a drastic difference between the attitudes of men and women with regard to CCS, women were marginally more likely to have a positive attitude (39% as against 35%). However, men were more likely to “really like it” (8% as against 4%) and women more likely to be in the “don’t like it at all” category (11% as against 9%). Such small differences are not significant given the relatively small size of the sample, and would need to be tested through a larger survey.

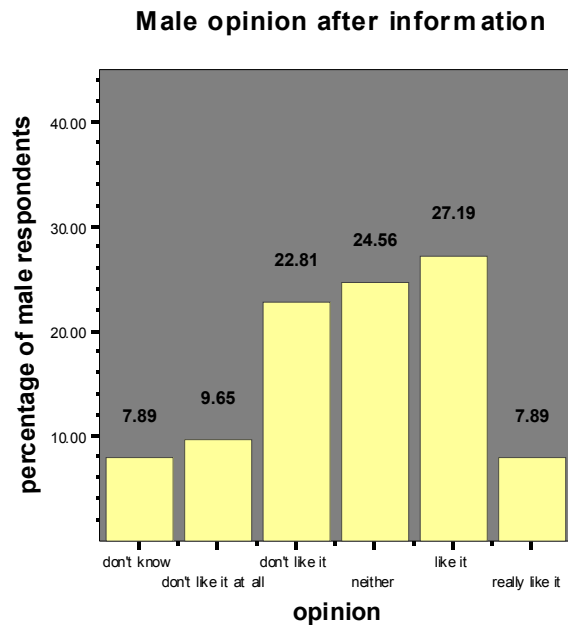


Figure 5.15: Male opinion after information

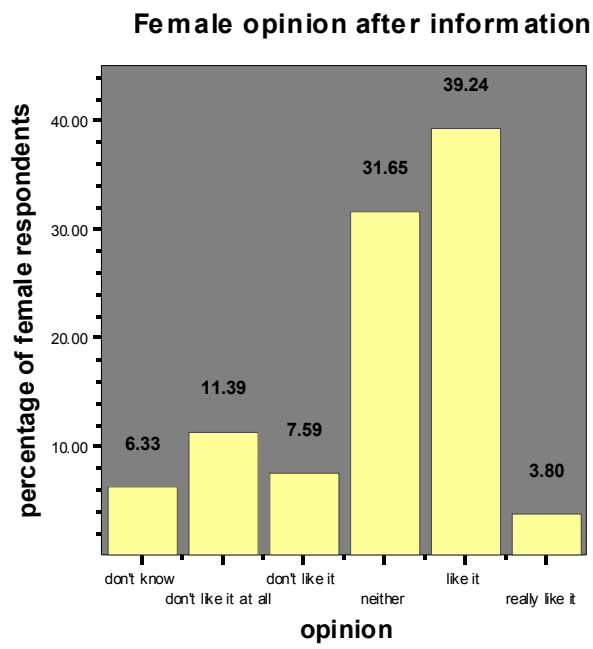


Figure 5.16: Female opinion after information

6. Summary and Conclusions

In this final chapter we bring together the key findings from the citizen panels and the survey work and interpret the results for the further development of CCS in the UK context. We use the set of eight questions that we posed in Chapter One to structure the discussion and the text in italics is copied from Chapter one to remind the reader of the rationale behind each question.

- (i) What do the public think about carbon sequestration when the idea is initially presented to them? (questionnaire)

Do people have an immediate 'like or 'dislike' to the idea of CCS or do they simply not know? This question is perhaps the closest we get to a lay, cursory contact with the idea of CCS, as might be experienced through a brief news item, informal conversation with a friend or half-listened to media report.

On first contact with CCS, most people are slightly against, neither for nor against it or say that they do not know.

We found that nearly half of respondents do not express an opinion either in favour or against CCS when the notion of carbon storage is presented without any other information (e.g. concerning why it is being done). 38% of the respondents were either slightly or strongly against CCS and only 13% expressed support. This suggests that on first hearing about CCS without any information as to its rationale or risks, the majority of people may be somewhat sceptical or just not form an opinion at all.

- (ii) How do their opinions change when provided with more information on CCS and the problem of climate change? (citizen panels & questionnaire)

Does a small amount of information on CCS, climate change and the challenge of reducing greenhouse gas emissions by 60%, affect people's perception of CCS? We might expect that as the purpose of CCS is revealed, i.e. to tackle the problem of global climate change by contributing to a reduction of carbon emissions by 60%, there would be a certain proportion of respondents who might express greater support for the concept. We have explored this issue of opinion-change in the survey, whilst in the citizen panels we have explored the underlying reasons why people's opinions change as more information is provided, and as group discussions are undertaken.

Carbon Capture and Storage is generally recognised as a potentially important carbon mitigation option for the UK

The survey results showed that CCS was slightly supported by 43% of respondents, and strongly supported by a further 12%, whilst 22% slightly or strongly opposed CCS, once basic information had been provided. The response was elicited *relative* to the other major carbon mitigation options (wind, solar, wave, nuclear, energy efficiency, etc.). The support for CCS is somewhat less when respondents were asked just about CCS (i.e. not compared to other decarbonisation options) towards the end of the survey, at about 39% slightly or strongly supportive. A larger number also said that they did not know or were neither in favour nor against CCS when asked specifically about CCS than when compared to

other decarbonisation options (at 35% compared to 24%). Support for CCS can be described as moderate or lukewarm compared to strong support in general for wind, solar and energy efficiency.

The citizen panels also show a moderate support for CCS, provided that a range of other decarbonisation options are also supported – in particular renewable energy and energy efficiency. An integrated approach towards decarbonisation was generally preferred in which all options were considered, including social change as well as the ‘harder’ technological options.

Support for CCS is, however, conditional on understanding the reasons for CO₂ mitigation

The survey respondents’ showed a marked shift towards moderate support for CCS once the purpose of carbon storage had been explained and, to a variable extent, discussed, during the course of the survey. Nearly one half of the respondents became more positive in their perception of CCS on receipt of information as to its rationale, with about 17% becoming more negative in their perception. We found that the key information which had to be conveyed was the use of CCS in removing CO₂ from power plant emissions to avoid it entering the atmosphere and contributing to global climate change.

(iii) Is there a difference in perception depending upon standard demographic variables (age, socio-economic status, gender, education, etc.)? (citizen panels & questionnaire)

There is no strong a priori reason why we would expect CCS to be more or less preferred according to the standard demographic variables, yet it is important that we at least check if this is the case. The evidence about age-related effects, education and socio-economic status in previous surveys of sustainability is less clear, with contradictory findings in past work.

There was not a drastic difference between the attitudes of men and women with regard to CCS, though women were marginally more likely to have a positive attitude. At the ‘extremes’, men seemed slightly more likely to really like CCS, whilst women were slightly more likely to not like CCS at all. The influence of the other variables (socio-economic status and education) requires more detailed analysis of the survey findings but may be limited by the relatively small sample size.

From the citizen panels we suspect that gender, socio-economic status and education all play a role in influencing perceptions of CCS, though just how important a role it is difficult to ascertain. Although the two panels ‘reasoned’ very differently with regards to CCS, they did arrive at similar end points.

(iv) Is there a difference in perception depending upon peoples' values and beliefs? (citizen panels, and to an extent questionnaire)

Previous research on the underlying reasons for different perceptions of sustainability suggest that values, beliefs and ‘world views’ are a more important determinant than standard demographic variables (e.g. Pendergraft 1998). Attempting to address values and beliefs is notoriously difficult, whether in surveys or focus groups, and in this work we were not able to explore this issue in any depth. In the citizen panels, we were able to infer different values and beliefs from extended discussions with the participants, at least to a limited extent. In the questionnaire we attempted to ascertain beliefs

about the role of experts in making decisions about how to respond to climate change, and several other questions provide clues as to the underlying world views of the respondents.

This question proved too difficult to address convincingly in the present research. In the questionnaire we tried to gauge individual's beliefs in public participation in deciding what should be done about climate change, and to their readiness to accept expert delineation of climate change policies. A strong belief in public participation, together with a reluctance to accept expert-led policy making, might have indicated a more 'egalitarian' worldview, whilst the converse (low belief in public participation plus support for expert led policy) might have indicated a 'hierarchic' worldview (Thompson et al. 1990). In practice, we found that many respondents supported *both* public participation and expert-led policy making, a somewhat contradictory position. We suspect that the two questions did not access respondent's worldviews, but rather worked at a more superficial level, whereby both public participation and expert input were regarded by most as a 'good thing'. A more detailed questionnaire focusing upon world views specifically would be required to improve our understanding.

Three Broad Positions vis-à-vis CCS “Pro-, Anti- and Ambivalent” were identified in the Citizen Panels.

The Citizen Panels were more successful at elucidating broadly different perspectives on CCS which did appear to relate, at least to some extent, to underlying worldviews and different sets of values. A small minority were in favour of CCS, mainly for utilitarian reasons that it is an effective use of geological reservoirs and removes CO₂ so reducing the risks of global climate change, which are regarded as larger than the risks of CCS itself. Another small minority were opposed to CCS, mainly for moral reasons that it is basically wrong to 'inject mother earth' with an industrial waste by-product. Humans have responsibility, according to this perspective, for changing their ways – through new technologies and lifestyle changes – such that CO₂ emissions are not produced in the first place. The third, and most common perspective, was essentially ambivalent – at times in favour, at other times against, CCS. Whilst many in this third group were initially sceptical of CCS, they became more favourably inclined as the scale of the decarbonisation challenge was revealed (see (v) below), as the risks of CCS were more thoroughly discussed, and as the risks associated with the other major decarbonisation options were also discussed. The majority view tended to find more support for CCS when the latter was combined with other options which had a (seemingly) more favourable cost-benefit profile than CCS itself, in particular renewable energy, energy efficiency, energy demand reduction, and the hydrogen economy, based at least initially on fossil fuels with decarbonisation. This finding strongly supports the need to embed CCS within a portfolio of decarbonisation options and to promote CCS as a 'bridging strategy' to other low- or zero-carbon energy sources.

(v) Is there a difference in perception depending upon what people think about climate change and its seriousness? (citizen panels & questionnaire)

A sub-set of beliefs relates to the respondents beliefs about whether climate change is a real problem to be concerned about and whether it is caused by human activities. The hypothesis is that if the respondents are concerned about climate change and its human causes, then they may be more favourably inclined towards CCS. Certainly, if the respondents do not believe that climate change is human-caused and/or a problem, then it is more difficult to imagine why they might lend strong

support to CCS, since there is no other reason why CCS should be undertaken. The only partial exception relates to the use of CO₂ for enhanced oil recovery (EOR) and we explored whether this possibility might change opinion on CCS.

Belief in, and concern about, human-caused climate change, plus recognition of the need for major CO₂ emission reduction, is likely to be a necessary prerequisite for including CCS as a serious response option to climate change.

We found that both belief in human-caused climate change and concern about climate change amongst our survey sample was high. These two factors did not, therefore, help to explain the variation in the perceptions of CCS. It is possible that the high levels of belief and concern that we obtained are a consequence of conducting the survey just after the heat wave of 2003.

The citizen panels (held in November 2002 and February/March 2003) told a somewhat different story. Although there was an awareness of the issue of global climate change, the potential impacts, government policy on climate change and the extent of CO₂ reductions likely to be required was not at all well appreciated. We found that the potential acceptability of CCS in the citizen panels depended on it being clearly understood as a key carbon mitigation option. In other words, there appear to be three prerequisites which provide the context in which carbon capture and storage is regarded as a potential option:

- (i) Acceptance of the basic underlying science of climate change;
- (ii) Acceptance of the seriousness of the potential threat of climate change impacts to life in the UK and more generally;
- (iii) Acceptance of the need to make very large reductions in carbon emissions (e.g. 60% cuts) over the next 50 years.

Even amongst the most sympathetic and trusting of our citizen panel participants, no one was aware of the enormous scale of the challenge of a -60% reduction in carbon emissions, and there was in general a lack of awareness and knowledge of what different carbon mitigation options had to offer.

- (vi) Does (carefully presented) information on alternatives (behavioural change, energy prices, renewables, etc.) influence the perception of CCS? (citizen panels & questionnaire)

Since CCS is one of a range of options being considered as a route towards decarbonisation, a comparative approach is necessary. We therefore asked about perceptions of the main other contending routes towards decarbonisation: demand reduction, energy efficiency and the range of renewable energy sources.

CCS is not liked as much as wind, wave, tidal and solar power, and energy efficiency measures, but there is slight support for it and CCS is certainly preferred to nuclear and higher energy bills.

CCS is not ranked as favourably by the majority of respondents as wind, wave & tidal, energy efficiency and solar, all of which are strongly supported. CCS is, however, much more favourably received than either nuclear power (which c.55% of respondents are either slightly or strongly against,

with c.24% either slightly or strongly supportive) or higher energy bills to try and reduce demand (with 69% either slightly or strongly against, and again about 24% either slightly or strongly supportive). (We should note, however, that we did not include any measures to address equity problems arising from higher energy bills in the questionnaire - this could have changed the response, since many objections to higher energy bills appeared to relate to exacerbating fuel poverty). The ‘not known’ response rate was highest for CCS, nuclear and wave & tidal, but is not large enough to explain differences in response rates. The citizen panels show a similar set of preferences for the known and emerging renewable energy technologies and energy efficiency options, though again tended to include CCS as an option which required further investigation and R&D.

(vii) What policies and processes would make carbon sequestration more acceptable? (citizen panels & questionnaires)

This slightly more free-ranging discussion focused upon what types of changes (technical, risk, environmental, social, economic, policy, etc.) might influence peoples’ perceptions of CCS.

More certainty about the risks of CCS in the long-term would help people to come to a clearer decision about the desirability of CCS.

The main concerns of the survey respondents about CCS were leakage (49%), ecosystems and environmental impacts (31%), the new and untested nature of the technology (23%) and human health impacts (18%). Many respondents indicated that they would like more information and more certainty in the risk assessments of CCS with regards to the above issues. Although these practical, physical risks were the most frequently mentioned, there were also a number of negative attributes mentioned in relation to CCS as a part of climate change abatement policy. Avoiding the real problem (13%), short termism (12%) and the policy demonstrating reluctance to change from government (11%) were all mentioned regularly (or 36% expressing the sentiment that CCS is ‘treating the symptoms not the cause’). When asked if they could think of any positive effects of CCS (Figure 5.8), by far the most frequent response was abating climate change (58%). The notion that using CCS could “buy time” to develop other solutions was the next most frequently mentioned at 7%.

CCS as one within a portfolio of decarbonisation technologies, options and measures, and as an explicit bridging strategy to a low- or zero-carbon energy system, would do much to increase its public acceptability.

The citizen panels had the advantage of more lengthy discussions and with expert witnesses. Their ability to cross-examine experts does appear to have influenced their perceptions and to have provided some greater reassurance than was available to the questionnaire respondents. This might, however, be a function of the particular experts chosen and the panel might have responded differently if a ‘sceptical geologist’ had spoken to the group, i.e. one who might have posed more basic questions about the integrity of geological reservoirs for storing CO₂. The panels seemed to recognise that most decarbonisation options have a set of associated risks and benefits, and that uncertainties would remain until further implementation of the technologies or other options had proceeded. Hence, they supported further research, alongside R&D on the other major options, and money spent on encouraging energy efficiency and demand reduction. Finding positive applications of captured CO₂ (even if only in

relatively small volumes) would also be beneficial in influencing public opinion favourably, as there is a strong ethic in favour of recycling waste by-products where possible.

Enhanced Oil Recovery, combined with CCS, will, in general, be regarded as an additional reason in support of CCS, rather than counting as a reason against.

47% of respondents did not change their opinion of CCS because of EOR, though 43% became **more favourable**. Less than five percent became less favourable because of EOR. On the other hand, the citizen panels found that the motivation of those promoting the technology is questioned; if it is thought to benefit the oil companies, reactions are likely to be more hostile. The questionnaire also found that most respondents thought that the oil & gas industries should pay for CCS, followed by government (this response might have been influenced by the order of the questions, since the notion of EOR was introduced three questions before asking about who should pay for CCS).

Regulation involving a partnership between Government, the Environment Agency, Environmental organisations and the energy industry would help to reassure the public

The questionnaire found that there was widespread support for regulation to involve more than a single agency. In particular, there was support that an Environmental NGO should be involved in a regulatory role, to ensure that the regulatory process is conducted in a due and proper manner.

A transparent, inclusive and open decision-making process was advocated by one citizen panel.

The York panel was very clear on the importance of a decision-making process which was transparent and in which a range of stakeholders and the public could have faith. A joint meeting of decision-makers and a sample of the members of the Manchester and York groups was proposed and generally supported. Further elaboration of the concept identified the following decision-makers as important to this process:

- MPs who sit on the Science and Technology and Environment Select Committees
- Senior civil servants
- Leading industrialists
- Leading environmentalists

We would suggest that a joint meeting of this nature on the issues surrounding the desirability of CCS and its uses in different circumstances, with appropriate media coverage, would be a highly valuable exercise (comparable with the debate on Genetic Modification which is currently underway in the UK).

(viii) What policies and processes would make CCS less acceptable? (citizen panels)

Rationale as above

CCS should not be considered or presented as a ‘technical fix’. Ownership by the public is important, as one participant expressed it: “we own the problem we should own the solution”.

The citizen panels were opposed to regarding CCS as a single ‘fix it’ solution and expressed concerns that such use of CCS would be to treat the symptoms rather than the causes of climate change. There was a sense that CCS could "let us off the hook" of making more fundamental, deep-rooted changes and this avoidance of change was perceived generally negatively. There remained a minority of opponents who saw the concept and practice of CCS as either morally questionable, or as posing too great a risk in terms of geological integrity. There was also concern expressed that CCS would divert R&D resources and attention away from renewable energy technologies, demand reduction and energy efficiency. This concern was largely allayed when the level of new resources being directed to energy R&D, demonstration and support schemes was indicated, alongside the very small amount going into CCS R&D at present.

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(ask respondent to look at page 4)

4. In general, would you say that climate change receives too much or too little attention by politicians at the present time?

Far to much	Some what too much	About right	Not quite enough	No where near enough		Don't know

Ask Respondent to look at page 5

5. Do you think that the public should be actively involved in deciding what should be done about climate change ?

- a) The public should be consulted and actively involved
- b) The public should be consulted only
- c) The public should not be consulted

if respondent asks what is meant by 'actively involved', say: referenda and public meetings to decide what should be done.

Repspondent page 6

6. Do you think that policies to combat climate change should be decided mostly by government experts and scientists?

Yes

No

Don't know

SECTION 3 CARBON STORAGE AND CLIMATE CHANGE POLICY Respondent page 7

Most experts believe that in order to have a significant impact upon climate change we must achieve a 60% reduction in emissions such as carbon dioxide.

By using Carbon Storage the United Kingdom could significantly reduce its carbon dioxide emissions while continuing to use fossil fuels. This could allow society to continue to use existing levels of fossil fuels for many decades to come.

It could also act as an “in-between” strategy while longer-term solutions are further developed, such as renewable energy technologies.

Respondent page 8 (PICTURE)

7. Do you think that there may be any negative effects of doing this?

Please allow the respondent a few moments to think about this question. You must note down their key concerns and then gauge the strength of that concern. Set answers are given on the following page (your hand out only). If the respondent asks about any of these areas, read them the set answer.

LEAKAGE: If carbon storage is done properly and with due care, then leakage should be at a very low level. It would take more than 300 years for all the CO₂ to escape, by which time the problem of global climate change will hopefully have been tackled.

ENVIRONMENTAL IMPACTS: If proper care is taken, the environmental consequences of carbon storage should be minimal. There could, however, be localized environmental problems from CO₂ leakage in parts of the seabed or on-land pipelines.

HEALTH IMPACTS: There should be few risks to human health arising from carbon storage. The main risks would arise from: a) accidental leaks from pipelines on land; b) general risks to off shore workers.

COSTS: Carbon capture and storage increases the electricity generation costs by between 50% and 100% (i.e. doubling). In terms of prices paid by the final consumer the costs would only increase by about 20% however. Carbon capture uses up more energy, hence uses up more fossil fuels than normal.

POTENTIAL DISASTERS: In the worst case scenario, carbon dioxide would leak in large volumes from storage sites due to, e.g. a major geological fault. This could make the problem of climate change even worse. Geologists are confident that such disasters are very unlikely in the next few hundred years. Natural gas and oil has been stored in such reservoirs, sometimes for millions of years, without leaking. There is, however, still a small risk arising from uncertainty.

PIPELINES: Carbon capture and storage would require the installation of major new pipelines connecting power stations with locations under the sea bed. Depending on where the power stations are located, these pipelines would have to be constructed overland and enter the sea, travelling along the sea bed.

IS IT ALREADY HAPPENING? Yes, since 1997, about 1 million tonnes of CO₂ have been put into an under sea-bed storage site in Norway. This site is being monitored and so far there are no leaks of unexpected movements of the gas, but it is still early days. A new project is just starting in North America, which will use CO₂ to extract from oil from oil wells.

HOW MUCH CO₂ COULD BE STORED IN THIS WAY? Potentially, the UK North Sea sites could store hundreds of years of all the CO₂ produced from power stations in the UK.

WORDS

Classification (and strength of concern): **Note do not use these to prompt the respondent; use these to categorise their response and get an assessment of their level of concern**

	no concern 1	Mild concern 2	Moderate concern 3	Extreme concern 4
1) Tech (i.e. it wouldn't work)				
2) mistakes resulting in large Leakage –				
2a) Effects of leakage on –wildlife				
2b) -effects of leakage on human health				
Environmental impacts from routine operation				
Infrastructure (e.g. pipelines)				
Moral (e.g. no “right to do this” “shirking responsibility”)				
Gives green light to storage of other waste in such sites				
Political - shouldn't allow INDUSTRY to profit from carbon storage				
Political – Government trying to change as little as possible				
Detract from other climate change policy				
Other(state)				

8. Do you think there may be any positive effects of doing this?

WORDS

Classification and strength of positive dimensions **Note do not use these to prompt the respondent; use these to categorise their response and get an assessment of their perceived level of benefits**

	No benefit	Slight benefit	Moderate benefit	Very Substantial benefit
Abate CC				
Allow to keep using oil, gas and coal				
Cheaper than other cc options				
Technological advancement				
Political				
Allows time to develop other technologies				
Other				

Respondent page 9

9. Carbon Dioxide could also be used to obtain more oil from existing North Sea fields. By pumping in the carbon dioxide the oil becomes thinner and less sticky and is therefore easier to extract. The Carbon Dioxide would stay in the oil well.

Does this change your opinion of the idea of Carbon Storage?

Less Favourable

No Difference

More Favourable

DK

Why? (Some words)

10. Do you have any other questions you would want to have answered before you came to a stronger view?

SECTION 4 COMBATTING CLIMATE CHANGE Respondent page 10

Just to remind you, most experts believe that in order to have a significant impact upon climate change we must achieve a 60% reduction in emissions such as carbon dioxide. There are a number of ways in which the Government could try to achieve this target.

Respondent page 11

11. Please could you indicate your support for each of the following in terms of strongly support, slightly support, neither support nor against, slightly against, strongly against.

	Strongly support	Slightly support	Neither	Slightly against	Strongly against	Don't know
Wind Power						
Wave and Tidal						
Solar						
Nuclear						
Energy Efficiency e.g. energy efficient light bulbs						
Much higher energy bills to reduce use						
Carbon Storage						

Energy efficiency definition : improving the design of appliances and machines that we already use, so that they use less energy and therefore result in less carbon dioxide being released in to the atmosphere.

Respondent page 12

12.If the Government approved Carbon Storage, who should pay for it? (you may give as many answers as you wish)

- Government
 - Oil and energy companies
 - Other Industry
 - Local government
 - EU
 - End consumers through fuel tax
 - Other _____
-

Respondent page 13

13. Who do you think should control and monitor the development of Carbon Storage?

- Government
- Oil & energy industry
- Other industry
- Local government
- Environmental Organisation e.g. Greenpeace
- Environment Agency
- A new Government Agency
- EU
- End consumers
- Others (please state)

I would now like to ask you about your own willingness to pay extra for your electricity in order to fund carbon storage.

14. Would you be prepared to pay one (two, three four more than four) pound(s) more on your monthly electricity bill to support a carbon storage scheme?

- 0 1 2 3 4 4+ (laddering question)

Respondent page 14

15. Given the discussion we've had so far, do you wish to change your overall reaction to carbon storage?

Don't like it at all	Don't like it	Neither like nor dislike it	Like it	Really like it		Don't know

SECTION 5 : ABOUT YOU

Finally some general questions about you. This is only to ensure that we have included a cross section of the population in the survey. All the information that you give will be completely confidential. If there are any questions you do not feel comfortable answering please just say so, and we will move to the next one.

16. Are you.....

Male

Female

Respondent page 15

17. Could you please tell me which age group you fall under

Group	Age group (years)
A	Under 18
B	18-20
C	21-25
D	26-35
E	36-45
F	46-54
G	55-64
H	65+

Respondent page 16

18. Which of the following qualifications do you have?

	Qualifications
A	GCSE or equivalent
B	A levels or equivalent
C	HCN/HND
D	University degree or equivalent
E	Other(s) (please specify)

Respondent page 17

19. Could you please tell me which category best describes your personal income? (If you are living with a partner whose earnings you share then please take the total of both your earnings

	Total household income	
	Yearly	Weekly
A	0-4999	0-96
B	5000-7499	97-144
C	7500-9999	145-192
D	10000-14999	193-288
E	15000-19999	289-385
F	20000-29999	386-577
G	30000-39999	578-769
H	40000-49999	770-962
I	50000+	963+

20. Could you please tell me what your occupations is _____

21. What type of trip are you going on today?

Business Holiday Other

Appendix B: Demographic information of respondents

gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	119	56.4	58.3	58.3
	female	85	40.3	41.7	100.0
	Total	204	96.7	100.0	
Missing	missing	6	2.8		
	System	1	.5		
	Total	7	3.3		
Total		211	100.0		

age group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Under 18	3	1.4	1.4	1.4
	18-20	20	9.5	9.6	11.1
	21-25	32	15.2	15.4	26.4
	26-35	48	22.7	23.1	49.5
	36-45	34	16.1	16.3	65.9
	46-54	32	15.2	15.4	81.3
	55-64	26	12.3	12.5	93.8
	65+	13	6.2	6.3	100.0
	Total	208	98.6	100.0	
Missing	missing	2	.9		
	System	1	.5		
	Total	3	1.4		
Total		211	100.0		

qualifications

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	11	5.2	5.6	5.6
	GCSE or equivalent	32	15.2	16.2	21.7
	A levels or equivalent	37	17.5	18.7	40.4
	HNC/HND	28	13.3	14.1	54.5
	University degree or equivalent	72	34.1	36.4	90.9
	other	18	8.5	9.1	100.0
	Total	198	93.8	100.0	
Missing	missing	11	5.2		
	System	2	.9		
	Total	13	6.2		
Total		211	100.0		

household income

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-4999	11	5.2	6.6	6.6
	5000-7499	12	5.7	7.2	13.9
	7500-9999	6	2.8	3.6	17.5
	10000-14999	25	11.8	15.1	32.5
	15000-19999	22	10.4	13.3	45.8
	20000-29999	20	9.5	12.0	57.8
	30000-39999	24	11.4	14.5	72.3
	40000-49999	20	9.5	12.0	84.3
	50000+	26	12.3	15.7	100.0
	Total	166	78.7	100.0	
	Missing	missing	43	20.4	
System		2	.9		
Total		45	21.3		
Total		211	100.0		

purpose of travel

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	business	18	8.5	8.8	8.8
	holiday & leisure	116	55.0	56.9	65.7
	other	70	33.2	34.3	100.0
	Total	204	96.7	100.0	
Missing	missing	5	2.4		
	System	2	.9		
	Total	7	3.3		
Total		211	100.0		

Appendix C: Explanation of The Variables in The SPSS Analysis

Variable Name	Meaning of the Variable
Idnum	Identity number of respondent
Initial	Initial perception of CCS without any information of any sort being provided
Beliefac	Extent of belief that human activities are affecting the climate
concernc	Degree of concern about climate change
Attention	Level of attention in climate change on the part of politicians
Publicin	Extent to which the public should be actively involved in climate policy
Experts	Extent to which government experts & scientists should decide content of climate policy
Negleak	Negative risk of CO ₂ leaking from storage sites
Negeco	Negative risks of CO ₂ upon ecosystems, marine environments, sea-life, etc.
neginfra	Negative risks from construction and operation of new infrastructure
negcosts	Costs arising from CCS. It also includes a few responses which alluded to the extra energy penalty involved in storing CO ₂ .
negshort	Concern that CCS is too short-term a response.
negavoid	Concern that CCS avoids more radical or alternative responses
negcapac	Concerns over how large the reservoirs are. Also, concerns over whether CCS would be that effective because of limited supplies of CO ₂ from large point sources.
Negtest	Concern arising from the untested nature of CCS. This includes concerns over uncertainty and unspecified risks associated with CCS.
negexplor	Concern arising from explosions associated with CCS.
neghuman	Concerns arising from risks to human health
negnocha	More of a political concern that we should be trying to change more fundamentally than CCS implies. This includes the potential detraction of efforts to reduce climate change in other ways or through technological innovation of other types (e.g. by diverting R&D and policy attention). It also includes responses where the point was made that there might be better ways to reduce carbon emissions than CCS.
negmoral	Where a moral sentiment was expressed that 'burying the problem' was not desirable.
neggreen	Concerns that CCS might give the 'green light' to storage of other wastes at similar sites. It includes the perception that storage of any type of waste or by-product is always dangerous and should be avoided, this often based on past experience of storing chemicals.
negprofi	Concerns that industry should not be allowed to profit from CCS.
posabate	Positive in terms of reducing CO ₂ emissions
posbuys	Positive in buying-time for society to identify future low-carbon trajectories
pospower	Positive in allowing the power sector to reduce CO ₂ emissions
poscont	Positive in allowing us to continue to use fossil-fuels and to keep the energy system similar to today's
poscheap	Positive in that CCS is cheaper than other options to reduce CO ₂
postech	Positive in allowing development of new technologies. This includes opportunities for new jobs arising from CCS and its development.
Eor	Perceptions of Enhanced oil recovery
Wind	Perceptions of wind energy
Wave	Perceptions of wave & tidal energy
Solar	Perceptions of solar energy
Nuclear	Perceptions of nuclear energy
energeff	Perceptions of energy efficiency
Bills	Perceptions of higher energy bills to reduce energy demand
CCS	Perceptions of carbon capture & storage
Paygov	Whether government should pay for CCS

Payoil	Whether oil & gas industry should pay for CCS
Payind	Whether other industry should pay for CCS
Payloc	Whether local government should pay for CCS
Payeu	Whether EU should pay for CCS
paycons	Whether end consumers should pay for CCS
payother	Whether others should pay for CCS
Reggov	Whether government should regulate CCS
Regoil	Whether oil & gas industry should regulate CCS
Regind	Whether other industry should regulate CCS
reglocal	Whether local government should regulate CCS
Regeu	Whether the EU should regulate CCS
regcons	Whether end consumers should regulate CCS
regengo	Whether Environmental NGOs should regulate CCS
Regea	Whether the Environment Agency should regulate CCS
regnewea	Whether a new governmental agency should regulate CCS
regother	Whether other agencies should regulate CCS
Wtp	Willingness to pay for CCS
Change	Whether the respondent wishes to change their opinion on CCS
Gender	Gender
Age	Age
Qualific	Qualifications level
Income	Household income bracket
travelpu	Travel purpose

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for Climate Change Research

The trans-disciplinary Tyndall Centre for Climate Change Research undertakes integrated research into the long-term consequences of climate change for society and into the development of sustainable responses that governments, business-leaders and decision-makers can evaluate and implement. Achieving these objectives brings together UK climate scientists, social scientists, engineers and economists in a unique collaborative research effort.

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The Tyndall Centre is named after the 19th century UK scientist John Tyndall, who was the first to prove the Earth's natural greenhouse effect and suggested that slight changes in atmospheric composition could bring about climate variations. In addition, he was committed to improving the quality of science education and knowledge.

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