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NearCO2 WP 2

Opinion shaping factors towards CCS and local CCS projects: Public and stakeholder survey and focus groups

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Executive summary

WP2 of the NearCO2 project sought to investigate the opinions, attitudes and perceptions of CCS by residents in five European Union member states (Germany, Netherlands, United Kingdom, Poland and Spain), comparing the views of those who live close to planned projects, a national sample and a selection of (local and regional) stakeholders and opinion shapers.

The Work Package was broadly designed to look at four sub-areas:

- Task 2.1 Role of the media
- Task 2.2 Importance of the information source
- Task 2.3 Characterisation and communication of risk
- Task 2.4 Importance of local contingencies

The study consisted of five elements:

- A qualitative evaluation of the local contingencies and characterisation of each of the five projects (primarily to address Task 2.4)
- A large-scale public survey on around 200 members of the public in the region of the project and 200 representative members of the national public for each of the five countries (All tasks)
- Coincidentally with the public survey, a stakeholder survey distributed to journalists, local and regional politicians, local and regional officials, and non-governmental groups with a presence in the region (All tasks)
- Online focus groups with around 25 survey participants from two countries (Spain and Poland) using dialogue boards (DBs) (All tasks)
- An experiment designed to assess the impacts of congruency of text and visuals on perceptions and understanding of CCS (Task 2.3)

Main findings

Knowledge of CCS

- A large minority of public respondents across the five countries (43%) responded that they had never heard of CCS, whereas 10% indicated that they knew quite a bit. Self-reported knowledge of CCS among stakeholders was substantially higher: only 3% of stakeholders claimed never to have heard of CCS and fully 78% stated they knew "quite a bit" about this technology.

- Other than in the Netherlands, where a large majority claimed to have heard of CCS, the share of those answering that they had never heard of CCS was far higher in the 2011 Eurobarometer on CCS than in the nearCO_2 surveys. Unlike the Eurobarometer surveys which are nationally representative, our respondents were intentionally selected so that half of them came from the region in the vicinity of a CCS project.

- Male respondents reported more familiarity on CCS than females (34% of males had never heard of CCS vs 53% of females). Respondents with at least an undergraduate education were more likely to have heard of CCS; similarly, older respondents were more likely to have heard of CCS.

- Only 19% of all public respondents indicated 'genuine knowledge' that CCS is supposed to reduce climate change only and other options (such as ozone depletion, acid rain, toxic waste, smog or water pollution), although this is higher than the 10% claiming to know "quite a bit"

about CCS. By contrast, whereas 78% of stakeholder claimed to know "quite a bit", just over half (51%) indicated that CCS only addresses climate change.

- Although UK respondents claimed to be least aware, they show the highest level of genuine knowledge (31%), followed by German respondents (25%), whereas although more than three-quarters of Dutch respondents (78%) claimed to know at least a little bit" about CCS, fewer than a quarter possessed genuine knowledge (21%). Spanish and Polish respondents are among the least knowledgeable (12% and 7% respectively).

- In the qualitative phase of the research, many participants of the focus groups stated that they did not feel well informed about CCS at all, and that in particular they did not know about the local project that was being planned – only a few participants of the Polish focus group have heard of it while none of the Spanish participants had.

Attitudes towards CCS in general and to the local project

- The survey showed that public respondents from all five countries were supportive of CCS technology in general (net +51% favourable). By contrast, stakeholders were more negative about CCS in general than positive (net -20%). Support for CCS in general ranged from a net +72% favourable rating in Poland to +20% in Germany, which was more than 20% more negative than the next nearest country (+43% in the Netherlands).

- Relative to CCS in general, support for the local project was notably lower (10% lower net favourable rating among the public and 16% lower net favourable score among stakeholders). Net support declines among the public in all countries, most dramatically in Germany where, on net, more have an unfavourable view of the local project. In the other four countries, there are still large majorities who view the local project favourably (ranging from +38% net favourable in the Netherlands to +66% in Poland).

- The relationship between respondents' position relative to the capture site and their attitudes towards CCS was found to be less pronounced than their position relative to the storage site.

- A (positive) linear trend was found between distance to the storage site and opinion about the local project. This can be associated with a NIMBY effect with respect to the CO_2 storage site. For the capture site, the relationship between distance to the site and respondents' opinion is more complex. We found quadratic behaviour, those who live closest to the capture site were more positive towards the local project than those who live farther away.

- After being given additional information about risks of CCS technology, more than half of all respondents did not change their opinion towards the local project, more than one-third change their opinion towards more negative and slightly more than one-tenth even change to more positive view on the local project, so the net effect of information was negative. The (net) negative effect of additional information about risks of CCS on respondents' opinion is statistically significant for all five countries.

- As expected, respondents who are genuinely knowledgeable about CCS were less likely to change their opinion towards the local project than those who are not knowledgeable. Further, females, on average, changed their opinion more than males did after additional information about risks of CCS was given. However, all groups, including males and those with genuine knowledge became more negative with additional information.

Role of the media & sources of information

- The most likely source for further information about CCS was deemed to be interactive websites such as Wikipedia or blogs (27% indicated that they were very likely to go there for more information). University scientists/scientific publications were the next preferred source of information (18%), followed by national/international NGOs and national news media (14%). Word of mouth (6%), the developers (7%), and the EU were the least preferred sources.

- Among stakeholders, interactive websites were ranked much lower and the most likely sources for more information were university scientists/scientific publications, national/international NGOs and local NGOs/community groups. Stakeholders were far more likely to consult different sources and more than half consulted any of six different sources of information.

- Public respondents in the UK, Poland and Spain chose interactive websites as the most preferred source of information about CCS, whereas Dutch respondents opted for the local government and German respondents named university scientists. Across all countries, the least likely sources of information were the EU, the developers and word of mouth. Local and national governments and media outlets scored somewhere in the middle.

- Similar to stakeholders, German and Dutch public respondents were also much more likely to choose multiple sources of information and six different sources were listed by over half of respondents. These figures were considerably higher than in other countries.

- Stakeholders were also very likely to seek additional information about the CCS project. Among public respondents, only the Dutch respondents were more likely than not to want additional information about the project.

- University scientists/scientific publications scored highest in terms of respondents' trust to give them impartial information about CCS, with national/international NGOs being the second highest, while the developers, national governments and word of mouth scored lowest.

- There were large differences in trust in the information source between the countries: German respondents tended to rate national/international NGOs as most trustworthy, while the other countries rated university scientists and publications the highest. While 21% of German respondents indicated that they would look to university scientists/publications as the most likely source of information, only 15% – the lowest percentage of the five countries – thought that university scientists/publications was the most trustworthy source. Polish respondents had a much higher trust in the EU than respondents of other countries.

- While the survey indicated only a middling importance of national and local news media as a source of (trustworthy) information, participants in the dialogue boards argued that the media has a very important role to play in the dissemination of information about CCS. DB participants argued that the news media is important for those without internet access as well as for drawing the public's attention to CCS in the first place.

- Participants in the DB focus groups also reported that they were very dissatisfied with the amount and quality of the information they did manage to get about the project when they tried to find more information after completing the survey.

Characterisation and communication of risk

- For all countries surveyed, public respondents were more risk-averse regarding first level risks (uncertainties over parameters and models) than zero level risk (uncertainties about outcome). More surprising, public respondents were more risk-averse over first level risk than over second level risk (uncertainties about the implicit assumptions). As one would expect, respondents from all five countries were most risk-averse regarding third level risk.

- We hypothesised that risk perceptions are intertwined with issues of trust. A statistical relationship between perceptions about outcome risks of CCS technology (zero level risk) and their trust in industry and national governments/politicians was found to be significant across most countries surveyed. In all countries (except for the Netherlands), respondents who are more risk averse were less trustworthy of national politicians. Similarly, for all countries surveyed (except for Poland), those who are risk-averse (about zero level risk) trust in the project developers less than those who are risk-prone.

- We also found a relation between respondents' perceptions of risk and their location. Respondents who lived within 100km of the storage site tended to be more concerned about risks than those who lived further away.

- The survey included open ended questions about advantages and disadvantages of CCS technology and whether they had any other questions about it. Answers to the open question on disadvantages were split mostly between concerns over safety and the costs CCS, with safety concerns being the more prevalent. One particular theme that emerged consistently was a worry over "long-term" consequences: it was felt that there is no way even for experts to know what would happen in the distant future. Similarly, respondents worried about unknown risks, unpredictable side-effects and whether the technology had been adequately tested.

- These concerns were also discussed in length during the DB focus groups. A particular focus of the unpredictability of risks was framed with reference to the March 2011 Japanese earthquake which occurred only a few days before DBs were conducted. Respondents used this event to illustrate how even a technologically advanced country used to earthquakes can be caught unprepared by unforeseen events.

- A separate experiment was performed on ~400 people to test the effect of visualisations of CCS on comprehension and attitudes towards CCS and risk perceptions. Respondents were given either: (i) no diagram, (ii) a "wrongly scaled" diagram which appears to indicate a shallow injection shaft, or (iii) a "properly scaled" diagram that indicated an injection depth of 1km. The visuals were accompanied with a text describing CCS as either storing the CO_2 "underground", "deep underground" or "1km underground", resulting in 9 experimental groups.

- Respondents were then asked to recall or estimate the depth of injection and answer questions on risk perception, attitudes and personal relevance of CCS. We found that the more precise indication of depth in the text the better respondents' estimate of depth, but the more precise the indication of depth in the visual, the worse the respondents' estimate of depth. We also found that respondents' depth estimate of the injection of CO_2 is unrelated to their attitude towards CCS, risk perceptions of CCS, and to perceived personal relevance of CCS. However, a more positive attitude towards CCS is related to less perceived risk and lower personal relevance.

Importance of local contingencies

- Each of the five projects is different in the form they would take, the local area they would be situated in including socio-demographics and level of economic development, the national legislative context through which infrastructure planning is done, and wider local and regional political context.

- Some areas, such as Yorkshire and Humberside in the UK, have a history of coal mining where the industry is generally held in a nostalgic view, others such as the German project are either in an area with no industrial history (storage site) or where coal mining has had a very destructive effect on the local community through surface mining (capture site). The local industrial history was therefore hypothesised to influence whether respondents see the technology in a positive or negative light. There was a correlation between projects in areas with previous history of coal mining and those in other areas: 19% and 13% of respondents from countries with "previous history" were very favourable towards CCS and the local project respectively, compared to 8% and 4% of respondents from other countries.

- Local perceptions of the fairness of the planning process in general and whether the local community had been treated fairly also had an important effect on respondents' attitudes towards CCS, particularly with respect to the local project. Respondents who agreed that the current planning process gives sufficient voice to local concerns and that their local community was treated fairly in the past were more likely to be positive towards the local CCS projects. Polish respondents were most likely to feel like they were treated unfairly in past developments and Dutch respondents least likely to feel mistreated.

- Trust has been repeatedly found to be an important factor in residents' attitudes towards new infrastructure projects such as CCS. A significant linear relationship for all countries surveyed (except for respondents in Poland) was found between public respondents' attitudes towards the local project and their trust in the project developers. This linear trend indicates that as the support for the local project increased, trust in the project developers increased proportionately.

- Social capital, measured here as time spent with colleagues outside the workplace and participation in environmental organisations, and political activism, measured as participation in strikes, public demonstrations and signing petitions, were found to have a number of statistically significant associations with attitudes towards CCS. As social capital increased, measured as associating with work colleagues, support for the local CCS project increased proportionately. Similar to the question on environment as a national priority, membership of an environmental organisation was actually associated with lower support for the local CCS project.

- Social capital was also related directly to political activism. Those who spend more time with colleagues outside the workplace tended to sign petitions, participate in public demonstrations and/or in strikes more than those who spend less time. Further, those who signed petitions or took part in lawful demonstrations were less positive about the local CCS project than those who did not.

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1. Introduction

1.1 Overview

The overall aim of the NearCO2 project is to develop effective strategies to communicate to stakeholders and the public at large the advantages and risks of CO_2 capture and storage, and to involve these parties in local decision-making on CCS projects (to accomplish effective engagement of the local public in implementation trajectories of CCS projects). The objective of WP2 is to define public information needs regarding CCS and unravel the factors shaping public opinion in general in so far as these may relate to CCS. To achieve this aim we will examine a number of factors that shape public opinion in more detail. These factors have been identified in WP1.3 (Desbarats et al. 2010) and WP2 will examine them in more detail.

This work package is particularly novel by focusing on the critical role information and communications play in shaping public and stakeholder opinions towards CCS, and examining particularly the local element in perceptions and communication needs.

The methodologies used will be public opinion surveys and face to face interview as well as a post-survey discussion group and a stand-alone experiment on the effects of differently conceived diagrams explaining CCS (the latter will be written up in a separate report). The large sample size public opinion surveys will allow us to obtain statistically significant differences across key demographic variables such as gender, age, and education. In addition, the shaping influence of the level of environmental awareness or activism, political affiliation or orientation and relation to broader concerns will also be investigated, as well as differences between local and national opinions and between the surveyed countries.

WP2 was divided into four subtasks:

- Task 2.1 Role of the media
- Task 2.2 Importance of the information source
- Task 2.3 Characterisation and communication of risk
- Task 2.4 Importance of local contingencies

These subtasks are all interrelated and will be performed in parallel, but for pragmatic purposes we discuss them separately in more detail in the theoretical background chapter.

1.2 Conceptual framework and main definitions

WP 2 intends to deepen our understanding of the role of factors that shape the opinion of CCS

- for both the public (local and national) and local stakeholders
- in terms of what they perceive as advantages and as risks of CCS
- in general and when faced with a concrete project.
- for different configurations of a project (on-shore/off-shore; in traditional coal-mining areas or non coal-mining areas)
- for different European countries and the accompanying local contingencies
- the role of visual information material on the shaping of opinions (written up in separate report)

The main hypothesis of this WP is that the opinion shaping factors mentioned below are interrelated and shape the opinion of stakeholders (general public and local stakeholders). For each stakeholder the opinion-shaping factors will demonstrate a different configuration and as such will result in an individual translation process that will show different risk opinions. The shaping process is not yet investigated sufficiently. Insight in how people judge uncertainties and risks involved in CCS projects, and how this translates into their opinion on the acceptability of the project, and how such opinions are affected by other factors as well, is something that needs more in depth inquiry.

The opinion-shaping factors have been identified in WP 1.3[1] (Desbarats et al. 2010). They include

- Identity related issues such as:
  - Socio-demographics variables such as gender, age, and education.
  - Level of environmental awareness or activism, political affiliation or orientation and relation to broader concerns
  - Practices (habits, routines, social and technological systems)
  - Place identity (how physical, and symbolic attributes of particular locations contribute to an individual sense of self or identity)
  - Self-esteem/ distinctiveness/, continuity and self-efficacy

- Communication and information related issues such as:
  - The role of the media
  - The importance of the information source
  - Trust issues
  - Role of risk characterisation and communication (from project developers to stakeholders)
  - Stakeholder information needs and the extent to which these are met
  - Framing issues
  - Access issues
  - Level of uncertainty of knowledge and information as experienced by stakeholders

- Local contingencies such as:
  - Place attachment
  - Site history
  - Associative reasoning (to other economical, societal or political developments)
  - The general attitude of local and regional policy makers
  - Procedural justice

- Project specifics
  - Off-shore/onshore
  - Project developer
  - Size

The opinion shaping process (or translation of opinion shaping factors into a specific risk opinion) is depicted in figure 1. The figure depicts the process of interaction between a project (its representatives and proponents) on the one hand and the local contingencies and identity related

[1] The attitude and behaviour of the project developers regarding the take-up of a participatory and communication strategy that is inclusive and transparent, are important to consider as well. What is the perspective of the project developer, what important 'opinion shapers' and identity issues play a role here? (e.g. organisational culture, sectoral culture, (lack of) experiences with participation, (lack of) competences to adopt such a strategy, etc). This was investigated in more detail in WP3.

issues on the other hand, with the communication and participation issues as mediating in between (these are the intervention entrance for the NEARCO2 project).

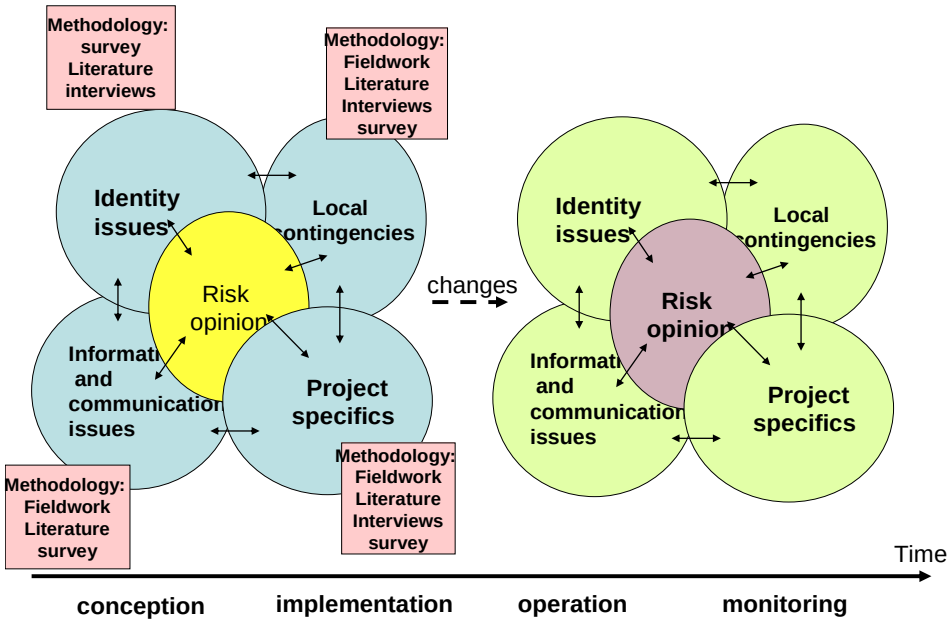

Figure 1.1: Opinion shaping factors and the opinion shaping process

There often is a mismatch between expectations from on the one hand, the project developer and related parties, and on the other hand, local stakeholders and the local public. The project developer may think that when following the "right rules" in public engagement, this will take away opposition, while this need not be the case. "General recipes" need to be tailored to the specific context in which these are used (see figure 1.1 - learning how opinion shaping factors play a role, e.g. how a project affects local identities, how socio-demographics shape risk opinions, how local contingencies shape risk opinions and in sum, learning how to make use of this knowledge in devising a communication and participation strategy that meets the information needs of different segments of the public). Interaction with the targeted stakeholders is needed so that the project developer can learn from the local target groups what their specific concerns are, what their information needs are, and if there are opportunities to e.g. take away these concerns.

With a better understanding of how the above factors shape opinions about the advantages and risks of CCS in general and for concrete projects, participatory and communication strategies can be devised that target the specific risk opinion of people and the accompanying information needs, taking into account all the factors that shape that opinion and attempting to work those factors. In other words, when we better understand how opinion shaping factors shape risk opinions we can try to influence this translation process, by being better able to take better notice of what matters for stakeholders.

The things that matter can be addressed as conditional factors that, if taken notice and account of, can positively influence the risk opinions and in turn whether the local public will ultimately be happy for the project to proceed. Many people are conditional supporters: they are willing to lend support, but conditionally. The conditions may relate to process or content. Examples are conditions with respect to the specific site, the size of the project, the use of local subcontractors, the sharing of other benefits, the design of the process, perception of the ability of local people to contribute to decision making on the project, credible guarantees over safety, etc. What these conditional factors

are, however, are different and will depend on the opinion shaping process of each (segment of) stakeholders. To find out what matters to stakeholders is important to ensure the engagement of the local stakeholders in the local debates. For effective (procedural) engagement, the stakeholders need to be informed as to how the implementation of a project may directly affect them, either through risk aspects, negative implications for the value of their properties, and advantages such as new job opportunities or other positive (or negative) economic effects. This information and communication process also needs to be tailored to the different segments of stakeholders with different risk opinions.

The participatory and communication strategies are expected to be more effective in the sense that they meet the (information and participation) needs of the involved stakeholders in terms of risks and advantages of that project.
With 'effective participatory and communication strategies' we explicitly do not refer to strategies that can be successfully used as lubricants to facilitate a higher acceptance of the project. The effectiveness we investigate refers to the process, not the outcome of that process.

Effective communication and participation strategies thus:

- are predicated on a better understanding of how opinions on risk are shaped by an interplay of various conditions
- fit the context of the specific project:
- take due account of local expectations, concerns and needs
- take due account of the expectations, needs, motivations and aims of the project developers
- contribute to the articulation of expectations from different sides

1.3 Previous research on Public engagement with CCS

Over the past decade, surveys on the public have consistently shown that CCS is not a widely known or understood technology, in all the countries surveyed (Gough et al. 2001; Gough et al. 2002; Shackley et al. 2005 for the UK; Miller et al. 2007 for Australia; Curry et al. 2004 and Reiner et al . 2006 for US, UK, Japan and Sweden; Itaoka et al. 2004, Huijts et al. 2007; Ha Duong et al 2009 in France). Even when knowledge of CCS was judged by respondents to be good, it was often accompanied by wrong answers in questions about what CCS is (Curry et al 2007, Reiner et al. 2006; de Best-Waldhober and Daamen 2006; and EC 2011 for a recent Eurobarometer survey on CCS in selected EU countries). In a further elaboration on public awareness of CCS, Miller et al. (2007) found that awareness of CCS was higher in male than in female respondents, and those of higher incomes and education levels, while there was no correlation with age.

There may have been a slight increase found in the public knowledge of CCS over the past ten years during which CCS has steadily become more widely discussed in national media forums, though it is of course difficult to compare studies that differ in methodology and surveyed population. The past few years in particular have seen CCS being increasingly discussed in various mass media forums in reaction to more controversial plans in the Netherlands (Barendrecht, see Feenstra et al. 2010, Brunsting et al. 2011) and Germany (Schleswig-Holstein and Brandenburg, Schulz et al. 2010 and Dütschke 2010 respectively); we might therefore expect that public awareness would have increased slightly from the studies performed in the mid 2000s, particularly so in the Netherlands and Germany.

In their convenience sample of interviews conducted at Liverpool John Lennon airport and focus groups with students and their acquaintances, Shackley et al (2005) found moderate support for CCS as a climate change mitigation technology, although there was a clear preference for renewable

energy technologies. Reiner et al. (2006) found similar attitudes in their cross-country study. Though attitudes towards CCS (and nuclear power) improved after respondents were provided with some more information about the costs and emissions on the various technologies, renewables still remained the favoured option (see also Itaoka et al. 2004). Reiner et al. conclude that while this may show that education about CCS will improve opinions, their results still show that CCS remains one of the least preferred solutions to climate change overall. However, more information about CCS can also influence opinions against CCS, as shown in the focus groups performed as part of WP4 (Upham and Roberts 2010); concerns about CCS that emerged in the focus group discussions were not allayed by the provision of further information.

This demonstrates that mere information provision and education may have its limits in terms of persuading the public about CCS, and policy makers will have to accept that CCS will probably remain one of the least preferred options for climate change mitigation. This brings to the foreground the argument made for example prominently by Stern (2007), that CCS is necessary as part of a portfolio of options, rather than presenting it as an alternative to other energy technologies.

Unlike renewable energy technologies such as wind or solar power, CCS only really makes sense within the context of climate change: it does not provide a new source of energy which could be construed as a desirable thing even if we don't believe in climate change; instead it adds to the costs (and risks) of existing fossil fuel power generation. Therefore it is reasonable to assume that public perceptions of CCS are closely linked with public perceptions of climate change as a pressing global problem. Though some of the above studies showed a link between awareness of climate change and perceptions of the need to reduce CO2 emissions (Shackly et al. 2005; Itaoka et al. 2006; Tokushige et al. 2007), others (de Best Waldhober and Daamen 2008) found hardly any relation.

On the other hand, because CCS is often seen as a least preferred option for mitigating carbon emissions, a large section of those who do accept the reality of climate change, green and environmental campaigners are lukewarm towards CCS, if they don't reject it outright as the wrong direction (for analysis of environmental NGO opinions of CCS see Corry and Reiner [add reference to GCCSI report], Wong-Parodi et al. 2008 and Anderson and Chiavari 2009) . In some groups of environmental campaigners CCS is often characterised as a “fig leaf” that allows polluters to continue burning fossil fuels, or as “technofixes” which don't address the underlying problems that cause climate change, and therefore there is an active opposition towards the technology (see Corry and Riesch forthcoming for an analysis of NGO views on CCS). In their study of stakeholder opinions on CCS van Alphen et al. (2007) also find at most lukewarm acceptance among environmental NGOs. The implications for the general public perceptions of the technology are that it is unlikely to appeal to either those who reject climate change as well as those who are most actively engaged in raising awareness of it, which means that the undecided or receptive portion of the population will be those in the middle, i.e. those who accept climate change but do not actively engage in the green movement.

As part of the ACCSEPT project (ACCSEPT 2007), Shackley et al (2009) have analysed stakeholder opinions on CCS in several European countries through a large-scale survey, where by stakeholders they mean representatives from the energy, research and government sectors, as well as environmental NGOs and national parliaments. Generally, though the stakeholders were moderately supportive of CCS, it was also often thought that investing in CCS would impact negatively on other low-carbon technologies. The NGOs and parliamentarians tended to be the most sceptical in this regard while energy sector respondents were the most positive. While generally they found that as would be expected individual stakeholders who were more involved with CCS professionally were also more positive towards the technology, this was only true for people who do not spend more than half their time on CCS. Shackley et al. conclude that “those most closely involved in

CCS do not allow this level of involvement to unduly bias their perceptions of CCS" (p.346). They also found differences between the European countries they surveyed, with Norwegian respondents being generally the most positive, followed by the Netherlands and the UK.
Cough (2007) also found that the stakeholders she surveyed (CCS experts from the academic, industry, policy and NGO communities) thought the most pressing problems for CCS were costs and policy/regulatory frameworks, and though CCS was seen as a positive technology there was still clear support for higher use of renewable technology. Similarly van Alphen et al.'s (2007) study of Dutch stakeholders (industry, government and environmental NGOs) showed that while there was a generally favourable view of CCS, it was not the preferred option (for the NGOs), and that CCS should only be deployed if conditions are met among others about assured safety and the promise that it is only a temporary and partial solution to green energy production.

The survey study presented in this report will complement the growing literature on public and stakeholder understanding of CCS and attitudes towards it. The novel aspects of the research are: The cross-country comparison of the UK, the Netherlands, Spain, Germany and Poland will identify national differences. The split between national and regional public will allow comparisons between those members of the public who are more directly affected by proposed CCS project through virtue of living locally, and the more general public mood towards the same issues. To complement the emerging literature of stakeholder opinions and to contrast those more national findings with those of more locally concerned stakeholders, the survey was also sent to specifically local politicians, journalists and civic society organisations in addition to members of national environmental NGOs. Through this selection we hope to have sampled important stakeholders who are not usually part of the previous stakeholder research, which focussed on a more national level.

Because people tend to give opinions even if they do not have strong knowledge in a topic (de Best-Waldhober and Daamen 2008), we felt it is important to combine the quantitative analysis with a more in-depth qualitative study. We therefore made use of a service offered by the survey firm TNS which recruited the public respondents for the survey of holding two "dialogue boards" with a small number of respondents who indicated in the survey that they would be willing to participate. In the discussion boards we probed further into the issues raised in the survey to understand how respondents feel about the issues and arrived at their conclusions. Furthermore, given that there may be worries by developers about how surveys themselves can affect public opinion towards their projects, the dialogue board also offered us an opportunity to look into the effects that the survey itself has had on respondents' attitudes towards CCS and the specific local projects we asked about.

The following chapter will provide a review of the literature concerning the main theoretical strands that informed the direction of our research and the problematisation of the research questions. We will then outline the methodologies used in the various stages of the research and define some specific hypotheses and expectations. Chapter 4 will provide an outline of the local conditions and project-specific details of the five CCS projects the research has concentrated on. The survey results will be presented quantitatively in chapter 5 followed with a qualitative analysis of the open questions in chapter 6. Chapter 7 will present the findings from the online dialogue boards. Finally we will present a short summary of the main findings and offer some conclusions.

2. Theoretical background

2.1 Risks and Uncertainties

The communication of risks related to CCS is not straightforward for two important reasons. Firstly, the scientific methodologies for risk assessment of CCS projects are still evolving and different approaches are being developed. Secondly, communicating the risks of CCS is not yet an established art. Risk communication is already a difficult task in other fields; CCS is complicated by the novelty of the technology and the lack of consensus on approaches. There has been relatively little thought on how the public might be engaged in the actual risk assessment rather than simply being informed of outcomes. Incorporating the public into a subject that is both new and technically complicated might for instance help defining an acceptable representation of risk levels for the different stakeholders involved (see also the collection of essays in Flynn and Bellaby 2007).

Our view on risk opinions is based on the notion that in current risk communication strategies there is insufficient account taken of the way stakeholders shape their opinion and interpret risks. Often, when stakeholders such as concerned residents define statistically low-occurrence risks as being unacceptable, these stakeholders are depicted/framed as irrational or as having incorrect conceptions or perceptions due to lack of information. However, often these stakeholders do not change their opinion once made "knowledgeable", if they were not already well-informed. A growing body of literature argues that the reason for the "dialogue of the deaf" that often follows is not so much an "irrational" viewpoint or misperception of the stakeholders, but the inability of the project developers to acknowledge that their own risk assessment is as bounded and subjective as that of the non-expert stakeholders. In elaborating their concept of "post-normal science", Funtowicz and Ravetz (1993) have influentially argued that there are always multiple rational perspectives to take on risk issues on new technological developments, and that therefore it is an expected feature of post-normal science that experts, policy makers and publics have different but in their own contexts perfectly rational interpretations on new technologies and their risks (as also found through empirical case study research by Shackley and Wynne 1996). Project developers and their experts do not sufficiently recognise the factors shaping the stakeholders' risk opinions, and that each risk opinion can be rational within its own context, as every opinion holder works within the context of their own background knowledge, assumptions and ideologies. These underlying norms and values shaping risk opinions need to be assessed and identified to allow for a more tailored and targeted information and communication strategy.

Importantly though, information strategies cannot assume a simple relationship between information provider and recipient; there are many different interdependent factors that influence how information communication can develop and affect their outcomes (Brunsting et al. submitted).

Research in the field of "Public Understanding of Science" and by extension risk communication has long argued against the "deficit model" that assumes the public to be merely lacking enough technical information and understanding to be able to make informed decisions about science, and that merely need to increase knowledge and understanding if we want to communicate risks adequately (Wynne 1992b coined the term "deficit model" in his famous study of Cumbrian sheep farmers in the wake of the Chernobyl disaster, see also Irwin and Wynne 1996, and Lock 2008 for a history of the PUS movement). In particular one of the frequently made assumptions within the deficit model, that the public will be more supportive of new technologies if only they knew more about it, has been found to be suspect (see Allum et al. 2008 for a review); similar findings are being made with respect to CCS (for example in the WP4 report, Upham and Roberts 2010). Despite the academic literature having departed from the deficit model to a more contextual one which considers the contributions the public can make towards science policy issues, old assumptions are still very much evident in in contemporary science policy circles, despite the enthusiastic uptake of "the rhetoric of public dialogue" (Irwin 2007). This, Irwin argues, creates a

“tension concerning the meaning and purpose of terms like 'public dialogue'” (p.36). This tension raises very important points about the purposes of science communication research for policy: It cannot be, and more importantly it cannot be seen to be, merely research that aims at finding ways of making new technology more acceptable to the public, and we must therefore stress that the current report is aimed at understanding public information needs and opinion forming processes rather than providing a communication blue-print for CCS proponents.

A still more fruitful approach to risk opinions than merely surveying how the public feels about CCS and how much they know or understand the technology would therefore be to analyse the different and often diverging risk opinions as starting points for negotiating for an acceptable distribution of costs and benefits, instead of attempting to change the opinion by means of more (objective) information provision.

Finally, another issue that needs to be considered when analysing the risk opinion shaping process is that what is an acceptable risk standard, and the discussion around that definition, is in itself a political process, where the distribution of risks, other costs and benefits is debated – there is no such thing as an objective standard for what an “acceptable” risk should be.

Risk opinions are to a large extent formed by the level of uncertainty in respect to knowledge and information as experienced by the various groups of stakeholders. To understand different risk opinions and how they arise we seek to categorise where risk opinions of different stakeholders fall within a broad categorisation of risk. Definitions of levels of uncertainties however are abundant. For the NEARCO2 project we chose to follow the distinctions about different levels and sources of uncertainty in relation to information as developed by Van Asselt and Spiegelhalter.

Van Asselt and Rotmans (2002) (see also Walker et al. 2003), following the post-normal approach to science in the tradition of Funtowicz and Ravetz (1993) and Wynne (1992a), categorise uncertainties as uncertainty derived from the variability of nature, and uncertainty derived from our lack of knowledge. Philosophers of probability such as Hacking (1975) similarly divide probabilities into “aleatoric” or “ontological” (also sometimes called “ontic”) probability and “epistemic” probability. Van Asselt and Rotmans make a distinction between these two as sources of uncertainty:

- Due to variability (ontological uncertainty)
  - Natural variability
  - Behavioural variability
  - Societal variability
  - Technological variability
- Due to limited knowledge (epistemic uncertainty)
  - Measurable uncertainty
  - Structural uncertainty

They categorise different levels of uncertainty ranging from structural to measurable:

- inexactness
- Lack of observations/measurements
- Practically immeasurable
- Conflicting evidence
- Reducible ignorance
- indeterminacy
- Irreducible ignorance

Once the source for the uncertainty has been identified, a deeper understanding of the risk opinion can form and a more effective communication and information strategy can be devised.

Spiegelhalter and Riesch (forthcoming; also Spiegelhalter 2010 and Riesch forthcoming) make a distinction between the *sources* of uncertainty and *objects* of uncertainty. In contrast to the sources that van Asselt and her colleagues write about, the objects of uncertainty are *what* we are uncertain about (as opposed to *why*). These are put into five different categories, or levels of uncertainty:

1. Uncertainty about the outcome: we can be uncertain of the outcome, as predicted by the model
2. Uncertainty about the parameters: we can be uncertain of the parameters used in the model (this also includes other values to be put into a model, such as boundary conditions)
3. Uncertainty about the model: we can be uncertain about the model itself
4. Uncertainty about the implicit assumptions, or acknowledged inadequacies in the modelling process: we can be uncertain about the assumptions used to derive the possible models
5. Complete uncertainty, or uncertainty about unacknowledged inadequacies: we can be uncertain about the unforeseen events (things we don't know we don't know), often referred to as “unknown unknowns” after a speech by Donald Rumsfeld (2002)

Sources and objects of uncertainty relate on the different levels. While the first level of uncertainty is almost always due to aleatoric variability, uncertainty over parameters or models can derive either through variability of nature or our lack of knowledge. In this sense our conceptualisation extends van Asselt's scheme to arrive at a more fine-grained picture of what different conditions of uncertainty represent: There can for example be parameter uncertainty derived from lack of observations, conflicting evidence, or practical immeasurability. Similarly model uncertainty can be due to conflicting evidence or reducible or even irreducible ignorance.
These conceptualisations of uncertainty are not to be seen as describing the full range of possible ways of classifying uncertainty, but rather as a conceptual scheme or heuristic that differentiates between the more important aspects of uncertainty. This Spiegelhalter and Riesch argue, will help designers of risk communication material and risk policy in sorting out where the important differences lie while at the same time it avoids being too technically complicated and prescriptive as is for example Funtowicz and Ravetz's otherwise admirable “NUSAP” scheme (Funtowicz and Ravetz 1990).

2.1.1 The risk framework applied to CCS

The different levels of risk map onto CCS in that they are all present in some way with the technology, and may be of different relevance to different audiences. The first two levels of uncertainty are evident in much of empirical or statistical work, for example on the costs of CCS (McCoy and Rubin 2008). Uncertainty over the parameters usually reflects our lack of knowledge over the precise nature of the local conditions.

The third level is uncertainty over the model: Once the model is chosen, its parameters may still need to be ascertained, to predict an outcome with a particular probability. In the case of many studies on CCS for example, there are still debates to be had about how much models developed for and by the oil and gas industries apply to the storages of CO2 (Raza 2009). There may be additional uncertainties over what statistical methods are used, and their applicability. This is the level at which the journalist Arnoud Jaspers (2009, 2010) detected some uncertainty in the Dutch Barendrecht project, because he felt that the model used in the initial assessment was not applicable to this more complicated situation. Whatever the merits of those criticisms, they highlight that there is an additional uncertainty, which cannot be reduced through better measurements or calculations.

The fourth level is the uncertainty over our implicit assumptions: When choosing a model we also need to make judgements over the reliability of the modelling processes, the trustworthiness of the modellers and of the scientific assumptions they are using. This level, more so than the previous, is of importance to the more ideologically opposed critics of CCS. One of the most important implicit assumptions is whether we can fully trust the people who make the risk assessment (trustworthiness is one of the different sources of uncertainty discussed by van Asselt and Rotmans). Since levels of trust among environmental campaigners are low, pronouncements on risk assessments are treated with caution, because from the opponents' perspective there is a very real and relatively high probability that the risk assessment was not done properly, that relevant information was suppressed or that the experts are ideologically influenced to produce risk estimates that are lower than they really should be. Another source of uncertainty that casts doubt on our implicit assumptions is uncertainty in the underlying science. Though this doubt will be low in experts' assessments of the situation, the same cannot be said of the general public which will not know the science involved intimately enough and will therefore not be in the position to properly assess where our knowledge is secure enough to take it as given.

The fifth level is somewhat perpendicular to the others, and concerns “Rumsfeldian” uncertainties: Things we are not even aware that we don't know. These last two uncertainties are an important factor when considering non-experts' responses to CCS, since they need to factor in their own assessments over the reliability of the risk estimates they have just heard given background concerns that are not evident or assumed as given in the technical literature. The fact that despite all the reassuring risk modelling something almost always goes wrong due to unforeseen circumstances if the project is rolled out on a large enough scale (as in the airline industry where accidents still happen despite efforts to reduce the risks to zero), suggests the deep rationality behind the quite stringent public demands for “zero leakage” outlined by Ha-Duong and Loisel (2009).

Through this scheme we can explain how different stakeholders, with different background attitudes, knowledges, assumptions and ideologies can view the same technology through somewhat different lenses. Whether we think that level 4 or 5 uncertainties are more important than say levels 2 or 3 depends on the amount of trust we are prepared to give to the experts' risk assessments, the scientific knowledge they may take for granted, and their political viewpoints which to some extend inform levels of trust and background assumptions. These considerations show how different stakeholders' takes on risks are perfectly understandable and rational within their own contexts and that successful communication between stakeholders needs to take that into account if it wants to foster true dialogue. The application of this risk framework to CCS communication is elaborated in more detail in Riesch and Reiner (2010), and also applied as an elaboration of post-normal science to the example of EU bio-energy policy in Upham et al. (2011).

2.2 Identity issues

Breakwell defines four principles of identity which guide action and thus opinion: continuity, self-esteem, self-efficacy and distinctiveness. Accommodation, assimilation and evaluation of information is governed by the four principles of distinctiveness, continuity, self-esteem and efficacy. These processes work to “produce uniqueness or distinctiveness for a person, continuity across time and situation and a feeling of personal worth or social value.” (Breakwell, 1986, p. 24)

- Distinctiveness: the desire to maintain personal distinctiveness or uniqueness.
- Continuity: a desire to preserve continuity to the self-concept is also a motivator to action. Continuity over time and situation between past and present self-concepts.
- Self-esteem: refers to a positive evaluation of oneself or the group with which one identifies. It is concerned with a person’s feeling of worth or social value.

- Self-efficacy: an individual's belief in their capabilities to meet situational demands. Used as a measure of personal agency. High self-efficacy: when one believes he/she can perform or complete the task at hand. Maintaining a reasonable level of self-efficacy is important for psychological well-being.

The four principles of identity can be elaborated in such a manner that they relate directly and strongly to place attachment and local contingencies (e.g. value connected to be living in a particular neighbourhood; being a city or countryside person; the history of a site as a reference for past and present identity; feeling a sense of pride related to the specific site; the extent to which the environment facilitates someone's lifestyle). Conditional factors affect the four principles and can be identified and categorise under these four principles.

Twigger-Ross and Uzzell (1996) see Breakwell's concepts of place identity as developing the general theortical framework of social identity to include spatial aspects. In the social identity framework (Tajfel 1981, Tajfel and Turner 1985, Hogg and Abrams 1988), identities are linked to the social context in which the individuals move, and therefore group identity plays a role in the understanding and processing of new knowledge. Self-esteem is linked with the place we have within the group(s) we identify with, and therefore we strive to conform to the groups' established norms, values and world-views. Information about ourselves which conforms to those norms is accentuated, while those not in agreement are downplayed. Through this we tend to assimilate new knowledge in a way that accords to group values. Similarly, characteristics held by outgroup members which are not part of the ingroup values are accentuated, so that our perceptions of the outgroup's characteristics as different from ours are heightened: Tajfel explicitly designed the framework to make sense of outgroup stereotyping.

In the context of risk management and trust, Hogg (2007) uses social identity to explain social behaviour. Group identification can reduce or accentuate uncertainties if particular attitudes to these risks are part of the group values, and it can affect trust in people or organisations that are perceived to be part of or outside of the group. Thus it will affect the perception of risk that emanates from other members of the group, as well as accentuate the distrust between groups.

Different groups' understandings and interpretations of risk issues are evaluated within the light of established group norms, values and worldviews (see also the social representation and associative reasoning literature introduced below). Thus groups with a strong established identity such as environmental campaigners will interpret CCS in a way that accords with their established worldviews, which will more likely give a negative evaluation of the technology as it is associated with fuels such as coal that carry very negative connotations for these groups. Industry representatives or local people involved with coal mining will have much more positive associations with coal, and are thus likely to be more positive about the technology in that respect. In this way, we may for example expect that people living in areas with positive associations with coal, such as Yorkshire and Humberside will be more positive towards CCS. On the other hand, groups who identify against traditional energy companies, like much of the green movement, may be more negatively inclined towards CCS even though the technology has been designed to mitigate climate change (see also Corry and Riesch, forthcoming).

2.3 Opinion shaping factors: Communication and information issues and Risk

To date, there has been minimal analysis of the role the media plays in influencing public attitudes towards CCS although experience with other novel technologies would imply that the media will play the major role in providing information to the lay public. The Tyndall Centre investigated media coverage in five major English-speaking countries (Mander and Gough, 2006). In the process of understanding the role of the media it is essential to identify:

- Public usage of different media outlets (print vs television vs Internet) in gathering complicated technical information;
- The ways in which the information available through the media is viewed by different segments of the public, namely attentive publics, interested publics and the residual public (after Miller 1992)
- How the media views its role as providers of information and shapers of opinion
- The influence of trust placed by the larger public on better informed actors; or source of information (e.g. information broadcast on TV as a news item on a public channel is considered to be more objective than information issued through a flyer by a local political party (which has distinct political stand points).
- In addition, there is a need to identify in detail the information needed by the public, as well as the influence of this specific need to the shaping of public opinions.
- Also the way the information is framed has an impact. Consider for instance an interview with a well respected scientist, the use of scientific language, the use of specific type of pictures, or the effect of leaving out certain information. (Scheufele 1999)

The mass media have a significant impact on how the public conversation about public risk issues is shaped. Seminal work on the social amplification of risk (Kasperson et al. 1988, Pidgeon et al. 2003) has shown how the media can serve to attenuate or amplify risk issues due to reliance on traditional news values (see also Allan 2002) which emphasise high impact but low probability risks over everyday risks which may be more probable but affect only relatively few people. This framework is intricately linked with the traditional research on risk perception which has shown that certain types of risks are seen as more "risky" by people than others (so-called "dread risks", risks over which we have no control, high impact risks and others), and these risk perceptions can get amplified (or attenuated) through the mass media and other social mechanisms.
The specific risks associated with CCS are particularly vulnerable in this regard: though the probability that things may go wrong are assessed (by the experts) to be very low, if they did they would easily become disastrous in scale – this sort of low probability but high impact risk has been identified (Slovic 2000) to be viewed as particularly "risky" by people. Similarly people living near CCS sites will have very little active control over the risks, having instead to rely on their trust in the operating industry – again, risks where there is a perceived lack of individual control are often seen as more risky. Finally, CCS may represent a "dread" risk as well, with the possible disaster scenarios easily painted in the mass media representing a particularly nasty set of consequences. Unlike other alternative energy options such as wind or solar power, CCS only really makes sense as a technology if we accept the contribution CO2 makes to global warming. This leads to the fact that the benefits of CCS are themselves much disputed, especially in light of successive scandals in 2010 with the UEA emails and the IPCC glacier melting error have led to large sections of the media actively questioning the whole basis of climate change.

On a local level, as the case studies in WP1 have demonstrated, there are further issues regarding local knowledge, local political atmosphere, local contingencies (such as tourism and wildlife parks in the affected areas), impact on house prices, previous experience with similar projects and/or experience of the energy companies etc. (see the discussion on local contingencies below in section 5) which will influence how the media may respond to any planned CCS projects. The effects on local as opposed to national media is still relatively understudied especially in the UK where the media landscape is traditionally dominated by the large national newspapers and TV channels. Here a comparative perspective of the different participating countries will provide a useful insight into the possibly differing roles of local and national media outlets.
How the media representation of risk translates into the public's understanding and acceptance is a matter of debate, though evidence points towards being cautious when evaluating the impact of the media on the public. While newspapers do not substantially deviate from more general public

perception of risks, this correlation can go either way – i.e. newspapers may be as much influenced by their readership as the other way round. Wahlberg and Sjöberg's review (2000) for example finds that the media may influence general risk perception through availability (i.e. pointing the readership towards particular issues), but that personal factors rather than media interpretation are often much more important in informing the individual's perspective. Similarly Lupton and Chapman's (1995) study suggest that there may be a large amount of cynicism with the readership about the newspapers' accuracy towards risk issues, at least concerning the health risks that they studied.

Consistent with these findings, Petts et al (2001) argue that the amount of media influence on public risk perceptions depends on the nature of the risks – perceptions of risks such as air pollution with which we have intimate everyday experience are less influenced by their media representations than risks which we usually only hear about from third sources, primarily the media, such as train accidents. This suggests that different risks have different "signatures", i.e."different risk issues have different capacities to engender specific patterns of understanding and response" (Horlick-Jones 2007).

2.3.1 Public action and the media

Couldry et al. (2010) analysed the role of the media in public engagement with political issues through their "public connection survey" in the UK. Media consumption habits were highly stratified with older and working class respondents reporting watching more television while younger and more middle class respondents going online for news more than other groups. The internet however still remained one of the least used media resources, not being accessed at all by about half the population (at the time of the survey, this may have changed somewhat during the last few years with increasing broadband coverage). Most respondents stated that they follow the news regularly (90%) and that it is important to know what other people are talking about (76%). However, as many as 44% thought that politics has little connection with their own lives, and that "there is no significant correlation between voting and the amount of time spent watching television, and the same is the case for the news consumption variables" (p. 157).

Generally, they found that the worries over declining public participation in democracy in contemporary western democracies are reflected through a decline in participation in elections, but otherwise does not reflect a decline in public interests in political issues. Particularly local political issues are very much a public concern, and the local media still plays a large role in the shaping of public political participation.

There are, however, trends that show a decline in the amount of influence that particularly local news sources can wield in communication about new technological developments. The rise of free internet news sources is often directly blamed for the decline of local news, though the relationship here is slightly more complex – as Couldry et al. have shown the internet is still only the main source of news for a minority of the public. However, the economics of newspapers, especially local news has altered partly as a result of the challenges from the internet. As journalist Nick Davies (2008) has argued in his insider account on contemporary journalism, the declining revenues as well as economic streamlining has resulted in journalists being under an enormous amount of time pressure which prohibits the diligent investigation of new stories and instead trends towards the simple rewriting of news agency stories and press releases (a practice Davies calls "churnalism"). Especially the more financially pressured local press is increasingly less able to diligently investigate local projects like CCS, and instead is vulnerable to regurgitating press releases from the industry or pressure groups. In this sense, though they are still widely used, the local news sources are very vulnerable to outside manipulation and possibly less influential as opinion formers than they used to be.

2.4 Opinion shaping factors: Social capital

Building on previous ideas such Bourdieu's influential concept of "habitus" (Field, 2008), Coleman (1988) introduced the concept of "social capital" into social theory to provide an explanation of social behaviour analogous to financial and human capital. Just as with these other widely used concepts of capital, individuals can possess varying amount of social capital to draw upon in order to advance their interests. Social capital is made up of the various networks of family, friends, work colleagues and other social relations through which we exchange favours, trust and influence each other's viewpoints.

One indicator of the amount of social capital in a population is the amount of socialisation within various political, special interest or social groups through which the local public can build up interactive networks of relationships and personal friendships. These would include groupings such as church congregations, sports clubs, parent-teacher associations or active trade union membership – associations which unlike more passive party membership or supporting a football club involve close personal interactions between the members. Using the prevalence of these sorts of organisations as an indicator of the social capital in the United States, Putnam (1995, 2001) famously argued that the recent decline in membership of these kinds of organisations shows a recent general decline in social capital. Citing a study that shows a close correlation between social capital and general civic engagement in the US, Putnam argues that the decline of social capital can be used to explain falling public engagement with the democratic public sphere, as evidenced by declining participation in elections and interest in political matters (a phenomenon which is itself not only evident in the US, but has been generally observed in Western democratic societies and been termed the "crisis of democracy" - though this is only to an extent consistent with the findings also of Couldry et al. (2010) discussed above, who find that less engagement with formal democratic procedures is not necessarily an indicator of less general interest in politics or political issues).

It can therefore be expected that populations with higher social capital will be more engaged with the civic issues facing the community, and will thus take more interest in and action about locally planned infrastructure developments such as planned CCS projects. Therefore the survey instrument for WP2 includes questions on social activities and membership of community leisure, political and religious associations. The intuitive mechanism of how these indicators translate into more active interest and civic participation is that through more local community involvement of whichever form, individual members of the public will be more likely to share information, gossip and build up relationships of trust. Through the exchange of mutual favours and trust, more people than individually possible will be brought into any developing movements or actions regarding the new development, and the local public will be able to show a more united and engaged role in the planning process. This of course doesn't mean that social capital translates into more opposition to CCS since the reactions that are amplified through social capital can be positive as well as negative, as higher social capital effects the feeling that a community is able to influence local developments and therefore will have the effect of raising trust in the planning process.

2.5 Opinion shaping factors: Local contingencies

Local contingencies are likely to be an important influence on the local acceptance of CO2 storage and transport infrastructure. Low level risk and loss of amenity (e.g. via visual intrusion) are more likely to be tolerated where there is some benefit to a community, such as continuing employment. Local precedents can also be important, just as historical relationships with a trusted (or untrusted) company can also be important.

Chen and Chaiken (1999) discuss another mechanism that influences the opinion of the general (and local) public when dealing with unfamiliar complex concepts or technologies: through associative reasoning Associative reasoning implies that CCS as a mitigation technology is related to other positive or negative phenomena. The relevance of this mechanism for CCS is uncertain still and needs to be investigated.

A theoretical framework similar to associative reasoning is social representation theory, developed originally by the social psychologist Serge Moscovici in the 1960's (Moscovici 2000) and developed further with a particular regard towards public understanding of new science and technologies and risks by Farr (1993), Bauer and Gaskell (1999 and 2008) and Joffe (1999). A social representation is the shared idea a social group has of a concept. If a group is confronted with new and previously unfamiliar concepts they seek out familiar facets within it to anchor it to their understanding of previous ideas. The way they understand a new technology or emerging risks therefore takes on aspects of already familiar concepts, and thus public understanding of new technological concepts is in a way inherently conservative as new concepts tend to correspond to already held worldviews and other social group concepts. Devine-Wright and Devine-Wright (2006) use social representation theory to analyse local action groups' understanding of the intermittency problem for wind power, finding that the groups' conceptualisations of the problem as either manageable or a profound deal-breaker depends on their wider worldview in terms of political, environmental and ideological stances to which they anchor their understanding of intermittency.

A similar argument can be made about protest groups' understanding of CCS. CCS, as a rather new and unfamiliar technology, gets anchored to the various stakeholder groups' previous ideological understanding of familiar concepts. The association of CCS with the fossil fuel and in particular the coal industry is very strong for obvious reasons, and this influences how different groups interpret and make sense of it: For environmental groups who already hold very negative opinions on the industry, the anchoring process of CCS on their previous understanding of the industry is likely to influence their understanding of the technology very negatively. On the other hand some local groups, such as residents living in an area very familiar with the industry will attach their more positive understanding of the industry also to CCS. We also argue that social identity issues (as introduced above) play a crucial role in the way these representations are held by which groups and why. Thus environmental campaign groups form a very strong social identity which makes the social representation argument even more compelling because group members have an active interest in aligning their understanding of the technology along the groups' norms, values and worldviews. Other groups with a strong identity formed along for example religious, political or ideological or local/regional/national lines are also likely to influence how CCS will be perceived. With respect to local familiarity with existing infrastructure, research by Pidgeon and colleagues (Venables et al 2009) has tried to find out more about the common assumption that communities near existing nuclear power stations would be more accepting due to their familiarity with the technology. While warning that perceptions or nuclear energy by the local public cannot be easily polarised into accept or reject, they have found that strong local support can exist even among in “sections of local communities that are not economically dependent on the power station”, although there is also some ambivalence among viewpoints “apparently supportive of the local facilities” (p.1102).

There may also be a possible factor of habituation to the risks which have lost their novelty and become part of every-day experience. Though this familiarity aspect will be less likely to be found in CCS locations since it is a new technology, it will however possibly affect to a lesser degree areas familiar with coal industry, either through mining or existing coal-fired power plants.

This is a strong argument for the inclusion of local contingency such as the relation of the local area with the coal industry, and careful attention needs to be paid when characterising the local populace. Mere familiarity with the coal and energy industry does not guarantee that there is positive local view of them, particularly when, as is the case of surface lignite mining in the Brandenburg area that resulted in the forced movement of whole villages, the coal industry has had very disruptive local effects. Previous experience with the planning and implementation of large infrastructure developments also affects how new CCS developments will be seen, as through associative reasoning and the mechanisms of social representation, the new development will be seen in the light of what went before, and therefore we would expect an area with previous bad experience of other projects to be much more wary of any planned CCS developments. Furthermore, bad local experiences with infrastructure planning will have an effect on whether people will feel their concerns will be taken seriously, which in turn effects levels of trust people have in the planning process and the energy industry itself.

The case studies performed as part of WP1 showed that the local conditions varied a lot in terms of the variety of CCS projects, local political landscape, planning regulations and previous history of similar large infrastructure projects and a variety of other, case -specific contingencies. In light of this, it is extremely hard to generalise any findings about perceptions of CCS projects by the local public, and attention needs to be paid to the variety of local conditions that affect the eventual course of the planned CCS projects. However, the theoretical considerations presented above and our case studies point to several local factors:

Place attachment
The (non-CCS) case study of a natural gas pipeline that was built in South Wales highlighted that wider political divisions to do with local and regional place attachment can play a role in how a project will be received. Since Wales has a separate history and national identity from the wider United Kingdom which is often perceived to be dominated by English interests, protesters against the pipeline saw the project to be about Wales shouldering the risks to meet purely English energy demands. One of the slogans of the campaign against the pipeline was that “this would never happen in Surrey” [a wealthy commuter region near London], when in fact similar projects were being build there as well, according to the interview with the developers.

Local context and history
The comparison between the two German projects in Ketzin and Beeskow (Dütschke 2010), showed that one project (Ketzin) went relatively smoothly in terms of public acceptance, the other one (Beeskow) was plagued by protests. While there were many similarities between the two projects (they are located in roughly the same area of Germany, do not have large CO2 producing industries and the developers were in both cases trying to comprehensively inform the public about the projects from the early stages), there were also a few telling and interesting differences: the storage site for the Ketzin project had already been used earlier to store natural gas, so the local population was more familiar with a similar technology; the size of the Beeskow project was much larger than the Ketzin one, which interviewees suggested may have been a factor in how they perceived the project; trust in the developers was lower in Beeskow because they (Vattenfall) are a large energy company that is generally not very trusted, while the Ketzin project was run by academic scientists who usually score much higher in surveys on trust (see for example the survey contained in Chapter 5).

There may be additional factors as well: For example, residents in an area that depends on tourism may be worried about the impact on the local economy even if they are personally not worried by CCS[2] (this may have been one of the factors that determined the very negative reaction towards a prospective storage site in the Nordfriesland area in northern Germany, see Schulz et al. 2010).

Procedural justice
This is a local contingency consideration more on a national rather than local scale, in the sense that planning legislation differs slightly from country to country. In the UK, at the time of writing, the final decision over infrastructure projects deemed of "national importance" rests Home Secretary, and thus the local authorities will not have a lot to say over whether a project will go ahead (this however may change with the new Conservative-LibDem government, as the Conservatives have argued against this law when in opposition). Similarly in the Netherlands, the local authorities are not be in a position to decide on the projects either. This impacts public perception because if local people may feel the project is imposed on them by the central government against their will and against local democratic procedure. This is one of the lessons from the Barendrecht case study (Brunsting et al. 2011, Feenstra et al 2010).

Also of course, previous experience in the local area with similar infrastructure projects will play a role here as well. If these projects were perceived to have been imposed on the area from without any future similar projects will be seen in a similar light. We would for example expect that the experiences of the nearby Barendrecht storage project described in the WP1 case study may have an impact on the perceptions on the Maasvlakte project.

Local concerns about infrastructure projects are often dressed up in the language of NIMBY-ism (Not In My BackYard), or what has been called in the context of CCS, NUMBY (Not Under My BackYard, see Huijts et al 2007). Whether intentionally or not, this rhetoric unfortunately seems to ascribes some selfishness onto local concerns which is then easily dismissed through the idea that local campaigners are merely interested in their own welfare rather than the social good and that by extension their worries should be counteracted or even be dismissed. We contend that this discourse is both counter-productive as it may well provoke resentment that local concerns are not being taken seriously, but also unfair since local concerns are very often serious and distressing for those involved – falling house prices for example can leave mortgage holders in negative equity, and of course living in fear (justified or not) of CO2 leakage will seriously impact quality of life. It is also untrue, as to a large extent local concerns do not arise solely out of selfishness and often address issues of the local natural environment and social justice (see also Burningham 2000, Burningham et al. 2006 and Devine-Wright et al. 2009 for a critique of the NIMBY concept).

The dynamics of public action and its relation to locality
Although as we have argued above the nature of local contingencies will have a huge influence on how a project is perceived by the local public, there is also a larger interplay between local actors on the one hand and national and even international ones on the other. One of the lessons that can possibly be learned from the case studies of WP1, particularly the Barendrecht and the South Wales pipeline, is that large scale energy infrastructure projects do not just attract local attention but play out on the national stage as well.

One particular local contingency regarding public participation and influencing public action is social capital as introduced above (in section 4). The amount of social capital in the area as indicated by membership in social political religious and similar associations, and the frequency

[2] http://www.spiegel.de/international/germany/0,1518,710573,00.html

with which meetings occur will be an indicator of wider public engagement with local civic affairs and therefore an important local contingency influencing the dynamics of planned infrastructure project.

On a more national level, energy projects that for whatever reason have attracted the attention of national and international environmental NGOs – and CCS is very much on their radar – may become a national *cause celebre* through which environmental groups may want to draw attention to wider national and international energy policy. An interviewee from the communications team of the South Wales pipeline developers for example stated that most of the protests against the pipeline were organised through national environmental campaigns rather than through worried locals. There was here an interplay between national and local interests which fed off one another: Green anti-gas protesters whose agenda was against gas use in general banded together with local protesters whose concerns were more to do with safety. Through that process, the environmental campaigners also started using safety worries in their arguments against the pipeline, while safety campaigners started using the more general green arguments against gas as an energy option.

Similar dynamics played out in the protests against the (ultimately shelved) plans to build a new "CCS ready" coal fired power station at Kingsnorth in Kent, UK, which was from the beginning visited regularly by protesters from the "Climate Camp" amalgamation of protest movements. The interplay between national-level of protesters who actively built links with the local public through information evenings resulted in a probably much heightened negative local opinion towards the planned project, a campaign which was ultimately successful in getting the project abandoned. Similarly, Griggs and Howarth's (2002) examination of the protests against the third runway at Heathrow shows that an "unlikely working coalition" has been set up (see also Griggs and Howarth 2004; 2008) between environmental campaigners and more conservatively inclined local residents. Though Rootes (2009) finds that the large NGOs such as Greenpeace or Friends of the Earth have been rather ineffective in protest campaigning on local issues, this dynamic may have changed with the rise of more grassroots level campaign groups such as Climate Camp (Doyle 2009).

While energy companies deliberate over how to communicate with the local public and getting their views across about the benefits of the planned developments and how to mitigate the risks perceived by the local public, opponents of the developments have remarkably similar meetings, discussing the exact same issues: how to communicate effectively with the local public, how to engage and further dialogue, etc (notes, Climate Camp London, Sept. 2009). In that sense risk communication cannot be seen as merely a dialogue between developers and the public, but is instead a process where various interest groups, such as developers, national green campaigners, local activists and other parties, struggle for attention space with the public, using in many cases similar rhetoric and strategies. It is therefore misleading to think that the developers are alone in working with the local public, and there are instead two or even more competing sides that work at getting their views across.

Neither can the local public be seen as passive recipients of pro and against project communications where one or the other will end up winning the argument; instead they bring their own set of issues and concerns to the table that often are not related to what motivates either proponents of opponents of the planned projects. The interplay here between the various national and local actors is complex and we will not be able to unpick these with the survey instrument, and indeed, there is a general need for further more detailed research on this dynamic which is probably best picked up through more detailed case studies. As Feenstra et al (2010 p. 30) argue, one of the features of the Barendrecht case was that proponents and opponents of CCS have both determinedly pursued their communication efforts with the local public, and that as a result of the lack of communication between these two camps, the feeling of a very polarised debate was generated where one had to be either for or against the project.

3. Methodology

3.1 Introduction

WP2 uses a mixture of social research methods designed to investigate the research questions in more varied way. First, a characterisation of the five different projects investigated in WP2 was performed where we sought to identify the different contingencies that characterise each of the proposed projects and their suggested localities. This informs some of the research hypotheses that we want to ask in light of the literature surveyed in chapter 2 and our expectations derived from the case studies of WP1. The projects have some interesting differences, such as the nature of the proposed storage (on- or off-shore), the local and national planning regulations or the local familiarity with the coal and energy industries. These factors will be elaborated more in chapter 4. The main element of WP2 is a survey which is administered through the market research firm TNS to around 200 members of the public in each of the five countries who live locally to the proposed CCS project, as well as an additional 200 members of the public per country who are recruited from a national sample. Additionally, we have contacted key stakeholders (local politicians, local officials working within the planning area, NGOs and community organisations, and journalists).

These stakeholders were recruited through the contacts from the qualitative case study phase and contacts gained through internet research – these were then contacted and asked to "snowball" the questionnaire to colleagues – success rate varied hugely by country though; while in Germany over 100 stakeholders replied, we only had 5 respondents from Spain.

Additionally, we make use of a service offered by TNS to conduct online "dialogue boards" in two of the countries (Poland and Spain): survey participants from the local public group will be asked if they want to participate in a two day online discussion with NearCO2 researchers to go into more qualitative detail about issues raised in the survey. This will provide us with a qualitative supplement to the survey research and allow us to combine the best elements of both quantitative and qualitative research.

Finally, WP2 also includes an online experiment to test the effect of visualisations of CCS: we test the effect that proper scaling in diagrammatic presentations of the technology has on risk perception compared with improperly scaled presentations of the type frequently found in corporate communication leaflets and text only presentations of CCS. The experiment will be written up in a separate report.

3.1.1 Characterisation of the projects

We have identified five proposed projects in each of the countries under study (Germany, the UK, Netherlands, Spain and Poland). For each project we have, through desk research and interviews with key stakeholders, identified some of the local contingencies that are unique to each case as outlined in the literature review (chapter 2), such as local familiarity with the coal and energy industries, technical specifics about the projects (most importantly whether it will feature onshore or offshore storage), local planning culture and if possible previous experience with similar infrastructure projects. The cases will be outlined in more detail in chapter 4. This provides an important background with which to judge the survey responses and provides some specific hypotheses the survey will be able to test, such as whether local familiarity with coal mining is correlated with more acceptance of CCS as the literature review would suggest.

3.1.2 Public and stakeholder survey

The survey will address the key questions identified in chapter 1, addressing the four main tasks of

WP2, namely the role of the media, importance of the information source, characterisation and communication of risk and the importance of local contingencies.
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The survey was online and respondents were directed to a link via email. Of the roughly 400 respondents recruited by the survey firm TNS for each country, we aimed to have about half living relatively close to the project site. Actual numbers we managed to recruit varied somewhat and are reported in chapter 5. Respondents received a brief introduction to the NearCO2 project before proceeding to the survey. The population in the two countries we selected for the discussion board, Spain and Poland, received an additional question at the end on whether they would like to participate. If no, respondents were given a link to the NearCO2 website, if yes they were given the link after the discussion board had taken place to make sure that the information on our website didn't influence the discussions. All other respondents also received a link to our website.

The stakeholders have been identified within each of the five countries to include local politicians, members of community associations and national environmental NGOs as well as local and national journalists. For each case an appropriate contact person has been contacted and asked to distribute the questionnaire with their colleagues. The stakeholders will get a slightly different survey as we ask additional questions about their position, for example how long they have worked in the area for council officials, or what percentage of their articles relate to science and technology for journalists. The survey started by asking respondents to provide their postcode of name of their town of residence, and located them on an interactive map with which we could later show them how their location is spatially related to the planned CCS project in their country, as well as give us analysable data on how far each respondent lives to the storage as well as capture sites.

The questionnaire was structured along the main issues identified in Chapter 1 and as such addressed, in order:

- Four questions on background knowledge and attitudes which explore the respondents' general concerns of what societal issues are most pressing (such as crime, economic situation, climate change etc.), their views on different energy sources (wind, coal, nuclear etc.), whether they have heard of CCS, and what environmental problems they think CCS is designed to address.
- We then give a short, four paragraph general introduction to CCS and ask, whether respondents, given this information, are in favour of the technology (on a 1-7 scale). We then gave a short description of the project that is planned locally (which of course varied between the five different language versions of the survey, and featured an interactive map which showed the planned capture and storage areas for that project in relation to the location of the respondent (who had been given the option of locating their town or postcode at the start of the survey). Again, we asked the respondents, given this more project specific information, whether they were in favour of the project, and included three free text questions about what they perceive as the major advantages and disadvantages, and whether they had any other questions on the project.
- We then gave some more in-depth information about CCS, describing some of the environmental and safety objections that have been made against the technology while at the same time trying to give an objective evaluation of their merits. This was followed by four questions on risk and benefit perception, starting with a question asking respondents whether they agree or disagree with a range of statements about positive and negative aspects of CCS, whether they are concerned about several negative aspects or risks of CCS, whether they agree or disagree with a range of statements relating to different levels of risk (as introduced in chapter 2, section 1). In addition we also asked three further questions to stakeholders only on whether they think significant deployment of CCS in the foreseeable future is likely, what they think public opinion on it will be, and which factors they think influence public perception the most.

- Five questions addressed issues on information sources and trust; we asked whether respondents feel they can get all the information they need on new local developments, where and whether they would look for more information and which actors they trust most to provide impartial information.
- Four questions dealt with issues on procedural justice, whether respondents believe that the current planning process gives them sufficient voice for their concerns, whether they would like to be involved in decision making processes and have participated in the past and whether they think the local community had been treated fairly in the past. In some countries where we identified particular previous projects (gas storage projects in the UK and Spain), we also ask questions on whether they are aware of them and if so whether they approved. For the Dutch survey, we also asked about prior awareness and approval of the ROAD CCS project.
- A question on media preferences asked what newspapers respondents read regularly, followed by three questions (for the public only) on community engagement (to identify social capital): what voluntary organisations respondents are participating in, whether they spend spare time with family friends or in voluntary organisations and whether they have participated in various forms of civil engagement within the last year (such as voting, attending protests or writing to local politicians).
- The final section included demographic questions on gender, age, education and income.

3.1.3 Discussion boards

The discussion boards featured around 25 respondents from the regional sample in two of the surveyed countries, Spain and Poland. Respondents were asked to log into an online forum (one for each of the two countries) at least three times a day for two days to discuss issues arising out of the questionnaire with the researchers. Guiding the discussion was a list of questions that were available to the participants the day before the forum and was (fairly lightly, owing to the particularities of online discussion boards) moderated by nearCO2 team members in Spain (CO) and Poland (AL).

The discussion forum was an opportunity for us to respond and further investigate any particularly interesting issues that arose out of the survey, drilling down for example on questions of risk perceptions for which a qualitative approach is more suitable due to the different possible interpretations of risks and accompanying uncertainties. Furthermore it allowed us to go into more detail on some of the questions such as intuitive responses to CCS and the specific projects, as well as what images and metaphors the participants associate with CCS, all of which requires more detailed qualitative analysis because they are not as easily picked up through survey methodology.

These online discussion boards were treated methodologically as a variant of the focus group methodology (see Bryman 2001), with a few methodological caveats concerning the online element which will be explored in more detail in chapter 7. The resulting material was treated as qualitative data and analysed through qualitative data analysis techniques, by coding emergent themes into categories and broader meta-categories through which the resulting discussion was charted and interpreted. The coding categories were developed by CO and independently re-checked by HR. The Spanish DB was coded in the source language, while the Polish one had to be translated into English for analysis, which was then rechecked by the Polish moderator (AL) to assure that the analysis adequately reflected the discussion.

The list of questions is split into two sections, one for each day of the dialogue board, which were made available to the respondents a day before each day. The first day consisted of a “laddering” section, in which we asked a series of questions and gather the arguments and motives from all the respondents. We then followed the discussions/interaction between the respondents on these

arguments to see what arguments remain, which get more followers, will they be elaborated more fully in the following discussions. We also aimed to follow the less successful arguments, whether and why they vanish from the discussion. This will give us an insight into the process of how opinions on CCS are formed through discussion with others.

The second day firstly investigated the effect that the questionnaire itself has had on respondents' opinions about CCS. Did it prompt them to seek further information, and if so where did they go? Did they have a prior opinion on CCS and do they feel they changed their views through participating in our research? Did it prompt them to discuss the issue with family, friends or work colleagues? Now that they have had a couple of weeks to think about the issue, has their opinion changed?

We also asked a few more specific questions that arise out of the survey to probe deeper into the variety of opinions on offer in a way that is less accessible through the survey. We asked them to reflect on whether CCS is a good way of combating climate change or solving national problems of energy security, whether they think CCS should be developed further or whether there are any issues that weren't addressed in the survey that they feel are important and what images or metaphors do they associate with CCS.

3.1.4 Experiment

The experiment, which is presented in Chapter 8, will test the effect that different visualisations have on respondents' perceptions of the risks of carbon storage and will be presented in a separate report.

3.2 Issues addressed in the survey: Research questions and hypotheses

The rest of this chapter will concentrate on how the survey addresses each of the four tasks from the WP2 work description and formulate specific hypotheses which the survey will test with regard to the literature reviewed in chapter 2 and our prior expectations regarding the qualitative data.

3.2.1 Role of the media

The role the media play in the opinion shaping process will be investigated through the survey and the subsequent discussion forum. In particular our inclusion of journalists themselves as a stakeholder group will us the opportunity to investigate how, if at all, journalists opinions and perceptions of CCS differ from other groups and in particular the local public. This is tied in to the research on the media reviewed in chapter 2, particularly Wahlberg and Sjoberg (2000) which suggests that the interaction on opinion forming between public and the media is more complex than the often supposed model that suggests the media forms opinions which then in turn influences the public. This is slightly counter-argued in the “Social Amplification of Risk” framework (Kasperson et al. 1988), which sees the media (alongside other social networks) as mediating the risk message between sender and receiver and either amplifying or attenuating the severity of the risk message. We might thus expect the media to have some influence on how a risk is being perceived.

However, since in most issues journalists are no better or worse informed about new technologies than the public at large and they themselves are arguably part of the public themselves, we might expect opinions not to differ substantially between journalists and the public. The one influence that

the media has about public perception is that of availability: the media is able to attract attention to particular topics that readers may not have been aware of, and therefore the media shapes the agenda, if not the actual risk opinions. By including a question on whether the respondents have heard of CCS as well as asking for newspaper reading habits and where respondents are likely to get their information from, we will be able to see if the media did have this agenda setting effect with respect to CCS. An issue related to this is the matter of trust in the media as an information source, which is addressed below in task 2.2.

The issue of the role of the media is not easily disentangled from the related task of the importance of the information source. The survey includes questions on type of media usage, i.e. preferred newspapers; whether respondents tend to seek further information on these sort of developments primarily from the traditional media outlets (national and local), alongside non-mainstream media sources such as local, national or European governments, directly from university scientists and/or scientific publications, the developers themselves or environmental NGOs or friends and family, and how much they trust these different sources to give impartial information. This allows us to test the influence that mainstream media outlets have on public opinion as compared to other information providers. The numbers in brackets refer to the relevant question in the survey (see Chapter 11 for the full version of the UK questionnaire).

Hypotheses:

- Respondents are more likely to seek more information from the news media than other sources (5.2)
- The local media sources score higher in terms of trust than national sources (5.3)
- The media in general is less trusted to provide more impartial information about CCS than environmental NGOs, friends and family and local government, but more trusted than national and European governments and industry. (5.3)
- Respondents will generally feel they do not get enough information on local projects (5.1)
- The mainstream media sources (papers, television and radio) are the main sources of information that respondents use to find out about CCS. (5.2)

3.2.2 Importance of the information source

This task will focus on the relevance of the source of the information provided, using the same instruments as in Task 2.1 with its specific focus on the media. Central to this task is specifically the question of trust, and therefore which channels respondents use to find out more information and how that information is rated.

The role of trust will be investigated with respect to key actors including NGOs, national, local and European governments, energy firms such as electric utilities and oil and gas companies, and the media (print, television and internet). From the case studies, as well as the place and social identity literature reviewed in chapter 2 we can expect that trust will be higher in local authorities and newspapers (see also above) than in national and international actors. Trust in the industry may be related to the industrial history of the area, where we expect regions with a history of coal mining and energy infrastructure to have more trust in general in the industry actors than in areas without such a history. The issue of place identity is therefore also important, and though the survey does not ask specific questions on this, the characterisation of the area in terms of industrial history and general local civic involvement is part of the project characterisations reviewed in the next chapter and thus informs some of the hypotheses which will be presented in the context of local contingencies.

Social capital is also related to this task, as it concerns the formal and informal networks through

which information is shared and disseminated and through which civil engagement arises. As social capital is related to better dissemination of information within the community we may expect regions as well as individuals with high social capital to be more informed about the CCS projects. The survey will also go to particular stakeholders such as local politicians and planning officials and members of environmental NGOs. We expect that issues of trust will be distributed differently between the different stakeholder groups and the local and national public.

Hypotheses:

- Trust in the industry is correlated to more favourable views on general and local CCS, as well as with lower estimations of the risks. (5.4 & 2.2, 3.3)
- Trust in local actors (local news and government, friends and family) will be higher than in national/international actors, especially so within areas and individuals with higher social capital. (5.4 & 6.1, 6.2, 6.3)
- Areas and individuals with higher social capital will be more likely to have strong views on CCS, either locally or nationally. (6.1, 6.2, 6.3 & 2.2, 3.3)
- Previous experience with similar infrastructure projects impacts on issues of trust (in local and/or national government and energy companies) as well as acceptance of the planned project (7.5, 7.6, 7.8. 7.9 & 5.2, 5.3, 5.4)

Aside from the survey instrument, we will perform an experiment (reported in Chapter 8) that will determine the influence of visual schematics on comprehension and perceptions regarding CCS. Specifically, it will test the effect of proper scaling within the promotional and informational diagrams that often accompany presentations of CCS targeted at a lay audience. We hypothesise that schematics that show the injection shaft at approximately the same scale as the trees or houses depicted on the surface will lead to higher perceptions of risk than when the injection shaft is more realistically scaled with respect to the surface details, assuming an average depth of around 1.5 km. We also hypothesise that information about the proper depth of the injection shaft will more likely to be retained on questioning at the end of the experiment by the group that received the properly scaled diagram, compared with a control group that received a text-only description and a group that received a wrongly scaled diagram. The experiment will be described in more detail in Chapter 8.

3.2.3 Characterisation and communication of risk

This task will undertake to find out how the risks of CCS are regarded by the public and other stakeholder groups with respect to the framework outlined in Chapter 2 and how these opinions impact on the perceptions of the particular project planned in the area. This will be accomplished through the survey which will ask questions specifically designed to find out how different levels of risk with regard to CCS are evaluated. The experiment on visual representations of CCS will also be relevant here in drawing conclusions about the communication of risks. As a result we hope to formulate some recommendations on how risks can be communicated.

Since the risk classification system assumes that different levels will have different relevance for the different actors, we expect that members of the public will see the risks on the higher levels as more relevant than council officials, and that NGO members will be even more concerned about the higher levels. We will also be able to see how these estimations of risk are affected by demographic variables such as gender, age, income bracket, political leanings etc.

The presentation of CCS in the questionnaire is first generally about the technology, then about the specific project and finally about the benefits and risks of CCS. After the presentations we ask

whether respondents are broadly in favour of CCS, the local project and after the final risk and benefit presentations we include a number of open questions which will be analysed qualitatively about what respondents identify as the main risks and benefits of the technology. We are interested to see if opinions of CCS shift between general and local presentations, as well as whether the presentation of the risks and benefits shifts opinions on the project.

We expect perceptions of risk to be correlated with trust, since one of the specific uncertainties which we ask about is related to the question of whether respondents trust the experts to have performed the risk assessments adequately, and whether they trust the science in general not to lead to any unexpected or unforeseen consequences that even the experts cannot anticipate.

Hypotheses

- The evaluations of the different levels of risk will be correlated with perceptions of trust in industry and governments. (4.3 & 5.3, 5.4)
- Respondents react differently to the risks of CCS in general and the planned local project, with responses to the local project being more critical than general (2.2 & 3.3)

3.2.4 Importance of local contingencies

This task seeks to identify the local contingencies in each of the countries and find out how they impact on the perception of CCS as a technology in general and the specific local projects. Our characterisations of the projects pay particular attention to: local planning regulations for similar large infrastructure projects, previous experience with such projects, nature of the planned projects (i.e. off or on-shore), and familiarity within the area with the coal mining and energy industry. Additionally the survey will ask questions on local perceptions of procedural justice, place attachment and (also as part of Task 2.1 above) the influence of local media. Survey results will then be compared with expectations from the case studies.

Particularly worth noting here is the role of place and social identity in the development of opinions on CCS. We expect for example that regions with a strong coal mining history will be more positive about the technology.

Hypotheses (further elaborated in chapter 4)

- Respondents from the areas with planned on-shore storage (Poland, Germany & Spain) will be more concerned about the planned CCS project than those living near planned off-shore projects (UK and Netherlands). Furthermore, they will see the technology in general as more risky. (2.2, 3.3)
- Respondents from areas with a history of coal mining (UK, Spain, Poland and the capture site in Germany) will be more positive about planned CCS projects than those from areas without such a history (Netherlands and the storage site in Germany). Due to the disruptive nature of lignite mining in Germany, we expect somewhat more opposition in Germany (2.2, 3.3)
- Respondents from areas with strong local democratic traditions (i.e. where people feel that they have a possible influence on the project) will view the planned projects as more favourable. This is slightly less easy to pick out through the case studies as in some countries (for example Germany and the UK) there are still very many uncertainties about the local powers within the planning process, and furthermore people's perceptions of procedural justice may vary from what is actually the case. To address this, the survey will ask respondents directly about how much they feel they are able to influence the project planning process, and perceptions will then be compared to general attitudes towards CCS

as well as to the real situation within each country (as far as is possible). (3.3 & 7.1, 7.2, 7.3, 7.4, 7.5)
- Local experience with previous infrastructure projects within the area will influence people's perceptions of CCS. The Dutch experience with nearby Barendrecht for example may give people a more negative perception of the technology in general. (2.2, 3.3)

3.2.5 Cross-Task hypotheses

- Across the groups, attitudes towards CCS will be more negative after more information is provided, since we are specifically focusing on safety issues (echoing results from Upham and Roberts 2010) (2.2 & 3.3)
- The information effect will be more pronounced among respondents who are a) unfamiliar with CCS or b) class themselves as familiar but answer incorrectly (1.4)
- Among the general public, knowledge (both self-rated and assessed in q 1.4) about CCS will be low (cf. Previous research on public attitudes)
- CCS, both local and in general will be rated more positively by respondents who a) prefer coal as an energy option (1.2), b) who don't rate climate change as a high priority in q. 1.1
- Distance of the respondents to the project will influence whether they view it favourably or not (3.3)
- Correlations of opinions and knowledge about CCS with gender and education levels – we would expect women to be more risk-averse and less knowledgeable and for those with higher education levels to know more about CCS.

4. Characterisation of the local contexts

We have chosen a number of planned projects to investigate public and stakeholder opinions, one project in each of the Netherlands, the UK, Germany, Poland and Spain. The reasons for choosing these particular projects were availability for the researchers and the variety of local conditions such as on- or offshore storage or the character of the local area, which will give us some interesting comparisons to be made in the survey results over whether specific local conditions correlate with particular attitudes towards the planned projects and CCS as a whole. The projects were: the Don Valley project (formerly known as Hatfield) in the UK, Bełchatów in Poland, Maasvlakte (or ROAD-project) in the Netherlands, Jaenschwalde in Germany and Ponferrada in Spain.

4.1 Summary of the selected CCS projects and their local contingencies

For each location, we have spoken to a number of stakeholders, such as journalists, local politicians and council workers, prominent community members and/or NGOs to find out more about the characteristics of the region, the planned projects and other possible local contingencies such as previous large infrastructure projects which may have had a positive or negative influence on how other projects may be perceived (see table 4.1).

Table 4.1: Summary of the main characteristics of the five projects

Project	**Storage**	**Local powers in the Regulatory system**	**Character of local area**	**Previous experience or engagement with project**
UK: Don Valley	Off-shore	Uncertain – local planning office without much power to influence the project, but this may change	Traditional coal mining country which will be familiar with the industry and needs the jobs	Local engagement with the project seems to be very low, and there were no large scale previous projects that attracted much opposition
Netherlands: Maasvlakte	Off-shore	Mixed – planning procedure planned nationally, but municipality grants planning permission	Industrial area without large population nearby. The surrounding local area is predominantly middle class and environmentally conscious	Experience at nearby Barendrecht may influence perceptions negatively.
Germany: Jaenschwalde	On-shore	Very uncertain – relevant legislation not yet set up	Capture area familiar with lignite mining but feelings are ambivalent about coal. Storage area fairly unpopulated but people do not see sufficient benefits from CCS to balance risk.	CCS has been a very contentious political issue in Germany, which will probably influence how this project is perceived.
Spain: Compostilla, Ponferrada	On-shore	Regional and national authorities will grant permissions for CO_2 storage.	Capture area is familiar with coal power plants and would need the jobs.	Not much opposition expected, and there is little previous controversy in

		Municipalities with little influence on the planning of storage sites		Spain surrounding CCS
Poland: Bełchatów	On-shore	CCS needs concession from ministry of environment	Local economy historically dependent on coal mining	No previous controversy surrounding CCS, though local residents in some proposed storage areas are strongly opposed to CCS.

As expected, there were large differences between the local conditions – this was partly due to the very different natures of the projects: The UK and Dutch plans only include offshore storage, while the other three would be onshore and therefore potentially much more of a problem for the local population. There are also of course differences within the national and regional governments' attitudes to CCS and energy policy as well as differences in planning legislation, as the case studies of WP1 have also shown. There are also some differences in the industrial history of the regions, where the area around the UK project near Humberside for example is heavily influenced by a tradition of coal mining and coal fired power generation. Most of the projects we looked at are in or near areas with a history of coal mining for obvious logistic reasons, though they differ somewhat in their precise nature – while the coal mining industry in the UK case has mostly declined and though the industry is a familiar employer in the region's past, it is no longer a large a major employer. In the Polish case by contrast, coal mining is still a major local industry. The German case is different in that the local coal mining industry at the capture site is historically dominated by surface lignite mining and has therefore been far more disruptive to the local population (through the displacement of whole villages) and we may therefore expect more local resentment towards coal mining than for example the sometimes nostalgic image coal mining has in Yorkshire and Humberside. In addition, the proposed storage site for the German project is further away from the traditional coal mining areas of the capture site.

The UK interviewees all agreed that the decline in the coal mining industry in the 1980s has created a region that has suffered a lot of social deprivation and will probably suffer worse than other UK regions from the currently planned public sector spending cuts (at the time of writing, summer 2010). As a result there was a widespread feeling that any project that creates jobs within an industry that the region is very familiar with, will be welcomed by the majority of the population and shouldn't face too many problems with public acceptance.

On the other hand, the other off-shore project near Rotterdam has a completely different history: There are similarities with the UK case, insofar as the area is familiar with the energy and coal industries (though not with coal mining), and with E.ON playing a central role within the life of the area (such as sponsoring a local football team), which means that local councils and organisations don't want to be too negative towards them. Since the carbon capture would take place close to the shore in an industrial rather than residential area, not a lot of the local population would be quite as directly affected by any risks from capture, transport and of course storage as at the other projects. However, the experience and extensive national coverage of the nearby (recently canceled) Barendrecht project may have had a negative influence on public perception of CCS generally. Also, in contrast to the Yorkshire and Humberside region, the few villages and towns in the vicinity are relatively affluent and residents are concerned about local environmental impacts.

Similar to the Yorkshire and Humberside case, the capture site in Germany also has a history of coal (in particular lignite) mining and many local people are employed by the developer, Vattenfall. However, the general perception of coal is ambivalent, since most coal mining in the area has been surface mining for lignite, displacing 47 villages in the process. At the proposed storage site however there is less of a tradition in coal mining, nor a large proportion of residents employed in the sector, and therefore local opinions do not seem to see too many advantages to counterbalance the risks of the storage. In addition the political landscape regarding CCS in Germany is somewhat less enthusiastic than in other countries. Two minor but influential political parties, the Greens and the Linke (Left) are opposed to CCS in principle, and the major parties in the governing CDU/FDP coalition and the main opposition SPD are either in favour or neutral but do not at the moment actively communicate on it as CCS has turned out to be a very sensitive issue in Germany, as shown also in the case study report for WP1. On the local level, even the main political parties may oppose CCS projects against the national party view (as has happened at a proposed storage site in Schleswig-Holstein).

Unlike Germany and the Netherlands, CCS has not been a hugely controversial subject in Spain or Poland. The capture site for the Spanish project, the village of Compostilla and the nearby town of Ponferrada has an industrial history of mining and coal-fired power plants, and in common with similar sites around Europe including the UK and Germany sites, the decline of the coal industry has led to local concerns about unemployment. Since there is no extensive tradition of public involvement in infrastructure projects and because of the region's familiarity with coal mining and power-plants, the interviewees don't expect there to be much local opposition to the plans apart from possibly local environmental concerns. Similarly at the two storage sites (near Burgos and an unpublicised location in Leon province), there has not been much opposition to the plans and with one exception the local newspapers reported the story very positively.

In Poland, the project has faced some opposition near the capture site of Bełchatów and at a few of the proposed storage sites, particularly Lutomiersk and Pabianice. Apart from that opposition to the project has been relatively muted, probably due to the relative affluence of the region, its reliance on the project for employment, and the importance of coal to the local economy.

Based on the pre-survey interviews we expect the local German public to express most opposition to the project, Poland and the Netherlands to be somewhere in the middle and Spain and the UK to express the least concerns. The five projects and their local contexts are summarised in the table below [give table a number!], and the detailed descriptions are presented in the following sections.

4.2 Research hypotheses arising from the case studies

Based on the differences and similarities between the five projects and theoretical expectations from the literature review in chapter 2 around social and regional identities and social justice, we can formulate a number of hypotheses the survey instrument will test:

- Respondents from the areas with planned on-shore storage (Poland, Germany & Spain) will be more concerned about the planned CCS project than those living near planned off-shore projects (UK and Netherlands). Furthermore, they will see the technology in general as more risky.
- Respondents from areas with a history of coal mining (UK, Spain, Poland and the capture site in Germany) will be more positive about planned CCS projects than those from areas without such a history (Netherlands and the storage site in Germany). Due to the disruptive nature of lignite mining in Germany, we expect somewhat more opposition.

- Respondents from areas with strong local democratic traditions (i.e. where people feel that they have a possible influence on the project) will view the planned projects as more favourable. This is slightly less easy to pick out through the case studies as in some countries (for example Germany and the UK) there are still very many uncertainties about the local powers within the planning process, and furthermore people's perceptions of procedural justice may vary from what is actually the case. To address this, the survey will ask respondents directly about how much they feel they are able to influence the project planning process, and perceptions will then be compared to general attitudes towards CCS as well as to the real situation within each country (as far as is possible).
- Local experience with previous infrastructure projects within the area will influence people's perceptions of CCS. The Dutch experience with nearby Barendrecht for example may give people a more negative perception of the technology in general.

4.3 Detailed description of the projects

4.3.1 Local contingencies around the planned Yorkshire/Humberside CCS hub

Methodology
Two local business journalists and a local council official (who prefer to remain anonymous) were interviewed as well as Steven Brown from CO2Sense (created by the regional development agency Yorkshire Forward). More information was also gathered at a half-day conference organised by CO2Sense in Leeds on current CCS plans for the region aimed as an information and networking event for businesses, NGOs and other stakeholders.

Additional information about the plans were sourced from the promotional material and websites of CO2Sense, regional newspapers and various others, as well as the information leaflets handed out at the event in Leeds.

CCS plans in the region
The area around Humberside and South East Yorkshire has one of the highest concentrations of point source emitters in the country. The regional development agency (RDA) is planning to help build CCS infrastructure financed through a mixture of public and private funds which links up the various point sources by pipeline to a hub projected to be located in South East Yorkshire and Humberside and transports the carbon through a route crossing Yorkshire and North Lincolnshire to the coast and from there to several potential offshore storage sites close to the Humberside coast. Though the pipeline itself will naturally avoid going through major population centres, it will run past the larger towns of Doncaster and Scunthorpe and at somewhat more of a distance, Hull, Grimbsy and Lincoln.

Operators of the existing Drax power-station near Selby have been trying to reduce their emissions through partially switching to biomass are keen on the idea and happy for plans to go ahead. In addition a new power station is planned in Hatfield near Doncaster by Powerfuel, which would source coal from a recently re-opened mine from the area[3]. Unfortunately only a few weeks before the survey was due to be launched, Powerfuel went into administration, which created a considerable amount of uncertainty over the planned CCS project at the time the survey was being administered. Powerfuel however has recently (May 2011) been bought by 2Co Energy who plan to

[3] http://www.independent.co.uk/news/business/analysis-and-features/king-coal-makes-a-comeback-459918.html

go ahead with the CCS plans[4].

Characterisation of region and previous large infrastructure projects
The region has an extensive industrial history connected to coal mining, and has largely fallen into decline with the decline of the coal industry during the 1980s. The colliery near Hatfield in particular came to national attention during this time through the strikes and unrest that characterised the mine closures.

All interviewees stressed that the area, with a particular emphasis on Doncaster, faces severe problems of unemployment as a result of the decline in industry, and that the current recession with its accompanying cuts in the public sector will hit the area particularly hard. It was therefore felt that anything which would revive the area in terms of job creation and at least partly restoring its coal mining heritage will be welcomed by the majority of residents.

Previous energy infrastructure projects that could provide a possible guide on how CCS might be received include some smaller scale projects such as power stations, of which there is a large concentrations in the area, incinerators (near Hull), natural gas storage (slightly further away) and two gas pipelines in roughly the same area as the proposed CCS pipeline. Local reactions to these projects seem to have been rather muted. While there was a protest movement against the gas storage site ("mothers against gas storage") reported by two of the interviewees, it was not known by the journalists, one of them was not even aware of the project. Likewise the incinerator in Hull provoked some small reaction, but again on a small enough scale for one interviewee not to be aware of it. It was also felt that the reaction against the incinerator was not so much about potential risks of the technology, but the very concrete fact of air pollution, and the interviewee therefore couldn't see similar concerns applying to CCS.

Political and planning landscape
As with most other areas with a heritage of industry and mining, the region is heavily working class and the Labour party dominates the political landscape. In line with this, the region has also been part of a recent national shift where a fair number of voters have been disillusioned with Labour as the traditional working class party and voted for far right nationalist parties. This resulted in the election in Doncaster of a far right mayor from the "English Democrats", who has been championing the view that global warming does not exist and is a left-wing conspiracy. Though the shift from Labour to far right parties was not as pronounced as feared before the general election in May 2010, there remains a sense of disillusionment with the party within the general British working class areas (as well as with the current conservative – Lib Dem coalition), which would give a possible complication for any large project that is seen as being pushed through from London. This effect could be enhanced through the recent changes in planning regulation which restrict the potential for local councils to oppose any infrastructure project deemed of national importance. However the status of the planning regulation is currently somewhat unclear since the Conservative party has before the election promised to reverse them. There was a feeling that the outlook about the planning legislation is at the moment too uncertain to be able to say how much say the local councils would eventually have in the project, and what possible avenues the public would have should there be a large-scale negative reaction to the plans. All these factors could obviously complicate any plans on CCS, though as mentioned by the interviewees, anything that brings jobs to Doncaster would be welcomed even if global warming is not seen as a priority, and if the legislation stays as it is.

However, one of the interviewees, Steve Brown from CO2Sense, felt that there was not much appetite in the region to participate and inform about the current plans on CCS. CO2Sense has been

[4] http://www.yorkshirepost.co.uk/business/business-news/clean_coal_project_revived_by_company_buyout_1_3363981

trying to get local people and councils into a wider dialogue about CCS but found that there was no real reaction or interest. Though they expect that this may change once the plans become more concrete, it was felt that they have done what they can to involve the local residents and politicians in the process, and that there is simply not much of an interest and therefore opposition to them. This was echoed by one of the journalists who had written on CO2Sense's plans for the area, as they have received no reader reaction to them apart from local businesses who are keen to "jump on the CCS bandwagon". He also felt that though there is bound to be a little bit of opposition to the plans at the local council level when they become more advanced, he doesn't expect that to be large enough to affect the plans (and the new planning regulations, if they remain in place, would restrict their potential for action in any case). The two representatives of local councils at the CO2Sense meeting in Leeds expressed some concerns about how the plans would affect local public opinion and asked what they plan to do about it, they did not argue against them in principle. The council interviewee felt that they need to be representing the local community and act as an outlet through which people can voice their opinions, but it was not felt that there would be any significant opposition.

4.3.2 Identifying local contingencies around the ROAD CCS project in the Maasvlakte industrial area in the Netherlands.

Methodology
Interviews:

- Hans Schoenmakers: E.ON and director stakeholder management for the ROAD project (June 29th)
- Maarten van de Hoog: head Port & Industry DCMR (July 2nd)
- Johan van der Voorst: Milieufederatie Zuid Holland (July 6th)
- P.A.J. Thomassen: Vereniging van bezorgde burgers (July 7th)
- Ellen Verkoelen: Milieufederatie Zuid Holland (July 9th)

Location coal plant, CO2 capture and storage:
The coal plant where the CO2 capture facility will be built, is going to be located on the Maasvlakte, which is a large industrial and Port area in the Province of South Holland. The Municipality of Rotterdam and the Port of Rotterdam play an important role in the decision making about developments in the Maasvlakte area. Other municipalities of adjacent areas are Hoek van Holland (North of the Maasvlakte) and to the south Putten and Voorne (consisting of Brielle, Hellevoetsluis and Westvoorne – which on its turn consists of the villages OostVoorne, Rockanje, Tinte). The CO2 to be captured will be transported through a pipeline to the P18-A-platform at sea (some 20 km off the shore). The total length of the pipeline will be 25 km, of which 4 km over land.

The ROAD demonstration project is supported financially by the EU and by the Dutch government. For the period 2010-2019 the Dutch government supports the ROAD project with 150 million Euros for both the investment phase and the demonstration phase. In addition, European subsidies amount to some 180 million Euros for the investment phase during the period 2010-2014[5]. The expectation is that in the demonstration phase, at least 4 Mton CO2 will be stored. For the period thereafter it is expected that even more CO2 can be captured.

Description of the situation in the area
The Netherlands have had national elections and at present the new government coalition is still in the making. The previous government however expressed its interests in CCS and has awarded financial support to the ROAD project. The overall opinion is that CCS is needed as a transition

[5] letter by minister EZ, 2009

technology, hence it is awarded support under the Clean and Efficient programme.

Both Rotterdam Municipality and the Port of Rotterdam are supportive of the coal plant and the CCS facility. For the Port of Rotterdam, CCS is connected to the future expansion of industrial activity on the Maasvlakte, which is considered crucial in the face of competition of other Port facilities in Antwerp, Le Havre and Hamburg. DCMR is promoting CCS as well.

ROAD is an initiative of energy companies E.ON and Electrabel Groep, part of GDF Suez. The ROAD demo is part of the Rotterdam Climate initiative (RCI) that aims at developing a CO 2 transport and storage infrastructure for the region. Hence, a coalition of public and private parties favour a demonstration project such as ROAD.

ROAD partners have an image of being dominated by fossil energy giants: EON and Electrabel. Within the ROAD consortium, a special director for stakeholder management is in place. He just started the communication trajectory – approaching relevant local stakeholders.

Legislative context
The most important legislation is the Milieubeschermingswet and the Mijnbouwwet. In addition, Natura 2000 is relevant as one particular area (the Voornse dunes) has been designated under Natura 2000.

As of March 2010, the Electricity -, Gas - and Mining Act have been changed. As of that date the so-called Rijkscoordinatieregeling (central governmental coordination arrangement) applies to energy- and infrastructure projects. The spatial decision-making on such projects, if they have a certain size, is arranged at the national level. A Rijksinpassingsplan (central governmental …plan) is then in place. This plan is made jointly by the ministers of Economic Affairs and of Housing, Spatial Planning and the Environment. In addition, the economics ministry will coordinate the permitting procedures. The aim is to shorten and streamline these procedures so that projects can be realised more quickly. The law makes it possible that the procedures for the Rijksinpassingsplan and the several permits can take place in parallel. Participation is still possible but will be bundled, meaning that only at one moment, there is the opportunity to participate (voice viewpoints etc) on the various decisions. The economic minister has as a coordinator of permits also the power to move ahead (doorzettingsmacht), which can be used when e.g. a municipality is reluctant in collaborating in an environmental permit or if a municipality takes a decision that the minister disagrees with. The legal frameworks as given in e.g. the Environmental Law (Wet Milieubeheer) will remain intact.[6]
For the ROAD demonstration project, the Rijkscoordinatieregeling applies.

Some 50 permits are needed for the ROAD project, but those falling under the Environmental Law (Wet Milieubeheer) and the Mining Law are most important.
The Economic ministry has to grant a permit for the offshore storage
The municipality of Rotterdam has to grant building permission.

Update on public participation
As for the coal plant, as this point there is a procedure going on because of the impact it would have on the dune area in Voorne (which falls under Natura 2000). This case has been started by a coalition consisting of the Association of Concerned Citizens of Voorne, Greenpeace and Foundation for Nature and Environment. For the citizens' association, the main worries are about

[6] http://www.rijksoverheid.nl/documenten-en-publicaties/persberichten/2009/02/26/rijkscoordinatieregeling-vanaf-1-maart-2009-in-werking.html)

local environmental impacts (imissions), for the environmental organisations the larger question regarding the acceptability of new coal plants stands central. The council of state has asked the European court for their interpretation. Not awaiting the outcome, EON is continuing the building process of the coal fired plant.

Since the ROAD project will be capturing the CO2 from the coal plant that has raised opposition, many stakeholders argue that this CCS project is inextricably connected to the choice for more coal plants. The citizens association accuses the Port of having a preference for coal above LNG or nuclear, and that this preference is driven by EON and Electrabel.

DCMR has set up several regional platforms where industry, government and citizens meet. Industry uses these platforms to inform citizens about their plans, citizens can express their worries. The information provision is timely and sometimes there indeed is room to negotiate compensating measures (e.g. in response to complaints industry has implemented measures to decrease noise nuisance and the blowing away of dust). The feeling of the Citizens Association is that their advice is listened to, but no more than that. Usually more studies are promised and the proposed development continues unhampered. Therefore the association has decided to join Greenpeace and SNM as these organisations have the expertise to start procedures.

According to the Association of concerned citizens, the problem also is that the smaller municipality don't dare to take position against the plans of Rotterdam and the Port of Rotterdam. The port has paid for local developments like a cultural centre (1,5 million) or a new traffic roundabout, the local football team is sponsored by E.ON. This all makes the municipalities think twice before starting a row.

Local contingencies
Capture site
The Maasvlakte is an industrial area par excellence. There is a clustering of very large scale, modern industrial activity including chemical industries and oil refineries. As such, nobody lives on the Maasvlakte. The area is owned by the Port of Rotterdam, the Dutch State, the Municipality of Rotterdam (both of which are represented in the Port Authority as well). The area has a strong fossil focus including oil refineries and coal transfers.

Surrounding area:
Voorne island: Brielle, Hellevoetsluis and Westvoorne. Westvoorn: Oostvoorne, Rockanje, Tinte are quite luxurious villages. People living there have good jobs, often in industry. Also these people love nature, the dunes and all. The people living here don't want all the nuisance – even though they are not against industry nor anti-development.

The history of nature preservation goes back for more than 20 years, when an imaginary demarcation line was drawn along the A15/N15, starting in Nijmegen, until Pernis, Europort, the Maasvlakte. This was a line between nature on one side and industry on the other side. The Voornse Dunes were labeled 'quietness-area' (stiltegebied). However, politicians over the years have formulated more and more exemptions: the quietness did not apply to the needed industries, Betuwe railway, and road traffic. Sound nuisance complaints increased. Slowly the signs 'Stiltegebied'/Quietness area have disappeared. The nature itself has also decreased in quality, because of nitrogen, and imissions/precipitation (from refineries, transfers, coal plants). EON at some point installed some sort of catalytic filter, but at the same time made the fume stacks shorter, so it wasn't of much help. We see an increase of nettles and grasses, at the cost of other vegetation like wild orchids. The foundation Zuid Hollands Landschap and ? do their best to restore things, sometimes they simply take off the top soil to remove the pollution. The Association of Concerned Citizens is worried about the further degradation of the nature areas as well as the increase of

imissions (sound, particulate matter).

Offshore:
The North Sea Foundation (Stichting de Noordzee[7]) argues that risks and uncertainties around the storage of CO_2 under the seabed are diverse, significant and complex. Leakage of CO_2 from the storage site cannot be ruled out and would not only affect the Ph-degree of the water but also of the organisms living in the water (with potentially harmful impacts on the longer). The foundation criticises the draft National Water Plan (policy document) for not addressing these risks. As long as the potential risks for the marine ecosystem of the injection of CO_2, and the options for long term monitoring have not been further researched, no choice for CO_2 storage underneath the seabed should be made, according to the Foundation.

Conclusion on local contingencies and relevant variables to explain attitude towards CCS

- Traffic congestion as a result of the additional traffic needed to build the facility (A15) is a potential worry of local stakeholders
- Fine particulate matter worries are related to the coal-based activities on the Maasvlakte
- History with coal plants (national protest is on about the choice for coal; local protest is more about local environmental impacts);
- Local stakeholders and municipalities also find it difficult to be too critical (don't bite the hand that feeds you)
- Local employment opportunities might be created with the CCS plant
- Earlier experiences: gas storage Bergermeer and CCS onshore Barendrecht – negative experiences there can affect other projects like ROAD
- People feel that nature values are becoming increasingly under pressure because of industrial developments at the Maasvlakte.
- The main issues in the area around the Maasvlakte are noise en (fine) particulate matter.
- Local concerned citizens collaborate with Greenpeace and SNM in their struggle against coal plants
- Concerned citizens that participate actively are knowledgeable and Pensioners with an engineering background as vehement opponents
- Procedures against the coal plant are still running
- Rotterdam municipality and the Port of Rotterdam appear to be very much in favour for expanding the coal based activities in the port.
- Starting procedures against the planned coal plant.
- As the storage is offshore, the project consortium has little concerns about safety risks and risk discussions among the general public
- The main issue is nuisance and pollution from the coal plant.
- Remains to be seen if this project is going to be associated with the coal plant that it relates to and how that will affect the acceptability

4.3.3 Vattenfall's CCS project at Jänschwalde (capture plant) and Beeskow (storage site)

Methodology
Local contingencies in this area were gathered mainly by updating the information gathered for the case study which was part of WP1.2. Three additional interviews were conducted – two with

[7] A nature and environmental organisation that advocates the sustainable use of the North Sea. It critically looks at shipping, fisheries, spatial planning at sea, energy and protected areas (www.noordzee.nl)

Vattenfall employees and one with a representative of the protestant church which is politically active in this area. Additional material was gathered from the homepages of the "Märkische Oderzeitung", the local newspaper in the Beeskow area, as well as of the "Lausitzer Rundschau", the newspaper around Cottbus / Jänschwalde, for recent articles on the project as well as CCS.

Description of the situation in the area
Since last September the German government is built upon a coalition between the CDU and FDP, i.e. the Conservative and the Liberal Party, led by Chancellor Angela Merkel. This government has faced a series of severe challenges during the last months, e.g. the almost bankruptcy of Greece, the necessity to cut down costs, the unexpected resignation of the Bundespräsident. Environmental and / or energy topics have not been high on the agenda (shortly during the Kopenhagen conference). In general, of the relevant German political parties, Die Grünen, i.e. the Green party, and Die Linken, i.e. a newly formed left-wing party of former socialists and the PDS[8], have adopted a position of opposition to CCS. SPD (the Socialists), CDU (the Conservatives) and FDP (the Liberals) are in favour or neutral towards CCS. However, none of them actively communicates about CCS on a national level since it turned out to be a sensitive topic.

The project under study is situated in the Bundesland Brandenburg which is now governed by a coalition between SPD and Die Linken. Elections took place in September 2009 when the local protests against carbon storage had already begun in Beeskow. During the campaign, Die Linken took a position against CCS. Now the minister for economic affairs, Ralf Christoffers, which is a member of Die Linken, supports and promotes CCS. He has now proposed to establish a committee with representatives from the local communities, NGOs, the church etc. to accompany and monitor the exploration process. This committee is supposed to meet for the first time in July 2010, thus it is not clear whether it will be successfully established, who is going to take part and what will be the agenda for it. Additional locations have been proposed, most notably Neutrebbin, which is also in Brandenburg.

Update on legislative context
Germany still does not have legislation on CCS. A draft had been prepared last year and been on the schedule for the parliament, but was withdrawn for revision. In March 2010, the German minister for the environment, Norbert Röttgen, declared that the government now intends to develop a CCS-law that is valid for demonstration and research projects only. Thus, at the moment, the conditions and possibilities for building and operating a CCS facility are at best unclear. At the moment, many different laws might apply.[9] Some experts assume that it would not be possible to integrate CCS technology into a commercial power plant due to legislative boundaries. Generally, experts agree that the current legislation does not allow a large-scale commercial storage site to be operated.[10] However, Vattenfall has obtained a permit for exploring a possible storage site under mining law (Bergrecht). Against this decision the town of Beeskow now wants to file a suit.

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[8] The PDS is the party that succeeded the SED, the Communist party that ruled the former GDR.

[9] Cp. Falk Schulze / Andreas Hermann / Regine Barth (2008): Rechtliche Rahmenbedingungen für die Ablagerung von CO2 in tiefen geologischen Schichten: Vorschläge zur Ausgestaltung des Rechtsrahmens. DVBL, November 2008, 1417-1427.
Fischedick et al. (2008): Sozioökonomische Begleitforschung zur gesellschaftlichen Akzeptanz von Carbon Capture and Storage (CCS) auf nationaler und internationaler Ebene. Endbericht.
(http://www.wupperinst.org/projekte/proj/index.html?projekt_id=150&bid=155)

[10] Cp. Fischedick et al. (2008): Sozioökonomische Begleitforschung zur gesellschaftlichen Akzeptanz von Carbon Capture and Storage (CCS) auf nationaler und internationaler Ebene. Endbericht.
(http://www.wupperinst.org/projekte/proj/index.html?projekt_id=150&bid=155)

The situation regarding the demonstration plant at Jänschwalde is less urgent as – up to now – it was possible to start working on preparing the installation of the plant building on the same legislation that generally applies for coal-fired power plants. However, later in the process, CCS-legislation will be needed in order to define details about the demonstration plant, e.g. the rate of CO_2 to be captured.

Update on public participation

Power plant

In order to erect a new power plant, public participation will be part of the environmental impact assessment (EIA). The general procedure is that any proposals or plans to apply for a permit have to be made available to the public by the competent authority for four weeks before said authority may rule on the application. This four-week-period is followed by a two week period in which written objections may be submitted. Objections may then be further discussed in a hearing (Erörterungstermin). However, these hearings are neither mandatory nor necessarily open to the public. Before starting this official procedure, a scoping process is conducted which is currently taking place in Jänschwalde. It is the aim of the scoping process to identify relevant issues that need to be considered during the planning process. The scoping is led by the relevant authority which is the Landesumweltamt Brandenburg, i.e. the office for environmental issues of the federal state Brandenburg. Participants in the scoping process are so-called Träger öffentlicher Belange, i.e. public stakeholders. In this case this includes representatives from relevant administrative agencies as well as for example NGOs. A first scoping discussion has taken place, Vattenfall now revises and refines its plans and a second scoping is scheduled for September 2010.

Storage site

Under German Bergrecht ("mining law"), public participation is not obligatory when applying for a permit. In March, 2009, after Vattenfall submitted its application for an exploration permit to the LBGR Brandenburg[11] as the competent authority, this application has been discussed with other affected authorities, e.g. authorities concerned with environmental issues in the area. They had the chance to raise objections which usually lead to certain constraints being applied to the permit.[12] An outright refusal of the application is only possible if serious factual objections are raised. Since the LBGR approved the application in October 2009, Vattenfall had to hand in more details on the exploration process (Hauptbetriebsplan and Sonderbetriebsplan) which were approved as well in the following months. Thus, Vattenfall may now start to explore and is now about to prepare this next step. However, in order to do the actual exploration, Vattenfall will need the consent of the respective land owners. The local NGOs protesting against the storage have already started a campaign in order to convince land owners not to give their consent. As Vattenfall has not yet started to ask land owners for permission – the earliest date for this is in autumn – it is not clear how they will actually react to Vattenfall's request.

Local contingencies

Capture site

The area around Jänschwalde and Cottbus has been strongly shaped by lignite and the industry related to it including surface mining and energy generation. A lot of people are employed by Vattenfall and related industries. The perception of coal is ambivalent. For example, due to surface mining, 47 villages have been moved in the past and several are on schedule for moving in the future. There have been protests from inhabitants of these villages, however, due to the Bergrecht regulations, these protests have only been able to gain some time, but have never been successful.

[11] The Landesamt für Bergbau, Geologie und Rohstoffe (state office for mining, geology and resources) is responsible for issues, permits and supervision related to these three areas.

[12] E.g. no exploration work in a certain area during certain periods of the year because of breeding seasons.

At the same time, a referendum against lignite in Brandenburg in 2008 has not been successful as the number of supporters was far too low. In addition to this, the number of employers that are not related to lignite is low and there are also some areas of untouched nature for recreation and tourism.

There was no indication that some kind of major accidents or significant event has happened in the past in this area that might have relevance for the current perception of CCS. In combination with mining, some small incidents, e.g. landslides, have taken place, however, none of them seemed to have been perceived as extraordinary by the local public.

Storage site
The area was described by the interview partners from the case study (WP1.2) as special because it has been left undisturbed on a grand scale and is not densely populated. They describe those who live there as having strong ties to the area and claim that those with weaker ties have already moved to other regions – due to the better chances for employment elsewhere. At the same time, several individuals have moved into the area from Western Germany and Berlin in order to live closer to nature. There is a general perception that these people are especially engaged in resisting CCS. In sum, local opponents do not see any advantages for them that may counterbalance the associated risks. There was no indication that some kind of major accidents or significant event has happened in the past in this area that might have relevance for the current perception of CCS.

Conclusion on local contingencies and relevant variables to explain attitude towards CCS

- Relationship to local natural reservoirs
- Place attachment
- Attitude towards coal (economic strength vs. destroying nature and places to live)
- Importance of economic development (Vattenfall and related industries as employers)
- Perception of public participation / stakeholder participation in decision making on CCS as well as lignite

4.3.4 Local contingencies around Ciuden and Endesa's CCS project

Methodology

In order to identify local contingencies in this area we conducted three interviews, one with a local journalist, one with a member of a local NGO and another with a representative from Ciuden. In addition, two local newspapers from Leon and Burgos were consulted in search of articles on the project

Description of the situation

- Situation of the project

The CCS project involves three sites:

- Compostilla (Ponferrada, León). Capture (Ciuden & Endesa)
- Hontomín (Burgos). R +D storage (Ciuden)
- Unknown (probably in León). Industrial storage (Endesa)

Compostilla, Ponferrada (Capture):
A pilot power plant for CO_2 capture is already under construction in Compostilla (Ponferrada,

León) by Ciuden. Ciuden is a public body created in 2006 to promote the socioeconomic development of the region through different activities in the energy and environmental fields. Ciuden has three main areas of activity, one of them related to clean carbon technologies. Ciuden is a well known actor in the area, due to its high investments in different cultural and economic activities not related to CCS (Energy museum, urban revitalisation, sustainable tourism, environmental restoration, etc.).

Endesa has been active in the area since 1950's when a first power plant was built in Compostilla. Endesa has been an active actor in the community in the last 50 years. In 2010 Endesa builds a CCS pilot plant in the area and is currently planning the building of a demonstration power plant with CCS. Articles in local newspapers have stated the economic benefits that this kind of technological projects will have for the region.

Hontomín (Pilot Storage):
In 2009 Ciuden started pre-injection studies in the area. Hontomín is a small town (80habs.) at the north of Burgos. The CO_2 captured in Ponferrada will be transported by trucks to Hontomín. After the area was selected for the pilot storage, Ciuden arranged meetings with different actors in the area. Interviews were held with local majors, regional authorities, state level authorities in the region, the University of Burgos and other scientific bodies in the region.
Since last year, the pilot storage project at Hontomín has received attention from the local newspapers. The dominant frame seems to be science and technology activities in a rural area (CO_2 storage lab), which is associated with positive ideas about top research and innovation.

Industrial Storage (Unknown):
Industrial storage is planned for 2015. It will be carried out by Endesa, but the exact location has not been publicised. Geological studies have been carried out in the region (Castilla y León). CO_2 will not be stored in Ponferrada, where the capture power plant is planned. The most likely area is the province of León.

Local contingencies

Compostilla, Ponferrada:
Industrial infrastructures have played an important role in the economic and social history of Ponferrada. Compostilla is a small town nearby Ponferrada where two coal power plants are located. Coal power plants as well as mining, cement and steel industries have driven economic development in the city in the last decades. Unemployment is currently a main concern in the area, as coal industry has lost importance in the local economy. But also health and the state of the environment are becoming relevant issues in the area.
Ciuden's activities seem to be linked to cultural and economic development in the area. The Energy Museum has received a lot of attention from the media, as well as different projects of urban revitalisation and environmental restoration. Ciuden's CCS project in Compostilla has received less attention and has been linked to clean carbon technologies and EU funds. There are high expectations on Ciuden's technological activities in the area.
Endesa and other local actors (trade unions) consider that the familiarity with coal power plants is so high among community residents that the future demonstration plant will be welcomed. There is no tradition of public involvement with infrastructural developments. Some informants perceive that environmental awareness has increased in the last years among local population (not so linked to the coal industry as in the past). In this sense, some local opposition has been organised around the building of a new incinerator.

Hontomín, Burgos:

Hontomín is a very small town close to Burgos. There is not significant economic activity in the area. Small scale oil prospecting activities were developed nearby in the last decades.
After several contacts with different actors in the region and the local community in Hontomín, the storage project was formally announced by Ciuden in the area in July 2010 in collaboration with the major, the University of Burgos and other authorities. The main frame of the announcement has been the huge economic investment that Ciuden is making in this project. Local newspapers have been very positive about the project. The main idea is that Hontomín will host an advanced technological lab.

Industrial Storage (site non publiziced)
The industrial storage project under study is situated in the province of León, but the exact location is not yet decided. Endesa has been carrying out geological studies in the area.
Surprisingly, an article from a local newspaper in León (May 2010) stated that "local majors denounce an attack to the mountain by CO_2 pipelines". It is a confusing article where different majors of small towns in León are asked about a potential CCS project in the mountain by the journalist. Lack of information, CO_2 "graveyards", impacts of pipelines on rural life and the concerns of the majors are the main ideas in the article.

CCS regulation

A new law on CO_2 storage, the *Ley de almacenamiento geológico de dióxido de carbono*, was proposed by the Spanish government in April 2010. The law is a transposition of the EC Directive on geological storage. The law is currently being discussed in the Parliament. According to the law, the planning procedure for CO_2 storage will be shared between the national (Ministry of Environment and Ministry of Industry) ant the regional authorities. The regional authorities will be responsible for the granting of permissions for CO_2 storage in their territory as well as on site inspections and monitoring. Municipalities will not have authority on CO_2 storage issues.

Conclusion on local contingencies and relevant variables to explain attitude towards CCS

- Relationship to coal industry in Ponferrada
- Attitude towards coal (economic strength vs. destroying nature)
- Importance of economic development (Endesa as employer in Ponferrada; new economic activities such as sustainable tourism, etc.)
- Positive attitude towards Ciuden (Ponferrada)
- Rural area, very few people living nearby the pilot storage site (Hontomín)
- The pilot storage is perceived as a project revitalising a rural area (Hontomín)
- Frame of the project as advanced scientific and technological research (Hontomín)

4.3.5 Local contingencies around the Belchatów CCS project in Poland

Method
Interviews:

- Dominika Kukieła, PGE Bełchatów, July 7, 2010
- A representative of the City Council of Bełchatów, June 22, 2010[13]
- Tomasz Lottko, Deputy Chair of the Environmental Protection League (Liga Ochrony Przyrody), June 22, 2010

[13] . This particular interviewee has requested anonymity.

Location coal plant, CO_2 capture and storage
The Bełchatów CCS project, located in the Łódź Voivodship, was awarded 180 million Euro under the European Economic Plan for Recovery (EEPR) in October of 2009. For the last two years PGE and staff at the Belchatów Power Plant have been involved in preparatory work related to the construction of a CCS unit that will be integrated in to a new power generation unit with an installed capacity of 858MW. The development of the Belchatów CCS project involves three key components:

1) The installation of a Carbon Capture Plant (CCP) and its integration with the power generation unit of 858 MW. It is based on AAP technology (Advanced Amine Process), and is expected to capture around 1.8 million tonnes of CO_2 per year;
2) The installation of a CO_2 transport pipeline and the related infrastructure necessary to transport compressed CO_2 to the storage site;
3) The dedication of a CO_2 storage site which will allow for the pumping of compressed CO_2 underground into deep saline geological layers for a permanent storage.

Three potential routes for CO_2 transport have already been taken into account in the spatial development for the project site. With respect to actual geological storage sites, a detailed assessment of these sites is being conducted and the final selection of a storage site will be made by the end of 2010. Research activities will be carried out with a participation of two contractors: the National Geologic Institute and the Carbon Services Division of Schlumberger.

Description of the situation in the area
Update on political context:
Since November 2007, the Polish government has consisted of a coalition government primarily on two key political parties: the Civic Platform and Polish People's Party. The coalition is led by the Prime Minister Donald Tusk (PO). During the global economic crisis the government managed to keep the Polish economy in relatively good shape and sustain stable economic growth.
Environmental and energy topics were high on the government's agenda, particularly following negotiations of the EU Climate Change and Energy Package in the second half of 2008.
In November 2009 the government adopted a new "Energy Policy for Poland till 2030" prepared by the Ministry of Economy. The document outlines main directions for further development of the Polish power sector and identifies energy efficiency, security of energy supplies and development of renewable energy sources as the main priorities. The document assumes that the power sector's impact on the environment will be reduced through, among other means, active participation in the initiative of the European Commission to construct large-scale CCS installations. Two CCS installations are planned in Poland in Kędzierzyn and in Bełchatów.
The project under consideration is situated in the Łódzkie Province. The capture component of the installation will be constructed at the site of the PGE Bełchatów Power Poland in Bełchatów. From there, carbon dioxide will be transported around one hundred kilometers away from the power plant. Currently, three geological structures near Bełchatów are being tested by an expert group. Only two of these sites are known by the wider public: Wojszyce next to Kutno and Lutomiersk next to Pabianice. Research boreholes are being drilled in the Pabianice district, between Jadwinin and Pawlikowice. Research activities commissioned by the Ministry of Environment are also taking place in the following districts: Konstantynów, Aleksandrów, Łódzki, Rzgów, Tuszyn, Zgierz, Parzęczew, Dalików, Dłutów, Dobroń, Lutomiersk, Ksawerów, Grabica, Wodzierady, Czarnocin and Moszczenica.

Update on legislative context:
In December 2009, the Ministry of Environment closed a consultation process related to a proposed new law on the underground storage of CO_2. This process has been initiated in response to the conclusion of legislation at the EU level. Transposition of the relevant EU law (2009/31/EC) will

require amending the following acts:

- The Geological and Mining Law Act
- The Freedom of Business Activity Act
- The Environmental Protection Act
- The Energy Law Act
- The Act related to the provision of information related to the environment and environmental protection, public participation in environmental protection, and on environmental impact assessment.

The Ministry's proposed legislation addresses the following issues:

- Research related to the search for potential storage sites
- Technical requirements applicable to the siting and exploitation of storage sites
- Closing, monitoring and taking responsibility for storage sites by the State
- Regulating control, rescue and repair activities at storage sites in case of carbon leakage or other kind of damages.

CO_2 sequestration will require a concession from the Ministry of Environment. In order to obtain it, a developer will have to present an environmental impact assessment report based on which a planning decision will be made. CO_2 storage will be controlled by the Ministry of Environment and the President of the Higher Mining Office. Developers who obtained concessions to sequester CO_2 underground will be obliged to monitor the storage site and its geological structures. They will be obliged to control the quality of the pumped-in carbon dioxide. Compliance with the quality standards will be a precondition for storage.

In order to guarantee security of the storage site, developers will be obliged to close down storage sites and monitor them for at least twenty years. Once long term stability of the stored carbon dioxide is demonstrated, the responsibility for the storage site will be taken over by the State. The State will continue the monitoring process. A developer will be obliged to finance another thirty years of monitoring and repair activities. Closed storage sites will be administered by the Country's Administrator of the CO_2 Underground Storage Sites.

Companies testing and examining geological structures for CO2 underground storage will be charged with a fee. The fee will be shared between the district (60%) and the National Fund for Environmental Protection and Water Management (40%).

In April 2010 a seminar of the Polish Platform of Clean Coal Technologies took place in Bełchatów. The State Chief National Geologist, Dr. Henryk Jacek Jezierski, took part in it and underlined a crucial role of the Ministry of Environment in carrying out the first CCS demonstration projects in Poland. He also said that the proposed legislative text (the amended Geological and Mining Law Act) will be sent to Parliament at the end of 2010. According to him, it is crucial that the existing demonstration phase is sufficiently regulated by the applicable legislation.

Update on public participation:
The interview results indicate that participation in the development of the Belchatów CCS project is initiated primarily by the project developer. Information is obtained from the PGE website and leaflets dedicated to the topic. PGE has held ten public meetings on the project since September 2009, and intends to hold additional meetings in the direct vicinity of the chosen storage site. They expect to narrow the scope of their consultation to the ten districts impacted by the project in the first half of 2011.

The meetings held to discuss the project have either been initiated by PGE, or have in some cases been initiated by local authorities or municipal politicians.

Position of local contingencies:
While CCS has become a campaign issue for local politicians in the Belchatów municipal government, since the potential storage sites are not located in Bełchatów, the voice of the population and public authorities from districts selected for geological research and carbon storage will be crucial for the success of the CCS project. At the moment, the strongest reluctance and opposition towards carbon dioxide storage originates from Lutomiersk and Pabianice. The local population in Lutomiersk is sceptical of CO_2 stored underground and the borough leader of the district does not support CCS more generally speaking. However, his position is not a final one as he expressed a will to participate in further consultation which, according to him, should aim at convincing the people that the installation will be safe. Inhabitants of Pabianice established an anti-CO_2 association and are against research activities and carbon storage in their district.

Conclusion on local contingencies and relevant variables to explain attitude towards CCS:

- Complaint that the technology is not adequately tested.
- With the exception of some isolated incidents, the Belchatów project has been more or less left alone. There have been few protests. The acceptance of the project can be attributed in part to the affluence of the region, and reliance on the project for employment. Coal is vital to the local economy.
- Local government supports the project given the participation of the Commission, and their faith in EU standards and guidance.
- Feeling that perhaps the consultation process in the area lacks objectivity given that the investor is also the main employer
- Feeling that perhaps the opposition to the project may become more of an issue for communities far removed from Belchatów, that are less reliant on PGE and the coal industry for employment.

5. Analysis of Public and Stakeholder Surveys in Five EU Member States

5.1 The Survey

In order to measure the drivers of public opinion discussed in Chapter 2 and the hypotheses presented in Chapter 3, we sought to develop a survey instrument that could address issues such as level of trust, sources of information, risk and social capital. Given the focus on local infrastructure, we wanted to examine not only the views of the local public, but also to compare views with those of key stakeholders in the region and with members of the public drawn from a larger national sample. To do so, we developed an online questionnaire that included a geographic interface that could address all of these issues at the same time (the questionnaire can be found in Chapter 11).

The online questionnaire was administered to public and stakeholder participants in February and March 2011. The market research firm TNS was used to recruit public participants to ensure that samples were representative of the larger national and regional population. The actual survey tool, including the geographic interface, was developed by the nearCO2 team in conjunction with the subcontractor LinksChina. Both public and stakeholder respondents were directed to the same survey interface. The survey was carried out in five European member states, the UK, the

Netherlands, Poland, Germany and Spain. Prior to the survey we identified the postcodes of areas that were close to the projected capture and storage sites of the projects described in Chapter 3 and the areas of the projected pipelines in between. We did not indicate the path of a proposed CO_2 pipeline, in large part because in most cases there no final decisions have been made on the actual route in any of the countries involved.

We asked TNS to ensure around half the survey respondents were people living within the specified areas in each country. The eventual number of people surveyed were: 457 in the UK, 413 in the Netherlands, 535 in Poland, 516 in Germany and 407 in Spain; thus, in total 2328 members of the public were surveyed.[14] The survey was intended to take no more than 20 minutes.

Stakeholders were recruited by the nearCO_2 team in each of the five countries through a snowball process starting from a nucleus of previous contacts in the region amongst the partners, and supplemented by stakeholders identified from websites of relevant organisations, and suggestions for stakeholders from existing contacts. We aimed for local journalists, members of national NGOs based in the region and local NGOs and community organisations, local politicians (in particular those on the relevant planning or environment committees) and local planning/council officials. Success rates varied widely: we received 103 responses in Germany, 13 in Poland, 28 in the UK, 22 in the Netherlands and 5 in Spain. In part, the responses reflected the differences in saliency of the different projects and national contexts, with the German project, as will be seen in Section 5.5, by far, the most controversial and least popular. Unlike public respondents who were compensated by the market research firm, stakeholders did not receive any remuneration for participating in the survey and so we needed to rely on their interest in the issue and in several of the countries, the project was not widely known, even amongst regional respondents.

The distribution of stakeholders varied by country: in Poland, no elected officials responded, whereas in the UK, the majority of stakeholder respondents were local elected officials but relatively few local government officials responded, and in the Netherlands, a larger share were NGO representatives. In all countries it was difficult to get response from journalists. In total, 11% of the stakeholder respondents were journalists, and 12% classified themselves as "other".

The majority of the questions were identical across all categories of respondents, although additional questions were asked of each group. For example, we asked local politicians about the committees on which they served, we asked NGO respondents about the focus of their organisation's activities and journalists were asked about the types of news stories they covered and their years of experience. Public respondents were also asked several questions not asked of stakeholders such as income level.

All respondents were asked at the beginning of the survey to provide their home address or hometown, on a map. When specific information of the local project was provided later in the survey, respondents were shown a map indicating where they lived (image of a house) in relation to the CO_2 capture site (image of a power plant) and the CO_2 storage location (image of a well) and were able to zoom in and out to gain a better perspective on distances. Appendix 5.1 includes a screenshot of a typical respondent's view of the survey tool in each of the five countries, assuming the respondent is based in the respective capital cities. The appendix also illustrates how a respondent can interactively determine how far they are located from either the capture or storage sites.

[14] The public surveys were conducted by TNS from 9-21 February 2011 in the UK, Netherlands, Germany, and Poland and from 9 February to 8 March 2011 in Spain. The stakeholder surveys were conducted from 9 February-15 March 2011.

Demographic description of the survey

Table 5.1 describes the socio-demographic characteristics of respondents. Respondents for the public sample were chosen to reflect the population as a whole, so men and women were roughly equal in number, whereas more than three-quarters of stakeholders were male. The mean age of the public sample was 42.8 years, ranging from 18 to 91 years. Unsurprisingly, the stakeholders skewed older and their mean age was 50.0 years, ranging from 20 to 77 years, with almost two-thirds (63%) being 46 years and older compared to the public sample where more than half (55%) were 45 years and younger.

Public respondents reported relative high level of education compared to rates in the overall population, with roughly one-third having at least an undergraduate degree. Almost one quarter (23%) of respondents possessed a university degree or equivalent (BA or BSc) and 11% possessed an advanced degree (masters of doctorate). As expected, we found a much higher level of educational attainment among stakeholders, almost half of stakeholder respondents indicated that they had an undergraduate degree, and an additional quarter of stakeholders held a Masters or Doctoral degree, whereas only 21% did not have at least a university degree (compared to almost two-thirds of public respondents).

In terms of political ideology, public respondents generally followed a normal distribution, with the majority (52%) occupying the middle ground (answering between 4 and 6 on a 1-9 scale, where 1 is far left and 9 is far right). By contrast, the political views of stakeholder respondents are skewed leftward, 26% of stakeholder respondents were left-leaning (1-3 on a 9-point scale) and only 6% were on the right of the political spectrum, whereas amongst the public there were roughly equal numbers identifying with right and left. About 20% of respondents from each group refused to answer.

Table 5.1: Socio-demographic statistics for public and stakeholder respondents

	Public		Stakeholder	
	N	Percentage	N	Percentage
Gender				
Male	1186	51%	131	77%
Female	1146	49%	39	23%
Age				
18-30 years	519	23%	14	8%
31-45 years	755	32%	46	28%
46-60 years	650	28%	72	43%
more than 60	404	17%	34	20%
Education				
School Education or equivalent	1465	63%	36	21%
University degree or equivalent (BA/BSc)	547	23%	83	49%
Post-graduate degree or equivalent (MA/PhD)	264	11%	43	25%
No Comment/Other	56	2%	8	5%
Political view				
Left	339	15%	45	26%
Moderate	1205	52%	79	46%
Right	329	14%	11	6%
Not applicable/refused	458	20%	35	21%

Figure 5.1 shows stakeholders' positions across all five countries. More than one third of stakeholders were elected politicians, about one-fifth of all stakeholders were representatives of NGOs and a similar percentage (19%) were civil servants and journalists only amounted to 11% of stakeholders. These percentages are mostly driven by stakeholders from Germany (about 61% of all stakeholders).

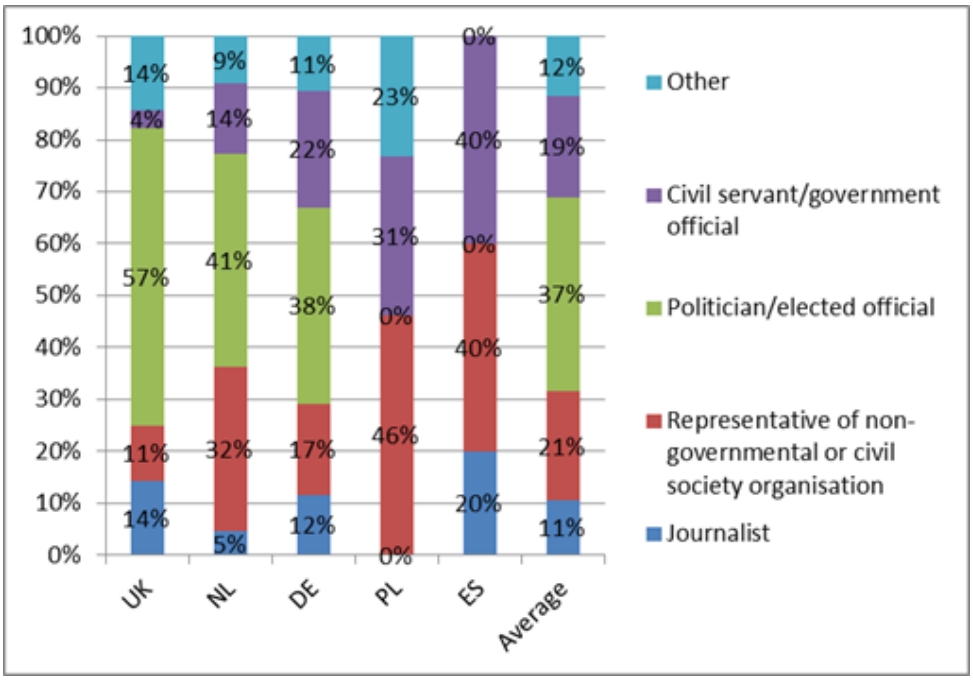

Figure 5.1: *Stakeholder survey*

Notes: Number of respondents: UK - 28; NL – 22; DE – 103; PL – 12; ES - 5

Distances to CCS Infrastructure

One of the main reasons for developing a geographic interface was to provide respondents with a sense of proximity to the proposed CCS infrastructure and thereby assess the impact of distance on support for CCS projects. Table 5.2 and

Table 5.3 show the distribution of respondents based on their distance from the capture and storage sites respectively. We sought to have roughly half of the public respondents recruited from the region of the project although the distribution of respondents relative to distance varied quite widely from one country to the next because of differences in the population density near the capture and storage sites and constraints imposed by the database that TNS had available in each region in each country. For example, the densely populated corridor between The Hague, Delft and Rotterdam is well within 50 km of the proposed capture site in the Netherlands. By contrast in Germany, the capture site and the two proposed storage locations were in a relatively unpopulated corner of Brandenburg in eastern Germany, the main town in the region being Cottbus (population 100,000). Thus, in the Netherlands, more than 50% were within 25 km of the capture site, whereas less than 10% of German, Spanish and Polish respondents were within 25 km.

Table 5.2*: Geographical distribution of respondents relative to the capture site*

	Public respondents						**Stakeholders**	
Distance to capture site (km)	UK	NL	DE	PL	ES	Average[a]	DE[b]	Average[a]
0-25	19%	54%	9%	5%	1%	17%	17%	29%
26-50	16%	7%	6%	22%	1%	11%	30%	26%
51-75	18%	7%	9%	9%	1%	9%	17%	15%
76-100	5%	10%	15%	5%	5%	8%	22%	14%
101-125	2%	6%	6%	9%	19%	8%	8%	5%
126-150	4%	5%	1%	12%	10%	6%	1%	2%
151-175	1%	5%	2%	7%	2%	3%	0%	2%
176-200	2%	3%	2%	9%	3%	4%	0%	1%
More than 200	32%	3%	50%	22%	59%	33%	5%	7%

Note: [a] average across five countries
[b] since responses for the other four countries are limited, only German stakeholder responses are displayed

Table 5.2 also shows the geographical distribution of stakeholders relative to the capture site. Due to limited responses from stakeholders in the UK, the Netherlands, Poland and Spain, we report only geographical distribution for all five countries combined and separately for German stakeholders only since, as noted above, some 60% of all stakeholders are from Germany. As can be seen, a large majority of stakeholders live within 100 km of the capture site, in both Germany and the other four countries (84% of the overall sample and 86% in Germany).

Table ***5.3*** shows geographical distribution of respondents relative to the storage site. In the German survey we recorded respondents' distance relative to two proposed storage sites – one near Neutrebbin (DE1) and another near Beeskow (DE2), both in Brandenburg in eastern Germany. Although most projects had not finalised a storage site, the German project is especially contentious and so we offered two widely discussed alternatives. Further, the distance from capture to storage also varies from one country to the next. In the UK, the CO_2 pipeline would pass 150 km on land

from the capture site near Hatfield to the rural Lincolnshire coast and then offshore, whereas the Dutch project, though also stored offshore, would only be on land for perhaps 5 km.

As noted, in the UK and the Netherlands the storage sites are located offshore under the North Sea, which helps explain some additional differences in distribution with respect to distance. Further, one might expect that offshore storage would be less likely to be subject to NIMBY-type behaviour. The pipeline pathway was not included, in large part because the route has not been decided for most projects, but the pipeline and transport options were presented and nearby residents could infer from the map that if they live midway between the capture and storage site that they may well have to be concerned about a possible pipeline.

***Table 5.3*:** Geographical distribution of respondents relative to the storage site

	Public respondents							**Stakeholders**		
Distance to storage site (km)	UK	NL	DE1	DE2	PL	ES	Average[a]	DE1[b]	DE2[b]	Average[a]
0-25	0%	0%	3%	4%	2%	4%	2%	17%	31%	11%
26-50	0%	56%	11%	18%	3%	7%	14%	22%	33%	24%
51-75	0%	7%	11%	18%	12%	2%	7%	27%	25%	19%
76-100	1%	8%	9%	3%	23%	4%	10%	17%	5%	13%
101-125	0%	8%	13%	1%	8%	3%	7%	9%	0%	6%
126-150	5%	5%	1%	3%	13%	2%	5%	2%	1%	4%
151-175	14%	7%	0%	5%	5%	3%	6%	1%	0%	4%
176-200	26%	5%	3%	2%	4%	22%	12%	0%	0%	7%
> 200	53%	4%	48%	46%	29%	54%	38%	5%	5%	12%

Note: [a] averages across five countries are calculated taking into account respondents' distance to the Neutrebbin (DE1) storage site in Germany

[b] since responses for stakeholder surveys in other four countries are limited, only German stakeholder responses are displayed

5.2 Knowledge of CCS

Respondents (both public and stakeholders) were asked whether they had heard of CCS before, the possible answers were "no, never heard", yes, a little" and "yes, quite a bit" (see Table 5.4).

Table 5.4: *Awareness of CCS for Public and Stakeholder Respondents across all 5 countries*

	Public						**Stakeholders**	
	UK	NL	DE	PL	ES	Average	DE[a]	Average
No, never heard	56%	23%	46%	42%	49%	43%	2%	3%
A little bit	37%	66%	39%	50%	43%	46%	11%	19%
Yes, quite a bit	7%	12%	15%	8%	9%	10%	87%	78%
N	459	415	518	535	407	2334	102	170

Note: [a] due to limited response for stakeholder surveys in the other four countries, only the German stakeholder responses are displayed separately

In total, a large minority of public respondents across the five countries (43%) responded that they had never heard of CCS, whereas 10% indicated that they knew quite a bit. Self-reported knowledge of CCS among stakeholders was substantially higher: only 3% of stakeholders claimed never to have heard of CCS and fully 78% stated they knew quite a bit about this technology. This is not surprising both since the reported average educational level of stakeholders is higher than that

of public respondents and since the stakeholders were explicitly chosen because they worked on issues of environment or planning. Hence, one would expect for both these reasons that stakeholders would be more aware of CCS and other low-carbon sources. We found a statistically significant relationship between level of education and knowledge of CCS (see Table 5.9 below).

There was some notable variation in self-reported knowledge of CCS across countries. Among public respondents, those who claimed to know quite a bit varied from 15% in Germany to 7% in Poland, but more dramatically, over three-quarters (78%) of Dutch respondents answered that they knew at least a little about CCS. Least aware were UK respondents – well over half (56%) claimed never to have heard of CCS.

Obviously, stakeholder respondents show much higher levels of awareness of CCS. Fully 87% of German stakeholders claimed to know quite a bit about CCS. In the remaining four countries, 64% of stakeholders claimed to know quite a bit about CCS and in some countries that figure was even lower, for example, only 54% for UK stakeholders.

It is interesting to compare results from our survey with those from the 2011 Eurobarometer survey on CCS presented in Table 5.5 which was being conducted almost at the exact same time in February-March 2011 in 12 member states including all five of the countries surveyed here (EC 2011). In both the Eurobarometer and nearCO_2 surveys, when compared to the other four countries, Dutch respondents were, by far, most likely to have heard of CCS to some extent. Still, other than in the Netherlands, the share of those answering that they had never heard of CCS was far higher in the Eurobarometer than in the nearCO_2 surveys. It should be kept in mind, however, that unlike the Eurobarometer surveys which are meant to be nationally representative, our respondents were intentionally selected so that half of them came from the region in the vicinity of one of the EERP-funded CCS projects and so one would expect a higher level of awareness in the region than would be true for the country as a whole.

Table 5.5: *Knowledge of CCS: the Eurobarometer Public Survey*

	Eurobarometer Survey				
Have you ever heard of CO_2 capture and storage?	UK	NL	DE	PL	ES
Yes, and you know what it is	11%	52%	13%	7%	5%
Yes, but you do not really know what it is	14%	30%	21%	11%	12%
No	70%	17%	62%	77%	79%
Don't know	5%	1%	4%	5%	4%
N	1019	1012	1622	1000	1004

Since self-reported knowledge of CCS does not necessarily indicate actual understanding (see, e.g., Reiner et al 2006), we asked a question about which problem CCS is designed to solve (see

Table ***5.6***). Respondents were given a series of possible answers: toxic waste, ozone depletion, acid rain, smog, water pollution and global warming/climate change. The latter was regarded as the "correct" answer for our analysis. The reliability of self-reported knowledge varied across countries – only 3% of UK public respondents who responded that they knew "quite a bit" about CCS answered the knowledge question incorrectly, whereas incorrect answers amongst the Spanish and Polish public self-described as most knowledgeable, roughly 29% offered the incorrect answer. By contrast, roughly half of those who answered that they had never heard of CCS chose the correct answer, which is the same as what one would expect as answering randomly or flipping a coin. Thus, higher levels of self-reported awareness of CCS should be treated with caution as an indicator of actual knowledge about CCS.

Regardless of claimed level of awareness of CCS, stakeholders were more likely to correctly associate CCS with climate change. Among stakeholders, 95% of those who answered that they know 'quite a bit' about CCS also indicated that CCS is supposed to reduce global warming compared to 85% amongst the public, and even amongst those who had never heard of CCS, 60% of stakeholders correctly indicated that CCS is supposed to address global warming compared to 47% across public respondents.

Table 5.6: *Knowledge of whether CCS technology is meant to reduce "Global Warming or Climate Change" according to claimed level of awareness about CCS*

Have you heard about CCS?	**UK**	**NL**	**DE**	**PL**	**ES**	**Public Average**	**Stakeholder Average**
No, never heard	45%	45%	51%	52%	38%	47%	60%
A little bit	76%	75%	84%	71%	55%	73%	81%
Yes, quite a bit	97%	85%	93%	71%	71%	85%	95%

Since we allowed multiple answers to the question concerning the goal of CCS technology, it is interesting to investigate associations between respondents' answers to this question (see Table 5.7). Among public respondents, those who agreed that CCS technology is supposed to reduce global warming over half (54%) also thought that CCS is supposed to reduce ozone depletion (as against 29% of those who did not think it reduced climate change). These differences are highly statistically significant ($\chi^2(1)=133.54$, $p<.000$). Further, 30% of those who agreed that CCS is meant to address climate change also agreed that CCS reduces acid rain; which is 14% higher than those who disagree that CCS is related to climate change (16%). Overall, Table 5.7 shows that even the majority of public respondents who answered 'correctly', i.e., that CCS is supposed to reduce climate change, also tend to pick other options. As in Reiner et al (2006), we find that even if respondents do not genuinely understand the goals of CCS technology, it is most related to several air-pollution-related problems. Table 5.8 shows further that, on average, well over 20% of the public answered either "yes" to all the options offered (19%) or "no" to all the options (3%).

Table 5.7*:* *Relationship between public respondents' knowledge of CCS and other environmental issues*

	CCS is supposed to reduce Global Warming or Climate change	
CCS is supposed to reduce	No	Yes
Toxic Waste	20%	16%
Ozone depletion	29%	54%
Acid rain	16%	30%
Smog	12%	15%
Water pollution	12%	15%

Table 5.8: *Number of respondents who answered "yes" or "no" to all options*

	All "Yes"		All "No"		
	N	%	N	%	Total N
UK	8	2%	128	28%	459
NL	6	1%	66	16%	415
DE	14	3%	97	19%	518
PL	28	5%	62	12%	535

ES	8	2%	90	22%	407

Figure 5.2 shows the distribution of respondents who choose only the option "global warming/climate change" and no other options. We consider this answer to reflect 'genuine' knowledge of CCS technology.

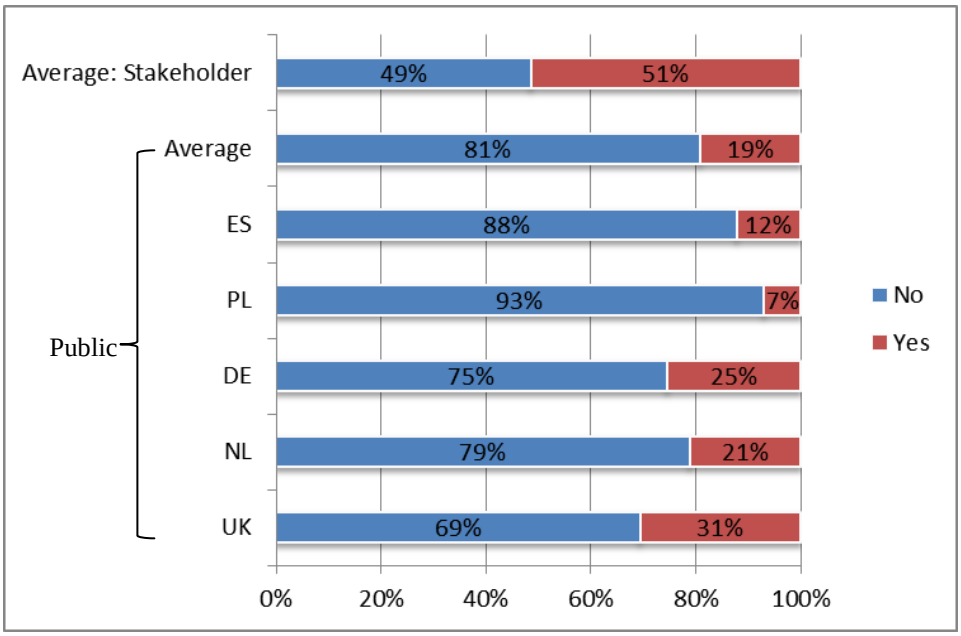

Figure 5.2: *'Genuine' knowledge of CCS technology*

As seen in Figure 5.2, on average, only 19% of all public respondents (total N=2338) indicated that CCS technology is supposed to reduce climate change only and did not also choose any other options (such as ozone depletion, acid rain, toxic waste, smog or water pollution). This 'genuine' response is much lower than for the stakeholder survey, where over half indicated that CCS only addresses climate change. Interestingly, this genuine knowledge level is higher than the 10% of public respondents who claim to know "quite a bit" about CCS when asked their level of knowledge (see Table 5.4). By contrast, although more than half of stakeholders did have genuine knowledge of CCS, this represents significantly fewer than the 78% claiming to know "quite a bit" about CCS.

Cross-country differences in genuine level of knowledge of CCS among public respondents are also all statistically significant ($\chi^2(4)=116.69$, $p<.000$). Ironically, compared to the self-reported knowledge of CCS shown in Table 5.4 which found UK respondents claiming to be least aware, it turns out that they show the highest level of genuine knowledge (31%), followed by German respondents (25%), then the Dutch respondents (21%), and the Spanish and Polish respondents are among the least knowledgeable (12% and 7% respectively).

Table 5.9 shows the relationship between respondents' level of education and their genuine knowledge of CCS (that is, that *only* 'climate change' option was chosen as the objective of CCS technologies). Among public respondents, those who genuinely knew about CCS technology and its purpose were generally better educated than those who did not know about CCS. Thus, 23% of respondents with an undergraduate degree or higher knew what CCS is supposed to do, which is 6% higher than respondents who had not completed their tertiary education. This relationship proves to be statistically significant ($\chi^2(2)=8.77$, $p<.012$). Due to the much smaller sample size of the stakeholder survey, the relationship between level of education and genuine knowledge of CCS was statistically less significant than for the public survey ($\chi^2(2)=4.60$, $p<.1$).

Table 5.9: *Knowledge of CCS and respondents' level of education – public survey*

		Public		Stakeholder	
		Less than undergraduate degree	Undergraduate degree and above	Less than undergraduate degree	Undergraduate degree and above
Genuine knowledge of CCS	No	83%	77%	64%	44%
	Yes	17%	23%	36%	56%

Information sources

Another key question is analysing the drivers of public opinion is how members of the public will inform themselves about a largely unknown technology, particularly if they find out that CCS infrastructure will be built in their region. Respondents were asked about the most likely source they would use in order to find out more information about CCS (see Figure 5.3 for the public survey and Figure 5.4 for the stakeholder survey). Perhaps surprisingly, since the news media is frequently mentioned as an important source of information (for example by our focus group participants, see chapter 7), it did not feature prominently in either the public or stakeholder surveys. The source that public respondents most commonly cited that they would be "very likely" to use to find out more information was interactive websites such as Wikipedia or blogs (27%). The public ranked university scientists/scientific publications (18%) and national/international NGOs (16%) as the sources next most likely to be consulted.

For stakeholders, the ranking of the most likely sources of information for learning more about the local CCS project were notably different (Figure 5.3 versus Figure 5.4). University scientists and scientific publications (42%) and national/international NGOs (39%) were both still listed as important sources, and local NGOs/community groups, residents' associations etc. were the third most likely source (30%). More generally, as can be seen by the magnitude of the responses, the likelihood of consulting *any* source of information is much higher for stakeholders. A majority of the overall public only listed two sources that they would be likely to consult (i.e., rate the source as 1-3 on a scale of 1-7): interactive websites (57%) and university scientists (52%). By contrast, over half of stakeholders listed six different information sources that they would consult, most notably university scientists/scientific publications (77%) and national and international NGOs (65%), but also four other sources (local NGOs, national media, national government and local/regional governments) were listed as likely sources of information by 50-60% of stakeholders. The least popular sources for both the public at large and stakeholders were friends and family, the European Union and the developers themselves.

It is striking that without even asking about trusted sources (which we discuss below in Section 5.4), that there was such little interest in getting information either from the developers themselves or from the EU. This resistance might be viewed as problematic since much of the detailed information that is publicly available on the five projects we presented is available either through the developers or the EU. All five projects are funded through the European Economic Recovery Programme (EERP) and so the developers and the EU are two of the sources likely to have the most information about the projects themselves (e.g., for the ROAD project in the Netherlands (www.road2020.nl) or the Compostilla project in Spain (http://compostillaproject.eu) or more generally from the European CCS demonstration project network (www.ccsnetwork.eu) which is intended as a dedicated information clearinghouse that has detailed information about all five projects as well as others around the EU .

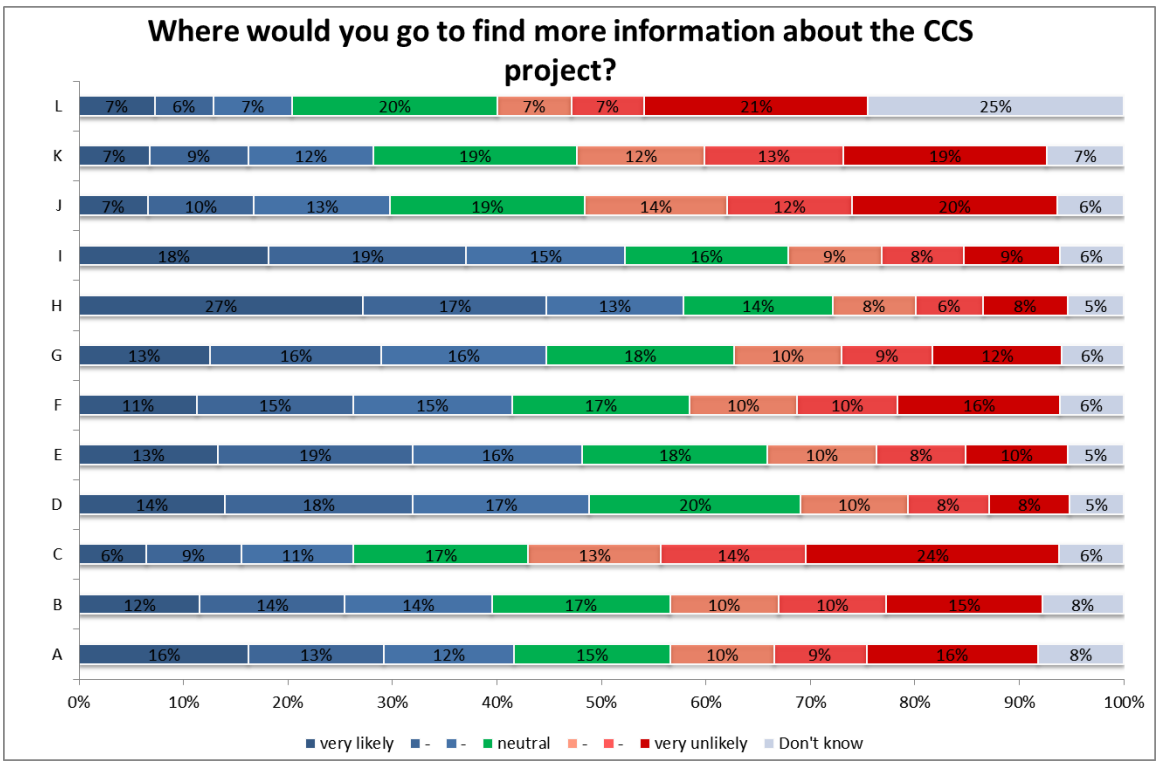

Figure 5.3: *Source of Information Regarding CCS: Public survey*

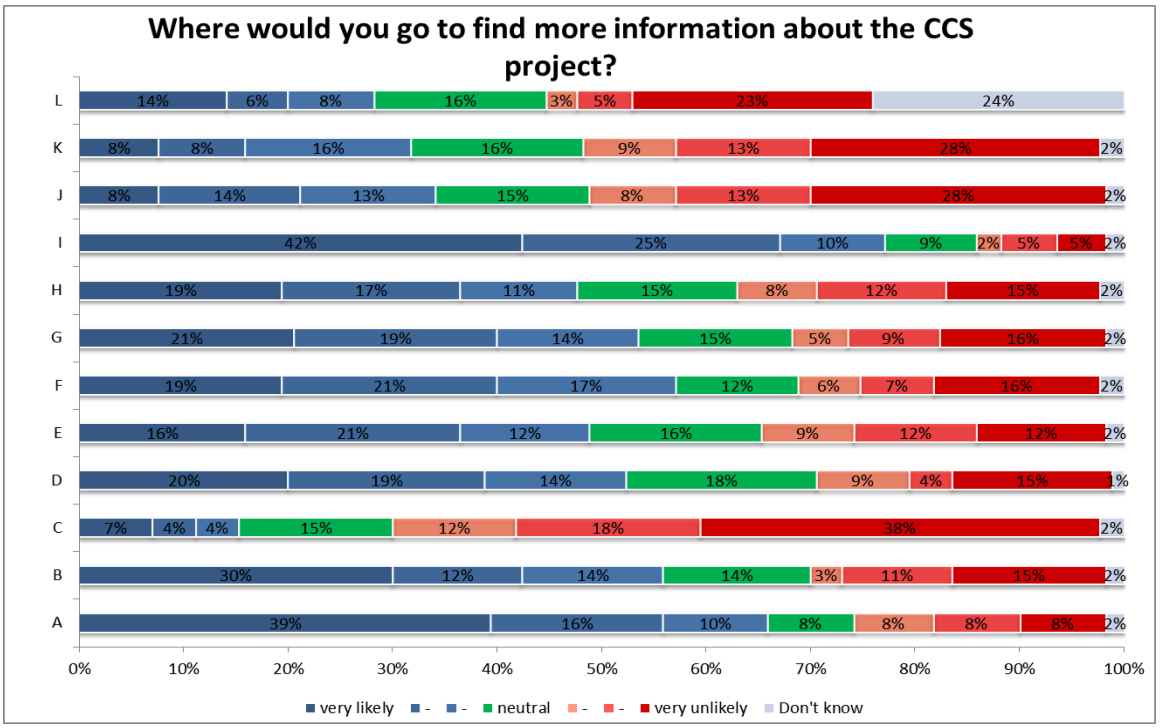

Figure 5.4: *Source of Information Regarding CCS: Stakeholder survey*

Notes for Figures 5.3 and 5.4: A-National/international NGOs (Greenpeace, WWF etc); B-Local NGOs/community groups, residents' associations etc.; C-Friends, neighbours, family; D- National media; E-Local/regional media; F-National government; G- Local/regional government; H- Interactive websites (e.g., blogs, wikis etc.); I-University scientists/scientific publications; J-The developers, energy companies etc.; K- European Union; L- Others.

A cross-national comparison of preferences (Table 5.10) shows many similarities and a few notable differences towards the sources of information about CCS. Among public respondents in the UK, Poland and Spain, interactive websites are the most preferred source of information about CCS (UK - 51%, Poland - 78%, and Spain - 48%), whereas in the Netherlands, 62% of public respondents indicated that local government would be their most likely source of information about CCS and German respondents prefer university scientists and scientific publication as their source of information about CCS (60%). Similar to stakeholders, in both Germany and the Netherlands, more than half of public respondents were likely to consult any of six different sources of information (although only four of the six sources were in common – Dutch respondents were more likely to seek information from governmental sources and German respondents from NGO sources). By contrast, in the UK only one source (interactive websites) was listed as a likely source by a bare majority of respondents and in Spain, that same top-ranked source was not even viewed as a likely source of information by half of respondents. These results reflect the greater interest in CCS in Germany and the Netherlands and the willingness of members of the German and Dutch publics to seek information from a wide range of sources, which is more similar to the results of stakeholders (though not necessarily in terms of rank ordering or the actual sources to be consulted) than the publics in the other three member states.

As for the overall results, in all five countries, the least likely sources of information were the EU, the developers and word of mouth, which reinforced the uniformly negative view of the EU and developers as a source of information. Local and national governments and media outlets scored somewhere in the middle. The relatively low importance of the news media as a further information source may be explained by the view (evident through the discussions in the focus groups) that the media is as an important disseminator for new information rather than giving more in-depth information. The media are therefore important in alerting people to new projects and technologies in the first place. It has also to be kept in mind that, since the survey was completed online, all participants had internet access. Again as was pointed out during the focus group discussion, traditional media outlets would still be much more important for many people who do not have internet access. The results also possibly reflects new habits developing about information gathering since, as a result of greatly expanded online access, it is now much easier to find out what governments, NGOs or scientists think about a technology.

Table 5.10: *Public respondents' likely source of information regarding CCS by country*

	Public						**Stakeholder**
	UK	NL	DE	PL	ES	Average	Average
National/international NGOs	34%	40%	52%	44%	35%	42%	66%
Local NGOs/community groups, residents' associations etc.	33%	42%	51%	42%	27%	40%	56%
Friends, neighbours, family	13%	26%	27%	36%	29%	26%	15%
National media	44%	57%	56%	51%	34%	49%	52%
Local/regional media	47%	57%	55%	48%	34%	48%	49%
National government	48%	61%	37%	35%	28%	41%	57%
Local/regional government	48%	62%	41%	45%	28%	45%	54%
Interactive websites	51%	55%	53%	78%	48%	58%	48%
University scientists/scientific publications	47%	54%	60%	59%	37%	52%	77%
The developers, energy companies etc.	42%	28%	31%	27%	20%	30%	34%
European Union	20%	30%	23%	42%	25%	28%	32%

It should be noted that since the number of stakeholder responses was relatively limited for most countries surveyed, we did not provide a breakdown by countries for the stakeholder survey.

We also asked whether respondents felt they could obtain all the information they needed regarding new local developments in their area (Figure 5.5). In general, public respondents are more likely to agree that would seek further information about the CCS project (25% of public respondents disagree with the statement whereas 57% agree). Comparing answers across the five countries (**Figure 5.5**), we can see that Dutch respondents are, by far, most likely to seek additional information about the CCS project (41% are likely to seek further information including 17% who are "very likely" to seek such information). Stakeholders are even more likely to seek further information about the CCS project -- 72% agreed with the statement whereas only 16% disagreed.

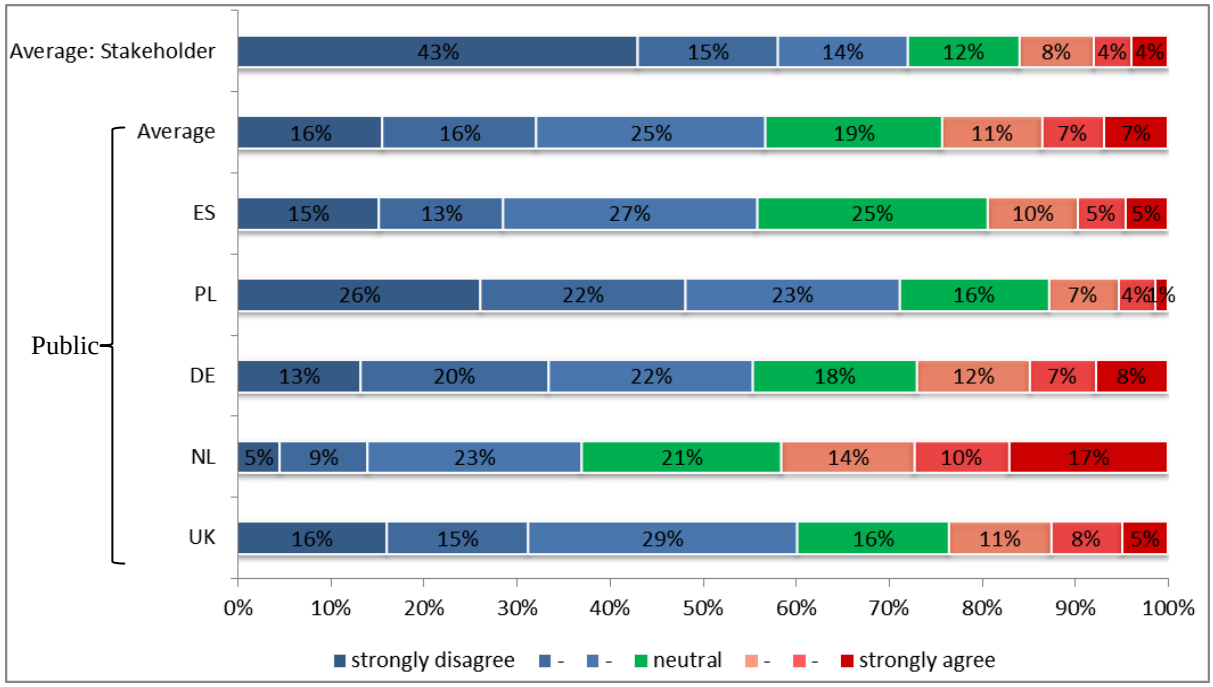

Figure 5.5: *Respondents' attitudes towards the level of information about local developments*

Note: the question was: "Level of agreement with statement: "I am likely to seek further information about this project" on a scale of 1-7"

Trust

The responses to the question of where respondents would seek information may also reflect the level of trust they have in the information providers to give them useful and impartial information. Both stakeholders and the public were asked to independently rank various groups and actors on a 1-7 scale from most trustworthy to least trustworthy. As seen in Figure 5.6, University scientists/scientific publications scored highest in terms of trust among both public and stakeholder respondents to provide them with impartial information (overall 22% of public respondents and 27% of stakeholder respondents indicated that university scientists are the most trustworthy source of information). Fully 79% of stakeholder respondents and 63% of public respondents considered scientists to be highly trustworthy (1-3 on a 7-point scale).

The next most trusted source, again for both stakeholders and the public, were national/international NGOs. Almost 20% of each group listed these NGOs as "most trustworthy" and over 50% of the public and of stakeholders list them as being highly trustworthy (1-3 on a 7-point scale). Trust in

project developers and energy companies is, unsurprisingly, low. A fifth (21%) of public respondents and a third (34%) of stakeholders indicated that project developers were the least trustworthy source for information regarding CCS and half of the public (50%) and two-thirds (63%) of stakeholders considered developers to be of low trust (1-3 on a 7-point scale).

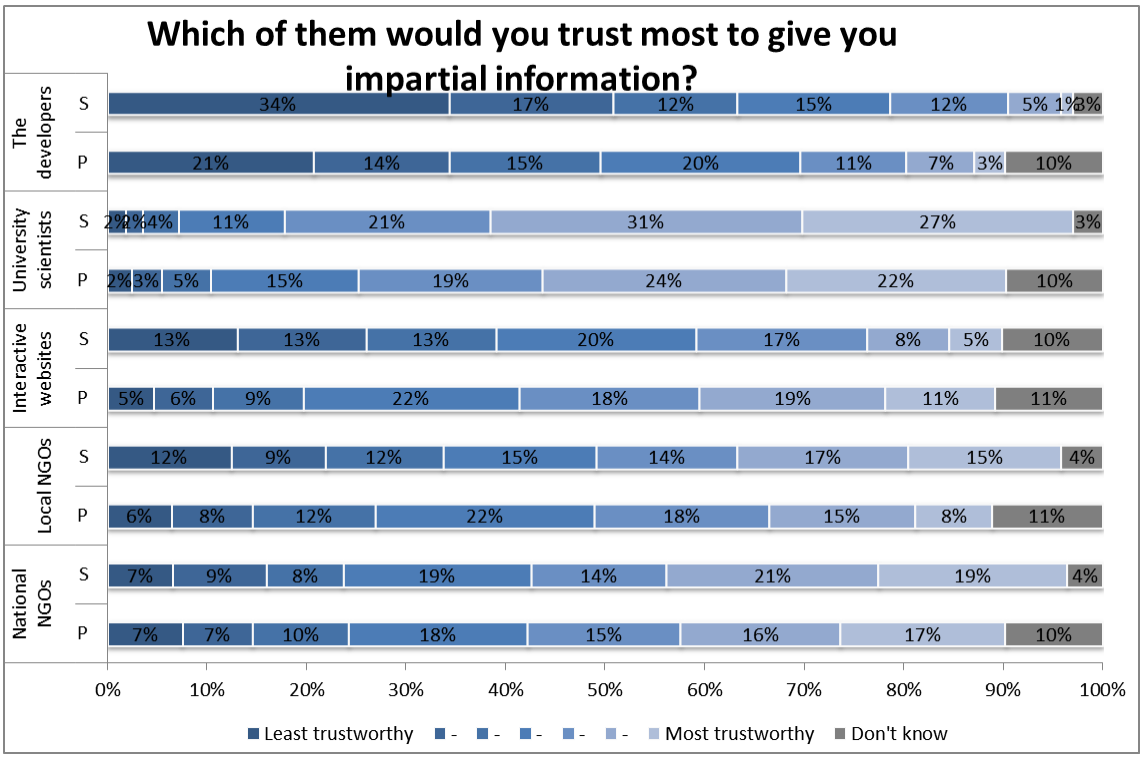

Figure 5.6: *Respondents' perception about trustworthiness of source of information regarding CCS*

Notes: P- Public survey; S- Stakeholder survey

Table **5.11** shows how the public's trust in sources of information regarding CCS varied across countries. As can be seen, the most trusted source of information about CCS in all five countries is university scientists/scientific publications. Other than in Germany, where almost as many respondents trusted national and international NGOs and Poland (and to a lesser extent Spain) where interactive websites were trusted almost as highly, these independent scientific sources were deemed, by far, to the most trusted. In both the Netherlands and UK, for example, the second ranked source of information was more than 20% lower than university scientists. The least trusted source in all five countries was project developers.

Also, it should be noted that respondents' choice of likely source of information does not always correlate with their trust in that source; for example, whereas in all countries surveyed, public respondents trust university scientists the most (Table **5.11**), in the majority of countries respondents' choice of source of information about CCS would be interactive websites (Table 5.10). Comparing the two tables we find that the dispersion between sources tend to increase, so that sources that are already consulted such as scientists are even more trusted and sources that are least consulted, such as the developers, are much less trusted. With the exception of Spain, national and local media, national and local governments, developers and interactive websites are all notably more likely to be consulted rather than trusted. By contrast, national NGOs and especially university scientists are even more likely to be trusted than consulted.

Table 5.11: *Public Respondents' trustworthy source of information regarding CCS by country*

	Public	**Stakeholder**

	UK	NL	DE	PL	ES	Average	Average
National/international NGOs	36%	43%	59%	53%	47%	48%	54%
Local NGOs/community groups, residents' associations	33%	34%	55%	38%	37%	40%	47%
Friends, neighbours, family	24%	18%	30%	25%	37%	27%	18%
National media	22%	40%	36%	37%	36%	34%	29%
Local/regional media	25%	39%	40%	38%	37%	36%	24%
National government	22%	41%	26%	33%	27%	30%	37%
Local/regional government	25%	44%	37%	35%	29%	34%	40%
Interactive websites	39%	41%	36%	67%	55%	48%	31%
University scientists/scientific publication	60%	65%	61%	73%	66%	65%	79%
The developers, energy companies	20%	10%	22%	24%	24%	21%	18%
European Union	21%	31%	25%	50%	40%	34%	36%

A related question we asked to find out the level of satisfaction respondents have in the planning process was which actor they would most trust to take local concerns seriously (Figure 5.7).

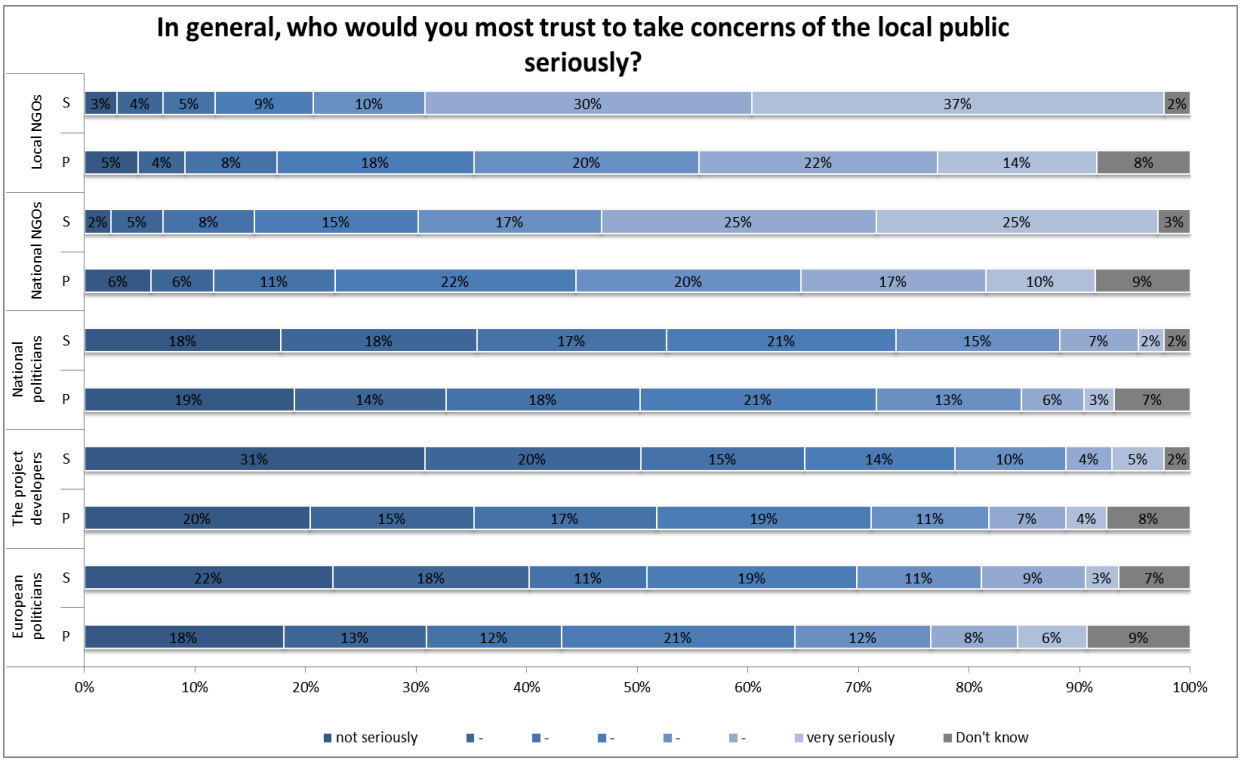

Figure 5.7: *Respondents' trust in various stakeholders to take concerns of the local public seriously*

Note: P- Public survey; S- Stakeholder survey

As Figure 5.7 shows, national and European politicians were among the least trusted to take local concerns seriously, along with, unsurprisingly, the project developers. On the other hand, NGOs, especially local NGOS, scored highest in terms of trust to take public concerns seriously (37% of all stakeholder and 14% of all public respondents indicate that local NGOs would take public concerns very seriously, i.e., 1 on a 1-7 scale).

Similar to public respondents, stakeholders showed least trust in project developers (31%), European politicians (22%) and national politicians (18%) to take the views of the local public

seriously. Trust in various actors to take local concerns varied among countries (Table 5.12). Within-country comparisons show, rather surprisingly, that in the UK and Poland public respondents trusted local media to take local concerns the most seriously, while in the Netherlands, Germany and Spain public respondents trusted local NGOs the most. On the other hand, in the UK and Germany, respondents trust European politicians the least (16%) while in Poland and Spain, where views of European politicians are much more favourable, national politicians are trusted least (19% and 28%) and in the Netherlands, the least trusted group was project developers (14%). It is interesting to note that in Poland and in Spain many respondents perceive European politicians as taking local concerns seriously – 47% and 46% respectively.

Table 5.12*: Actors highly trusted (rated as 5-7 on a 1-7 scale) to take local concerns seriously*

	Public						**Stakeholders**
	UK	**NL**	**DE**	**PL**	**ES**	**Average**	**Average**
National media	34%	44%	36%	41%	38%	36%	31%
Local media	60%	63%	51%	66%	54%	55%	53%
National politicians	23%	27%	20%	19%	28%	21%	24%
Local/regional politicians	43%	50%	38%	44%	38%	40%	66%
The project developers	23%	14%	19%	24%	36%	21%	19%
National NGOs	36%	52%	66%	45%	56%	47%	67%
Local NGOs	42%	66%	73%	62%	61%	56%	77%
European politicians	16%	18%	16%	47%	46%	26%	24%

Figure 5.8 below shows respondents' perception about whether the local community has been treated fairly in past developments. In general, across all five countries, public respondents are more likely to disagree that the local community had been treated fairly (36% of public respondents disagreed while 23% agreed). However, there are notable cross-country variations in responses. Polish respondents felt strongly that they had been mistreated in the past (net response of -32% when comparing those who agree that they have been treated fairly minus those who disagree). Public respondents from the UK, Germany, and Spain are similar insofar as respondents disagree with this statement more than agree (net response of -10% or -11%). By contrast, Dutch respondents were the most positive and overall tended to agree more with this statement than disagree (+10%).

Stakeholders are quite similar to public respondents on average when it comes to their perceptions about the issue of fairness in past developments (Figure 5.8) – stakeholders tend to disagree more than agree with the statement about fairness (net -13%).

Figure 5.9 shows responses to a related question on whether the current planning process gives sufficient voice to local residents. Here it is noteworthy that stakeholders are the most negative (net -52%) including over one-third (34%) who strongly disagree with the statement. Cross-national public responses also shifted to be more negative (other than in Poland). German respondents were most critical (net -35%), but respondents in all other countries were also negative overall, ranging from Spain (net -13%) to the Netherlands (net -23%).

On the question of past treatment, as many as half of national public respondents answered "don't know" or "neutral" (48% in the UK and 49% in Germany), whereas when asked about the fairness of the planning process, many more expressed some opinion, whether positive or negative (i.e., the highest value for "don't know" plus neutral was 36% in the UK).

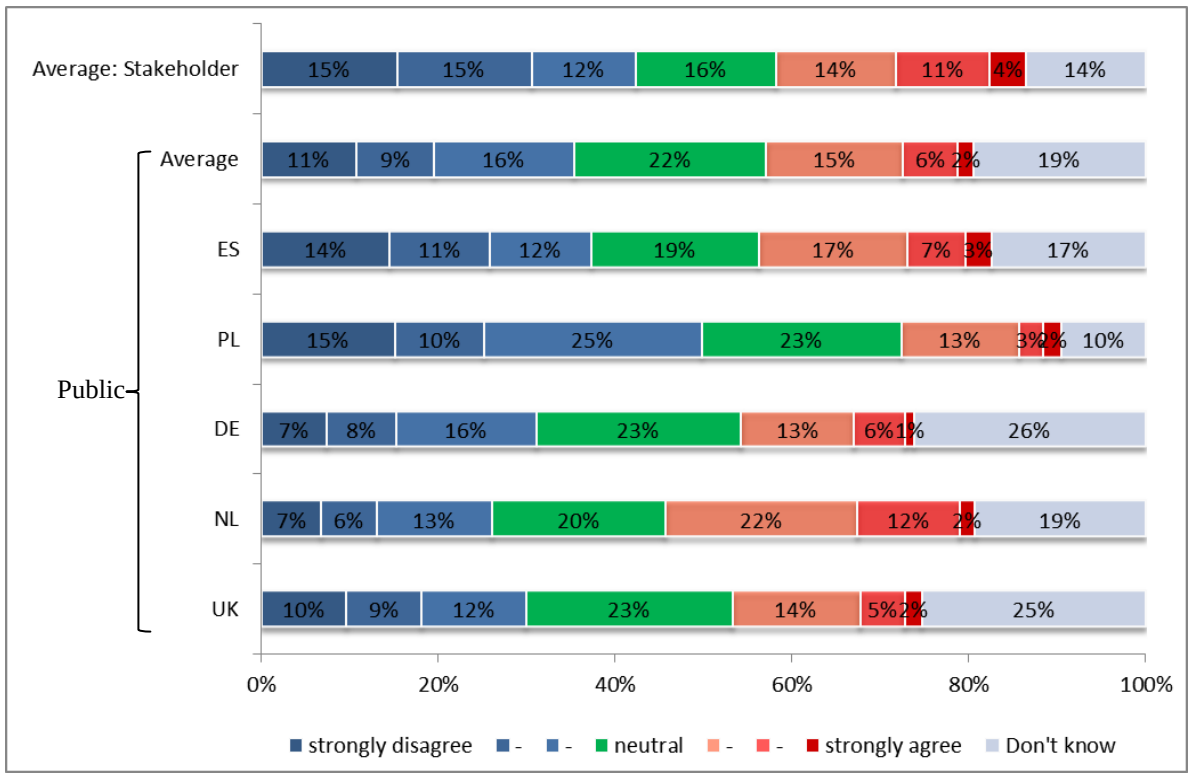

Figure 5.8: *Perceptions about fair treatment in past developments*

Note: the question we ask was: "Do you believe that your local community had been treated fairly in past developments?"

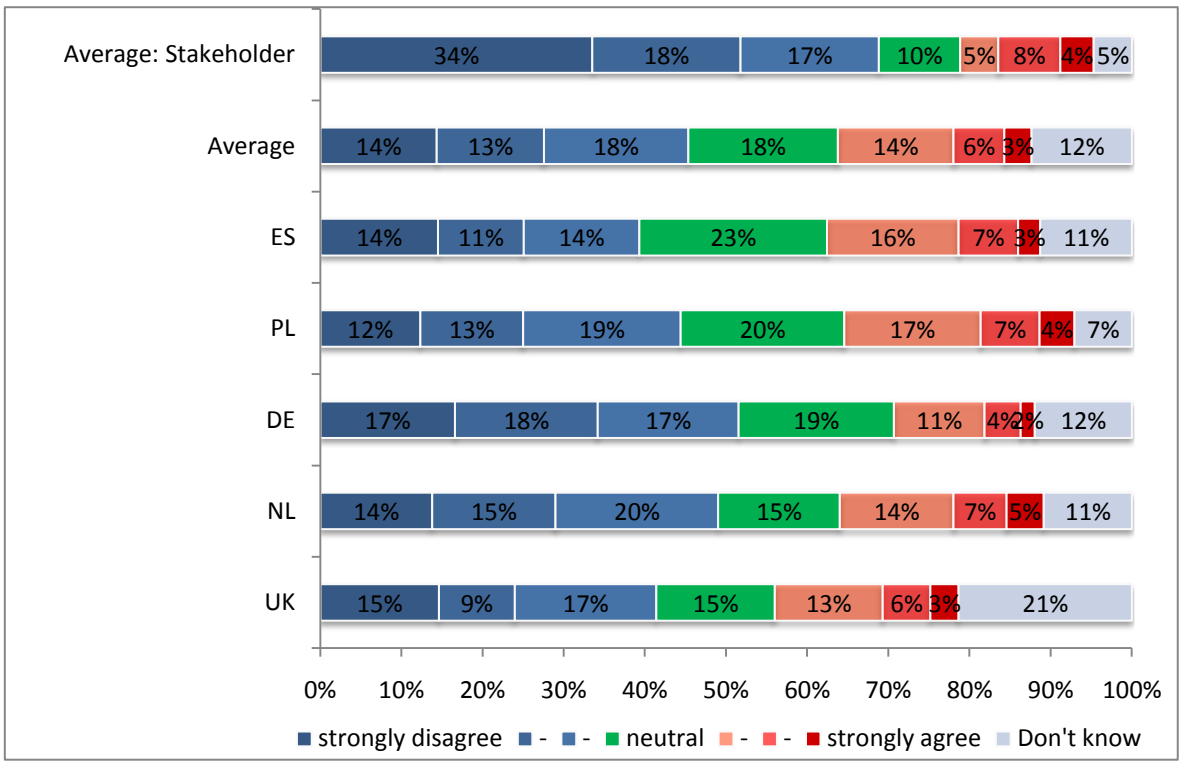

Figure 5.9: *Perceptions about influence of local residents in current planning process*

Note: the question we ask was: "Do you believe that, in general, the current planning process gives sufficient voice to the concerns of local residents?"

Opinions and attitudes towards CCS

After giving a general overview to describe the basic facts of CCS, we proceeded to give a more detailed exposition of the locally planned project and asked again whether respondents (both public and stakeholders) were favourable towards CCS in general and the local project in particular (on a 7 point scale ranging from "very unfavourable" to "very favourable"). As we can see in Figure 5.10, on average, public respondents from all five countries were more supportive of CCS in general (63% of public respondents were favourable, i.e., 5-7 on a 1-7 scale vs. 12% were unfavourable, i.e., 1-3 on a 1-7 scale). In contrast to public respondents, stakeholders were more negative about CCS in general than positive; thus, 53% of all stakeholders indicated that they are unfavourable of CCS and only 33% of stakeholders were favourable toward the technology.

Also, Figure 5.10 shows stakeholder opinions towards CCS in general and the local project across all five surveyed countries. First, as can be seen, stakeholders' opinion about CCS in general and the local project is substantially more negative than the opinion of public respondents.
All in all, public respondents were more positive about the local project than negative; whereas stakeholders were both more negative about the local CCS project and more certain (8% neutral plus 4% "Don't Know" versus 22% neutral plus 6% "Don't Know" for the public).

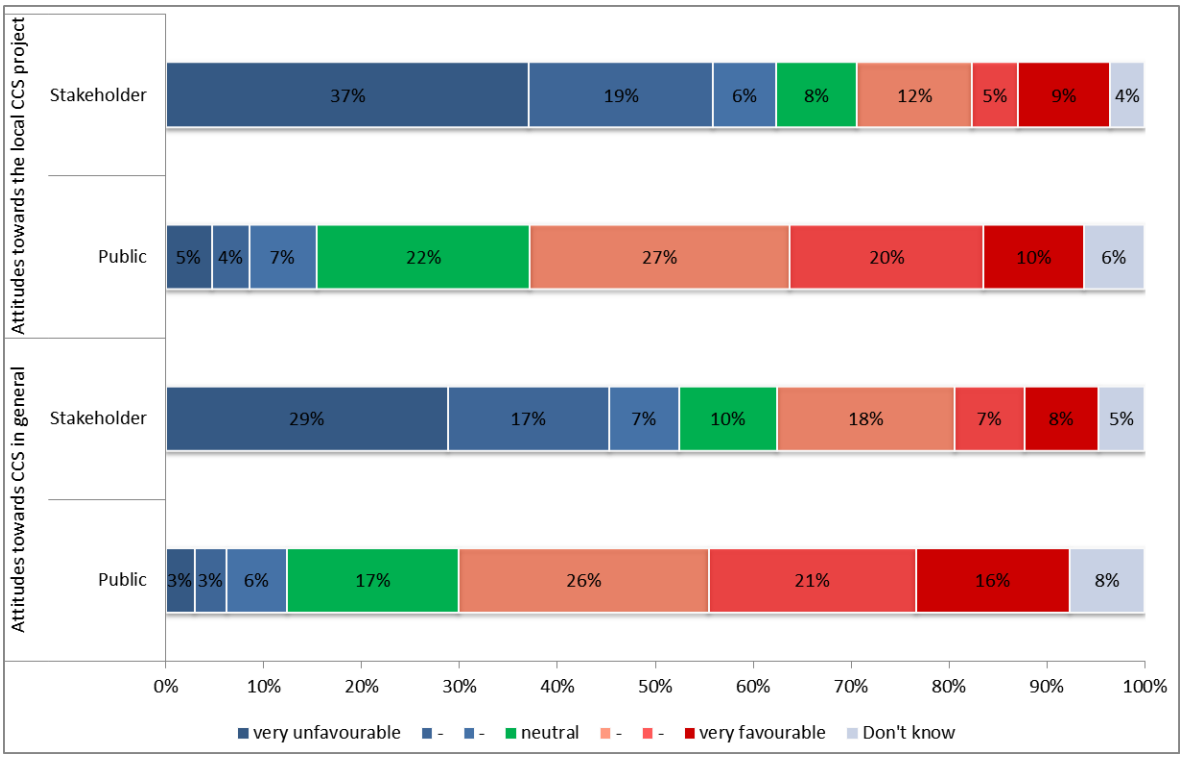

Figure 5.10*: Attitudes towards CCS technologies and the local CCS project*

In spite of the relatively small number of stakeholders (n=171), attitudes toward the local project was one area where we found significant differences between different stakeholder groups. As seen in

Table **5.13**, journalists have the most positive attitudes (quite similar to public respondents overall in being slightly more positive than negative) and NGO representatives show the least positive views of the project. Indeed, all stakeholder groups other than journalists viewed the project negatively. Of course, it should be recalled that the majority of stakeholders are from Germany, where public opinion towards the local project is also negative. The differences in opinion between

journalists and representatives of NGOs are very significant. Comparing attitudes towards the project between NGOs and politicians we can see that politicians are more positive than NGOs and this difference is also significant. Government officials seemed to be more positive about the project than politicians; however, differences in opinion between these two groups of stakeholders are not significant.

Table 5.13: *Differences in attitudes towards the local project between stakeholders*

	Mean	SD
Journalists	4.53	1.91
Representatives of non-governmental or civil society organisations	1.91	1.50
t value	5.35[ac]	
effect size	.61	
Representatives of non-governmental or civil society organisation	1.91	1.50
Politicians/elected officials	2.85	1.94
t value	-2.61[ad]	
effect size	.28	
Politicians/elected officials	2.85	1.94
Civil servants/government officials	3.61	2.32
t value	-1.68[bc]	
effect size	.17	

Notes: [a] statistically significant at $p<.05$; [b] statistically insignificant;
[c] equal variances assumed; [d] equal variances not assumed

Table **5.14** shows inter-country comparisons of public attitudes towards CCS in general and towards the local project in particular. Very large majorities of respondents in Poland, Spain the UK and the Netherlands were supportive of CCS in general, and clear majorities in Poland, Spain and the UK also favoured the local project (exactly half favoured the local Dutch project). By contrast, German respondents were, by far, the most negative, but even in Germany, many more Germans were favourable than unfavourable towards CCS in general. With regard to the local project, however, Germans were much more unfavourable and slightly negative on net, including 14% who viewed the project "very unfavourably". In total, over a third of Germans (34%) viewed the project unfavourably compared to only 6-12% in the other four countries. In all countries, net support dropped between asking about CCS in general and asking about the specific local project and this drop was largest in Germany, where net support for the local project was 21% lower than for CCS in general.

Table 5.14*: Cross-country comparison of public respondents' attitudes towards CCS technology*

	Attitudes towards CCS in general					**Attitudes towards the local CCS project**				
	UK	**NL**	**DE**	**PL**	**ES**	**UK**	**NL**	**DE**	**PL**	**ES**
very unfavourable	3%	2%	7%	0%	2%	3%	3%	14%	0%	2%
-	1%	4%	7%	2%	2%	3%	2%	9%	2%	2%
-	6%	8%	9%	4%	4%	6%	7%	11%	4%	6%
neutral	15%	19%	23%	12%	18%	18%	22%	33%	18%	18%
-	31%	28%	20%	24%	25%	27%	29%	21%	29%	27%
-	22%	22%	15%	25%	23%	21%	17%	7%	28%	26%
very favourable	14%	7%	7%	29%	20%	12%	4%	5%	15%	15%
Don't know	8%	11%	12%	3%	5%	9%	15%	0%	3%	5%
Net support (all favourable – all unfavourable)	56%	43%	20%	72%	60%	47%	38%	-1%	66%	58%

After giving a brief overview of CCS technology and asking respondents their opinion of CCS technology in general and of the local project in particular, we sought to provide a balanced presentation of the potential risks of CCS projects (such as leakage from CO_2 pipelines, etc). We then provided further details about the local CCS project and asked respondents to give their opinion on the project. Table 5.15 shows how this additional information affects public respondents' attitudes towards the local project. In general, after being given additional information about the risks of CCS, respondents' attitudes towards the local project became more negative. This effect is statistically significant for all five countries and this is a medium-sized effect (r~0.3). Analysis of the impact of additional information about risks related to CCS projects on stakeholders' attitudes towards the local CCS project was statistically insignificant due to the small sample size, although this may also be because stakeholders held a more fully formed view of the project.

Table 5.15*: *Effects of information concerning CCS risks on public respondents' attitudes towards the local project

	UK		**NL**		**DE**		**PL**		**ES**	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Attitudes[a] before information about risk	4.95	1.51	4.67	1.33	3.76	1.66	5.30	1.21	5.15	1.36
Attitudes[a] after information about risk	**4.64**	1.48	**4.22**	1.66	**3.55**	1.66	**5.01**	1.23	**4.73**	1.47
t value	5.05[b]		6.90[b]		4.59[b]		6.58[b]		7.06[b]	
Effect size (r)	0.26		0.36		0.21		0.28		0.35	

Note: [a] attitudes towards the local CCS project before and after giving information about risks were measured on a 1-7 scale, with the higher scores representing more positive view (1-"very unfavourable; 7-"very favourable"); [b] $p<.000$

We expected that the effect of additional information on attitudes towards the local project would be less pronounced amongst respondents who possess 'genuine' knowledge of CCS technology (see Section 5.2). Figure 5.11 shows the distribution of changes in opinion towards the local project before and after information related to the risks of CCS were given to respondents. Negative numbers along x-axis indicates change in opinion towards a more negative assessment and positive numbers reflect a shift in opinion towards a more positive view. For example, more than half of all respondents did not change their opinion towards the local project ("0" value on x-axis), 34% of respondents change their opinion towards more negative and only 13% shift to a more positive view

of the local project after being given information regarding the risks of CCS technologies.

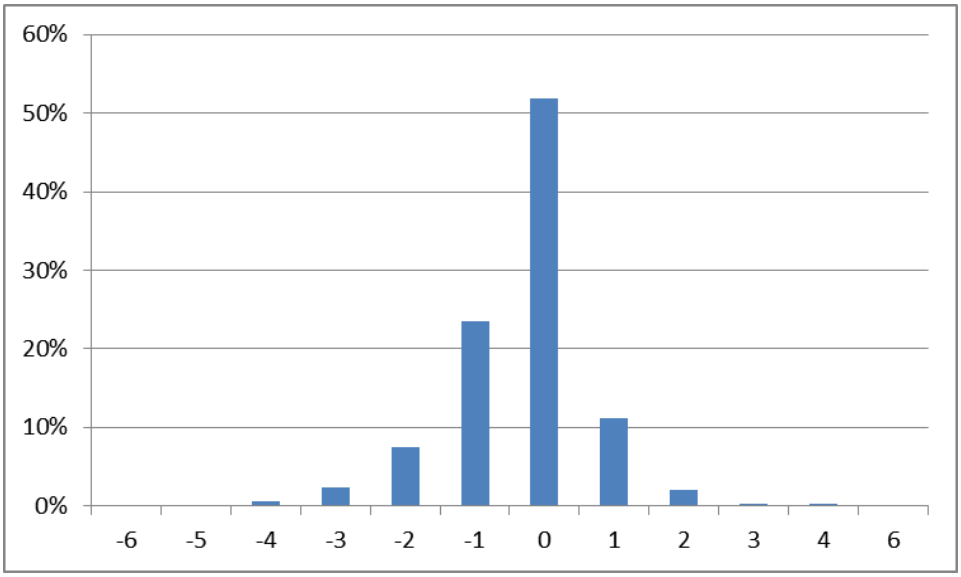

Figure 5.11: *Distribution of differences in opinion towards the local project: net change after versus before information on risks was given to respondents*

Table 5.16 shows changes of (mean) opinion towards the local project after information about risks related to CCS was given, between respondents with genuine knowledge and those without and between males and females. As expected, respondents who are genuinely knowledgeable about CCS (i.e., those who answered that CCS is supposed to reduce global warming only) changed their opinion towards the local project (mean change of -0.18) less than those who are not genuinely knowledgeable about CCS (mean change of -0.35). This difference is statistically significant although it represents a small-sized effect (r=0.06). Also, females, on average, became more negative more than males did when additional information about the risks of CCS was given (this difference is also statistically significant), i.e., females are more risk-averse than males.

Table 5.16: *Changes of opinion towards the local project: impact of genuine knowledge and gender*

	Change in opinion	
	M	SD
Genuine knowledge		
No	-.35	1.05
Yes	-.18	1.11
t value	-2.86[a]	
size effect	.06	
Gender		
Male	-.19	1.01
Female	-.46	1.11
t value	5.54[b]	
size effect	.13	

Note: [a] $p<0.05$; equal variances assumed; [b] $p<0.05$ equal variances not assumed

- *Genuine knowledge of CCS*

One may expect that people who live near the planned CCS projects would know more about CCS technology (or have heard of it more often) than those who live farther away. Figure 5.12 shows the relationship between respondents' genuine knowledge of CCS and their distance to CCS infrastructure (capture and storage sites).

There was a significant effect of respondents' distance to the capture site on levels of respondents' genuine knowledge about CCS technology, *F(2, 2286)* =4.87, *p*<.01, ω=0.06. A linear trend between distance to the capture site and opinion on the project was found to be statistically significant, *F*(1, 2286)=8.86, *p*<.01, ω=0.06. Figure 5.12 clearly shows that the relationship between respondents' distance to the capture site and their knowledge of CCS is indeed linear (fitted linear trend with a negative slope of 0.03). This indicates that as respondents live farther from the capture site their level of genuine knowledge of CCS decreases proportionately.

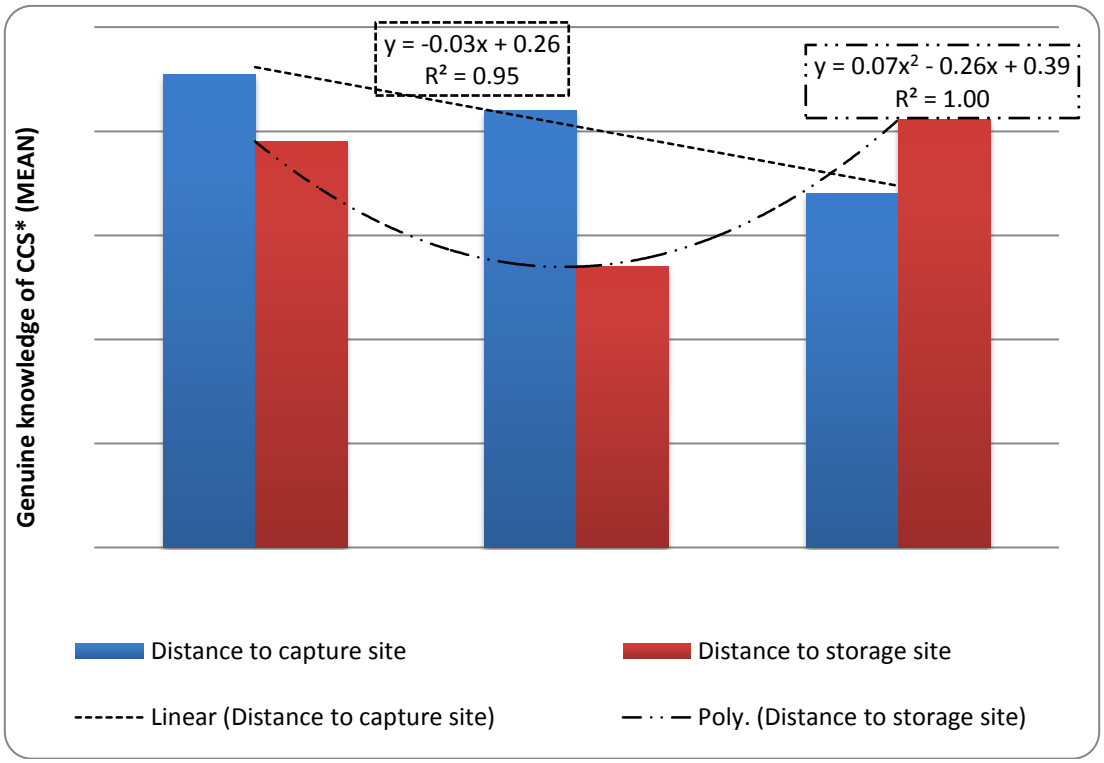

Figure 5.12: Relationships between distance to CCS infrastructure sites and respondents' genuine knowledge of CCS technology

Notes: *Genuine knowledge of CCS is measured as binary variable with 0 representing respondents who choose more than one answer option to the question related to the objective of CCS technology and 1 representing respondents who choose only 'climate change' option as the objective of CCS technology*

Similarly, we found that there was a significant effect of respondents' distance to the storage site on levels of respondents' genuine knowledge about CCS technology, F(2, 2292) =4.89, *p*<.01, ω=0.06. A linear trend between distance to the storage site and opinion on the project was not significant. Figure 5.12 clearly shows that the relationship between respondents' distance to the storage site and their attitudes towards the local CCS project is indeed not linear - it was found that there is a significant quadratic trend, F(1, 2292)=7.92, *p*<.005, ω=0.05, indicating that the relationship is

more complex than initially postulated (i.e., a quadratic curve fits the relationship quite well).

Planned comparisons of level of genuine knowledge of CCS between groups of respondents with different distances to the CCS sites were carried out (Table 5.17). The level of genuine knowledge of CCS (mean) between the following groups (as indicated in Figure 5.12) was compared:

1. Contrast N1: respondents who live within 50 km of the sites versus those who live between 50 and 100 km from the sites;
2. Contrast N2: respondents who live between 50-100 km of the sites versus those who live more than 100 km of from sites;
3. Contrast N3: respondents who live within 50 km of the sites versus those who live more than 100 km from the sites

Table 5.17: *Testing relationships between distance and genuine knowledge of CCS*

	Distance to capture site			**Distance to storage site**		
	Contrast N1	Contrast N2	Contrast N3	Contrast N1	Contrast N2	Contrast N3
contrast value	.02	.04	.06	.06	-.07	-.01
t value	.66[b]	1.71[b]	2.89[a]	2.22[a]	-3.46[a]	-.45[b]
effect size	.02	.07	.08	.08	.13	.02

Notes: [a] statistically significant at $p<.05$; [b] statistically not significant

Table 5.17 shows the difference in genuine knowledge of CCS between respondents who live within 50 km of the capture site and those who live more than 100 km away was significant, i.e., those who live closest to the planned CCS project were more aware of CCS technology than those who live farthest from the capture site. Similarly, we found that those who live within 50 km of the planned CCS storage site were more knowledgeable about CCS than those who live 50-100 km away from the storage site. Surprisingly we also found that those who live 50-100 km from the storage site are less knowledgeable about CCS than those who live more than 100 km from the site. These contrasts are statistically significant and show non-linear relationships between distance to the storage site and genuine knowledge of CCS.

It should be recalled, however, that distance to storage sites is less likely to be a reliable indicator because in two cases (UK and Netherlands) the site is offshore, in Germany two sites were provided and more generally, most storage sites have not been finalised and are not widely known, compared to the capture sites, which are well known in all five cases.

- *Attitudes towards CCS*

We hypothesised that distance to the proposed projects would have an effect on how positively respondents would rate it. In particular, it was expected that the farther respondents live from infrastructure (capture and storage sites), the more positive they should be towards the local CCS project. First, one-way analysis of variance (ANOVA) has been conducted to test this hypothesis using respondents' relative distance to the capture site (Figure 5.13). Thus, there was a significant effect of respondents' distance to the capture site on levels of respondents' attitudes towards the local CCS project, $F(2, 2011) = 8.04$, $p<.000$, $\omega=0.08$.[15]

A linear trend between distance to the capture site and opinion on the project was not significant. Figure 5.13 clearly shows that the relationship between respondents' distance to the capture site and their attitudes towards the local CCS project is indeed not linear. Nevertheless, it was found that

[15] The assumption on equal variances was violated; however, both Brown-Forsythe F-ratio (2, 1150) = 7.35 was significant at $p<.001$.

there is a significant quadratic trend, $F(1, 2011)=12.89$, $p<.000$, $\omega=0.08$, indicating that the relationship is more complex than initially postulated. More complex statistical models will be used to unfold these complexities in subsequent academic work.

Two planned contrasts were conducted (see Table 5.18). The first comparison, N1, revealed that those who live more than 100 km away from the capture site (group 3) were relatively more positive than those who live within 100 km (for the first planned comparison group 1 and 2 were treated as one group). Thus, the difference in (mean) support for the local project is -0.5 between the first group of respondents (living within 0-50 km and 50-100 km) and those living more than 100 km away from the site. Although this difference is statistically significant $t(1454)=-3.35$, $p<.001$, the effect is relatively small ($r=0.09$). This therefore shows a local effect, which can be characterised as a NIMBY-effect, which tended to become insignificant when we go further from the project sites.

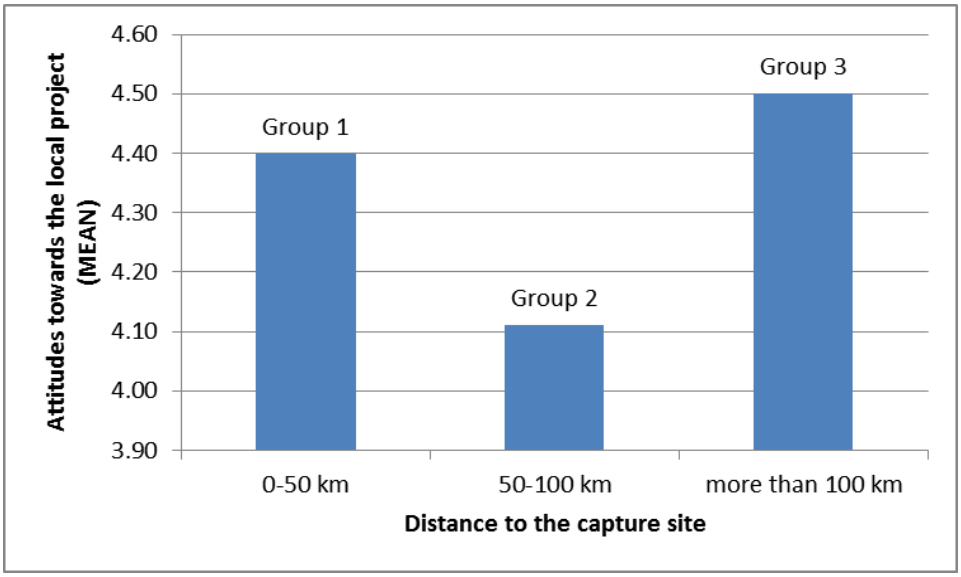

Figure 5.13: *Relationships between distance to the capture site and attitudes towards the local project: public survey*

Note: attitudes towards the local CCS project (after giving information about risks) were measured on a 1-7 scale, with the higher scores representing more positive view (1-"very unfavourable; 7-"very favourable").

The second planned contrast, N2, revealed that those who live within 50 km from the capture site (group 1) are relatively more positive about the local project than respondents living within 50-100 km from the site. This difference in opinion is significant $t(703)=2.47$, $p<.05$ however the effect is also relatively small ($r=0.09$). One possible explanation of this rather counterintuitive (i.e. the opposite of the NIMBY-effect revealed by the first planned contrast) is that who live close to the capture site (within 50 km) might expect some local economic benefits, such as higher levels of employment, or economic compensation from project developers. This effect is quite similar to opinions on siting of nuclear power stations or large international airports whereas many of those who live very close to such facilities are either workers or have received economic compensation.

Table 5.18: *Planned contrast on relationship between distance to the capture site and attitudes towards the local project*

	Contrast N1	Contrast N2
contrast value	-.49	.29
t value	-3.35	2.47
effect size	.09	.09

Similarly, one-way ANOVA has been performed to test whether there is a statistically significant relationship between respondents' location relative to the storage site and their view on the local project (Figure 5.14). We found that there was a significant effect of respondents' distance to the storage site on levels of respondents' attitudes towards the local project, $F(2, 2017) = 10.82$, $p<.000$, $\omega=0.10$.[16]

A linear trend between distance to the capture site and opinion on the project was found to be statistically significant, $F(1, 2017)=21.38$, $p<.000$, $\omega=0.10$. Figure 5.10 clearly shows that the relationship between respondents' distance to the storage site and their attitudes towards the local CCS project increases with distance.

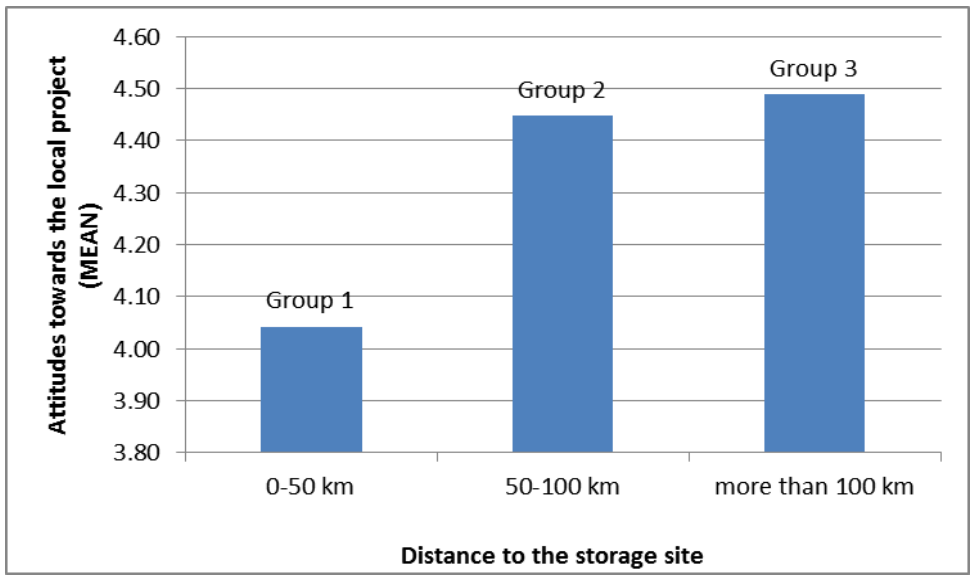

Figure 5.14: *Relationships between distance to the storage site and attitudes towards the local project: public survey*

Note: attitudes towards the local CCS project (after giving information about risks) were measured on a 1-7 scale, with the higher scores representing more positive view (1-"very unfavourable; 7-"very favourable").

Two planned contrasts were conducted (Table 5.20). The first comparison revealed that those who live more than 100 km away from the storage site are relatively more positive than those who live within 100 km (for the first planned comparison respondents living within 50 km and those living within 50-100 km from the capture site were treated as one group). Thus, the difference in (mean) support for the local project is -0.5 between the first group of respondents (living within 0-50 km and 50-100 km) and those living more than 100 km away from the site. Although this difference is statistically significant $t(1225)=-3.19$, $p<.001$, the effect is relatively small ($r=0.09$). The second planned contrast revealed that those who live within 50 km from the storage site are relatively less positive about the local project than respondents living within 50-100 km from the site. This

[16] The assumption on equal variances was violated; however, both Brown-Forsythe F-ratio (2, 888) = 9.99 was significant at $p<.000$.

difference in opinion is significant $t(652)=-3.17$, $p<.002$ however the effect is also relatively small ($r=0.12$).

Table 5.19: *Planned contrast on relationship between distance to the storage site and attitudes towards the local project*

	Contrast N1	Contrast N2
contrast value	-.49	-.40
t value	-3.19	-3.17
effect size	.09	.12

Overall, the two planned comparisons revealed that the distance to the storage site showed a more prominent "NIMBY" effect, possibly reflecting the intuition that storage would be seen as the locally more risky part of the CCS chain than the capture site. Moreover, the capture site may be associated with local benefits which might appeal to respondents (e.g., jobs or economic development), whereas the storage site seem to be less attractive in terms of economic benefits to local residents.

Both stakeholder survey and public country-by-country analysis showed that there is no statistical relationship between respondents' location relative to the local CCS projects (capture and storage sites) and their attitudes towards the local project due to limited sample sizes.

Genuine knowledge of CCS and attitudes towards CCS

We have shown above (Table 5.16) that genuinely knowledgeable (about CCS) respondents reacted quite differently to information about the risks of CCS technology compared to those respondents who are less knowledgeable about CCS. Thus, it might be natural to expect that genuine knowledge about CCS may also influence respondents' attitudes both towards CCS technology in general and towards the local project in particular. Table 5.20 shows the relationship between respondents' knowledge about CCS and their attitudes towards CCS in general and towards the local project. As one can see, respondents who are more knowledgeable about CCS tend to be more negative about CCS technology in general and also about the local project. This difference in attitudes between the two groups is statistically significant and represents a small- to medium-sized effect.

Table 5.20: Genuine knowledge and attitudes towards CCS

	Attitudes towards CCS in general		Attitudes towards the local project[a]	
Genuine Knowledge	Mean	SD	Mean	SD
No	5.08	1.45	4.46	1.55
Yes	4.72	1.57	4.22	1.70
t value	4.30[b]		2.60[b]	
size effect	.17		.11	

Notes: [a] attitudes towards the local CCS project were measured after giving information about risks; [b] statistically significant at $p<.05$ and equal variances not assumed.

Attitudes towards CCS and trust in local actors

Trust has been repeatedly found to be an important factor in residents' attitudes towards new infrastructure projects such as CCS (Chapter 2). One-way ANOVA has been performed to test

whether there exist a significant relationship between public respondents' attitudes towards the local project and their trust in the project developers for all five countries surveyed (Table 5.21). Obtained F-ratios for all five countries are statistically significant at $p<0.05$ indicating that in general there is a significant relationship between attitudes towards the local project and trust in the project developers for all five countries surveyed (for details see Appendix 5.2). Moreover, there was a significant linear trend for all countries surveyed (except for respondents in Poland), indicating that as the support for the local project increased, trust in the project developers increased proportionately.

Table 5.21: *Relationships between support for the local project and trust in the project developers*

Group	Support for the local project**	Trust in the project developers*									
		UK		NL		DE		PL		ES	
		M[a]	SD	**M**[a]	SD	**M**[a]	SD	**M**[a]	SD	**M**[a]	SD
1	strongly opposed	**1.70**	1.34	**1.61**	1.39	**2.02**	1.46	**2.80**	2.17	**2.47**	2.00
2	-	**2.14**	1.17	**1.84**	.85	**2.34**	1.22	**2.67**	1.78	**1.93**	1.22
3	-	**2.15**	1.26	**2.40**	1.19	**2.56**	1.45	**2.32**	1.18	**3.00**	1.85
4	Neutral	**3.13**	1.73	**2.76**	1.35	**3.39**	1.48	**3.20**	1.55	**3.39**	1.58
5	-	**3.41**	1.57	**3.13**	1.50	**3.50**	1.56	**3.54**	1.63	**3.87**	1.72
6	-	**3.65**	1.72	**3.25**	1.52	**4.11**	1.52	**3.48**	1.77	**4.48**	1.64
7	strongly supportive	**4.84**	1.37	**4.00**	1.85	**4.73**	2.33	**3.49**	2.03	**5.71**	1.61

Notes: * Trust in the project developers to take concerns of the local public seriously was measured on a 1-7 scale, with the higher scores representing higher trust (1-"not seriously; 7-"very seriously");

**Support for the local CCS project (after giving information about risks) was measured on a 1-7 scale, with the higher scores representing more positive view (1-"very unfavourable; 7-"very favourable");

[a] F-ratios are statistically significant at $p<0.05$.

Planned comparisons of level of trust in the project developers between groups of respondents with different level of support for the local project were carried out (

Table ***5.22***). The level of trust (mean) in the project developers between the following groups (as indicated in Table 5.21) was compared:

Contrast N1: group 1 versus group 7
Contrast N2: group 2 versus group 6
Contrast N3: group 3 versus group 5

From

Table ***5.22*** we can see, for example from the UK survey, that for the first contrast (N1) there was a significant difference in the level of trust in developers between those who were strongly opposed the local project (group 1) and those who are strongly supported the project (group 7). This difference is -3.14 (value of contrast), which means that those who strongly opposed the project are, on average, substantially less trusting of developers than those who are strongly supportive of the project. The second contrast, N2, in the UK, shows that difference in trust in developers between group 2 (those who were slightly less opposed to the project) and group 6 (those who were slightly less supportive) was statistically significant. Thus, those who were moderately supportive of the project expressed, on average, a higher level of trust in developers (1.51) than those moderately opposed to the project. It should be noted that this difference in trust is roughly half that of the difference in trust between those who were strongly supportive (group 7) relative to those strongly opposed (group 1) of the project. Contrast N3 shows that difference in trust decreases further. This means that as respondents become more neutral towards the local project their differences in level

of trust in project developers become less prominent.

Table 5.22: *Planned contrasts on relation between support for local project and trust in developers*

		Contrast N1	**Contrast N2**	**Contrast N3**
UK	Value of contrast	**-3.14**	**-1.51**	**-1.25**
	t value	-6.62[a]	-3.26 [a]	-3.66 [a]
	effect size	.34	.17	.19
NL	Value of contrast	**-2.39**	**-1.41**	**-.73**
	t value	-4.81[a]	-5.19 [a]	-2.90 [a]
	effect size	.67	.52	.32
DE	Value of contrast	**-2.70**	**-1.77**	**-.94**
	t value	-5.64	-5.50	-4.02
	effect size	.26 [a]	.25 [a]	.19 [a]
PL	Value of contrast	**-.69**	**-.81**	**-1.22**
	t value	-.68[b]	-1.51 [b]	-4.58 [a]
	effect size	.30	.38	.59
ES	Value of contrast	**-3.24**	**-2.55**	**-.87**
	t value	-6.31 [a]	-5.42 [a]	-2.45 [a]
	effect size	.32	.28	.13

Notes: [a] $p<0.05$; [b] statistically insignificant ($p>0.05$)

Although the precise results vary, the basic relationship holds for all countries except Poland. In Poland, the relationship between attitudes towards the local project and trust in developers is more complex, and a linear trend was insignificant.

Attitudes towards CCS and local influence in the planning process and previous experience with infrastructure projects

Figure 5.15 and Figure 5.16 show relations between respondents' perception related to local democratic traditions (as reflected by respondents' perception about fairness in the infrastructure planning process and fairness about treatment in past developments) view the local CCS project. One-way ANOVA has been performed to test whether there is a significant relationship between respondents' perception about fairness of the infrastructure planning process and their view on the local project (Figure 5.15). Thus, we found that there was a significant effect of respondents' perception about "fairness" in the planning process on levels of respondents' attitudes towards the local project, $F(6, 1875)=68.66$, $p<.000$, $\omega=0.47$.[17] A linear trend between perception about "fairness" in the planning process and opinion on the project was found to be statistically significant, $F(1, 1875)=211.37$, $p<.000$, $\omega=0.33$. As can be seen, Figure 5.15 **cl**early shows that the relationship between respondents' perception about fairness in the planning process and their attitudes towards the local CCS project is indeed linear. This indicates that as respondents' perception about fairness increases their view on the local project becomes proportionately more positive.

[17] The assumption on equal variances was violated; however, Brown-Forsythe F-ratio (6, 698) = 59.83 was significant at $p<.000$.

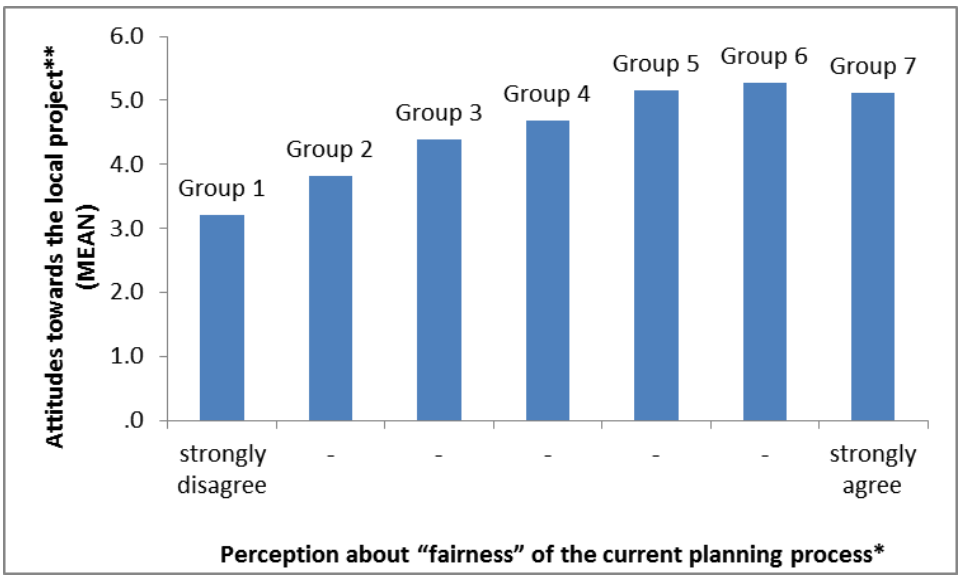

Figure 5.15: *Impact of perception about "fairness" of the current planning process on view on the local CCS project: public survey*

Note: * perception about "fairness" of the planning process is reflected by respondents' agreement over the following statement "Do you believe that, in general, the current planning process gives sufficient voice to the concerns of local residents? The answers were based on a 1-7 (1-"strongly disagree; 7-" strongly disagree")"; ** Attitudes towards the local project (after giving information about risks) was measured on a 1-7 scale, with the higher scores representing more positive view (1-"very unfavourable; 7-"very favourable")

Three planned comparisons of level of attitudes towards the local project between groups of respondents with different perception about fairness in the planning process were carried out (Table 5.23). The (mean) attitudes towards the local project were compared between the following groups:

1. Contrast N1: group 1 versus group 7
2. Contrast N2: group 2 versus group 6
3. Contrast N3: group 3 versus group 5

Table 5.23 shows respondents who strongly disagree that the current planning process is fair (Figure 5.15: group 1) were on average substantially more negative than those who strongly agreed that the current planning process is fair (Figure 5.15: group 7) (the difference in means is -1.91). This difference in opinion (-1.91) is statistically significant and represents large-sized effect (effect size is 0.57). Similarly, contrasts N2 and N3 show that those who felt that the planning process is fair are on average more positive about the local project than those who in general felt that the planning process is not fair. As expected, the difference decreases the less extreme the views.

Table 5.23: *Relationship between perceived "fairness" of the current planning process and views on the local CCS project*

	Contrast N1	Contrast N2	Contrast N3
Contrast value	-1.91	-1.45	-.77
t value	-7.32[a]	-9.95[a]	-8.35[a]
effect size	.57	.48	.30

Notes: [a] $p<0.05$;

Similar analysis was conducted to test the relationship between perceptions about past treatment and attitudes towards the local project (Figure 5.16). It was found that there was a significant effect of respondents' perception about fair treatment of the local community in past developments on levels of respondents' attitudes towards the local project, $F(6, 1716)=19.12$, $p<.000$, $\omega=0.25$.[18] A

[18] The assumption on equal variances was violated; however, Brown-Forsythe F-ratio (6, 718) = 18.01 was significant at

linear trend between respondents' perception about fair treatment of the local community on their attitudes towards the local project was found to be statistically significant, $F(1, 1716)=81.11$, $p<.000$, $\omega=0.22$. As can be seen, Figure 5.13 clearly shows that this relationship can be described by a linear trend. This indicates that as respondents' perception about fair treatment in the past becomes more positive, their view on the local project becomes proportionately more positive.

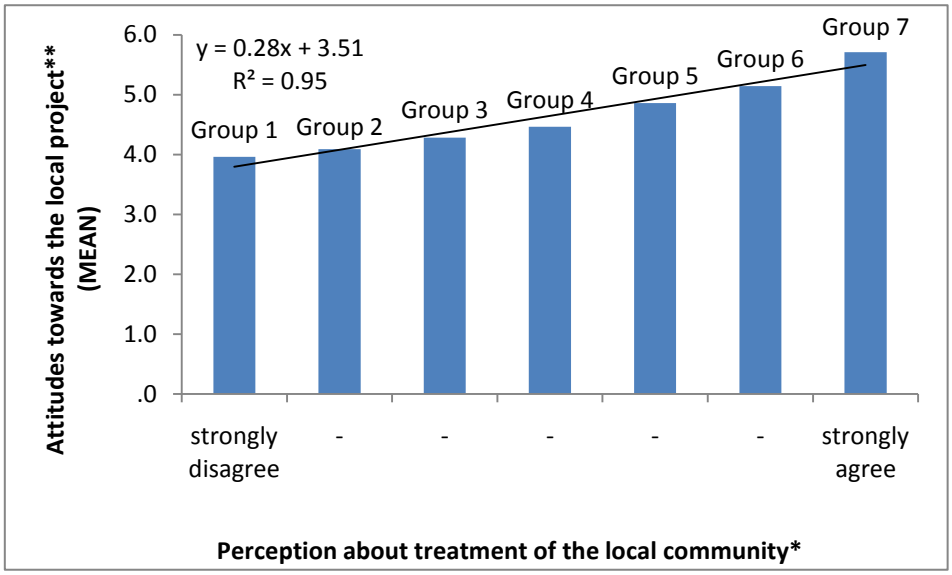

Figure 5.16: *Impact of perception about treatment of the local community on their view about the local CCS project: public survey*

Note:* respondents perception about "fair" treatment of the local community in past developments is reflected by respondents' agreement over the following statement: "Do you believe that your local community had been treated fairly in past developments?" (on 1-7 scale); ** Attitudes towards the local project (after giving information about risks) was measured on a 1-7 scale, with the higher scores representing more positive view (1-"very unfavourable; 7-"very favourable")

Similar to the previous analysis, three planned comparisons respondents'' attitudes (mean) towards the local project between groups of respondents with different perception about fair treatment in the past were carried out. The (mean) attitudes towards the local project between the following groups were compared as follows:

1. Contrast N1: group 1 versus group 7
2. Contrast N2: group 2 versus group 6
3. Contrast N3: group 3 versus group 5

As can be seen from

$p<.000$.

Table **5.**22, respondents who strongly disagree that they were treated fairly in past developments (Figure 5.16: group 1) were on average substantially more negative (the difference in means is -1.75) than those who strongly agreed that they were treated fairly in the past (Figure 5.16: group 7). This difference in opinion (-1.75) is statistically significant and represents large-sized effect (effect size is 0.62). Similarly, contrasts N2 and N3 show that those who felt that they were treated not fairly in the past are on average more negative about the local project than those who in general felt that they were treated fairly in the past. In general, the contrast values with respect to the planning process comparisons are slightly stronger than for past treatment.

Table 5.22: *Relationship between perceived "fair" treatment in the past and view of the local CCS project*

	Contrast N1	Contrast N2	Contrast N3
contrast value	-1.75	-1.05	-.58
t value	-5.95[a]	-6.35[a]	-5.00[a]
effect size	.62	.34	.19

Notes: [a] $p<0.05$

Attitudes towards CCS and opinions on coal and the environment

We expected that opinions about CCS would be influenced by other aspects of the respondents' worldviews. Thus for example people who have a generally positive opinion on coal as an energy source would not tend to associate CCS with the same amount of negativity than those who already have a negative view of coal. Figure 5.17 shows relationship between respondents' view on coal and their view on the local project. It was found that there was a significant effect of respondents' opinion towards coal as energy source on levels of respondents' attitudes towards the local project, $F(6, 2016)=7.15$, $p<.000$, $\omega=0.14$.[19] A linear trend between view on coal and opinion on the project was found to be statistically significant, $F(1, 2016)=37.80$, $p<.000$, $\omega=0.14$. This indicates that as respondents' opinion on coal becomes more positive their view on the local project becomes proportionately more positive as well.

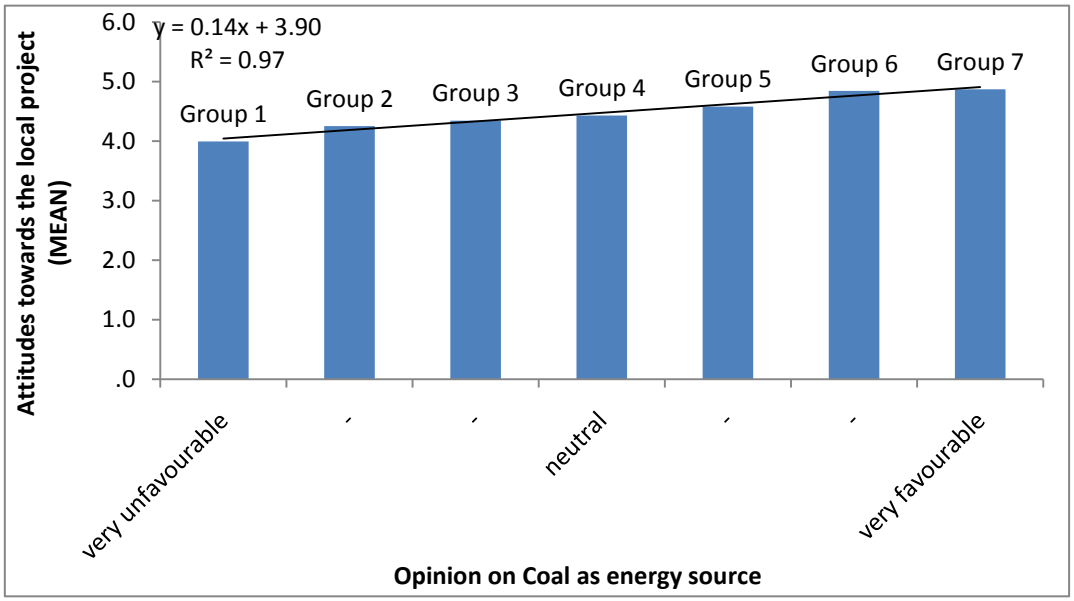

Figure 5.17: *Respondents' attitudes towards the local CCS project in general and their view about coal as energy source*

Three planned comparisons of level of attitudes towards the local project between groups of respondents with different view about coal as energy source were carried out (Table 5.24). The level of attitudes (mean) towards the local project between the following groups was compared:

1. Contrast N1: group 1 versus group 7
2. Contrast N2: group 2 versus group 6

[19] The assumption on equal variances was violated; however, Brown-Forsythe F-ratio (6, 1304) = 6.96 was significant at $p<.000$.

3. Contrast N3: group 3 versus group 5

We can see from Table 5.24 that respondents who were very unfavourable towards coal (Figure 5.17: group 1) were on average more negative about the local CCS project (the difference in means is -0.88) than those who were very favourable towards coal (Figure 5.17: group 7). This difference in opinion (-0.88) is statistically significant and represents a medium-sized effect (effect size is 0.28). Similarly, contrasts N2 and N3 show that those who are more positive about coal were also on average more positive about the local project.

Table 5.24: *Testing relationship between perceptions about "fairness" of the current planning process on view on the local CCS project*

	Contrast N1	**Contrast N2**	**Contrast N3**
Contrast value	-.88	-.59	-.24
t value	-4.19[a]	-4.08[a]	-2.07[a]
effect size	.28	.21	.08

Notes: [a] $p<0.05$;

Another association we expected to influence perceptions of CCS was respondents' attitude towards the environment as a national priority. As CCS is explicitly designed to reduce carbon dioxide emissions and therefore lessen the effect of energy production on global warming, one might expect that people concerned about the environment would be more positively inclined towards the technology or oppose CCS because it is perceived to undermine preferred alternative options, such as renewables.

As Table 5.25 shows, the relationship between respondents' attitudes towards the local CCS project is negatively associated with respondents' perception about importance of "environment". Thus, those who do not consider the environment to be a national priority are on average more supportive of the local CCS project (mean - 4.45) compared with those who consider environment to be a national priority (mean - 4.13).

Table 5.25: *Respondents' view about the local CCS project and their perception about importance of environmental issues*

	Opinion towards the local project	
Environment as national priority	Mean	SD
No	4.45	1.56
Yes	4.13	1.76
t value	2.58[a]	
size effect	.16	

Notes: [a] $p<0.05$; equal variances not assumed

This association is certainly one of the more interesting results of this survey, and demonstrates that CCS faces severe problems of acceptance by precisely the group of people who should be most supportive of it due to its potential impact on mitigating climate change. In this, the general population seem to mirror the concerns voiced by many green and environmental groups about CCS (such as Greenpeace 2008) who generally argue that the risks of CCS to the environment outweigh the benefits and that it runs the risk of creating complacency among energy providers who should ideally switch to sustainable sources than continue relying on fossil fuels (see Corry and Riesch forthcoming; Curry et al 2004).

Whether this reflects a spontaneous emergence of opinion by the population or whether this is

influenced by green groups' position statements (after all, NGOs were also pointed to as one of the most trusted sources of information in the survey) is unfortunately hard to tell from the data available here and would require further research.

Attitudes towards CCS and demographics

Statistical associations between key demographic variables such as gender, education and age versus respondents' knowledge and opinion about CCS were found to be significant (Table 5.26). According to results (Table 5.26), in general males seem to be more knowledgeable about CCS and less positive about CCS in general than females. Also, it was found that respondents with less than an undergraduate education were less knowledgeable about CCS than respondents with university education. This difference is statistically significant. However, relationship between level of education and opinion about CCS in general was found not to be statistically significant.

Table 5.26: *Gender and Education versus genuine knowledge of CCS*

	Genuine knowledge of CCS[a]
Gender	
Male	24%
Female	14%
t value	6.34[b]
effect size	0.13
Education	
Less than undergraduate degree	17%
Undergraduate degree and above	23%
t value	-2.87[b]
effect size	0.07

Notes: [a] Genuine knowledge of CCS is measured as binary variable with 0 representing respondents who choose more than one answer option to the question related to the objective of CCS technology and 1 representing respondents who choose only 'climate change' option as the objective of CCS technology; [b] statistically significant at p<.05.

Table 5.27: Gender and Education versus opinion about CCS

	Opinion on CCS in general	
	Mean	SD
Gender		
Male	5.13	1.65
Female	5.36	1.60
t value	-3.31[a]	
effect size	0.07	
Education		
School education	4.99	1.46
University education	5.05[a]	1.51
t value	-0.78[b]	
effect size	0.02	

Notes: [a] statistically significant at p<.05; [b] statistically significant at p<.05.

Figure 5.18 shows the relationship between respondents' age and their genuine knowledge of CCS.

Age had a significant effect on levels of respondents' genuine knowledge, $F(3, 2324)=2.92$, $p<.05$, $\omega=0.05$.[20] A linear trend between age and knowledge of CCS was found to be statistically significant, $F(1, 2324)=37.80$, $p<.05$, $\omega=0.05$. This indicates that as respondents' age increases they become proportionately more knowledgeable about CCS.

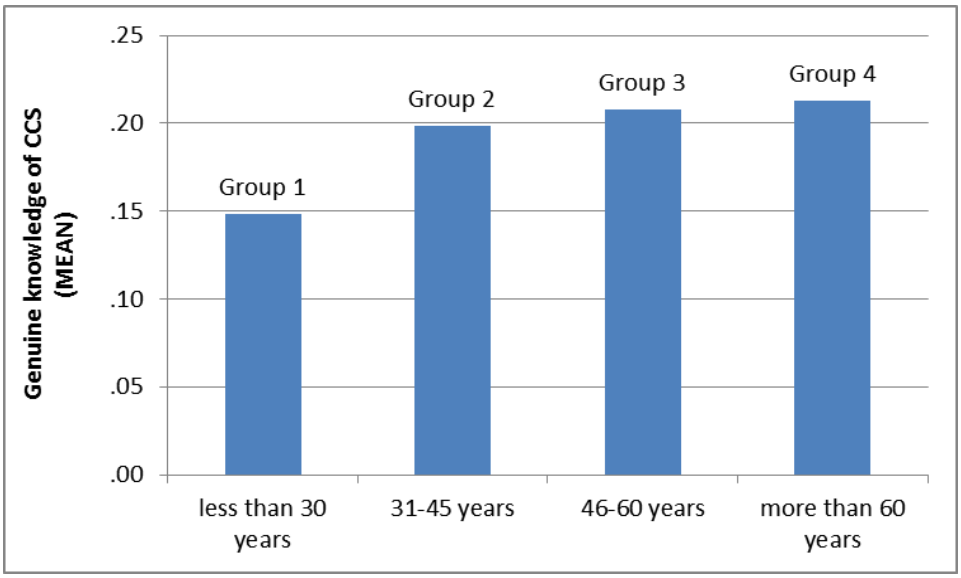

Figure 5.18: *Relationship between age and knowledge of CCS*

Note: Genuine knowledge of CCS is measured as binary variable with 0 representing respondents who choose more than one answer option to the question related to the objective of CCS technology and 1 representing respondents who choose only 'climate change' option as the objective of CCS technology.

Three planned comparisons of respondents' genuine knowledge of CCS and their age were carried out (Table 5.28). Respondents' genuine knowledge of CCS was compared between the following groups (Figure 5.18 shows these groups):

1. Contrast N1: average of groups 1 and 2 versus average of groups 3 and 4
2. Contrast N2: group 1 versus group 2
3. Contrast N3: group 3 versus group 4

In Table 5.28, we can see from the first contrast, N1, that, on average, respondents who are less than 45 years (i.e., groups 1 and 2) are less knowledgeable of CCS than respondents who are 46 years and older (i.e., groups 3 and 4). Further, comparing knowledge of CCS between groups 1 and 2 (contrast N2) we can see that those who are less than 30 years are less knowledgeable about CCS than those who are 31-45 years. For both contrasts, the effect size is small. However, differences in genuine knowledge of CCS between groups 3 and 4 (contrast N3) are statistically not significant.

Table 5.28: *Testing relationship between age and knowledge of CCS*

	Contrast N1	**Contrast N2**	**Contrast N3**
contrast value	-.04	-.05	-.01
t value	-2.19[a]	-2.36[a]	-.20[b]
effect size	.05	.07	.01

Notes: [a] $p<0.05$ and equal variances not assumed; [b] statistically insignificant

[20] The assumption on equal variances was violated; however, the Brown-Forsythe F-ratio (6, 1304) = 6.96 was significant at $p<.000$.

Risk perceptions

As elaborated in Chapter 2 (Theoretical Background), risk perception, or level of uncertainty, is characterised as follows:

Table 5.29: *Conceptualised type of risks associated with CCS technology*

Type of risk	Description of risk level	Survey questions[a]
Zero level risk	*Uncertainty about the outcome*: we can be uncertain of the outcome, as predicted by the model	Current estimates of likelihood of leakage from underground storage sites are accurate;
First level risk	*Uncertainty about the parameters and about the model*: we can be uncertain of the parameters used in the model or be uncertain about the model itself.	Experts disagree over the methods used in their risk assessment for CCS
Second level risk	*Uncertainty about the implicit assumptions, or acknowledged inadequacies in the modelling process*: we can be uncertain about the assumptions used to derive the possible models	Some of the scientific assumptions used for the risk assessment for CCS are wrong
Third level risk	*Complete uncertainty, or uncertainty about unacknowledged inadequacies*: we can be uncertain about the unforeseen events (things we don't know we don't know), often referred to as "unknown unknowns" after a speech by Donald Rumsfeld (2002)	Completely unforeseen events can happen in relation with CCS projects that nobody can anticipate

Note: [a] To capture respondents risk perception according to the conceptualised risk levels the following statements were given to respondents to agree or disagree (on 1-7 scale).

Figure 5.19 and Figure 5.20 describes different levels of risk (as defined in

Table **5.29**) related to CCS technology among public and stakeholders. Comparing public perception about different level of risks (Figure 5.19), it can be seen that zero level risks are relatively less worrisome for public respondents than higher order risks. For example, only 30% of all public respondents agree that 'current estimates of likelihood of leakage from underground storage sites are accurate' whereas 21% disagree with this statement. On the other hand, 40% of public respondents agree that 'Experts disagree over the methods used in their risk assessment for CCS' while only 8% disagree; this means that public respondents are somewhat worried about uncertainties in risk assessment for CCS. Similarly, public respondents' are quite worried about second level risks, i.e. 27% of respondents agree that 'some of the scientific assumptions used for the risk assessment for CCS are wrong' whereas 12% disagree with it. However, we should note that majority of respondents are either neutral (23%) or ignorant about this statement (38%). This is not surprising since public respondents might not be well informed of the scientific assumptions made when assessing CCS risks. It is not surprising to see that a large majority of public respondents agree (64% agree versus 8% disagree) with the statement that reflects public respondents' perception about third level risk or "unknown unknowns". In addition, public respondents are least neutral about this statement and are least likely to offer "Don't Know" in response.

A similar pattern in perception of different risk levels can be observed among stakeholders (Figure 5.20). Compared to public respondents, stakeholders seem to worry more about accuracy of estimates of likelihood of leakage from underground storage sites (zero level risk); thus, 46% of stakeholders disagree with the statement that 'Current estimates of likelihood of leakage from underground storage sites are accurate' which is more 25% more than agreement for this statement by public respondents (Figure 5.20). In spite of the trust put in scientists, as seen in Section 5.3 and

especially 5.4, there is a clear concern over the basic parameter estimates of leakage rates.

Stakeholders are even more concerned about 'unknown unknowns' uncertainties related to CCS than public respondents; for example, 48% of stakeholders strongly agree that completely unforeseen events can happen in relation with CCS projects which is 18% higher than in the public survey.

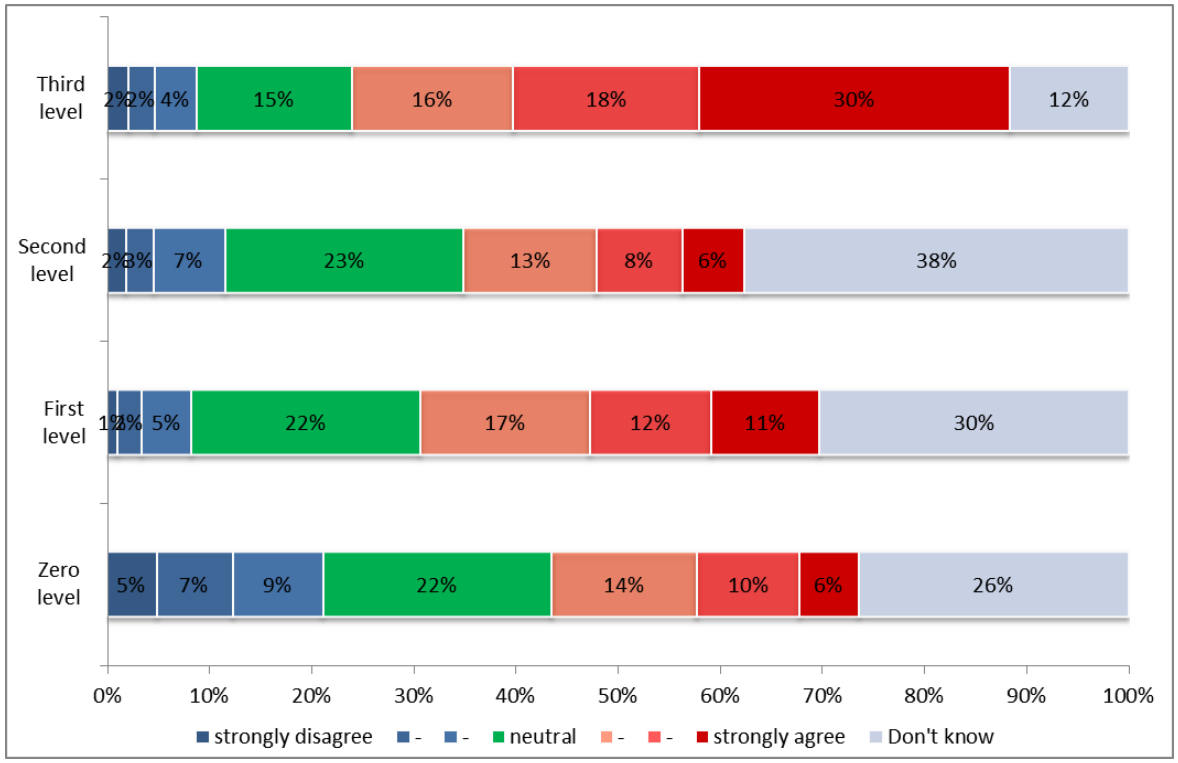

Figure 5.19*: *Public respondents' perceptions of the risks of CCS technology

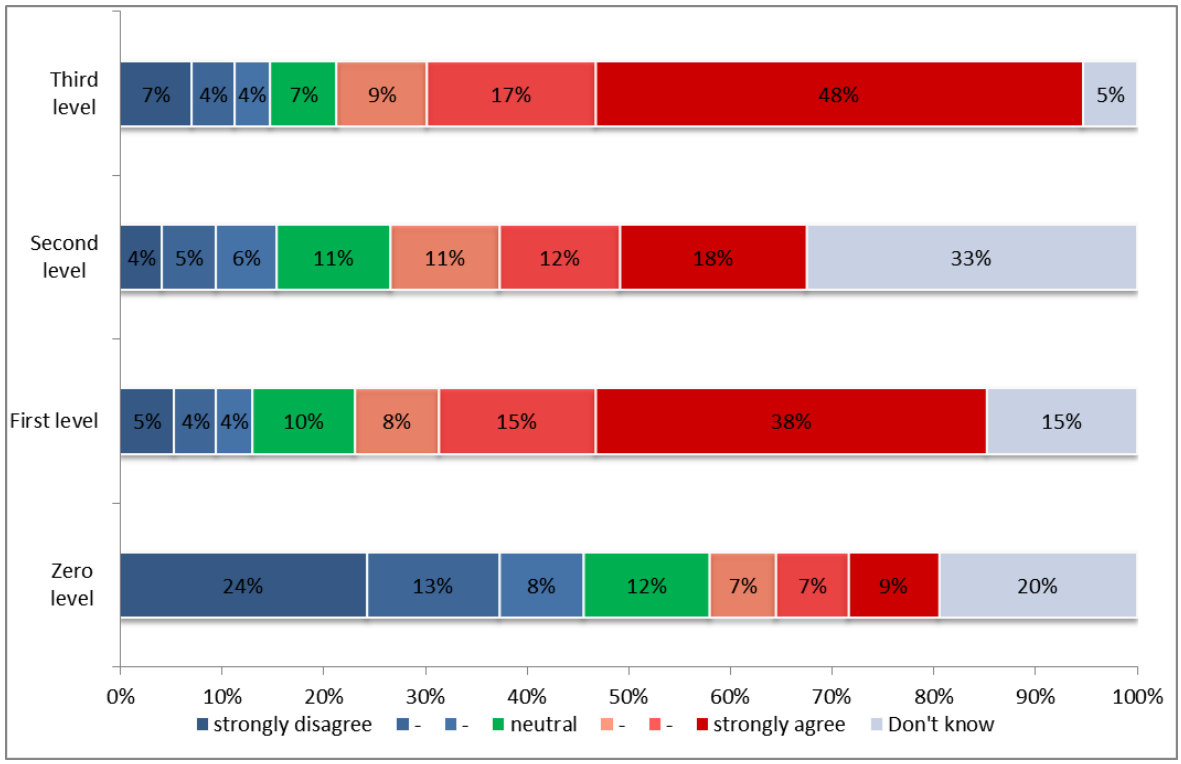

Figure 5.20*: *Stakeholders' perceptions of the risks of CCS technology

Figure 5.22 shows inter-country comparisons of public perception about zero and third level uncertainties regarding CCS. Slightly more German respondents disagree than agree with the statement "Current estimates of likelihood of leakage from underground storage sites are accurate" which means that they seem to be the most risk-averse with respect to zero level uncertainty, followed by UK and Dutch respondents.

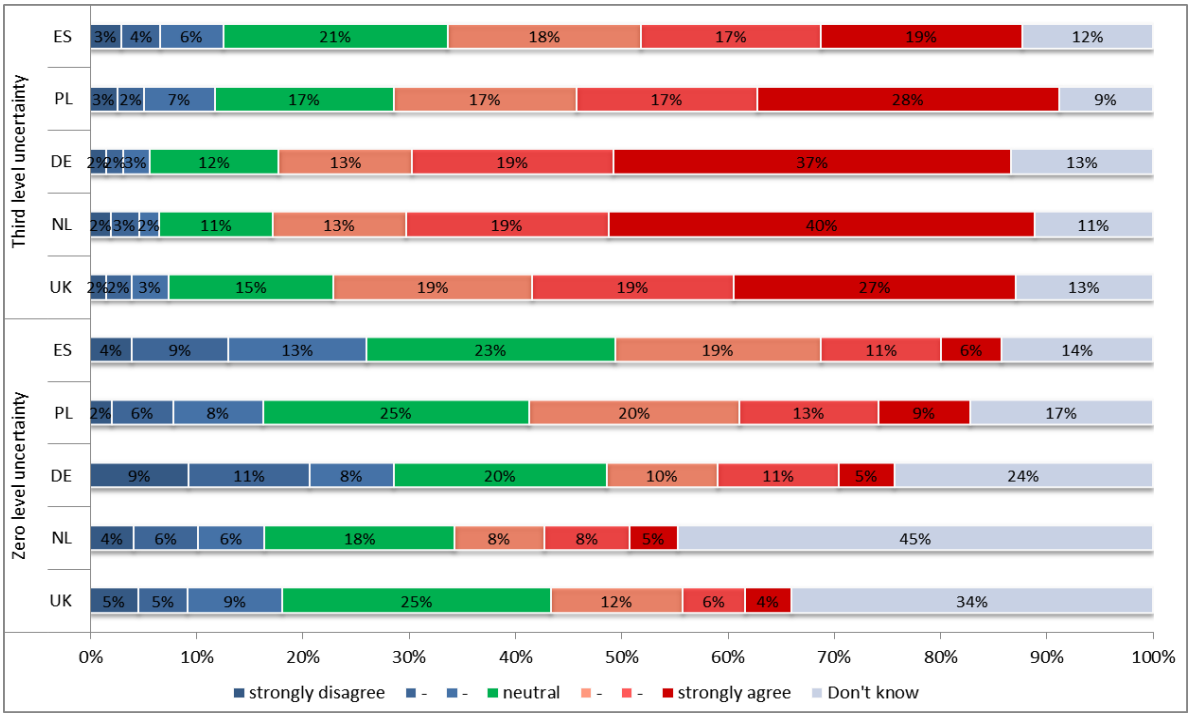

Figure 5.22: *Public perceptions of the risks of CCS technology: Inter-country comparisons*

In comparing respondents' risk attitudes towards third level uncertainties, one can see that respondents are much more risk-averse with compared with zero level uncertainty. Looking at risk attitudes towards third level uncertainty it can be noted that the German, Dutch and UK respondents are more risk-averse compared to respondents from Poland and especially Spain. Although Spanish and Polish respondents can be described as the most risk-prone,

Table **5.30** describes the results of comparisons between our conceptualised risk levels within each of the countries surveyed. As we can see, for all surveyed countries, public respondents were more risk-averse concerning the first level risks (uncertainties over parameters and models) than concerning zero level risk (uncertainties about outcome). It is rather surprising to find that public respondents were more risk-averse over first level risk than over second level risk (uncertainties about the implicit assumptions).[21] This is perhaps because public respondents are not aware of scientific assumptions used for the risk assessment for CCS (second level risk) (see Figure 5.19). Further, as one would expect, respondents from all five countries were more risk-averse regarding third level risk than about the second level risk. This is statistically significant (

[21] We should note that this pattern is statistically significant for Dutch, German and Spanish public respondents.

Table **5.30**).

Table 5.30: *Respondents' perception concerning risk levels*

		UK		NL		DE		PL		ES	
		M	SD	M	SD	M	SD	M	SD	M	SD
Pair 1 (zero vs 1st level risks)	Zero level risk	3.97	1.88	3.87	2.07	4.17	2.10	3.05	1.65	3.58	1.77
	First level risk	**4.85**	1.66	**5.20**	1.76	**5.92**	1.22	**5.01**	1.62	**5.18**	1.39
	t value	-3.23[a]		-4.90[a]		-10.61[a]		-10.21[a]		-7.88[a]	
	effect size	.30		.45		.59		.57		.53	
Pair 2 (1st vs 2nd level risks)	First level risk	**4.81**	1.72	**4.98**	1.85	**5.88**	1.19	**4.93**	1.68	**5.10**	1.52
	Second level risk	4.76	1.70	4.66	1.75	5.48	1.45	4.78	1.70	4.78	1.67
	t value	.48[b]		2.32[a]		4.29[a]		1.28[b]		2.24[a]	
	effect size	.05		.25		.31		.09		.20	
Pair 3 (2nd vs 3rd level risks)	Second level risk	4.79	1.65	4.69	1.79	5.34	1.57	4.73	1.69	4.56	1.69
	Third level risk	**5.55**	1.53	**5.89**	1.63	**5.96**	1.52	**5.47**	1.72	**4.95**	1.76
	t value	-5.26[a]		-6.55[a]		-5.68[a]		-6.10[a]		-2.98[a]	
	effect size	.43		.54		.38		.37		.25	

Note: [a] statistically significant at p<0.05; [b] statistically insignificant (p>0.05); higher mean score means more risk-averse.

Furthermore, we hypothesised that these risks are intertwined with issues of trust – if we trust the CCS experts to be competent in managing the facilities or if we trust the political structures to keep safety concerns a priority, then worries over uncertainties should be lessened. Indeed, a statistical relation between respondents' perception about risks of CCS technology (zero level risk) and their trust in industry and national governments/politicians was found to be significant across most countries surveyed (

Table **5.31**). Relationships between all other risk levels and trust in politicians and in project developers were not found to be statistically significant.

Thus, according to results from

Table **5.31**, in all countries (except in the Netherlands), more risk averse respondents were less trustworthy of national politicians and vice versa those who are risk prone tend to have higher trust in national politicians than those who were risk averse. Similarly, those who are risk-averse (about zero level risk) trust in the project developers less than those who are risk-prone. This relationship is statistically significant for all countries surveyed except for Poland.

Table 5.31: *Relationship between respondents' perception regarding 'zero-level' risk and trust in national politicians and project developers*

	Trust in national politicians[b]		Trust in the project developers[b]		Trust in national politicians[b]		Trust in the project developers[b]	
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
UK					**PL**			
risk averse[a]	2.60	1.57	2.51	1.66	2.73	1.75	3.15	1.71
risk prone[a]	3.61	1.72	3.80	1.73	3.32	1.69	3.56	1.69
t value	-4.01[e]		-5.05[e]		-2.71[e]		-1.81[d]	
effect size	.29		.36		.15		.11	
NL					**ES**			
risk averse[a]	3.43	1.70	2.34	1.39	2.92	1.64	3.14	1.93
risk prone[a]	3.62	1.55	3.11	1.75	4.09	1.74	4.44	1.69
t value	-.72[d]		-3.03[ce]		5.35[e]		5.63[e]	
effect size	.06		.24		.32		.34	
DE								
risk averse[a]	2.56	1.42	2.33	1.45				
risk prone[a]	3.39	1.74	3.64	1.73				
t value	-4.36[ce]		-6.88[ce]					
effect size	.26		.39					

Notes: [a] risk averse (prone) respondents are those who agree (disagree) on the following statement: "Current estimates of likelihood of leakage from underground storage sites are accurate"; [b] Respondents' trust in national politicians and in project developers (as actors who care about local concerns when it comes to siting CCS infrastructure) was measured on a 1-7 scale, with the higher scores representing higher trust; [c] equal variances not assumed; [d] statistically insignificant; [e] statistically significant at $p<0.05$.

Social Capital

5.1.1. Social capital and attitudes towards CCS

We asked a number of questions regarding the extent to which respondents were involved in a variety of community activities and groups in order to get a measure of their community activism. We hypothesised that areas and individuals with higher social capital would be more likely to have strong views on CCS, either locally or nationally. One measure of social capital is the time spent with work colleagues outside of the workplace.

Figure 5.21 shows relationships between attitudes towards CCS and level of social capital. It was found that there was a significant effect of respondents' social capital on levels of respondents' attitudes towards CCS in general ($F(3, 2147)=13.54$, $p<.000$, $\omega=0.13$) and towards the local CCS project ($F(3, 2054)=19.69$, $p<.000$, $\omega=0.17$).[22] A linear trend between social capital and attitudes towards CCS in general was found to be statistically significant ($F(1, 2147)=36.55$, $p<.000$, $\omega=0.13$). Similarly, linear trend between social capital and attitudes towards the local project was

[22] The assumption on equal variances was violated; however, Brown-Forsythe F-ratio (3, 1880) = 19.83 was significant at $p<.000$.

also statistically significant (F(1, 2054)=52.28, p<.000, ω=0.16). This indicates that as respondents' social capital increases (i.e. they spend more time with their colleagues from work outside the workplace) they become proportionately more positive towards CCS in general and towards the local project (this is clearly seen in the fitted linear trends in Figure 5.21).

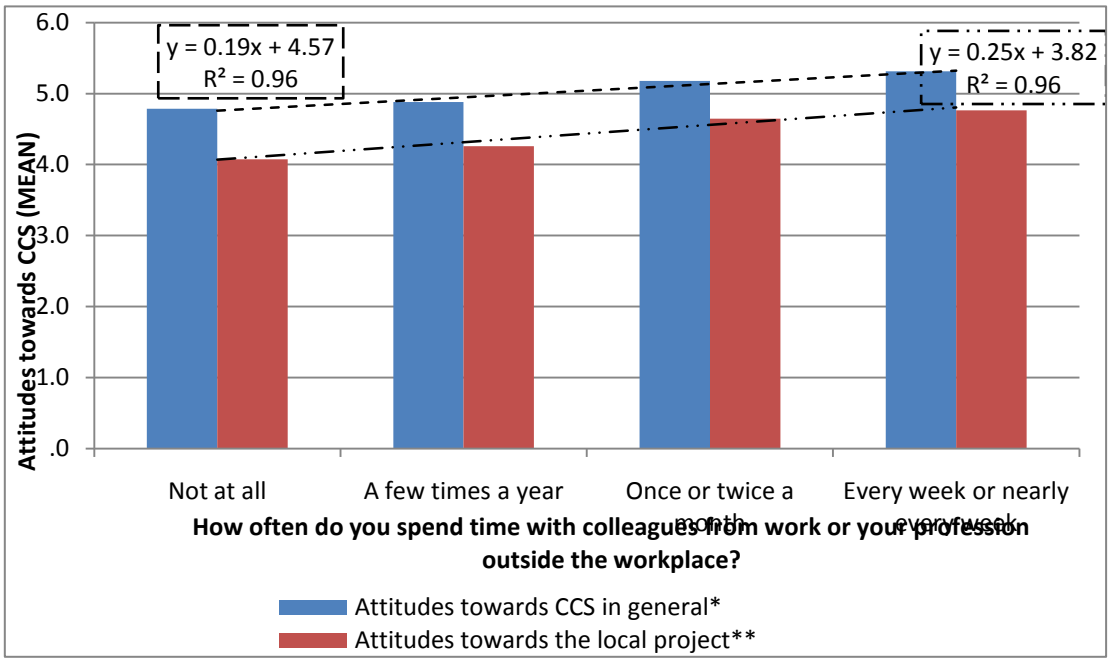

Figure 5.21: Relationships between social capital and attitudes towards CCS

Notes: * Attitudes towards CCS in general was measured on a 1-7 scale, with the higher scores representing more positive view (1-"very unfavourable; 7-"very favourable"); ** Attitudes towards the local project (after giving information about risks) was measured on a 1-7 scale, with the higher scores representing more positive view (1-"very unfavourable; 7-"very favourable").

Two planned comparisons of respondents' attitudes towards CCS and their social capital were carried out (Table 5.28). The comparisons were made between the following groups of respondents (Figure 5.21 shows these groups):

1. Contrast N1: group "not at all" versus group "every week or nearly every week"
2. Contrast N2: group "a few times a year" versus group "once or twice a month"

Thus, Table 5.32 shows for the first contrast that, on average, respondents who indicated that did not spend time "at all" with colleagues outside the workplace are less supportive of CCS in general (-0.53) and the local project (-0.69) than those respondents who indicated that they spent every week or nearly every week with their colleagues. Further, those who spend "a few times a year" seemed to be less positive about CCS in general (-0.30) and the local project (-0.39) than those who spend times with colleagues "once or twice a month". These differences in attitudes towards CCS (mean) between compared groups are statistically significant and these differences represent small to medium-sized effects. The differences were larger for the local project than for CCS in general.

Table 5.32: *Testing relationship between social capital and attitudes towards CCS*

	Attitudes towards CCS in general		Attitudes towards the local project	
	Contrast N1	Contrast N2	Contrast N1	Contrast N2
contrast value	-.53	-.30	-.69	-.39
t value	-5.28[ab]	-3.58[ab]	-6.25[ac]	-4.44[ac]
effect size	.11	.08	.21	.13

Notes: [a] p<.000; [b] equal variances assumed; [c] equal variances not assumed

Further, social capital might also be reflected through respondents'' participation in different voluntary organisations and activities (such as social welfare services for elderly, religious organisations, trade unions, or organisations involved in conservation, the environment, or animal rights).

Table 5.33 describes differences in attitudes towards CCS in general and towards the local project between those who participated in voluntary environmental organisations and those who did not. Thus, those who participated in conservation and environmental organisations were more negative towards the local project than those who indicated that they did not participate in such organisations. This difference in opinion towards the local project among these two groups of respondents was statistically significant; however, difference in opinion towards CCS in general among these two groups was not significant.

Table 5.33*: Social capital (participation in voluntary organisations) and attitudes towards CCS*

Member of group involved in "conservation, the environment, animal rights"	Attitudes towards CCS in general		Attitudes towards the local project[a]	
	Mean	SD	Mean	SD
No	5.02	1.48	4.45	1.56
Yes	4.96	1.50	4.19	1.72
t value	.63[b]		2.41[c]	
size effect	.01		.12	

Note: [a] attitudes towards the local CCS project was measured after giving information about risks; [b] statistically not significant and equal variances assumed; [c] statistically significant at p<.05 and equal variances not assumed.

5.1.2. Social capital and political activism

One might expect that social capital may also be associated with respondents' political activism. This type of activism is reflected in respondents' answers to questions related to whether they have signed petition, taken part in a lawful public demonstration and/or participated in strikes in the last twelve months.
Table 5.34 shows the association between respondents' social capital and their political activism. These relationships are statistically significant and can be described by linear term quite well. Thus, those respondents who indicated they spend more time with colleagues outside the workplace are more likely to sign a petition, participate in a public demonstration and/or in a strike than those who spend less time.

Table 5.34: Relationships between social capital and political activism

		Which of the following, if any, have you done during the last twelve months?[a]					
		Signed a petition		Taken part in a lawful public demonstration		Participated in strikes	
		Mean	SD	Mean	SD	Mean	SD
How often do you spend time with colleagues from work outside the workplace?	Not at all	.38	.49	.03	.17	.01	.09
	A few times a year	.45	.50	.04	.19	.01	.08
	Once or twice a month	.48	.50	.06	.25	.02	.13
	Every week or nearly every week	.49	.50	.07	.26	.03	.18

Notes: [a] answers were based on 0-1 scale (0- "no"; 1 – "yes").

Two planned comparisons of respondents' political activities (such as signing petitions, participating in public demonstrations and/or strikes) and their social capital were carried out (Table 5.35). These comparisons were made between the following groups (
Table **5.34** shows these groups):

1. Contrast N1: group "not at all" vs group "every week or nearly every week"
2. Contrast N2: group "a few times a year" vs group "once or twice a month"

In Table 5.35, the first contrast shows that, on average, respondents who indicated that they did not spend time with colleagues outside the workplace "at all" were less likely to sign a petition, participate in public demonstration or in strikes than those who indicated that they spent every week or nearly every week with their colleagues. Further, those who spend "a few times a year" seemed to be less likely to participate in these political activities than those who spend times with colleagues "once or twice a month". These differences in (mean) attitudes towards CCS between compared groups are statistically significant and these differences represent small-sized effects.

Table 5.35: *Testing relationship between social capital and political activism*

	Signed a petition		Taken part in a lawful public demonstration		Participated in strikes	
	Contrast N1	Contrast N2	Contrast N1	Contrast N2	Contrast N1	Contrast N2
contrast value	-.11	-.03	-.05	-.03	-.02	-.01
t value	-3.11[ac]	-.98[bc]	-2.74[ac]	-1.96[ac]	-2.29[ac]	-1.56[bc]
effect size	.12	.03	.13	.07	.11	.06

Note: [a] statistically significant at $p<.05$; [b] statistically not significant; [c] equal variances not assumed.

Further, we found that political activism relates to participants' attitudes towards the local project (see Table 5.37). Respondents who signed a petition or taken part in a lawful demonstration were less positive about the local CCS project than those respondents who were not politically active. These differences in opinion are statistically significant.

Table 5.36: *Relationship between political activism and support for CCS*

	Attitudes towards the local CCS project[d]	
	Mean	SD
Signed a petition		
No	4.44	1.55
Yes	4.23	1.66
t value	2.66[ac]	
size effect	.06	
Taken part in a lawful public demonstration		
No	4.37	1.59
Yes	3.90	1.74
t value	2.67[ac]	
size effect	.06	
Participated in strikes		
No	4.34	1.60
Yes	4.75	1.70
t value	-1.252[bc]	
size effect	.03	

Note: [a] statistically significant at $p<.05$; [b] statistically not significant; [c] equal variances assumed; [d a] attitudes towards the local CCS project was measured after giving information about risks.

Conclusions

- **Knowledge of CCS**

Across all five countries surveyed, self-reported CCS awareness among public respondents was fairly good (in total about 56% of the public had heard of CCS technology, including 10% who claimed to know "quite a bit"). These results were generally higher than for the Eurobarometer on CCS (EC 2011) conducted at roughly the same time. Self-reported knowledge of CCS among stakeholders was considerably higher (only 3% had never heard of CCS and 78% claimed to know "quite a bit"). However, genuine knowledge of what CCS is supposed to do is notably lower for both the public and stakeholders – it was only 19% across all public surveys and just over half (51%) amongst the stakeholders. Even though the UK had the lowest self-reported public awareness (43%), it registered the highest level of genuine knowledge (31%), whereas the Netherlands, which had, by far, the highest claimed awareness (78%), had much lower genuine knowledge (21%). Polish and Spanish respondents showed the lowest levels of genuine knowledge.

- **Information sources**

We found that the most likely sources public respondents would go to for more information about the CCS project were interactive websites, university scientists/scientific publications and national or international NGOs. Possibly surprisingly, since the news media is frequently mentioned as an important source of information, it did not feature very prominently in either the public or stakeholder surveys. Among stakeholders, interactive websites were ranked much lower and the most likely sources for more information were university scientists/scientific publications, national/international NGOs and local NGOs/community groups. More striking was that stakeholders were more likely to consult different sources and more than half consulted any of six

different sources of information.

At a cross-national level, public respondents in the UK, Poland and Spain chose interactive websites as the most preferred source of information about CCS, whereas Dutch respondents opted for the local government and German respondents named university scientists. Across all countries, the least likely sources of information were the EU, the developers and word of mouth. Local and national governments and media outlets scored somewhere in the middle. The relatively low important of traditional media outlets may be explained by easy access to the internet and emergence of new ways of information gathering through internet, particularly about technical issues. Like stakeholders, German and Dutch public respondents were also much more likely to choose multiple sources of information and six different sources were listed by over half of respondents. These figures were considerably higher than in other countries.

Stakeholders were also very likely to seek additional information about the CCS project. Among public respondents, only the Dutch respondents were more likely than not to want additional information about the project.

- **Trust**

Both stakeholders and members of the public trusted university scientists most to provide impartial information about CCS. By contrast, whereas interactive websites were the most likely source for the public to consult, they were seen as much less trustworthy. More generally, likely source of information does not necessarily correlate with trust. Trust in project developers and energy companies is, notably since they are the main sources of information on the project, very low.

The survey showed that European politicians and project developers were among the least trusted actors to take local concerns seriously. On the other hand, national and local NGOs scored highest in terms of trust. Similar to public respondents, stakeholders appeared to most distrust the project developers, European politicians and national politicians. Among those most trusted to take local concerns seriously for stakeholders were local NGOs and national NGOs.

It was rather surprising to see that, although media was not a popular source of information, local media in particular were viewed as a trusted source on local matters, especially in the UK and Poland. In the Netherlands, Germany and Spain, public respondents trusted local NGOs most. For UK and German respondents, European politicians were the least trusted to take local concerns, while in Poland and Spain, respondents trust national politicians the least and in the Netherlands, project developers were the least trusted.

Further, on net, respondents tended to disagree that the local community were treated fairly in past developments. In the Netherlands alone, more respondents agreed that they were treated fairly in past developments, whereas in Poland, respondents very negative (net -32%). All other countries were slightly negative.

- **Opinions and attitudes towards CCS**

The survey showed that public respondents from all five countries were supportive of CCS technology in general (net +51% favourable). By contrast, stakeholders were more negative about CCS in general than positive (net -20%). Support for CCS in general ranged from a net +72% favourable rating in Poland to +20% in Germany, which was more than 20% more negative than the next nearest country (+43% in the Netherlands). Relative to CCS in general, support for the local project was notably lower (10% lower net favourable rating among the public and 16% lower net favourable score among stakeholders). Net support declines among the public in all countries, most dramatically in Germany where, on net, more have an unfavourable view of the local project. In the other four countries, there are still large majorities who view the local project favourably (ranging

from +38% net favourable in the Netherlands to +66% in Poland).

- *Effect of information about risk on opinions about CCS*

An analysis of impact of additional information regarding risks of CCS on opinion towards the local project was conducted. Firstly, after being given additional information about risks of CCS technology, more than half of all respondents did not change their opinion towards the local project, more than one-third change their opinion towards more negative and slightly more than one-tenth even change to more positive view on the local project. However, the net effect is negative. Secondly, the (net) negative effect of additional information about risks of CCS on respondents' opinion is statistically significant for all five countries.

One can expect that the effect of additional information on attitudes towards the local project would be less pronounced for respondents who are more knowledgeable about CCS. As expected, respondents who are genuinely knowledgeable about CCS were less likely to change their opinion towards the local project than those who are not knowledgeable. This difference in change towards negative view on the local project is statistically significant. Further, females, on average, changed their opinion more than males did after additional information about risks of CCS was given. In both comparisons, the difference is statistically significant, although all groups, including males and those with genuine knowledge became more negative with additional information.

- *Attitudes towards CCS and distance to project*

Firstly, we should note that in general the relationship between respondents' position relative to the capture site and their attitudes towards CCS was found to be less pronounced than their position relative to the storage site.

Secondly, a linear trend (positive) between distance to the storage site and opinion about the local project was found. This can be associated with a NIMBY effect with respect to the CO_2 storage site. For the capture site, the relationship between distance to the site and respondents' opinion is more complex. We found that those who live quite near to the capture site were more positive towards the local project than those who live farther away. Expected local economic benefits from the project may explain this more positive attitude.

- *Attitudes towards CCS and trust in local actors*

Trust has been repeatedly found to be an important factor in residents' attitudes towards new infrastructure projects such as CCS. A significant linear relationship for all countries surveyed (except for respondents in Poland) was found between public respondents' attitudes towards the local project and their trust in the project developers. This linear trend indicates that as the support for the local project increased, trust in the project developers increased proportionately.

- *Attitudes towards CCS and local influence in the planning process and previous experience with infrastructure projects*

An analysis of relationships between respondents' perception related to local democratic traditions (as reflected by respondents' views on the fairness of the infrastructure planning process and their perceptions about the local community was treated in past developments) and their view the local CCS project was conducted. We found that there is a significant linear trend between perception about "fairness" in the planning process and opinion on the project. This indicates that as respondents' perception about fairness increases their view on the local project becomes proportionately more positive.

Similar analysis was conducted to test the relationship between perceptions about fair treatment in past developments and attitudes towards the local project, which was also found to be significant. In particular, as respondents' perception about fair treatment in the past increases, their view of the local project becomes proportionately more positive.

- *Attitudes towards CCS and opinions on coal and the environment*

It was found that there was a significant effect of respondents' opinion towards coal as energy source on levels of respondents' attitudes towards the local project. This indicates that as respondents' opinion on coal becomes more positive their view on the local project becomes proportionately more positive as well.

Another association we expected to influence perceptions of CCS was respondents' attitude towards environmental problems as a national priority. The relationship between respondents' attitudes towards the local CCS project is negatively associated with respondents' perceptions about the importance of "environment". Those who do not consider the environment to be a national priority are, on average, more supportive of the local CCS project compared with those who consider environment to be a national priority. This association demonstrates that CCS faces severe problems of acceptance from precisely the group of people who should be most supportive of it due to its potential to mitigate climate change.

- *Attitudes towards CCS and demographics*

In general, males seem to be more knowledgeable about CCS and less positive about CCS in general than females. Also, respondents with lower educational qualifications (less than an undergraduate degree) were found to be less knowledgeable about CCS than respondents with a university education. We also found that there was a significant effect of respondents' age on levels of respondents' knowledge of CCS – as respondent age increases they become proportionately more knowledgeable about CCS.

- **Risk perceptions**

Zero level risk (uncertainties over outcome) is relatively less worrisome for public respondents than higher order risk concepts. For example, public respondents are more worried about uncertainties in risk assessment than about outcomes in terms of the risks of CCS technology. Similarly, public respondents' are quite worried about second level risks (implicit assumptions about risk assessment). However, we should note that majority of respondents are either neutral or ignorant about implicit scientific assumptions used in risk assessment. It is not surprising that a large majority of public respondents and stakeholders agree with concerns over third level risks ('unknown unknowns').

For all countries surveyed, public respondents were more risk-averse regarding first level risks (uncertainties over parameters and models) than concerning zero level risk (uncertainties about outcome). More surprisingly, public respondents were more risk-averse over first level risk than over second level risk (uncertainties about the implicit assumptions). Further, as one would expect, respondents from all five countries were more risk-averse regarding third level risk than about the second level risk.

We hypothesised that these risks are intertwined with issues of trust. A statistical relationship between perceptions about outcome risks of CCS technology (zero level risk) and their trust in industry and national governments/politicians was found to be significant across most countries

surveyed. In all countries (except the Netherlands), it was found that respondents who are more risk averse were less trustworthy of national politicians and vice versa those who are risk prone tend to have higher trust in national politicians than those who were risk averse. In the Netherlands, this relationship is statistically not significant. Similarly, those who are risk-averse (about zero level risk) trust in the project developers less than those who are risk-prone. This relationship is statistically significant for all countries surveyed except for Poland.

- **Social Capital**

Social capital, measured here as time spent with colleagues outside the workplace and participation in environmental organisations, and political activism, measured as participation in strikes, public demonstrations and signing petitions, were found to have a number of statistically significant associations with attitudes towards CCS. As social capital increased, measured as associating with work colleagues, support for the local CCS project increased proportionately. Similar to the question on environment as a national priority, membership of an environmental organisation was actually associated with lower support for the local CCS project.

Social capital was also related directly to political activism. Those who spend more time with colleagues outside the workplace tended to sign petitions, participate in public demonstrations and/or in strikes more than those who spend less time. Further, those who signed petitions or took part in lawful demonstrations were less positive about the local CCS project than those who did not.

Appendix 5.1 – Screenshots of a respondent's view of survey tool

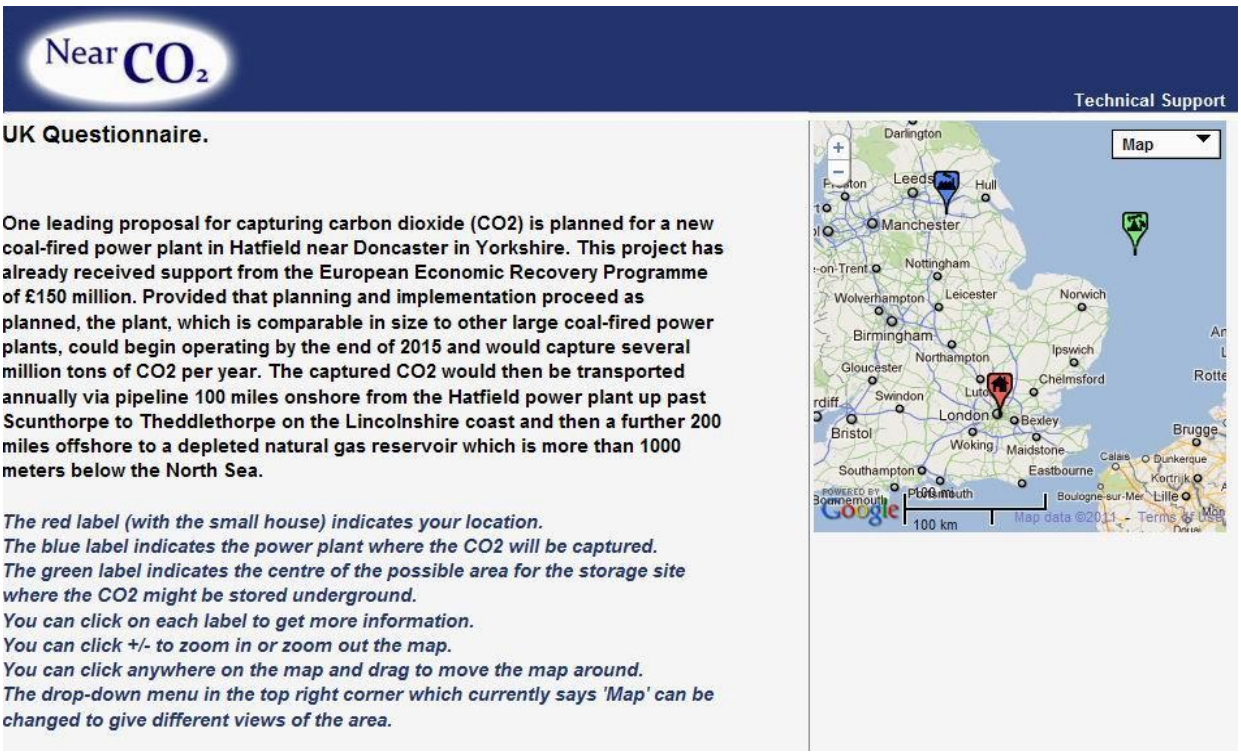

Figure A5.1.1 *Screenshot of geographic interface for UK survey assuming respondent is based in London, UK*

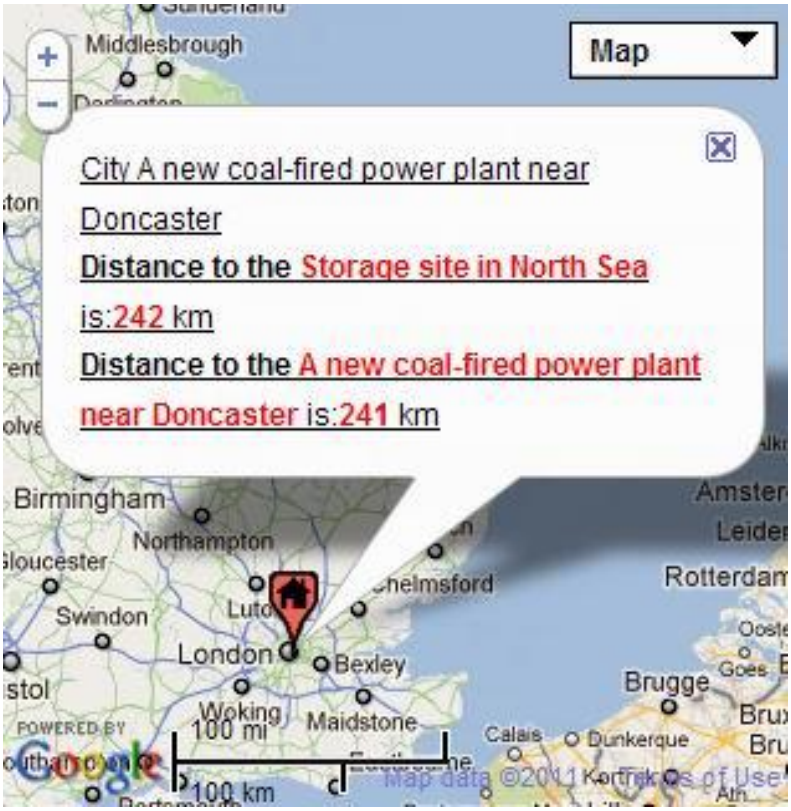

Figure A5.1.2 *Interactive "mouse-over" to determine distances from respondent's home to storage and capture sites*

Figure A5.1.2 *Screenshot of geographic interface for Dutch survey assuming respondent is based in Amsterdam, the Netherlands*

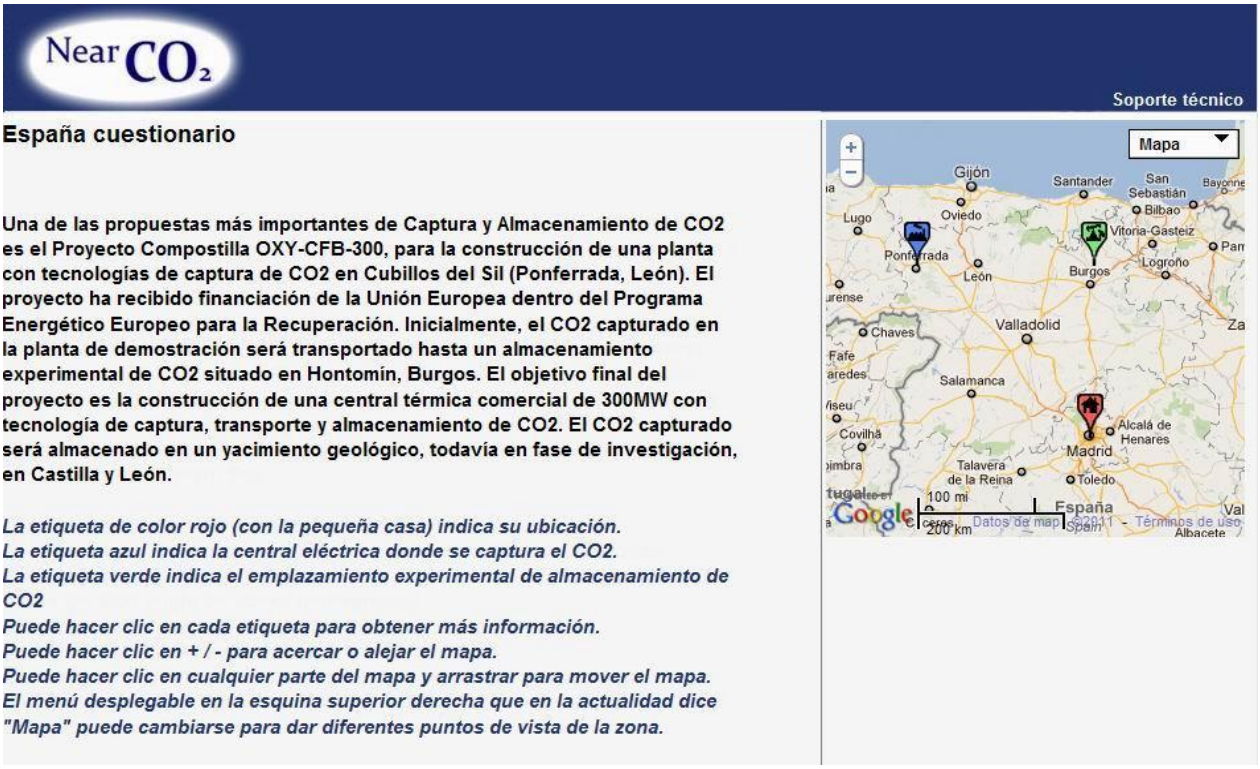

Figure A5.1.3 *Screenshot of geographic interface for Spanish survey assuming respondent is based in Madrid, Spain*

Figure A5.1.4 *Screenshot of geographic interface for Polish survey assuming respondent is based in Warsaw, Poland*

Figure A5.1.5 Screenshot of geographic interface for German survey assuming respondent is based in Berlin, Germany (note: all respondents were presented with two storage locations)

Appendix 5.2 – One-way ANOVA for testing relationship between attitudes towards the local project and the project developers

Test of Homogeneity of Variances: UK			
Levene Statistic	df1	df2	Sig.
2.031	6	340	.061
Test of Homogeneity of Variances: NL			
Levene Statistic	df1	df2	Sig.
2.951	6	325	.008
Test of Homogeneity of Variances: DE			
Levene Statistic	df1	df2	Sig.
1.883	6	440	.082
Test of Homogeneity of Variances: PL			
Levene Statistic	df1	df2	Sig.
2.598	6	471	.017
Test of Homogeneity of Variances: ES			
Levene Statistic	df1	df2	Sig.
.993	6	344	.430

Robust Tests of Equality of Means: NL				
	Statistica	df1	df2	Sig.
Welch	11.433	6	99.058	.000
Brown-Forsythe	10.355	6	156.084	.000

Robust Tests of Equality of Means: PL				
	Statistica	df1	df2	Sig.
Welch	3.821	6	40.042	.004
Brown-Forsythe	2.407	6	52.083	.040

ANOVA: UK							
			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		174.841	6	29.140	11.665	.000
	Linear Term	Unweighted	156.167	1	156.167	62.516	.000
		Weighted	158.982	1	158.982	63.643	.000
		Deviation	15.859	5	3.172	1.270	.277
Within Groups			849.332	340	2.498		
Total			1,024.173	346			
ANOVA: NL							
			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		123.073	6	20.512	10.263	.000
	Linear Term	Unweighted	109.949	1	109.949	55.010	.000
		Weighted	119.526	1	119.526	59.801	.000
		Deviation	3.547	5	.709	.355	.879
Within Groups			649.587	325	1.999		
Total			772.660	331			
ANOVA: DE							
			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		231.886	6	38.648	17.351	.000
	Linear Term	Unweighted	139.013	1	139.013	62.412	.000
		Weighted	222.000	1	222.000	99.670	.000
		Deviation	9.886	5	1.977	.888	.489
Within Groups			980.034	440	2.227		
Total			1,211.919	446			
ANOVA:PL							
			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		45.057	6	7.509	2.658	.015
	Linear Term	Unweighted	10.083	1	10.083	3.570	.059
		Weighted	24.290	1	24.290	8.599	.004
		Deviation	20.767	5	4.153	1.470	.198
Within Groups			1,330.483	471	2.825		
Total			1,375.540	477			
ANOVA: ES							
			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		253.356	6	42.226	15.114	.000
	Linear Term	Unweighted	203.294	1	203.294	72.767	.000
		Weighted	229.753	1	229.753	82.237	.000
		Deviation	23.603	5	4.721	1.690	.136
Within Groups			961.060	344	2.794		
Total			1,214.416	350			

Appendix 5.3 – One-way ANOVA for testing relationship between social

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
Signed a petition	19.369	3	1,921	.000
Taken part in a lawful public demonstration	17.955	3	1,921	.000
Participated in strikes	16.347	3	1,921	.000

ANOVA								
				Sum of Squares	df	Mean Square	F	Sig.
Signed a petition	Between Groups	(Combined)		3.430	3	1.143	4.654	.003
		Linear Term	Unweighted	2.613	1	2.613	10.635	.001
			Weighted	2.996	1	2.996	12.197	.000
			Deviation	.434	2	.217	.882	.414
	Within Groups			471.928	1,921	.246		
	Total			475.358	1,924			
Taken part in a lawful public demonstration	Between Groups	(Combined)		.596	3	.199	4.435	.004
		Linear Term	Unweighted	.530	1	.530	11.831	.001
			Weighted	.563	1	.563	12.568	.000
			Deviation	.033	2	.017	.369	.691
	Within Groups			86.102	1,921	.045		
	Total			86.698	1,924			
Participated in strikes	Between Groups	(Combined)		.162	3	.054	4.073	.007
		Linear Term	Unweighted	.142	1	.142	10.680	.001
			Weighted	.129	1	.129	9.696	.002
			Deviation	.033	2	.017	1.261	.283
	Within Groups			25.487	1,921	.013		
	Total			25.649	1,924			

	Signed a petition	Taken part in a lawful public demonstration	Participated in strikes
Combined			
ω (effect size)	0.08	0.07	0.07
Linear term			
ω (effect size)	0.07	0.08	0.07

Robust Tests of Equality of Means					
		Statistic[a]	df1	df2	Sig.
Signed a petition	Brown-Forsythe	4.640	3	1,705.362	.003
Taken part in a lawful public demonstration	Brown-Forsythe	4.048	3	1,297.123	.007
Participated in strikes	Brown-Forsythe	3.332	3	903.417	.019
a. Asymptotically F distributed.					

6. Analysis of the open questions

In the survey we also asked three open questions after the expositions of CCS generally and the specific projects: (1) what did respondents think would be the advantages of the project; (2) what were the disadvantages; and (3) whether they had any other questions or comments. To give a more detailed overview of these answers, and to provide a further explanation behind the rationale of the coding frame used for the quantitative analysis, this chapter will present a more in-depth, qualitative analysis of the open questions, paying attention to the main themes participants wrote about and how they interconnect. We will also present and analyse here some of less often voiced thoughts.

6.1 Introduction

The answers were manually coded with the aid of qualitative analysis software, NVivo. The most frequent recurrent themes are shown in tables 6.1, 6.2 and 6.3. Some differences between the countries were evident even without further quantitative analysis. For example, a much larger number of the UK respondents thought that the main advantage of the project was the creation of jobs than German or Dutch participants, in keeping with our hypothesis after the case study phase (see ch. 4) that respondents from the Yorkshire and Humberside region will be more concerned about the local economy than the local Dutch respondents.

In the following sections, we will present a more qualitative analysis which pays closer attention to some of the more detailed answers and seeks to explain the rationale behind the coding frame. It has to be kept in mind that qualitative analysis, as well as the coding process in general, is more open to interpretation of the coder, since in many cases the precise meaning of the answer isn't entirely clear – there were, for example, many cases of sarcasm especially in answering the first question on advantages:

> One of the biggest advantages is surely that Vattenfall won't for the moment have to think about changing their energy policy, polishing up their image, and keeping on displacing villages to develop new coal fields![23] (Germany)

Sarcasm in this vein unfortunately wasn't always as obvious. Nor is it always clear when respondents use terms that are ambiguous, either because a word or term has double meaning or because the respondent is unclear in their own minds or when the respondent is either confused or trying to make a subtle point in a short space.

The variety of answers in the open question was very rich and produced some interesting but, of course, not representative answers. In this section we provide a qualitative overview of these answers, paying attention to describing the various categories into which answers were coded for the following quantitative analysis of the open questions, but it will also show some of the more unusual but interesting answers which were not made often enough to be included into the main categories.

6.2 Advantages

[23] Einer der größten Vorteile ist sicherlich der, dass Vattenfall ersteinmal keine Gedanken über eine wende in ihrer Energiepolitik machen muss, ihr Image aufpolliert und weiterhin Dörfer versetzen kann um neue Kohlevorkommen zu erschließen!

The question on what respondents saw as the main advantages of the project elicited some interesting permutations of answers across the five countries. Across the board, unsurprisingly, most people (818) listed the reduction of CO_2 emissions as the main advantage. Within this large coding category however, there were some surprising variations: at first responses were divided between those that listed CO_2 reduction or fighting global warming on the one hand, and those that were more general remarks that it "benefits the environment" on the other. However, it became clear that there was often no clear or obvious divide between these types of comments: some respondents may clearly have meant "better for the environment" to refer to global warming, which may also reflect subtle differences in language ("Umwelt" in German for example is usually understand to refer to the global environment as well as the local environment, more than would be the case for the English "environment"; similarly the Spanish answer "contamination" would translate into "pollution", which however can also refer to the contamination of the atmosphere and therefore imply reduction of CO_2 emissions). On the other hand, some respondents listed both CO_2 reduction and the environment as advantages, showing that they thought these were separate advantages: "Climate change prevention, better environment[24]" (Netherlands). When a respondent mentioned both CO_2 emissions *and* a better environment, the answer was coded under both categories.

Some respondents thought that the main advantage of CCS is the *removal* of CO_2 from the atmosphere; these comments were included as well, since it often wasn't clear whether the comment arose through misunderstanding of our exposition of CCS, or because it was simply unfortunately formulated:

> overal [sic] reduction of CO_2 in atmoshere [sic] reducing effects on environment and helping maintain safe atmosphere for all inhabitants of the world (UK)

Also, through the complication of comparing answers across five different languages we were inclined to be generous in the interpretation on this point since the methodology would otherwise be too vulnerable to subtle nuances we were unable to discern in a consistent manner.

Some respondents linked the reduction of CO_2 emissions (and thus cleaner air) not so much to its benefits to climate change, but to the health and well-being of the population: "the health of living beings, including humans"[25] (Spain).

Next to the reduction of CO_2 emissions or the project otherwise benefiting the environment, one of the main advantages that respondents saw of the project was the creation of jobs. This, interestingly showed a great variation between the different countries: While in the UK, Polish and Spanish surveys, "jobs" was one of the main categories, it featured much less in the German and especially the Dutch survey, which seems to support our hypotheses on the local character of the projects.

A smaller but still considerable number saw energy security as a major advantage of CCS. This category tied together perceptions that CCS will allow their country to be less dependent on foreign imports with the hope that it will allow continued use of coal and therefore benefit the local (mining) communities as well. Coal, however, was not always seen as a positive: Especially in Germany, coal mining was sometimes associated with the disruptive effects of surface mining for lignite, with the accompanied displacement of villages and communities. Since a number of respondents used the "advantages" question to detail what they thought were the disadvantages, this will be explored more below.

Also a number of respondents thought that CCS would be a cheaper way to produce energy, since it would make coal burning environmentally feasible again, and coal is, after all, relatively cheap

[24] Klimaatveranderingen tegen gaan, beter milieu
[25] la salud de los seres vivios, incluídas las personas

(though this was balanced by the number of respondents who for the "disadvantages" question thought CCS would on the whole be too expensive, see below). Related to this was the category of answers that identified the provision of "clean energy" as the main advantage of CCS (answers that simply stated "provides energy" can be assumed to imply that the energy is clean – the difference between this code and the overall "good for environment" one is that the emphasis is very much on the energy it provides).

The location of the project was also frequently listed as an advantage, especially in the UK and the Netherlands, where the planned storage site would be offshore: This was often mentioned explicitly ("carbon will be stored offshore away from inhabited areas" UK) and, in the Netherlands, sometimes compared directly to the (onshore) Barendrecht project ("In any case it is not (stored) under habited areas, such as the previously proposed plan to store CO_2 in Barendrecht."[26] Netherlands) or, more often, implicitly: "CO2 capture. No furious citizens" (Netherlands).

The location was mentioned as a positive – though less often – in the other countries as well. In Germany for example, a respondent noted that "the area is relatively unpopulated and this is a probably unique attempt to attack the CO_2 problem constructively"[27] (Germany). The location was, predictably, also a major negative factor (see below), especially by the local respondents.
A few Polish respondents also noted the central location of Belchatów within the country as a positive.

Much more frequently it was mentioned that the local area would benefit economically from the project (see also the "jobs" category above), or that it would give the region an "important technological advantage"[28] (Germany). In particular, one German respondent commented that

> finally they will finish what they started in the GDR and abandoned [flachgelegt] – like many other things – with reunification. (PS: my then employer was one of the major deliverers for the building of the power plant in Jänschwalde)[29] (Germany)

demonstrating the still considerable economic difficulties faced by east Germany after reunification and some of the resentment felt by the local population over how the transition was managed (these misgivings are also shown more strongly in the "disadvantages" question, and were in particular also made by some of the local stakeholders).

It was also mentioned that the plant was close to the coal mining area, meaning shorter transportation distance (in the UK, though it was also seen as a disadvantage by some because they thought that there were no longer any active mines in the Yorkshire and Humberside region), or the closeness of the plant to the storage site (in the Netherlands – this was obviously a disadvantage for some of the other countries).

More flippantly, some respondents thought the 'location' of the particular project was an advantage in the sense that it was "not in Berlin", or wherever else the respondent lived.

Of the less frequently mentioned advantages, a few stand out as particularly interesting. First, many

---

[26] Het is in ieder geval niet onder bewoont gebied zoals het eerder voorgestelde plan om co2 onder Barendrecht op te slaan.

[27] Das Gebiet ist relativ unbewohnt und stellt wohl einen einzigartigen Versuch dar, das CO2 Problem konstruktiv anzugehen.

[28] Bei Anwendung des Projektes hätte Brandenburg eine wichtigen technologie Vorsprung

[29] dass man endlich mal das fertigstellt, was in der DDR begonnen und durch die Wiedervereinigung - wie vieles andere - plattgemacht wurde (PS: mein damaliger Arbeitgeber war einer der Hauptzulieferanten für den Bau des Kraftwerkes in Jänschwalde).

responses state that CCS will protect the ozone layer, stop acid rain, or reduce extreme weather events, which, with the exception of the latter, may have been influenced by our earlier question testing 'genuine knowledge' (see Section 5.2) which listed acid rain and the ozone layers as options to the question of what CCS was designed to combat. Since less than a fifth of the public answered the knowledge question correctly, a majority of respondents evidently associate CCS with other environmental problems.

A number of respondents, especially in the UK and Germany thought that the main advantage of CCS is that it's "not nuclear". Some of these answers may however, hide a small amount of sarcasm: "better than nuclear energy and its rubbish"[30] (Germany). On the whole, the comparison with nuclear power was associated with a more negative view of CCS (for a more detailed discussion in the context of the Dialogue Boards, see Section 7.2.7). Energy efficiency was also cited fairly frequently, with CCS being seen as, for example, more efficient than wind. A few respondents also thought that implementing CCS will buy time to further develop renewable energy technologies.

One particular advantage that was only mentioned in Poland was that the project would help the country meet its EU emission targets and thus escape hefty projected fines:

> Reduction of CO_2 emissions, reduce penalties for the emissions imposed on Poland by the EU, reducing unemployment in the region[31] (Poland)

Other less frequently listed advantages were "the development of new technologies", that it showcases a positive image of the country (often in Poland) abroad, that it is safe and has little impact on the environment or local people, that it will help raise the public awareness of climate change, that it utilises existing storage fields or power plants (and conversely, that it will help develop new ones), and that it "gets rid of the waste", or finally that they think it is a positive development or technology, but without specifying why. The "development of technology" argument was made particularly often by the stakeholders.

When respondents from countries other than Poland referred to emission targets, they were either unspecified or referred to the Kyoto agreement – only Polish respondents were worried about fines for not complying with EU targets.

Respondents also often simply mentioned "the storage"; that it is seen as good because it uses the waste products (it was not entirely clear whether this signified a misunderstanding of the technology or was clumsily formulated).

Finally, there were a number of answers that appeared to make little sense, such as "life", "everything" or "not Norway or Canada", where we would probably run the danger of overanalysing and misinterpreting if we tried to fit them into specific categories.

Before going on to the section on perceived disadvantages, it needs to be pointed out that a substantial number of respondents (152) used the question on advantages to list their doubts or reservations about the project (possibly because the question was asked first and they didn't know that a question on disadvantages would follow– a point made explicitly by one respondent). Among those, a large portion simply wrote that they saw no advantage without specifying further (though in some cases it is difficult to differentiate those from the simple non-responses: Does "none" mean

[30] besser als atomstrom und dessen müll

[31] Ograniczenie emisji Co2, zmniejszenie kar za tą emisje nakładane na Polskę przez UE, zmniejszenie bezrobocia w tym regionie

that the respondent sees no advantage, or that they can't think of any answers? Often though, the intended meaning was clear enough: "I see no advantages"). Among the reasons given for doubts about the technology, the most frequent were worries about the safety of the project. Possible leakage was mentioned frequently, but more often it was felt that there may be unforeseen consequences in the long term because the technology is still in its infancy:

> Not only dangerous underground, whose consequences are incalculable in an environmental disaster! (Netherlands)
>
> Well, I think there is no benefit in trying to hide the CO_2, and it could produce natural disasters if there are any leaks and the death of many living things[32] (Spain)
>
> The harmful CO_2 would be underground – before doing this though more research needs to be done, whether for future generations it is reasonable [zumutbar] to know there is a ticking time-bomb underneath.[33] (Germany)

Some worried that CCS is only a short-term solution and does not tackle the real problems of high energy consumption, and possibly storing problems for future generations: "Sham, partial settlement of the problem of CO_2"[34] (Poland); "Postponement of a problem"[35] (Germany). Others worried that it is too expensive or that we should be looking at other energy technologies: "We should be planting more trees that help reduce CO2 immersions" (UK); "no [advantages], it's not about storing CO_2, but about avoiding it"[36] (Germany).

Finally, a considerable number of respondents, particularly in Germany, felt that the technology is pursued purely for the benefits of the energy industry or politicians: "no benefits, just concerned citizens and wasting money and profits of oil giants"[37] (Netherlands); "Benefits only for the friends of politicians"[38] (Spain); "a bit of sarcasm if you like? Some few will earn a lot to the detriment of the broad public"[39] (Germany).

The German stakeholders were particularly negative about CCS in general, even in the "advantages" question, where the main worries seemed to be the profit-motive of the developers and other similar remarks that highlighted a lack of trust in both developers and politicians – including some who were politicians themselves.

Perceived disadvantages will be discussed in more detail in the following section.

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[32] Pues creo que no tiene ningún beneficio el intentar esconder el CO2, y puede producir desastres naturales si existen fugas y la muerte de muchos seres vivos

[33] Das schädliche C02 wäre unter der Erde- vor der Realisierung sollte aber noch geforscht werden, ob es für kommende Generationen zumutbar ist unter sich im Boden eine tickende Zeitbombe zu wissen.

[34] .Pozorne, częściowe załatwienie problemu CO2

[35] Aufschiebung eines Problems

[36] keine, es geht nicht darum CO2 zu speichern, sondern zu vermeiden..

[37] geen voordelen,alleen verontruste burgers en geld verspilling en winsten van oliereuzen

[38] Beneficios sólo para los amigos de los políticos.

[39] ein wenig sarkasmus gefällig? einige wenige verdienen sehr viel auf kosten deer [sic] breiten masse

Table 6.1: *Summary of most often named advantages*

Number of occurrences	Category	Comments	Examples
818	Reduced CO_2 emissions	CCS serves to reduce CO2 emissions; helps fight climate change	That a considerable part of CO2 emissions is processed and it therefore has no adverse effects.[40] (Netherlands)
434	No answer/don't know	-	-
329	Good for the environment	CCS benefits the environment, but emission reductions or climate change is not mentioned	Improving the environment[41] (Spain) It will be more environmentally friendly and prevent further global warming (UK)
98	Creates jobs	-	Creation of investment and with that employment[42] (Germany)
53	It's offshore	Only in the UK and the Netherlands	It's certainly not under inhabited areas such as the previously proposed plan to store CO2 in Barendrecht.[43] (Netherlands)
44	Cuts costs; helps economy	-	Money for Germany[44]
43	Energy security	-	Increase energy security while not increasing the risk of contamination Environment[45] (Poland)
38	Provides (clean) energy	-	generating clean energy[46] (Spain)
37	Good, undefined	-	Excellent idea[47] (Netherlands)
34	Distance	Many respondents saw it as a positive that project would be far away from them or that the distance between capture and storage would be short.	Reduce CO2 in the atmosphere, relatively short distance from storage point[48] (Netherlands) Berlin will be spared[49] (Germany)
28	Safety; storage is safe	-	Absolutely safe and not bother anyone[50] (Netherlands)

[40] Dat een flink deel van de CO2 uitstoot verwerkt wordt en zodoende geen nadelige gevolgen kan hebben.
[41] mejorar el medio ambiente
[42] Schaffung von Investition und damit Arbeitsplätze
[43] Het is in ieder geval niet onder bewoont gebied zoals het eerder voorgestelde plan om co2 onder Barendrecht op te slaan.
[44] geld für deutschland
[45] Zwiekszenie bezpieczeństwa energetycznego przy jednoczesnym nie zwiększaniu ryzyka skazenia środowiska naturalnego
[46] generar energía limpia
[47] uitstekend idée
[48] vermindering co2 in de atmosfeer; relatief korte afstand tot opslagpunt
[49] Berlin bleibt verschont
[50] Volstrekt veilig en niemand tot last

Number of occurrences	Category	Comments	Examples
17	Energy efficiency	-	iT [sic] keeps the air cleaner and use less energy (UK)
16	"The storage"	Some respondents just listed "storage" as an advantage, without elaborating further	proper storage[51] (Netherlands)
15	Ozone layer	-	It would generate employment and help reduce the ozone layer[52] (Spain)
10	Not nuclear		Better than nuclear energy and its rubbish[53] (Germany)
9	Development of new technology	-	Integrating Spain at the forefront of research for CO2 capture[54] (Spain) Permanent or at least long-term storage of the CO2, testing of new technologies[55] (Germany)
152	Disadvantages/no advantages	Subdivided into: • Sceptical about climate change • Doubts over safety/whether CCS works • Too expensive • Distrusting industry/politicians • No advantages at all • Other	Capturing CO2 is nonsense, during the creation of the earth was much more CO2. The earth is busy with his next cycle. Man thinks he actually influenced everything he has against the earth is less than an ant[56] (Netherlands) What happens when this stuff leaks and we get a more concentrated burst of CO2 into the atmosphere? (UK) That the taxpayer will once again be asked to the till[57] (Germany) It benefits only the friends of politicians[58] (Spain) None, I don't think burying a contaminant is the solution[59] (Spain)

[51] goede opslag
[52] . generaría trabajo y ayudaría a reducir la capa de ozono
[53] besser als atomstrom und dessen mull
[54] Integrar a España en la vanguardia de la investigación de captura de CO2
[55] dauerhafte oder zumindest langfristige Lagerung des CO2, Erprobung neuer Technologien
[56] het opvangen van Co2 is onzin, tijdens het ontstaan van de aarde was de Co2 veel meer. De aarde is met zijn volgende cyclus bezig. De mens denkt dat hij alles beinvloed eigenlijk is hij ten opzichte van de aarde nog minder dan een mie
[57] Das der Steuerzahler mal wieder zur Kasse gebeten wird
[58] Beneficios sólo para los amigos de los políticos.
[59] Ninguno, enterrar un contaminante no creo que sea la solucion.

6.3 Disadvantages

As shown also in the pervious section, many respondents felt very strongly about perceived disadvantages of CCS in general and the specific projects, although again there was considerable variation between the countries, with the German respondents being much more negative and distrusting than others, for example, the Spanish. The strength of the feeling for or against CCS is, of course, not always evident from the open answers alone. As we ask a specific question about disadvantages, even otherwise positive leaning respondents can think of possible risks or other objections. This was at times evident in the answers: "if there's no accident there should not be any negative effects of this project"[60] (Poland); "In principle I don't see any [disadvantages] maybe the economic costs"[61] (Spain).

Thus the strength of feeling for or against CCS is therefore better assessed through the quantitative questions discussed in Chapter 5. However, sometimes respondents made their feelings plain enough:

> Nonsense constructed out of lies! There are people dying of hunger! How long do you want to continue with this idiocy [Schwachsinn]?[62] (Germany)

As with the previous question, coding was often a matter of judgement, and therefore there were often no clear dividing lines between some of the categories used. In the most frequent overall category (after "no idea"), answers were divided into those that made explicit mention of leakage risks, those that mentioned risks to the environment or creating more pollution, risks of explosions, unforeseen or incalculable risks (including worries about CCS being an unproven technology) and finally unspecified risks (answers that for example consist of single words like "dangerous"). These were often not entirely separable, since for example respondents who worry about explosions may also worry about leakage (occasioned by the explosion), and of course respondents who think CCS is dangerous may well be thinking about leakages or explosions.

Of these categories, the one about "unforeseen risks" seemed particularly interesting in the light of our risk classification framework introduced in Chapter 2, and was a frequently cited concern particularly in the UK and Germany. It is also very interesting in the light of the risk perception questions we asked in the survey (see Section 5.6) where respondents tended to agree more with the statement that unforeseen events could happen, than with the statement that experts' risk assessments are accurate. This differentiation between uncertainties and "deeper" uncertainties was also a feature of the dialogue boards discussed in the following chapter.

Answers commenting on "deeper" uncertainties included respondents who were clearly worried that despite best intentions, accidents are always bound to happen, because nothing is ever "100% safe"[63] (Germany), and that even experts can disagree: "I suspect that even among the experts on this topic there are differences of opinion."[64] (Poland). Frequent references were made to phrases such as "ticking timebomb"[65] (Germany), or "sitting on top a so-called gunpowder barrel"[66]

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60 jeśli nie będzie żadnych awarii to nie powinno byc żadnych ujemnych skutków tego projektu.

61 en un principio no veo ninguno, quizas los costes economicos

62 auf lüge aufgebauter unsinn! es gibt menschen die verhungern! wie lange wollt ihr diesen schwachsinn noch weiter betreiben?

63 keine 100% Sicherheit

64 Podejrzewam, że nawet między specjalistami są na ten temat różnice zdań. Nie znam sie na tym..

65 Man sitzt auf einer tickenden Zeitbombe.

66 ich kann nicht einschätzen, ob man dann nicht auf einem sogenannten Pulverfass sitzt, sollte solch eine Lagerstätte

(Germany), echoing the feeling that the technology appears risky to respondents because it is unpredictable. "Unforeseen events" for example was a term that was used to describe the unpredictable nature of the technology as seen by a respondent: "The CO2 that is now stored will lead to problems sooner or later due to unforeseen events"[67] (Netherlands).

Similarly, many respondents felt uneasy with the technology because it is still new and in development, and that therefore long-term consequences are unknown: for example, "potential risks of untried technology. Lull people into a false sense of security" (UK) or, the "consequences are not yet researched"[68] (Germany).

The "long-term" perspective was a very frequently cited worry:

> The main drawback is the lack of knowledge of what will happen in x years with the stored CO_2 .... How long can it be stored without triggering problems?[69] (Spain)

This demonstrates the difficulty for current safety research and/or demonstration projects to assuage some of the most frequently mentioned worries about CCS, because the long-term future is not something easily accessible through empirical research and therefore the "deeper" uncertainty of the higher levels (see Section 5.6 on Risk Perceptions) dominates.

Another worry about the unknown and unpredictable was the human element: what if there are accidents, and will the workforce be qualified enough to handle them?

> Maybe it might be dangerous if the workforce is not qualified enough (which in this country is very likely) and the consequence that there may be an accident in these plants[70] (Spain)

> This, as previously: it worries me underground storage and eventual release of CO2 into the air, after all, accidents do happen. It seems to me that we can not ensure complete safety.[71] (Poland)

Apart from unforeseen or incalculable long-term risks, many respondents were simply worried that there may be leaks, or that it is in some way bad for the environment or produces more pollution. The risks of sudden and catastrophic release whether explosion or otherwise was also mentioned frequently (one respondent compared the storage to a champagne bottle[72]). In the two offshore countries (UK and the Netherlands), some of the respondents were worried about the effect on the ocean and marine wildlife, while respondents in the on-shore countries (UK, Poland, Spain and particularly Germany) worried about the effect the CO_2 might have on the groundwater. Several respondents were also worried about the effect that CO_2 storage or drilling the shafts might have on the local geology: "Because of the drilling the rock layers could become shaky"[73] (Germany).

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defekt sein, würde mit einem Schlage eine große Menge CO2 an die Umwelt abgegeben werden.

67 De CO2 die nu wordt opgeslagen, zal vroeg of laat problemen gaan opleveren door onvoorziene gebeurtenissen.

68 Folgen sind nicht erforscht

69 El inconveniente principal es el desconocimiento de lo que pasará dentro de x años con el co2 almacenado.... ¿hasta cuando se puede almacenar sin que genere problemas?

70 Que tal vez sea peligroso si el personal no esta lo suficientemente cualificado (cosa que en este pais es muy probable) y la consecuencia que pueda tener un accidente en esas plantas. (Spanish public)

71 To, co poprzednio: niepokoi mnie magazynowanie pod ziemią oraz ewentualne uwalnianie sie CO2 do powietrza, przecież awarie się zdarzaja. Wydaje mi się, że nie można zapewnić pełnego bezpieczeństwa.

72 If the release is after the gap from the depths of the earth CO2 may lead to a mighty explosion just as quickly releasing co2 from a bottle of champagne. (Poland): W razie uwolnienie się po przez szczeliny z głębi ziemie CO2 może dojść do potężnego wybuchu tak jak np. uwalniający się szybko co2 z butelki szampana.

73 durch bohrungen können die gesteinsschichten wakelig [sic] werden

In Germany in particular, the analogy with nuclear waste was made fairly often, which probably follows from the public debate in Germany around nuclear waste which seems more developed than in other countries.

> The storage of the waste, it sounds a bit like used uranium rods, which also have to somehow be stored, thus we would have already two time-bombs lying somewhere close to us[74] (Germany)

The locality of the project was also often seen as problematic. While a few simply stated that they're "not sure I'd like it happening so close to my area" (UK), concerns about effects on the local community went far beyond the often caricatured NIMBYism and included valid concerns about safety and social justice for the local population (not all of these comments were clearly written by local residents). The effect on house prices was mentioned in the UK, though not very frequently (three times). The idea that this region was being used as a "guinea-pig" was also formulated, which had a particular resonance in Germany where the area is part of the economically deprived East:

> Nobody knows about the consequences of the storage in deep geological formations [Erdschichten] – well, that's why it's coming to Beeskow[75] (Germany)

or

> Nobody is being asked. CCS is still not tested. Testing area [testgelände] Brandenburg? CO_2 doesn't smell… should it some day leak after all, nobody would notice[76] (Germany)

Interestingly, in the Dutch survey, where – as outlined in the section above – many respondents saw it as a positive that the area is relatively unpopulated, many others made exactly the opposite point as well.

Interestingly, the negative effects on the local area was something much more often mentioned by the stakeholders, who tended to worry about tourism, local economy and (in Germany) economic regeneration of the East.

Of the other potential risks that were mentioned less frequently, the threat of terrorism or possible future wars came up a few times, some thought it might trigger earthquakes, some worried about radioactivity and some were worried about who takes on the liability should things go wrong – the latter being more prevalent among the stakeholders. Four respondents thought it was "playing with nature". In Germany especially, some respondents were worried about the effects on coal-mining either in general, or the effect it has on the local community through surface mining and the displacement of villages. Lake Nyos was mentioned twice.

Next to the risks of CCS either to the environment or the population, most of the perceived disadvantages related to the costs of the technology. Though most simply mentioned "costs", there was nevertheless some variation in what these costs may be, or who the respondents worried would have to pay them. On the one hand, many respondents worried about higher electricity prices, while others worried that the construction might have to be heavily subsidised by taxpayers' money ("Money being drawn out of the citizen's pocket. Everybody wants the ordinary man to pay more",

[74] Die Ablagerung der Reste, es hört sich einbischen [sic] an wie ausgebrannte Uran-Stäbe, die auch irgendwo zwischengelagert werden, somit hätten wir schon zwei Zeitbomben irgendwo in unserer Näche [sic] liegen.

[75] Keiner weiß um die Auswirkungen der Lagerung in den tiefen Erdschichten- naja deshalb kommt es nach Beeskow

[76] niemand wird gefragt. ccs ist noch nicht erprobt. testgelände brandenburg? co2 ist geruchslos... selbst wenn es irgendwann doch austritt wird es keiner merken...

German public[77]), or even damage the economy as a whole ("In Poland? BANKRUPTCY"[78] – Polish, *caps in original*). It was also felt fairly often that CCS wouldn't be energy efficient. There was also some variation here between the countries, with particularly the Spanish respondents worried about costs more than risks. This may be an effect of people who have no strong opinions on CCS and therefore noting one of the more obvious disadvantages in the after all compulsory question. Spain was certainly also one of the countries where most respondents either wrote they didn't know any disadvantages or could not think of any. This though ties in with Spain having been one of the less concerned about CCS in the other questions, as shown in Chapter 5.

Other inconveniences for the local public that were not related to cost or safety/environmental risks which were frequently mentioned were the disruption the construction of power plant or pipeline would cause to the local population, either through increased traffic, noise or damaging the landscape. Many respondents felt that power plants and pipelines are "unsightly". There were also some isolated doubts about the benefits to the local area, it was worried for example that rather than the project benefiting the local job market, jobs would go to people from further away.

Many respondents questioned the feasibility or effectiveness of the project. While a few simply replied with "is it feasible?" or "not sure it will work", most in this category were more specific. On the one side there were concerns over whether the project would really make enough difference to carbon emissions: "This is a very expensive drop in the ocean"[79] (Netherlands). While some isolated answers coupled this with general scepticism towards climate change ("will it make any real difference to CO_2 globally - if that is really a problem", UK), others were concerned that it would be just one power plant in one country which, compared to China or the US, isn't even a main producer of CO_2:

> we are only a small island. What about China and the USA who are the worst culprits for co2 emmissions and polution [sic]? (UK)

Interestingly, quite a lot of the respondents especially in the UK were worried about storage space, how much space is there, and what do we do when we run out?

Some respondents didn't like the technology. This could be because they think it would divert funds away from alternative energy sources

> So like I said no way - more money earmarked for this purpose devote the photovoltaic panels, energy derived from winds, etc.[80] (Poland)

We should instead be looking at alternatives that do not produce any waste:

> that it is junk that you must lose. wind and sun do not litter.[81] (Netherlands)

Especially the latter concern is related to another frequent complaint about CCS, that it is not a real solution to CO2 production which stores up waste for future generations to deal with ("It's fighting the symptoms, not the cause"[82]; "Handing the problem to the next generations"[83], Germany). CCS would still be producing CO_2, and therefore it's not a real solution. It was also felt by a few

[77] Geld den Bürger aus der Tasche ziehen. Alle wollen das der einfache Mann mehr bezahlt
[78] w Polsce? BANKRUCTWO
[79] dit is een zeer dure druppel op een gloeiende plaat
[80] Jak powiedzialem nie tedy droga - lepiej pieniadze przeznaczane na ten cel przeznaczyc na panele fotowoltaiczne, energie pozyskiwana z wiatrow itp.
[81] dat het toch rommel is die je kwijt moet. wind en zon maken geen rommel.
[82] bekämpft Symptome, nicht die Ursache
[83] Weitergabe des Problems an die nachfolgenden Generationen

respondents that the technology would create complacency about the urgency of acting on climate change, some of which saw the technology as a ploy to make the coal industry look greener than it is ("Or is this a great solution that the industry gives a license to continue polluting to produce."[84] Netherlands). Additionally, some respondents thought CCS is a bad idea because it would still be depleting natural resources, and we would still run out of coal eventually. One worry which was only voiced by stakeholders, was that CO_2 storage would negate any possible future use of the area for geothermal energy.

There were also some interesting answers which saw one of the main disadvantages the lack of public support or understanding. Some respondents thought that it's a nice idea, but would have difficulties with "NIMBYs"[85]. Though it was not always clear here whether it was thought whether the prophesised local unrest was justified or not, some respondents made it clear that it was not:

> The fear of the local population, which is however mostly unjustified[86] (Germany)

Others sounded slightly more doubtful themselves:

> The public would have to be convinced that this was the viable way forward for energy conservation. Which may not be easy. (UK)

The possible resistance of the population, justified or otherwise, would itself bring its own disadvantages, for example the costs of policing public protests[87].
Some respondents also felt that one of the main problems for CCS would come from the official side, either because it would be difficult to get planning permission[88], or, for a couple in Poland and Germany, face opposition from politicians[89]. There was also some dissatisfaction and anticipated problems over environmental campaigners ("Green nutters might not be happy with it and they will start winging [sic] as usual" UK).

[84] Of is dit een oplossing die de grote industrie een vrijbrief geeft om vervuilend te blijven produceren.
[85] NIMBY attitude of people nearby. (UK public)
[86] Die Angst der Anwohner, die allerdings zum größten Teil unbegründet ist.
[87] menschliche wderstand [sic] und die entstehenden polizeikosten
[88] Planning permission and local objections. (UK public)
[89] governmental problems: problemy rzadowe (Polish public)

Table 6.2: *Summary of most often named disadvantages*

Number of occurrences	Category	Comments	Examples
587	No answer, not sure	-	-
313	Expensive	-	The construction of infrastructure will be expensive[90] (Spain)
243	Unforeseen problems; untested technology	Worries over long-term behaviour of the CO2 or whether the technology is sound and tested	No long-term study possible over consequences of the storage[91] (Germany)
212	Safety worries, unspecified or general	-	Is storage safe? (UK)
181	No disadvantages	Possibility of confusion with no answer possible, in many cases not entirely clear what was meant	I do not see any adverse effects[92] (Poland)
142	Risk of leakage	-	Danger of leakage of CO2 from storage sites[93] (Germany)
141	Bad for environment	-	Pollution of the environment[94] (Germany)
79	Not solving the problem	Worries that CCS is a short term solution, the real problem of CO_2 production is not being addressed, or that it won't make a difference globally	We need to reduce production of co2 not just store It for possible problems for future generations. (UK)
77	Effect on locality	Negative effects on the area, local people won't get a say	Displacement of villages and parishes[95] (Germany)
53	Worries over transport	-	Pipeline crossing through the large urban agglomeration[96] (Poland)
52	Public acceptance	The public won't accept or understand the technology; people don't want it in their backyards	Unrest among the people who live near and have no experience with this project[97] (Netherlands)
31	Limitations of storage capacity	-	When the storage is full, than what?[98] (Netherlands)
26	Diverts attention from alternatives	Funds should go to renewables, CCS creates complacency, we should look to alternatives	cost, could be used as excuse not to develop alternative sustainable sources e.g., wind, solar (UK)
19	Risk of explosions	-	It might be costly and risky if CO_2 escaped/exploded (UK)
8	Information needs	-	-
7	Not energy efficient	-	Safety of storage, higher energy consumption[99] (Germany)

[90] La construcción de infraestructuras será costosa
[91] keine Langzeitstudie möglich über Auswirkungen in den Lagerstätten
[92] nie widzę niekorzystnych skutków
[93] Gefahr des Austretens von CO2 aus den Lagerstätten
[94] Umweltverschmutzung
[95] Abbau von Dörfern und Gemeinden
[96] przejście rurociągiem przez dużą aglomerację miejską
[97] onrust bij de mensen die in de buurt wonen en geen ervaring met dit projekt
[98] als het vol is de opslag wat dan
[99] als het vol is de opslag wat dan; sicherheit der speicherung, höherer energiebedarf

6.4 Any other questions

Most of the respondents who used the space we provided for other questions or comments expressed worries about the safety of the project or CCS in general. Since most of these worries were also made plain in the previous question, this section will be relatively short and maybe a bit repetitive. Nevertheless a few interesting categories emerged from the analysis.
Again, worries about safety spanned a spectrum ranging from those who cautiously accepted CCS as long as safety can be guaranteed ("How will it be guaranteed that no CO_2 leaks? Otherwise I have no objections"[100] – Germany) to outright rejections because the risks and other disadvantages are too high:

> Is it necessary? Shouldn't it be possible to distance ourselves from one of the dirtiest energy sources? Is it 100% safe (storage, capture of the CO_2)? Why is so much money being pumped into such an old-fashioned energy source? Are there even enough suitable storage sites (not just for the next few years, but for the next centuries)?[101] (Germany)

Next to safety, this comment also highlights most of the other frequently asked questions, such as the long-term perspective and worries about how much storage space there is, how much money it will cost and whether we shouldn't spend it on cleaner energy sources, and that coal is seen as a "dirty" energy source.
While most questions about safety were one or two word answers on "risk" or "security", a considerable number listed the "long-term" perspective as a concern. This is not just as in the quote above about whether there is enough storage space, but concerns the idea that there is simply no way of knowing, from current scientific experience, whether the storage will still be safe in 100 years time:

> Is this method currently in successful use anywhere else in the world? What bugs would need ironing out? What happens to CO_2 stored long-term in this way? (UK)

The phrase "long term" featured very heavily here, as well as the question whether the technology is already being used and therefore more familiar to the scientists. Respondents worried very often about whether the technology is tested or proved sufficiently, or whether it is already in use elsewhere, and these worries were often coupled with concerns over the long-term, because even if it were running successfully in other places, no project has yet run the course of even 20, let alone 100 years.

As before, possible leakages were the most commonly cited safety worry, though a considerable number mentioned "public health", which presumably is linked to worries about leakage, but may also concern the health risks of living near any coal-fired power station. Worries about possible explosions were mentioned, about the effect of the CO_2 on the groundwater, the soil or the underlying geology, as well as worries about the transport and possible leakages from pipelines. Next to the safety and health of people nearby, another perceived risk was to the natural environment:

> The location of the project is close to the place I live. If there were leakages, would the

[100] Wie wird abgesichert, dass kein Co2 entweicht? Ansonsten habe ich keine Bedenken

[101] Muss das sein? Ist es nicht möglich von einer der dreckigsten Energiegewinnungsarten abstand zu nehmen? Ist das 100% sicher(lagerung,abpackung des co2)? Wieso wird so viel Geld in eine solche veraltete Energieressource gepummt? Gibt es überhaupt genügend geeignete Lagerstätten(nicht für die nächsten paar sondern die nächsten paar hundert jahre)?

fauna and flora also be affected?[102] (Spain)

As in the previous question, next to safety the most common worry was over the costs, either to the taxpayer, the national economy or the effect it would have on the electricity bills. The financing of CCS was seen as a problem also for different reasons; who would pick up the bill when things go wrong; a few more cynical respondents thought it would be financed by bribes. This relates to a concern that quite a few had especially in Germany, which is that money will be made out of this for the energy companies and the politicians, which the taxpayer will eventually have to pay (this worry was also clearly formulated in the dialogue boards, see chapter 7)..

As in the previous question, some respondents felt that CCS is not a long term solution; that it doesn't deal with the actual problem of CO_2 production and instead sweeps the problem under the carpet[103] for future generations to deal with. At the same time, it diverts attention and funds from alternative energy sources, or natural carbon storage schemes such as planting trees. Without specifically naming what they think the alternatives should be, a number of respondents also simply asked whether there really aren't any: "Why no research into other directions?"[104] (Germany). Feasibility was also questioned frequently – some expressed doubts over whether it will work on a technical level, while others were more worried about whether CCS would make a large enough impact on global CO_2 emissions to avert climate change. As in the previous questions a (very small) number of respondents questioned the necessity of the technology because they did not recognise climate change as a problem caused by CO_2. Relating to feasibility were also the fairly frequently mentioned worries about whether there will be enough storage space. As we found in the dialogue board; a number of respondents also thought that one alternative would be to find practical uses for the CO_2 rather than simply store it away (which is a theme that occurred also in the WP4 focus groups and the WP2 dialogue boards discussed in the next chapter).

A number of responses were related to a sense of social justice. On a societal level, some respondents were concerned that their country would have to shoulder the problem caused by every country, which implied that they would only be happy with CCS as long as it's not just, say, Spain or Poland which will be doing it:

> I would like to see all countries participating including China and the USA and others who cause the most pollution and not left to the smaller countries such as ourselves who do not produce as much. Is it worth it if it has little or no effect on the major polluters. (UK)

or

> How do the other countries act, what do they do against CO2 emissions[105] (Germany)

On a more communal level though, many respondents, including some that otherwise were more positive about CCS generally, thought that CCS should only go ahead if the local population is adequately informed and/or consulted.

> As a citizen you can only respond to what the government has done. There is a large gap between what the government plans and what the public knows.[106] (Netherlands)

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[102] la ubicacion del proyecto esta cercana a el lugar donde vivo. Si hay fugas ¿la fauna y flora también se veria afectada?

[103] It is not solving a problem at the end of the day, merely sweeping it under the carpet. (UK)

[104] warum keine Forschung in andere Richtungen

[105] Wie verhalten sich die anderen Länder, was unternehmen die gegen den Kohlendioxidausstoß.

[106] Als burger kun je alleen maar reageren op wat er door de overheid gedaan wordt. Er is een groot hiaat tussen wat de overheid van plan is en wat de burger weet.

There were however many more explicitly negative reactions on this topic, ranging from whether the local population will be consulted on the safety issues[107], to the blunt and cynical statements that it doesn't matter what people think because the government or energy industry will do what they want anyway; a particularly poignant example is this:

> Nobody has yet been interested in my opinion, the government decides what it wants anyway. At my age (51) I'm wondering how I can end the use of oxygen by me personally[108] (Germany)

Similarly, a few respondents were sceptical about the information, not so much the bit we have given them, but whether industry or politicians will ever give them clear and unbiased information: "What secrets are they keeping from the population?"[109] (Germany). Distrust was also signalled about the profit motives of the energy industry and political classes as mentioned above; it was also occasionally alleged that CCS is a "greenwash" technology. It has to be kept in mind though that the category of comments which alleged darker motives towards politicians and the energy industry were relatively few.

Often respondents asked more neutral questions about the process itself, i.e. without visibly worrying about safety, costs or darker motives. These were mostly questions like "how will it work", how big will it be or how much CO_2 would it capture and how many jobs would it create. Especially in Poland some respondents were keen to know when the project is planned to start, how long would it take, and whether there were other such projects in Poland. Respondents also frequently wrote that they would like to have more information about CCS or the specific projects before they would comment.

There were, finally, some respondents who did not ask about any safety, financial, or public legitimacy concerns, but instead made positive comments on CCS or the project: "I love it."[110] (Spain).

[107] What happens if the reservoir leaks and large masses of CO2 are freed? What do the people say who live within the immediate area of possible reservoirs? (Was passiert, wenn die Speicher undicht sind und CO2 in großen Mengen freigesetzt wird? Was sagen die Menschen, die in unmittelbarer Nähe zu den möglichen Speicherstätten wohnen?) – Germany public

[108] meine Meinung hat bisher keinen interessiert, die Regierung beschließt sowieso was sie will.In meinem Alter (51) überlege ich, wie ich den Sauerstoffverbrauch meiner Person beenden kann.

[109] was wird der Bevölkerung verheimlicht ?

[110] Me encanta

Table 6.3: *Main categories for other questions and comments*

Category	Comments	Examples
Don't know, no answer	-	-
Safety worries	Leakage, health and explosion risks	How safe is storage of co2? (UK)
Cost	-	Whether it is very expensive[111] (Spain) Will this cost me anything? How much would the fuel be on the invoice? (UK)
Long term	Long-term behaviour of CO_2, side effects, unforeseen impacts	How likely is it that the CO_2 there until eternity in the ground[112] (Netherlands)
Risk to environment	-	What happens with the environment?[113] (Germany)
Risk of leakage	-	Is there a possibility that the CO2 escapes?[114] (Spain)
Need more information	-	Would have to know more about it (UK)
Look to alternatives		Why do we have such ideas as storage? There are many much better ideas to reduce emissions.[115] (Poland)
Does it work?		Will it REALLY work? (UK)
Storage capacity		How long before the storage capacity is full?[116] (Netherlands)
Is it being used elsewhere?		Whether such a project has already entered into force in Poland?[117] (Poland)
Effect on locality		Possible disadvantages for residents[118] (Germany)
When? how?	Neutral questions on how CCS works and when the project starts	When will it start working?[119] (Spain)
Negative, unspecified		Why all that?[120] (Germany)
Ways to use CO_2		Are there no other possibilities to use the resulting CO2?[121] (Germany)
People need to be informed, consulted		Will there be an education for the region?[122] (Netherlands)
How was location chosen?	Also includes questions on why the storage isn't closer to the plant	Would it not possible to build a power station nearer to the coast? (UK)

[111] si es muy caro.
[112] hoe zeker is het dat de CO2 daar tot in de eeuwigheid in de grond blijft
[113] was passiert mit der Umwelt
[114] Hay posibilidad de que escape el CO2?
[115] Dlaczego mamy takie pomysły jak magazynowanie? Jest wiele dużo lepszych pomysłów na ograniczenie emisji.
[116] Hoe lang duurt het totdat de opslagcapaciteit vol is?
[117] czy taki projekt wszedł już w życie w Polsce?
[118] mögliche Nachteile für die Bewohner
[119] cuando empezaria a funcionar
[120] Wozu das alles?
[121] Gibt es keine andere Möglichkeit zum Verwerten des entstehenden CO2?
[122] komt er een voorlichting voor de regio ?

7. Dialogue Boards

7.1 Introduction/methodology

The WP2 survey was supplemented with two "virtual focus groups" held with selected survey participants from Spain and Poland: survey respondents from these two countries were asked at the end of the questionnaire whether they would be interested in participating in an online discussion board to be held about a month after the survey. Among those who have indicated an interest, around 30 per country were selected by TNS to achieve a roughly representative mix of gender and age. The dialogue boards were held over two days (15th and 16th March). Participants were given a link to a specific website set up by TNS and an account to log in. Our list of questions was split into two parts (one for each day) and made available to view beforehand.

The qualitative research was intended to supplement the survey by delving deeper and in more detail into how respondents feel about CCS and the two specific projects, and therefore provides valuable additional insights to help interpret the responses to the survey, as well as providing some interesting qualitative data in its own right. The dialogue boards (hereafter DB) were additionally used to inquire about the survey itself: because it has been a frequently voiced concern especially by the developers themselves about how social research can itself potentially influence public perceptions of a project, we thought this would be an ideal opportunity to look at how the survey itself was seen by participants, whether it encouraged them to seek out more information and discuss the issues with colleagues, friends, family or neighbours, and whether the survey itself had any influence on their opinions of CCS and the specific projects. The question schedule is available in appendix 7.1. As the role of the moderator in an online focus group is more passive than in traditional focus groups, the schedule played the role of a much needed and useful starting point to gather participants' reasoned initial responses and then generate discussions among them.

Holding focus groups online rather than face-to-face offers several advantages and disadvantages over traditional focus groups which will need to be be discussed briefly since this is a methodology which is still fairly new within academic research, even if online focus groups have been used for a while already in market research (see Turney and Pocknee 2005; Lang and Hughes 2004; Reid and Reid 2005 and Oringderff 2004).

Turney and Pocknee (2005) argue that online focus groups fulfil most of Krueger's (1994) criteria required of focus groups (involving people, conducted in a series, participants are homogenous and unfamiliar with each other, data collection procedure, qualitative data, focused discussion), and can therefore be considered as a legitimate version of that research methodology. There are however a few differences that need to be kept in mind:

- Participants in online focus groups do not see each other and can therefore not respond to (or convey themselves) non-verbal cues such as face expressions or hand gestures. This means that group dynamics in online focus groups have a different character to traditional focus groups.
- Since participants sit on the computer usually in the comfort of their own homes, they will have more time to consider and think about their responses, which makes completely spontaneous responses less likely to happen than in traditional focus groups. While this again changes the type of interaction we get in online focus groups and deprives us of some particular types of answers, this can also be a positive difference: It will for example give less articulate or confident members of the discussion board the time to think about and consider their answers and therefore makes it more likely that they will actively participate,

and less likely that one or two particularly vocal individuals will dominate the discussion.

- Online focus groups require internet access and at least some basic familiarity with online communication, thus screening out a lot of potential participants from older generations, or those without internet connections. While we might expect this problem to become less and less important as the internet becomes a more important reality of most people's day to day life, there is at this time still a significant number of people unable to participate. It has to be pointed out of course that this argument applies to the main survey itself.
- On the plus side, online focus groups can also widen the potential pool of participants, for example to those with mobility problems; online focus groups can also be held with participants spread over a geographically wide area or even different time zones.
- Online focus groups give participants a greater scope for hiding their identity, which may make participants more likely to share opinions particularly on more sensitive topics.
- Another difference is that the format allows participants to introduce new information themselves (i.e. through pasting in a link to a website) and therefore bring their own stimulus into the discussion.
- Although this depends on how the focus group is set up, the format can, as we have done in our case, be open for participants to join and leave at their own time, thus introducing new entrants who can introduce new ideas to the discussion.

For our case the benefits of online focus groups were clear since it allowed us to recruit respondents who participated in the survey who were separated geographically. The online format also gave us the option of regulating what participants see of each others' answer: Respondents were only able to see the other participants' respondents answers to specific questions once they have answered themselves, thus removing one of the traditional features of focus groups where participants tend to influence each others' opinions. This was much less developed in our virtual groups and coupled with the fact that participants had more time to think up reasoned responses and were more anonymous made for a different dynamic in the discussion, where we think that the online discussions were all in all very thoughtful and deliberative.

7.2 Results

Both the Polish and Spanish DBs were marked by a lively discussion and participants responded positively to the experience. The first day involved our attempt to employ a laddering technique to elicit how participants think about CCS and the specific projects; whether they are in favour or against it; paying particular attention not just to the themes and tropes that emerge, but also how these arguments develop, which arguments provoke disagreements, which ones get dropped out of the discussion, and which ones remained strong and were picked up by other participants. In this section we will present some of the dominant themes and how they developed within the discussions. On the second day we asked about participants' reactions to the survey itself, whether they sought more information afterwards, whether they discussed the issues with friends of family, and whether now that they had the time to think about it, their opinion has changed. We also asked more general questions to put CCS into context with the larger debates surrounding for example opinions on global warming or energy security.

7.2.1 Benefits

Pollution control
Reducing pollution is perceived as one of the main benefits from CCS. Particularly in Spain, participants tend to refer to pollution and to CCS as a technology that can reduce pollution more than to climate change, *per se*. This difference between the countries is also reflected in the open-

ended questions from the survey (Chapter 6), where "contaminacion" was mentioned in Spain frequently as one of the advantages on CCS, which possibly indicates a difference in the way environmental issues are discussed in different countries – slightly different national debates about environmentalism convey different mental images on what the main problematics are. While climate change is being discussed extensively in Spain, for the majority of the population the framing may still be one of waste or pollution rather than the more intangible and abstract issue of climate change. In a fairly typical example of this type of response, one participant argues that: "Reducing pollution always brings a better quality of life for us and for the future generations."[123] (Spain)

Participants also often refer to cleaner air as beneficial to people's health, with CO2 seen as polluting the air and thus reducing the quality of air we breathe:

> For me it is very important to keep the environment clean for the future generations. Even today, in some Polish cities is hard to breathe because of pollution. And pollution is causing an increasing number of diseases (Poland)[124]

What it is interesting here is that for some participants, CCS is initially framed as an environmental technology (end of pipe or pollution reduction technology) linked to the efforts and the need to reduce pollution and climate change. In this sense, it is perceived as a good idea.

Climate Change

In Spain, climate change was not a major topic at the beginning of the discussion and not too much emphasis was given to this issue. When asked specifically if the need to mitigate climate change makes CCS an acceptable technology, some participants considered CCS to be a necessary part of the solution. Here, participants establish a clear relationship between CCS and the need to reduce CO_2 emissions. It is interesting to note that when asked about climate change, many participants expressed a more positive attitude towards CCS.

> I think it's a help, not the solution. This should be accompanied by other real measures and in the whole world.[125] (Spain)

For others, the need to fight against climate change do not generate a more positive view of CCS, as they consider that there are many other options to mitigate climate change and CCS is not seen as a good solution: "There are many other more efficient measures, with less costs and less risky." (Spain). They even state that CCS could be an excuse to continue emitting CO_2:

While broadly similar opinions were voiced in Poland, the Polish DB also included a few participants who were sceptical about the reality of climate change or the role CO_2 from power plants plays in it. In this context, CCS of course made less sense to these participants. However, even those sceptical about climate change were aware that Poland needs to meet EU emission targets in order to avoid heavy fines, and thus reducing emissions would still financially benefit Poland as a whole, or the individual through lower electricity prices.

> The most important argument is the one about the possibility of limiting increases in energy prices which will be significant if the current EU climate policy is maintained and Poland

[123] Reducir la contaminación siempre es calidad de vida para nosotros y las generaciones posteriores

[124] Dla mnie bardzo istotna jest czystość środowiska, w którym będzie żyło przyszłe pokolenie. Już dzisiaj, w niektórych miastach Polski jest ciężko oddychać ze względu na zanieczyszczenie środowiska. Wzrasta ilość chorób spowodowana tym czynnikiem.

[125] Creo que es una ayuda, no la solución. Esta debería ir acompañada de otras medidas reales y en todo el planeta. Lo cual crearía otros problemas en países no tan desarrollados.

does not reduce CO2 emissions. (Poland)[126]

Climate change remained a constant theme throughout the discussions, which is understandable of course since it is the main issue that CCS is meant to address. In Poland, the participants who were sceptical towards climate change were inclined to bring their points up throughout the discussion, though as far as is evident from the other answers, they did not necessarily manage to persuade anyone else of this position.

Development of technology
Some participants, usually not the more active ones, state that the development of CCS could be an opportunity for Spain in terms of technological development. The link with R&D generates a positive attitude towards the project. However, this idea does not generate a significant discussion among participants. Linked to this idea, participants discuss if the project will generate qualified jobs in the R&D sector. This seems to be an important topic for participants.

> I think it is a chance for Spain to highlight our research and technology development. Also I see it necessary for our economy and sustainability.[127] (Spain)

> I am in favour of CCS. It is supposed to strengthen the Polish position on the international arena (although I somehow don't believe it) (Poland)[128]

Other participants argue that the cost is too high, so any potential economic benefit will be counterbalanced, and that there are many other technologies to invest on or that it will not generate many jobs.

> I think it is too expensive…We are not in a condition to spend money on this…
> We should now invest in other issues and leave this investment for the future… (Poland)[129]

Coal
The association of CCS with coal generates a negative attitude for some participants (see also the discussion of the survey results on the impact of the acceptability of coal on views towards the local project in Section 5.5.5). Over 90% of electricity generation in Poland is from coal, the large majority indigenous, whereas in Spain, roughly 20% of electricity generation is from coal, the majority of which is imported. In the focus groups, some familiarity with coal mining seems to be associated with a more sceptical view. Participants living in mining areas make statements such as:

a) Coal production is not clean: ("Coal is not clean, it is as polluting as oil." - Spain[130])
b) There is no coal in Spain
c) Spanish coal is expensive: "Ok, coal is nice and brings jobs, but have you asked yourself about its costs? Coal extraction from Asturian mines is very expensive…- Spain)[131]

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[126] Najważniejszy jest argument o możliwości ograniczenia podwyżek cen energii, które będą znaczące, jeśli utrzymana zostanie obecna polityka Unii Europejskiej, a Polska nie ograniczy emisji co2.

[127] Como he indicado en otras partes del foro de debate, me parece una oportunidad para que España pueda destacar con sus investigaciones y desarrollo de teconología. Además lo veo necesario para nuestra economía y sostenibilidad.

[128] Za- ponoć umocni pozycję Polski na arenie międzynarodowej (choć ja jakoś w to nie wierzę).

[129] Myślę, że to jest drogie... Nie stać nas na to... Powinniśmy się teraz skupić na innych sprawach i zostawić tę inwestycję na przyszłość.

[130] El carbón no es un modo limpio.. es tan contaminante como el petróleo.

[131] Sí, el carbón es muy bonito y da trabajo, pero de verdad os habéis preguntado sus costes? Sacar carbón de las minas asturianas es muy caro…

For other participants, CCS could bring more jobs in the carbon sector and the region of the project. These participants think that this statement could contribute to the social acceptance of the projects. But it does not seem to be a strong/ emotional argument for them.

> Some regions [Asturias] are willing to have some projects due to the permanent crisis of industrial sectors (Spain)[132]

> Obviously, it would be very beneficial to use the coal in a cleaner and less harmful to atmosphere way, especially for areas where the economy is very dependent on coal. (Spain)[133]

In Poland, despite its heavy reliance on electricity from coal, it is not necessarily seen in a more positive light by itself, and although some participants pointed out that many Poles rely on the coal industry for energy security and employment, this was also seen as a point of contention for others.

> Right, one cannot suddenly deprive these people of work! Transition from coal to other energy sources is a ghastly operation. But unfortunately, it is inevitable in the coming years. And no offense, but a miner will not be of much use at a nuclear power plant. (Poland)[134]

> The saying "Poland is coal" should land on the bottom of the history's junk. Restructuring of coal mining brings little economic impact and the social consequences of subsidising mines do not correspond with the benefits of mining... (Poland)[135]

Energy security

In policy circles, energy security is often seen as an important justification for CCS as it reduces the need to rely on imported natural gas, which, for the countries in question, comes primarily from Russia (very problematic for Poland in particular) or from North Africa or the Persian Gulf, whereas Spain and, especially, Poland, have significant reserves of coal. In Spain, participants do not understand the link between CCS and energy security: ("I do not understand the relationship between both issues…" – Spain)[136]. Only two participants express this idea once asked. This may of course also reflect the concerns mentioned above that Spain does not have large coal reserves and therefore energy security would be less relevant in Spain than in Poland.

However, when asked explicitly about energy security towards the end of the Polish DB, the participants did not see any obvious connections either, or stated that they did not understand the question. Interestingly though a spontaneous discussion about energy security did in fact occur earlier in the context of Poland's reliance on coal for its energy:

> Of course we should gradually abandon coal as the only source of energy. The problem is what to replace it with? We do not have large water resources, nuclear energy is in its infancy, and all other renewable energy sources are of a rather local importance and require

[132] En Asturias algunos proyectos son esperados fervientemente ya que existe una crisis permanente de los sectores industriales

[133] Evidentemente sería muy beneficioso poder utilizar el carbón de una manera más limpia y menos nociva para la atmósfera, sobre todo para zonas donde su economía subsiste gracias a las industrias del carbón.

[134] Jak najbardziej i nie można tych ludzi pozbawić nagle pracy! Przekształcenie energetyki z węgla kamiennego na cokolwiek innego to koszmarna operacja ale niestety w biegiem lat nieunikniona i bez obrazy ale górnik w el. atomowej też na nie wiele się przyda.

[135] Hasło "Polska węglem stoi" powinno wylądować na dnie lamusa historii. Wszelkie restrukturyzacje przynoszą niewielkie efekty ekonomiczne, społeczne skutki sztucznego utrzymywania kopalń przerastają korzyści związane z jego wydobyciem...

[136] No encuentro la relación existente entre ambas partes de esta pregunta.

investments. (Poland)[137]

Economics (employment)
Some discussion was generated around the potential economic benefits of CCS for Spain, in particular linked to the local benefits from the storage project. The main theme that emerges is the potential for job creation in the area: "Whenever you create industry, this brings jobs and economic improvements in the area" (Spain)[138]. Some participants state that engineers and scientists would be needed to run the projects. Usually this idea is confronted by concerns over the cost of the development of the technology.

> As all investments, CCS surely provides some opportunities for creating new jobs. The only question is whether people in the region would benefit from it or would it be organised at the state level. (Poland)[139]

Some Polish participants saw additional economic benefits as coming from the smaller amount of emission rights Poland would have to buy from the EU, while benefits of employment to the local area were not much discussed.

> I'm in favour of CCS because it reduces CO2 emissions and Poland will be able to sell more CO2 to other EU countries (Poland)[140]

Energy Transition
Some participants in Spain argue that CCS could help in reducing the problems of climate change while finding new solutions (less consumption, zero emission appliances, renewable energies). This is an argument used by those more favourable to the technology. This argument however was not made in Poland.

> I think is a very good idea to try to stop the problem, and this technology seems to be effective, while there is research on other sources of energy or a better solution to emissions. (Spain)[141]

Negative participants in both Spain and Poland on the other hand argue that CCS is not a solution to the needed transition, but just hides the problem (see *It's not a solution to the problem* below): "The thing is to 'solve the problem' while we look for alternatives to its origin." (Spain)[142].

7.2.2 Disadvantages: risks and costs

Economic costs
Several participants express a clear concern about the costs of a CCS project. The main themes are that CCS projects are very expensive and that in a period of economic crisis, uncertain investments

[137] Oczywiście, że powinniśmy powoli rezygnować z węgla jako praktycznie jedynego, istotnego źródła energii. Problem w tym czym ten węgiel zastąpić? Nie mamy dużych zasobów wodnych, energetyka jądrowa w powijakach, a wszystkie pozostałe źródła energii odnawialnej, póki co, mają raczej znaczenie lokalne i wymagają dodatkowych inwestycji.
[138] Lo que sea crear industria, es crear empleo y mejoras económicas en la zona
[139] Na pewno daje to jakies możliwości jak kazda inwestycja jeśli chodzi o miejsca pracy ale nie wiem do końca czy nie byłoby to realizowne odgórnie pomijając region.
[140] jestem na tak ponieważ zredukuje się emisję CO2 do atmosfery a przez to będzie można więcej sprzedać co2 do innych krajów UE
[141] En algún sitio ya he manifestado que me parece perfecto paliar el problema existente, y esta tecnología parece ser efectiva, mientras se investiga en otras fuentes de energía o una mejor solución a las emisiones.
[142] La cuestión es "resolver un problema" mientras se encuentra la alternativa al origen del mismo.

must be avoided.

> I believe there are other urgent issues to invest now, in these times of crisis, rather than this (CCS) projects.[143] (Spain)

As the transcript exemplifies, some participants consider that there are many other projects in which government or industry should invest. These participants are not the most negative about CCS, but do perceive economic cost as a main limitation.

Economic cost is also linked by some participants to the question of safety. Safety is seen as costly and the worry is that developers could reduce safety precautions to reduce costs.

> I am not saying I do not trust them to manage the storage, but the problem will come when the costs are so high that they will have to reduce costs. Maybe the costs are reduced in safety…(Spain)[144]

In Poland, it is further argued that the country is relatively poor (compared to other EU countries), and that CCS would negatively impact tourism in the area (though it was also recognised that tourism is already low because of the existing industrial/coal infrastructure). Mostly though, economic concerns were related to energy companies loading the additional costs of CCS onto the consumer or taxpayer.

> What are the actual costs incurred and by whom? Poland and the Polish people cannot afford to introduce technologies which do not provide at least the minimum savings in the long run (Poland)[145]

Risks to health and environment

How to handle the risks associated with the storage of a CO2 was the main issue of discussion in both DBs, and tended to dominate discussions over perceived benefits – even those more positive towards CCS were concerned about safety and the environmental consequences. As exemplified in the transcript, a fatal leakage is a recurrent image for many participants. Also prevalent was the idea of CO2 as a dangerous waste: "I am in favour because it reduces pollution, but against because it can produce a fatal leakage"(Spain)[146]; "I think it poses some risks, as other technologies, but maybe less than others." (Spain)[147]

The unpredictable risks are clearly an element reducing participants' acceptance of the technology, with participants arguing that the technology is still new and underdeveloped, and that it is unclear how the CO_2 will behave in the long term.

> The project assumes that the developer looks after the CCS installation for 20/30/50 years and if it is, so to say, "stable" in all kind of ways, the state takes care of it... However, physical and chemical processes characterize with some level of unpredictability and their impact, in particular on the zone of about 1000 to 1200 meters underground, is not known in

[143] La verdad que yo considero que hay otros temas primordiales en los que invertir ahora en estos tiempos de crisis antes que en estos proyectos.

[144] No es que desconfie de que no sean capaces de gestionar el almacenamiento, el problema será cuando los costes sean demasiado elevados y haya que reducir coste. Esos costes posiblemente se puedan reducir en la seguridad porque a corto plazo no se va a ver y los

[145] Jakie będą rzeczywiste koszty i kto je poniesie? Polski i Polaków nie stać aby wprowadzać technologie, które nie przyniosą przynajmniej minimalnych oszczędności na dłuższą metę

[146] A favor porque reduce la contaminacion, pero en contra porque se puede producir algún escape que resulte mortal.

[147] Yo creo que tiene riesgos como todas (las tecnologías) pero menores que otras.

> case of the long-term storage of CO2. (Poland)[148]

But interestingly, when asked about the risks of CCS compared to other technologies, participants often agreed on the idea that CCS will not bring more risks than other technologies or industries. It was also argued that new technologies are always scary at first.

> But let's be honest, our forefathers were afraid of electricity, without which we cannot imagine life today. (Poland)[149]

It's not a solution to the problem / There are better solutions

Participants were polarised on the question of whether CCS is a desirable solution. For some, CCS might contribute to reducing pollution, climate change and environmental problems. To these participants, CCS could at least be part of the solution ("Yes, but with other complementary measures" - Spain[150]), and it is positively associated with the search for solutions. The acceptance of CCS is linked to the promotion and feasibility of other solutions, as it is recognised to be only a bridging technology.

But for other participants, CCS is not a solution, it is a just a patch, usually with derogatory images, e.g., it is "putting the dirt under the carpet". These participants state the existence of many other options more ecological and less risky, as reducing the production of CO2 (less CO2 intensive behaviours, renewable) and reutilising the CO2 captured.

> CO2 storage is not even remotely going to resolve the problem, only the top, like the carpet ... but the source is clear ... fossil fuels consumption .... (coal, oil,..). It's time to consider alternative and clean energies and not "hide" the wastes of this. (Spain)[151]

> The problem is that the CCS as a solution "for now". It would only be a temporary solution, and unfortunately in our beautiful country, very often "temporal solutions" turn into "solutions for ever". So we have to look more prospectively and not engage in something that only masks the problem rather than solves it. (Poland)[152]

Some participants also consider that CCS is not an energy option but a contamination reduction technology, not comparable to other, preferred, energy technologies: "I think there are other cleaner technologies that do not produce CO2, as the solar and wind energies" (Spain)[153]. Not only do other preferred solutions not have the problem of being temporary bridging technologies, but they are also seen as less risky and less expensive: "There are many other solutions, more efficient and with less costs and risks." (Spain)[154].

Some of the preferred solutions included geothermal energy, nuclear energy and windpower and

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[148] Projekt zaklada ze firma budujaca opiekuje sie projektem przez 20/30/50 lat i jezeli jest on ze sie tak wyraze "stabilny" pod kazdym wzgledem to opieke przejmuje panstwo.. z tym ze istnieje nieprzewidywalność procesów fizycznych i chemicznych i ich skutków w szczególności w strefie oddziaływania ok. 1.000 do 1.200 metrów głębokości przy długoterminowym składowaniu CO2.

[149] Ale powiedzmy sobie szczerze nasi przodkowie bali się elektryczności bez której teraz nie wyobrażamy sobie życia.

[150] Sí pero con otras medidas que lo complementen.

[151] Un almacenamiento de CO2 no resuelve ni por asomo el problema, solo lo tapa, como la alfombra...el origen está más que encontrado... el consumo de energías fosiles.... (carbón, petroleo,..). Es hora de plantearse otra alternativa de energia limpia y no de como "esconder" los restos de esta.

[152] Problem jest w tym, że CSS jako rozwiązanie "na teraz" byłoby tylko rozwiązaniem tymczasowym, a niestety w naszym pięknym kraju :) bardzo często stała jest wszelkiego rodzaju tymczasowość. Dlatego trzeba patrzeć bardziej przyszłościowo i nie angażować się w coś co problem tylko maskuje, zamiast go rozwiązywać.

[153] A mí me parece que hay otras energías más limpias que no producen CO2 como la solar y la eólica

[154] Hay otras medidas más eficientes y con menos costes y riesgos

carbon sequestration through forestation. Mostly though it was argued that we should be more conscious of the energy we are using and strive towards producing less waste in our everyday life.

7.2.3 CO_2 Storage

Risks
Risks from CO_2 storage is a main issue in participants' discussion. The risks from leakages are spontaneously mentioned by most participants. The idea held by some participants is that CO_2 is a polluting and dangerous gas and that any storage will have some risks. CO_2 storage is then perceived to generate more risks than benefits, given the possibility of a local accident.

> I guess that as all massive storage, it would be dangerous in the event of a leakage or explosion, so I propose to reuse the waste… (Spain)[155]

The discussion shows the qualitative dimensions of risk perception. The risk perception of a CO_2 storage site is clearly based on several often intersecting considerations:

a) No (personal) control over the risk because somebody else is deciding on it.

> It is a large concentration of a pollutant gas, so a possible escape would be lethal. We can control everyday risks but we cannot do anything about a CO_2 leak (Spain)[156]

b) Not natural. It is a waste disposal.

> Solutions which do not eliminate problems, at best, move them to a different location. CO2 stuffed into the soil does not solve the problem of CO_2 emissions. And it hides from our view the yet unexplored consequences. (Poland)[157]

c) Catastrophic potential. CO_2 storage is perceived as a huge industrial storage with potential lethal consequences:

> There is a lot of information. But thinking that it is a storage of a polluting gas, in the event of an accident and a escape, I do not want to imagine the consequences. (Spain)[158]

d) Lack of familiarity and unpredictability: We do not know enough about the risks. (see also the discussion on risks of CCS generally above)

e) In Poland it was also pointed out that the Belchatów area had recently experienced some earthquakes, which participants found would heighten the risks of CO2 storage:

> On 22 January 2010, the earth shook at 4.42 Richter scale! How can we talk about safe storage of CO2 under the ground! (Poland)[159]

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[155] supongo que como todo tipo de almacenamiento masivo sería algo peligroso en caso de escape o explosión, por que propongo que se haga un consumo de ese tipo de almacenamiento, es decir, utilizar esos residuos para hacer

[156] Que es una gran concentración de un gas contaminante, con lo cual un posible escape sería letal. Los riesgos cotidianos los tenemos más o menos controlados pero no podemos hacer nada ante una fuga de CO2

[157] Wszystko co nie eliminuje problemu, w najlepszym przypadku przesuwa go w inny rejon. Upchanie CO2 pod glebę nie neutralizuje problemu, tylko go chowa, z niezbadanymi dotąd skutkami.

[158] existe mucha información. Pero pensando que es un almacenamiento de un gas contaminante, en el caso de que se produzca un accidente y haya un escape, no me quiero imaginar las consecuencias. Vale, que hay mucha

[159] Oczywiście, że w Bełchatowie. W dniu 22 stycznia 2010 roku zanotowano tam wstrząsy o sile 4,42 stopnia w skali Richtera!. Jak tu mówić o bezpiecznym składowaniu CO2 pod ziemią!

On the other hand, many participants, when asked about the risks of living close to a CO_2 storage site, show a more neutral reaction. These participants tend to argue that the risks will be under control and that other industries (petrol stations, power plants) pose the same level of risk to local communities. It is interesting that one participant (who was originally very negative about the risks), when confronted with other more positive participants, comes to argue that CO_2 is not toxic and that CO_2 storage has to be less risky than the storage of nuclear waste:

> I think I would live without problems near a storage site. I do not think there are risks to living near (Spain)[160]

The opposite however was also argued (in Poland), where some participants made favourable comparisons with nuclear power, arguing that it is *safer* than CCS: "Nuclear energy is a good alternative due to its safety and lack of CO_2 emissions" (Poland)[161]

Safety

Safety was an important issue for participants. Regarding to how participants make sense of safety issues in CO_2 storage, we can find two main ideas:

a) CO_2 storage is risky and there is not enough money and commitment to assure the safety of the storage. It is perceived that companies and governments are not going to invest enough money in safety. Also, since the storage is for the long term if not permanent, there is no knowing how safety will be monitored and financed in the future.

> Knowing how things are done… over the years they will be removing budget, making things worse... and the risk will increase. (Spain)[162]

The lack of long-term studies of how things will be in the future is also perceived as a concern more generally (see also the analysis of the open questions from the survey where uncertainty over the long-term was one of the major concerns for participants).

b) Safety is going to be a main issue in CO_2 storage projects. CCS projects are perceived to be advanced technological projects, so it is assumed that safety is a priority. ("I do not think there is too much risk since these things are studied and well studied." - Spain[163])

But equally clearly, acceptance is conditional only on *credible* reassurances on safety:

> If this method is confirmed by tests, and it provides the MAXimum safety, I am in favour of it. (Poland)[164]

> I would not have anything against CO_2 storage even close to where I live, provided that CCS meets all safety requirements were checked a couple of times by experts (Poland)[165]

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[160] Yo creo que viviría sin problemas cerca de un almacenamiento de CO2. No creo que existan riesgos para la convivencia cercana

[161] Energia atomowa ze względu na bezpieczeństwo i brak emisji gazów w tym co2

[162] Conociendo como se hacen las cosas,... con los años se irá quitando presupuesto, haciendo las cosas peor... y el riesgo aumenta.

[163] Mucho riesgo no creo que exista ya que estas cosas están estudiadas y bien estudiadas.

[164] Jeśli stosowanie tej metody będzie potwierdzone badaniami i zapewni nam maxymalne bezpieczeństwo jestem za.

[165] Ja bym nie miała nic przeciwko składowaniu nawet blisko mojego miejsca zamieszkania, pod warunkiem , że są spełnione wszystkie wymogi dotyczące zabezpieczeń i to po kilkakroć sprawdzone przez ekspertów.

Carbon dioxide (CO_2)

Participants show some difficulties in understanding the nature of CO_2. There is a clear perception that CO_2 is a toxic waste (this is why it is stored: "Of course it is a dangerous waste, otherwise they would not have to store it." - Spain[166]). Some participants try to argue that CO_2 is natural or present in daily life, but this is not an idea easily generated in participants' mind. Others question the amount of CO_2 that we live with. On the other hand, some participants have some difficulties in understanding the origin of CO_2 to be captured (e.g. from cars):

> I think we're referring to contaminating CO2 like that emitted by vehicles, the CO_2 that exists in nature I don't think is contaminating in those proportions (Spain)[167]

As with the case of perceived benefits of CCS shown above, CO_2 in Spain is more linked to contamination/pollution than to climate change. However, some participants introduce new information on the role of CO_2 in climate change which was then further discussed. Participants largely agree on the need to reduce CO_2 emissions, with the exception of a few sceptics in the Polish DB.

> Carlos – It is a solution, but not the only…to be effective to mitigate climate change, you will have to do it now and in all the countries… if China and USA do not do it, we are wasting the time…USA and China produce 75% of the CO2…do you think USA is going to invest in CAC?
> Visitación – I agree, only one CO_2 storage is not enough to affect climate change…
> Pablo – I think it may help, but it is not the solution. You need more measures and in the whole Planet.
> Susana – The rise in the concentration of CO_2 in the atmosphere has increased temperatures. I think a CCS project may help in the mitigation of greenhouse effect. (Spain)

If we follow the discussions on risks, we have some interesting results. When asked why they consider that CO_2 is dangerous, some state that "if they want to store it, it is because it is dangerous" and "I've read in Internet it is dangerous". The first statement seems to convince other participants who consider that CO_2 is not so risky. Many agree on this idea: if we are keeping CO_2 underground it is because it's very dangerous.

> Such a pioneering project is related with the possibility of CO_2 leakage which, if released in high concentrations into the atmosphere, can poison people and animals. (Poland)[168]

Other participants consider that "CO_2 is not so risky (it is natural)" and "CO_2 cannot be more risky than other industrial waste". In the Spanish DB these participants do not try to convince others. However in the Polish DB, the participants who argue that CO_2 is natural were those who are not convinced of its effect on climate change and thus tended more to trying to persuade people on that point, without however much success.

> CO_2 pollution is certainly global, but CO_2 is not the main greenhouse gas produced. Anthropogenic CO_2 has little impact on global warming (95% of CO_2 is produced by volcanoes or forest fires). (Poland)[169]

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[166] Claro que son peligrosos, si no no se tendrian que guardar

[167] Creo que nos estamos refiriendo al CO2 contaminante como el que emiten los vehículos, el CO2 que hay en la naturaleza creo que no llega a ser contaminante en esas proporciones.

[168] Działania pionierskie, a takim jest ccs, wiąże się z ryzykiem np. rozszczelnienia magazynu co2 i wydostania się go w dużym stężeniu do atmosfery, co może doprowadzić nawet do zatrucia ludzi i zwierząt.

[169] CO2 na pewno stanowi zanieczyszczenie globalne , ale to nie CO2 jest głównym gazem cieplarnianym.CO2 wytwarzany przez ludzi ma zbyt mały wpływ na ocieplenie klimatu (95% CO2 wytwarzane jest przez

> Carbon dioxide is not harmful [unless you breathe 100% of co2...] (Poland – this participant was one of the most vocal climate change sceptics on the DB)[170]

Reutilisation of CO_2

This is a main question for participants, in Spain which was also briefly touched on in Poland. Many of them spontaneously argue that the COy captured should be reused as a resource. It seems to be a main condition for acceptance. "What we have to do is to transform it, not to store it, to make use of it." (Spain)[171].

The idea that we should try to find uses for CO_2 instead of burying it underground as waste was also articulated fairly often in the survey (see chapter 6), and was also touched on in the focus groups conducted as part of WP4 (Upham and Roberts 2011); it is therefore clearly a concern that is widespread, but rarely addressed because the research in this area is still not very advanced. Even knowing this though, participants argue that research on this should be made a funding priority, and that we will probably soon be in a better position to re-utilise CO_2 in some beneficial way.

> … if in the near future no method is found to process or efficiently use CO_2, we will have great stocks of useless "junk" underground! (Poland)[172]

In this way this can also made into an argument in favour of CCS, because we will build up potentially valuable resources.

Limits of storage

Although this was not an argument made particularly frequently and only in Poland, this links up with a concern that was fairly frequently mentioned in the main survey: It is not clear to some participants how much storage space there is, and whether we might potentially run into problems when the reservoirs are full.

> And are there any hopes connected to it? A little bit of gas will be trapped for some time. And what if we run out of space for CO2 storage? (Poland)[173]

Location of the storage

An important debate was initially generated on the proper location of the CO_2 storage. Participants tend to consider this an important but difficult issue. They try to reflect on where would be the best place to inject CO_2. There are some interesting ideas:

a) The first criterion is to inject CO_2 in an area where the potential impacts to nature and human health are minimised:

> That is why it should be sited where it does not harm the flora and fauna, especially where there are no people, it should be placed in non populated areas. (Spain)[174]

b) Agreement on the difficulties of finding an area where risks are minimised: "The truth is that we

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wulkany,pożary)

[170] dwutlenek wegla nie jest szkodliwy [no chyba ze oddychamy 100% co2,

[171] Lo que hay que hacer es transformarlo, no almacenarlo, conseguir destinarlo a algún fin útil.

[172] Jeśli w najbliższej przyszłości nie znajdzie się metoda na przetworzenie lub efektywne wykorzystanie CO2, będziemy mieli spore zapasy nikomu do niczego niepotrzebnego "śmiecia".

[173] A jakie są w ogóle w tym nadzieje? Trochę gazu przez jakiś czas będzie uwięzione i tyle. A co jak już zabraknie miejsca?

[174] por eso estaría bien hacerlo donde no dañe a la flora y la fauna sobre todo donde n haya personas, deberían hacerlo en zonas despobladas.

do not know where is the best place to store CO_2 and not harm anyone" (Spain)[175]

c) For some, companies will only look for a cheap place where local opposition is low.

> That is, they will put it where there is more interest, where it is more profitable, where there is less opposition and do we have to accept it? It is incredible (Spain)[176]

d) There is a lack of understanding about the geological characteristics that a suitable storage area has to satisfy. For this reason, some participants were also worried about the distance between power plant and storage, asking why the storage would not be closer to the plant and/or further away from inhabited areas. But even when there was understanding of the required geological characteristics, the distance between capture and storage was seen as problematic.

> In the case of Kedzieryn-Kozle, suitable areas for injecting CO_2 underground are all within no less than 150200 km from the plant! In case of Belchatów the seismic examinations have not even been finished in all potential storage locations on a line-Tuszyn-Lutomiersk! And it's the storage – not the technology for CO_2 capture – which raises the most controversy (Poland)[177]

e) Polish DB participants concerns about the location were also connected to the earthquake risk in the Belchatów area (see also the quote above).

In the Polish DB there was also a lively debate towards the end over whether it wouldn't be better to move the storage to off-shore, which we found in the survey usually to be a factor that enhances public acceptance of CCS. In this case however, it was argued that off-shore storage would be more dangerous because it would be much more difficult to monitor. It was also seen as much more expensive, with for example higher transport costs – on the whole the developing consensus seemed to be that off-shore storage is not necessarily more preferable: "I think storage on land could be more controlled, so theoretically the risk of storage should be lower". (Poland). This provides an interesting counter-point to our finding in the main survey (see chapter 5), where we found that off-shore projects were generally more supported by the respondents than on-shore projects, as well as seen less risky.

Understanding/images

As participants try to make sense of CO_2 storage they reveal some difficulties in comprehension (issues we will explore in a more controlled fashion in Chapter 8, which describes the experiment we carried out on depth and the importance of congruence between text and visuals). Participants understand that the CO_2 will be stored underground but it is not clear to many how CO_2 can be captured or what a storage location would look like: "I've seen pictures of the process but I could not explain it to someone correctly" (Spain)[178]; "I do not have clear images…" (Spain)[179]. When asked how they would try to explain CCS to friends in a few sentences, most Polish respondents stated they didn't know enough about CCS to comment on this, even though most had in fact tried to discuss the technology with friends or family after the survey (see below).

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[175] Llevas toda lar razón, la verdad es que no se sabe donde seria mejor almacenarlo para que no perjudique a nadie

[176] Eso es así, lo pondrán donde mas intereses haya, donde sea mas rentable, donde menos oposición encuentren ¿y hay que aceptarlo? Me parece increible

[177] W przypadku Kędzierzyna-Koźla odpowiednie tereny do zatłaczania CO2 pod ziemię znajdują się w odległości nie mniejszej niż 150-200 km od elektrowni! W przypadku Bełchatowa nie dokończono nawet wszystkich badań sejsmicznych potencjalnych miejsc składowania na linii Lutomiersk-Tuszyn! A przecież to składowanie - a nie sama technologia wychwytywania CO_2 - budzi najwięcej kontrowersji.

[178] He visto imágenes de como seria el proceso pero no sabría explicarlo correctamente

[179] No me vienen imágenes. Antes de explicarlo

There is a clear link between storage and the potential risks. Other issues of discussion are the costs and the location of the storage.

> I imagine there will have to use specific stores for that matter, in places far from the population and that do not involve any risk.(Spain)[180]

Other images that were mentioned included: vacuum cleaner, garbage can, filters, a funnel, a time-bomb, soda water, Swiss cheese. ("… what I imagine is a land full of holes like a Swiss cheese. (Poland)[181])

There seems to be some confusion around off-shore storage, where it is thought that off-shore storage would just mean dumping CO_2 into the sea, rather than underground beneath the sea: this is linked to a waste disposal in the sea.

An interesting effect of group discussion is shown in the way arguments between participants developed. When one participant introduces some neutral technical information about the process of injection, another participant who had a more ambivalent attitude uses that piece of information to shift towards a more positive position on CCS.

> Pedro – I understand the storage of CO2 after capture, after a blending process, will become a liquid that could be stored in deep pools in places geologically optimal. It seems something natural and necessary for the world. I do not see it as dangerous.
> Rocio – In that case, maybe we are worrying more than we should (Spain)[182]

7.2.4 Polish/Spanish projects

General comments
One clear thread that emerged from the discussions was a lack of previous knowledge about the planned local projects, particularly in Spain. None of the Spanish participants have heard about the Compostilla Project. Only one participant says that a friend living in the area informed him about the project.

The Polish participants were slightly more informed, though still most had not heard of the project before. Those who did were on the whole very dissatisfied with the amount of information they had received, and/or the way it was disseminated:

> I've read about it after hearing about it on TV, but it was probably just a lucky strike, because you do not hear about it in the media on a daily basis. (Poland)[183]

> Yes. I've heard about this project earlier. I found out about a meeting with inhabitants about CCS only after the meeting took place. (Poland)[184]

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[180] Me imagino que habrá que utilizar almacenes especificos para esta materia, en lugares alejados de la población y que no conlleve ningún riesgo.

[181] Jednak skojarzenie jakie mi przychodzi to ziemia podziurawiona jak ser szwajcarski przez odwierty...

[182] Pedro- Entiendo el almacenamiento del CO2 después de su captura, y realizado un proceso de licuado, se convertirá en una líquido viscoso que podría almacenarse en balsas profundas en aquellos lugares geológicamente óptimos. Me parece algo natural y necesario para el mundo. No lo veo peligroso. Rocio- Viéndolo así a lo mejor nos estamos preocupando más de lo debido

[183] Czytałem co nieco po wyrywkowej informacji zasłyszanej dawno w TV, ale to był chyba szczęśliwy traf, bo na codzień praktycznie nie słychać o tym w mediach.

[184] Owszem. Słyszałam o tym Projekcie wcześniej. Dowiedziałam się, niestety już po fakcie o spotkaniu mieszkańców Gminy, na terenie której proponuje się realizację tego Projektu ze specjalistami.

> I have read about it in a business newspaper but I don't remember the title as I was waiting at the dentist's. It was a newspaper with coloured pages. I think I would never have heard of it, had it not been for the fact that I did not have anything to do then (Poland)[185]

Some commented that the survey and the discussion board included more new information than they had gotten through other channels.

> I have not heard before about this project. Having filled in the questionnaire I became interested in this topic. (Poland)[186]

None of the participants found the website of the Spanish project. The project itself did not generate a significant interest (mental and physical distance to the project). Confronted with the website of the project, the comments of participants emphasize:

a) The project is interesting
b) Lack of information on the risks (associated with the lack of trust)
c) There is relevant information on other projects

Local benefits
When asked about the local benefits of the Spanish CCS project during the second day, it is interesting how the initial reactions emphasize the potential local economic benefits of the project. It is perceived by some that the project will bring new infrastructure and jobs to the area. These participants show a very positive attitude towards the project.

Following these comments, some participants try to argue that the potential risks will destroy the economic benefits. Some other participants agree on the potential risk, but are more ambivalent. An example of how such an argument developed:

> Visitación – It is favourable in economic terms: infrastructures, jobs…but in other terms (risks) I do not think so.
> Jorge – Benefits, with no doubts
> Víctor – Everything creating jobs seems positive to me…
> Susana – The community will benefit from the economic and employment boost derived from job creation (direct and indirect). (Spain)[187]

In terms of the attitude towards the project, participants seem to be divided in the following way:

a) Positives. Emphasize the economic benefits to the community.

b) Negatives. Emphasize the potential risks (leakages, explosions) to the community.

> I think no one would like to live or visit a landfill, whatever it contains. The local

[185] Ja wcześniej czytałam w jakiejś gazecie biznesowej ale nie przypomnę sobie tytulu to było kiedyś jak czekałam na swoją kolej u dentysty . Jakaś gazeta z tylko częścią pokolorowanych stron. Myślę,że nigdy bym się nie wczytała gdyby nie fakt, ze nie miałam wtedy co robić.

[186] Nie słyszałem wcześniej o tym projekcie. Dopiero wypełnienie ankiety spowodowało, że zainteresowałem się tym tematem.

[187] En terminos económicos es favorable: infraestructuras, puestos de trabajo... pero en otros términos (riesgos) creo que no. Jorge
Beneficio, sin duda alguna. Víctor
Todo lo que sea creación de puestos de trabajo me parece positivo. Susana. La comunidad se beneficiará por el impulso económico y laboral que supondría la creación de puestos de trabajo (directos e indirectos).

community will be affected. (Spain)[188]

In Poland, tourism and depopulation of the area were also mentioned as negative side-effects to the local economy.

> I have an impression that any benefits to local communities may be of a temporary character. I assume that the long-term effects of the CCS project might be migrations of the population. CCS would leave only those directly involved in the work on the project . Without any action aimed at awareness raising, nobody will want to voluntarily live in the area of a potential "ecological bomb". (Poland)[189]

c) Ambivalent. Think that the project has both benefits and carries risks.

7.2.5 Reactions to the study/questionnaire

General comments
Asked about their experience with the questionnaire and the DB participants generally show a positive attitude towards the participation in this kind of project. The topic is considered by some as very interesting and the project allowed them to learn about something new and express their views and concerns.

> I think it is an interesting topic that affects all of us, that I was completely unaware. Now I can form an idea about it, more or less. (Spain)[190]

The following ideas are expressed (especially in relation to the DB):

a) The DB allowed me to learn about a new technology and project.

> I think this forum has served or will serve to know how they have to present the issue to the citizens. We have showed our fears and more. Knowing how a part of the population thinks, they will know how to reach the population as a whole, and they will come with the arguments to the questions we may have raised them here. (Spain)[191]

b) The questionnaire did not change my opinion as I had no opinion about the project.

> I've never heard of this project. The survey changed my opinion to the extent that previously I had no opinion on this subject and now I have one :) (Poland)[192]

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[188] Creo que a nadie nos gusta ni vivir ni visitar un vertedero, sea de lo que sea. A la comunidad local la perjudicaría.

[189] Odnoszę wrażenie, że wszelkie korzyści dla społeczności lokalnej mają wymiar doraźny. Zakładam, że długofalowe skutki wprowdzenia projektu CCS spowodują migrację ludności. Pozostaną tylko Ci, bezpośrednio zaangażowani w pracę przy projekcie. Bez akcji uświadamiającej rzeczywisty stopień ryzyka (lub wręcz niebezpieczeństwa) nikt nie będzie chciał dobrowolnie mieszkać na potencjalnej "bombie ekologicznej". Po za tym chyba jednak chodzi o korzyść pojmowaną globalnie, a nie ograniczoną do społeczności lokalnej.

[190] Me parece un tema interesante y que nos afecta a todos, que desconocía por completo. Ahora ya me puedo hacer una idea, más o menos.

[191] Creo que este foro les ha servido, o les servirá, para saber como han de presentar el tema a los ciudadanos, ya que nosotros hemos reflejado nuestros miedos y demás. Sabiendo como pensamos una parte representativa de la población sabrán como llegar a la población en su conjunto, y nos vendrán con los argumentos a las preguntas que nosotros posiblemente les hayamos planteado por aquí.
Más que hacernos oir ellos lo utilizarán como un lavado de cabeza, un saber venderse hacia el público en general.

[192] Nigdy wcześniej nie słyszałam o tym projekcie. Zmienił moją opinię o tyle, że wcześniej nie mialam żadnej opinii na ten temat

c) The survey or DB provoked me to have a closer look at the issue

> The survey was – yes – interesting... But the most important was that it provoked me to have a closer look at the topic (Poland)[193]

> I also thank you for the discussion and an opportunity to participate in this debate. The subject was interesting and I must admit that the discussion forced me to read more about CCS. There could be more such forums on interesting topics. (Poland)[194]

d) I have discussed the issues with friends, colleagues or neighbours. Often though participants reported that they did not seem too interested or knowledgeable about it.

> I've tried to talk to several people from the village, in which the project is planned. Unfortunately, apart from fear in their eyes and a question: what now? they were unable to say anything. A complete lack of knowledge. (Poland)[195]

e) I would like to have more information about this topic. I need it to have a better idea.

f) Mistrust about the motives of asking people about a technological project (they want to sell us the project)

7.2.6 Trust / Political efficacy

Companies
Some of the ideas expressed by participants in the DB show a sense of antagonism towards the companies promoting CCS. These participants tend to consider CCS as a strategy to keep the traditional business mode ("I think the cost must be very high. Moreover, I think that companies are not very predisposed to invest in ecology if they do not see a benefit." (Spain)[196]; It is true, at the end they are interested in the fact that we continue consuming polluting energies because everything is a business." - Spain[197]). This is tied up with suspicions that *someone* will profit from CCS, which in itself is often seen as a negative because it is money which is seen as important rather than the environment, which raises suspicions about the whole undertaking:

Of course they are not limiting, but companies are going to invest, if they see a business, all of them are going to invest (Spain)[198]

> Do not want to concoct a conspiracy theory here, because there is no evidence for doing so, but it seems logical that someone will earn money on this, someone has yet to build the installation and operate it. It will not be cheap and the money will go to the public sector

[193] Ankieta była - owszem - ciekawa ...
Ale najważniejszą jej cechą było sprowokowanie mnie do jeszcze bliższego zapoznania się z tematem.

[194] Ja również dziękuję za zaproszenie do dyskusji i możliwość uczestnictwa. Temat był ciekawy, a przyznam szczerze, że dyskusja zmusiła mnie do poczytania i zgłębienia wiedzy na temat CCSu, mogłoby być więcej takich for dyskusyjnych na ciekawe tematy.

[195] Usiłowałam rozmawiać z kilkoma osobami z miejscowości, na terenie których planuje się realizację projektu. Niestety poza przerażeniem w oczach - i co to teraz będzie? nie byli w stanie nic powiedzieć. Kompletny brak wiedzy.

[196] I think the cost must be very high. Moreover, I think that companies are not very predisposed to invest in ecology if they do not see a benefit.

[197] Es verdad, al final les interesa que sigamos consumiendo energías que contaminen porque todo es un negocio.

[198] Por supuesto que no lo va a limitar, y pienso que las empresas que comentas si van a invertir y como algunas otras vean negocio claro, ahí se meten todos.

(Poland)[199]

Though distrust of politicians and/or industry was very often mentioned in the survey (particularly the German one, see chapter 6), this was not a particularly prevalent concern in either of the two dialogue boards. In Spain, some comments express a lack of trust in politicians, but generally linked to local politicians not answering to local needs and concerns.

Another idea is that CCS will bring higher costs of electricity for consumers, i.e. energy companies will need to recoup the higher costs of using CCS with their power plants by adding to the price of their electricity. In Poland, this argument was made most fervently by the climate change sceptics, that is, those who already did not see too much need for CCS in the first place.

> The power companies should not bet on it. If there is a "tariff deficit", this would be an increase in energy prices: Over 50% (there is a case in Denmark: CASTOR project, and there are supposed to be productive). And we will have to keep paying it, I cannot afford this rise in everything, that's enough. (Spain)[200]

> The anticipated increase in energy prices after the introduction of this technology is of 30% (Poland)[201]

Policy makers
When expressed by participants, lack of trust in policy makers seems to be base on:

a) They are perceived as having the same interests of companies.

> But the problem is that our politicians should be an example to citizens, that is, stop using official vehicles and start going to work by public transport or car sharing at least. (Spain)[202]

b) They are perceived as being only concerned about elections

> The people's opinion is taken into account only when there is an election. They do not take into account the real opinion, just the potential votes for or against. (Spain)[203]

c) Links to corruption.

> Rather than fighting for the interests of citizens and obtain grants to develop projects, they are only driven by the interest of their pockets. They get subsidies and divert funds… they are all the same. (Spain)[204]

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[199] Nie chcę tutaj knuć teorii spiskowej, bo nie ma ku temu żadnych dowodów ale logiczne jest, że ktoś na tym zarobi, ktoś musi przecież to zbudować i obsługiwać. Nie będzie to tanie, a pieniądze pójdą z sektora publicznego.

[200] Las empresas eléctricas no deberían apostar por ella. Si actualmente hay "déficit tarifario", esto supondría un aumento en los costes de la energía: cerc del 50% (hay una caso realizado en Dinamarca: Proyecto CASTOR, y allí se supone que son productivos)
Y quienes lo tendrán que seguir pagando seremos nosotros, yo no me puedo permitir que me sigan aumentando todo, ya está bien.

[201] Przewidywany wzrost cen energii po wprowadzeniu tej technologii to 30%.

[202] ... pero el problema es que nuestros políticos deberían dar ejemplo a los ciudadanos, es decir, dejar de utilizar los coches oficiales y comenzar a ir en transporte público al trabajo o al menos compartiendo coche.

[203] The people's opinion is taken into account only when there is an election. They do not take into account the real opinion, just the potential votes for or against.

[204] Mas que luchar por los intereses de los ciudadanos y obtener subvenciones para desarrollar proyectos, se mueven por el interés de su bolsillo, obtienen subvenciones y desvían fondos, tanto unos como otros. Si cada día en las noticias hay algo nuevo, no se salva ninguno.

> I think companies should take care of the storage site. When the state takes care of things, everything always goes the other way round and instead of a well-prospering business we have corruption and nepotism. (Poland)[205]

d) The project is not perceived as a priority for policy makers, which could affect safety issues.

e) There was also an isolated argument in the Polish DB that the government *can* be trusted to work in everyone's best interest.

> I've been consistent in my attitude against CCS here, but after all I was guided by a personal feeling and not a profound knowledge of the issues. It should be decided by experts. The mechanisms of democracy should not guide all decision-making processes. It is for example difficult to vote over Ten Commandments or over the way of operating the blind gut. This should be left to specialists. So the decision on whether to construct CCS will be made by the government based on opinions of eminent specialists. (Poland)[206]

Poland
In the Polish DB, a recurring theme was the distrust of the participants towards their own country. Poland was perceived as "backward" and "poor", and there was a lot of cynicism over whether the Polish state or Polish companies would be able to manage such a project competently:

> Knowing the Polish reality I suspect it will not be very safe. We will do it superficially and the consequences can be dire. (Poland)[207]

Local opinion
Participants tend to express a very low sense of political efficacy. Asked about whether they think that local opinion will be taken into account in the design of the project, some participants argue that the local community is never heard.

> Local views are rarely taken into account. As in many other situations, there is an appeal to the "general interest" and that's it. (Spain)[208]

Some participants state that decisions are always taken before consulting the community. This is not going to be different in the CCS area.

> Then they will install the plant and although there will demonstrations against they will not care about local opinion, because of course ... is something that I had planned in advance and is not going to stop because some people are against. (Spain)[209]

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[205] sądzę że firmy. w przypadku państwa zawsze są wychodzi wszystko na odwrót zamiast dobrze prospekt ującej firmy wychodzi tak jak zawsze - korupcja obstawianie stołków wujkiem stryjkiem itp obecnie będących przy władzy

[206] Byłem tutaj konsekwentnie przeciw CCS, ale przecież kierowałem się tylko osobistym odczuciem, bez głębokiej znajomości zagadnienia. Zdecydują specjaliści. W niektórych sprawach nawet mechanizmy demokracji nie powinny decydować: trudno bowiem poddawać pod głosowanie dekalogu lub np. kwestii - jaką metodą operować ślepą kiszkę - jest to sprawa decyzji specjalisty chirurga. W tym sensie decyzję o budowie i instalacji CCS, podejmie rząd w oparciu o opinie wybitnych specjalistów.

[207] Znając Polską rzeczywistość podejrzewam , że będzie to mało bezpieczne.
Zrobimy jak wszystko po łebkach a skutki mogą być opłakane.

[208] Las opiniones locales raramente son tenidas en cuenta. Como en otras muchas situaciones, se apela al "interés general" y punto.

[209] Luego pondrán la planta y aunque haya manifestaciones en contra pasarán olímpicamente de la opinión local, porque claro... es algo que ya tenían planificado de antemano y no se va a parar porque x gente se manifieste en contra.

Some argue that only huge protests may avoid unwanted projects. ("Opposition is only taken into account if it is strong and noisy." - Spain[210])

The discussion about public consultation in Poland involved the (general lack of) information about the project, i.e. that information needs to be provided before people can make an informed decision, and as shown above, participants did not generally feel that information about the project was disseminated well.

> It is important for me that one can reduce CO2 released into environment. But even more important it is to me that people are consciously able to agree or disagree with the introduction of this technology. And this involved good information about the possible disadvantages and advantages of CCS. (Poland)[211]

One Polish participant (quoted above) on the other hand argued that important decisions on such complex matters should really be left to experts and professionals who understand the issue better. It was also argued that the public "always has concerns":

> [with more information] people would certainly be more informed but not necessarily more supportive of the project. People always have concerns, even in case of wind energy. (Poland)[212]

This view was argued against though, one participant for example, while agreeing that experts will know much better what the issues at stake are, thought that their role could only ever be to advise and present their point of view clearly, but not be the only ones making the decisions:

> I believe that any, even the most complex issue, can be presented so that the layman can understand it. Anyway, I'd prefer to have some input into what is happening around me. I have something to say. Professionals should advise, educate and, yes, have a major impact on the final decision, but they should not be the only ones with the voting rights. (Poland)[213]

7.2.7 Images / Metaphors

Natural gas storage
In Spain, the link to natural gas was often made to show that citizens are also exposed to risks from natural gas in houses. Gas storage however is not mentioned, and it seems is not familiar for participants.

> On the other hand I would not mind living near a store CO2 as there are other risks as a gas explosion at home and we live every day with them
> Raquel- I think that gas in homes, despite it is risky, it is more controlled currently than a CO2 storage (Spain)[214]

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[210] Sólo se tiene en cuenta si la oposición es muy rotunda y hace "mucho ruido"

[211] Dla mnie najważniejsze jest to, że można zmniejszyć wypuszczanie do środowiska co2. ale jeszcze ważniejsze jest to, aby ludzie świadomie zgadzali się lub nie zgadzali na wprowadzenie owej technologii. a z tym wiąże się przede wszystkim dobre poinformowanie o mozliwych wadach i zaletach

[212] byliby na pewno doinformowani, ale nie popierali by bardziej , społeczeństwo ma zawsze obawy nawet w sprawach np.elektrowni wiatrowych

[213] wierzę, że każdą, nawet najbardziej skomplikowaną kwestię da się przedstawić laikowi tak, aby zrozumiał. Zresztą wolałabym też mieć jakiś wkład w to, co się dzieje wokół mnie, mieć coś do powiedzenia. Specjaliści powinni doradzać, edukować i owszem, mieć duży wpływ na ostateczną decyzję, ale nie powinni byc jedynyi z prawem głosu.

[214] Por otro lado no me importaría vivir cerca de un almacén de CO2 ya que existen otros riesgos más cercanos como

Nuclear
Nuclear power was frequently mentioned in both DB, and usually brought into the discussions to show:

a) In Spain: Siting conflicts and problems. "Would you think the same if you lived close to a nuclear power plant? I think it is very similar" (Spain)[215]

b) CO_2 storage will have some similarities to a nuclear waste disposal

c) Nuclear facilities have more risks than the CO2 storage.

d) In Poland: Nuclear power was also seen as a less desirable than CCS because of the need to import uranium (i.e. lack of energy security).

> But the transition to nuclear energy brings huge costs of constructing reactors. Not to mention having to buy fuel from such uncertain sources as Russia (Poland)[216]

Although generally perceived negatively (particularly in light of developments in Japan, see below), nuclear power was also cited as less risky and more environmentally friendly:

> First nuclear power. High performance and safety, lack of harmful gas emissions, perfect for our country over the next 80-100 years. Secondly, renewable energy sources... (Poland)[217]

Japan
The DBs took place during the week after the earthquake and tsunami in Japan, and at the time, events surrounding the Fukishima nuclear power plant were still unfolding. The power plant withstood the earthquake, however the resulting tsunami overwhelmed it, which for a while (and still at the time of writing, though slightly less so) threatened a major catastrophe.
Developments with the Fukushima plant were at the time a major world media event and therefore very fresh in participants' minds. The relevance of this disaster to the safety of CCS, especially in the Belchatów area which has a recent history of small earthquakes is straightforward, and the Japan earthquake was therefore spontaneously and frequently mentioned in both DBs.

Specifically, the lessons from Japan for participants were:

> a) Even with strong safety measures CCS can be dangerous
>
> > In fact, no security can be guaranteed. Even the best technologies and the best researchers cannot guarantee complete security. The nature is unpredictable. We can see what is happening in Japan, such security… And this all for nothing. Nature won. (Poland)[218]

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una explosión de gas en viviendas y convivimos todos los días con ellos

[215] ¿Y pensarías lo mismo si vivieras cerca de una central nuclear? Yo lo veo parecido

[216] Ale przestawienie całego naszego sytemu na atom, to są gigantyczne koszty budowy reaktorów, nie wspominając o konieczności zakupu paliwa do nich z tak niepewnego źródła jakim jest Rosja.

[217] Po pierwsze energetyka jądrowa. Wysoka wydajność i bezpieczeństwo, brak emisji do środowiska szkodliwych pyłów i gazów. Idealna dla naszego kraju na najbliższe 80-100 lat.
Po drugie odnawialne źródła energii, w skali makro jest to narazie melodia przyszłości, głównie ze względu na koszty.

[218] Tak naprawdę bezpieczeństwa nikt nie może nam zagwarantować, nawet najlepsze technologie i najlepsi naukowcy. Natura jest nieobliczalna. Widzimy co się dzieje w Japonii takie zabezpieczenia, a i tak wszystko na nic.

b) CO2 storage can be dangerous even if it is located far from human populations
c) Japan makes us think about new ways of reducing our CO2 emissions.
d) We need other solutions
e) The same could happen to CO2 storage
f) Everything has some risks

Japan was also seen as a more technologically advanced country, and it was argued that if security concerns can happen in Japan, then it will be even more risky in Poland or Spain: "If an advanced country such as Japan is under alert, what can happen here in Spain?" (Spain)[219]. This is also in keeping with the theme from the Polish DB of general distrust in Polish institutions to manage risks adequately.

Gas stations
Gas (or petrol) stations are familiar to participants. The image was elicited in Spain to show that:

a) CO2 storage has to be safer than a petrol station (and we live close to them).

> (CO2 storage) It is probably safer than many other sites ... I do not think it is a bigger problem than living near a gas station ... I think they would pay more attention to safety. (Spain)[220]

b) Local protests to CO2 storage will not be heard, as have happened with some petrol stations rejected by the community

This was not an image that came up in Poland

2.7 Search for information
Although we do not have indicators of the level of active search for information of individuals, it seems that only some participants did actually look for some additional information in the web or the newspapers.

> I did not know anything about this issue. I searched for information in the Internet, in some webs and I got some idea. I think we still do not have complete information on the issue (Spain)[221]

Those participants that report having looked for information, mention the web as a source of information on:
a) The risks and benefits of the technology
b) General information on CCS, graphics, etc. (Greenfacts)
c) Some news about the Spanish and Polish Projects (Ponferrada and Belchatów)

The majority of Spanish participants have not looked for additional information about CCS ("The truth is that I did not look for information after the questionnaire." - Spain[222]). They state that they intend to look for some information in the future. The Polish participants however seemed to have

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Natura zwyciężyła.
[219] Si en Japón que es un país avanzado las centrales nucleares están en alerta que puede pasar aquí en España.
[220] Seguramente sea mas seguro que muchos otros sitios...no creo que fuera mayor problema que vivir cerca de una gasolinera... fijo que tendrian mas en cuenta la seguridad.
[221] Sí, pues desconocía el tema. Busqué información en internet, en varias páginas y me aclaré algo. Aunque creo que todavía no se tiene una información completa sobre el asunto.
[222] Pues la verdad es que no he buscado nada de información después de rellenar el cuestionario.

been slightly more interested in seeking out information after the survey.

Both Spanish and Polish participants reported a clear lack of some source of reliable information about CCS and the specific projects:

> Yes, I was looking for [information]. I have not found much. It seems that nobody cares to shed light on this matter. (Poland)[223]

> There is little information on CCS and projects in Poland. I just looked in the internet and have not found much. (Poland)[224]

Some Polish participants in fact found the survey itself to be one of the better sources of information about the project: "I've heard little about the project, but the poll provided me with more information" (Poland)[225]

In Poland there was also a lengthy discussion about how the information should best be disseminated. Though there was a clear preference by the participants themselves for the internet, it was also argued that a lot of especially older people would not have easy access, and that information provision should therefore also go through TV, the press and more traditional media.

> Better if something like this took place on TV, because not everyone has access to the Internet, and older people do not recognize this form of communication. And every citizen should have a simple and easy way to learn about CCS, its benefits and risks it brings to everyone. (Poland)[226]

The web site of the Spanish project is not easily accessed by participants. None of them mention it in the discussion. Once the moderator introduces participants to the web the main comments are:

> a) The project is interesting
> b) We are not informed about it
> c) The website lacks some information

Some participants say they have heard about the project in Ponferrada in the local news and through some friends in the area.

> I have read that is not dangerous, but I have no arguments.. Where I work a few miles away, they are building a co2 injection plant, but we know nothing yet. We were not well informed. More information on this plant would be useful to the debate. (Spain)[227]

7.3. Development of the arguments

The first day of the DBs was fairly lightly moderated and concentrated on only relatively few questions about what participants thought of the benefits and disadvantages of CCS and the

[223] Tak, szukałem. Nie znalazłem wiele. Wygląda na to, że nikomu nie zależy, żeby sprawę naświetlić.
[224] Na temat CCS i projektach w Polsce jest bardzo mało , szukałem przed chwilą w internecie i za dużo nie znalazłem.
[225] Słyszałem trochę o projekcie , ale ankieta bardziej mi przybliżyła ten temat.
[226] Lepiej gdyby cos takiego odbyło się w tv, gdyz nie każdy ma dostęp do internetu, a ludzie starsi nie uznają tej formy przekazu informacji. A każdy obywatel powinien w prosty i łatwy sposób dowiedzieć sie co to jest ten CCS i jakie korzyści i zagrożenia za soba niesie.
[227] Yo he leído que no es peligroso, pero no tengo argumentos.. Donde yo trabajo a pocos kilómetros estan haciendo una planta de inyección de co2, pero no sabemos nada todavía no nos han informado bien

particular projects. This allowed participants to develop their arguments through discussion with others and provides an opportunity for us to identify how the main arguments for and against develop and/or get dropped in favour of other arguments. Moderator input was mostly designed to elicit further thoughts about particular answers when there was a lull in the conversation ("i.e. "why do you think that") rather than to ask new questions.

Throughout the duration of the DBs, safety of storage was a recurring argument that participants made to either voice concerns about the technology or to give it some clear conditions that need to be fulfilled before they would support the project. Safety thus was an important issue for supporters and opponents alike. In this sense the arguments about safety and risks did not so much develop as stay strong throughout. Arguments about the costs for the consumer and the economy as a whole were also made throughout the DB.

By contrast, arguments in favour of CCS were established early on, but did not feature very much in the subsequent discussions, showing that the risks are certainly in the forefront of participants' minds, though it also shows that the advantages are seen as mostly straight-forward: Less pollution and limiting climate change. These advantages were questioned at least in the Polish DB by some of the participants who were sceptical of climate change in general, and those participants kept making these points, though without appearing to influence any of the others. Economic benefits were by contrast made rather towards the end, when the discussion shifted to the local projects, these however were balanced with arguments against CCS on account of economic costs, and therefore did not seem to develop significantly. Considering that in the survey (chapter 5), the Polish respondents placed much greater trust in the European Union than any of the other countries, their arguments about the benefits to the Polish economy for avoiding penalties about their carbon emissions set by the EU are interesting: It might easily be assumed that there could be a measure of resentment towards the EU, but this seemed to be pretty much absent, even with those participants who (through their doubts about climate change) did not see much other benefits for CCS. These arguments, though they were voiced several times by different participants did not eventually develop much further though in the final discussions about CCS and may therefore not have been particularly persuasive – the final discussions about CCS were more characterised by the risks and costs of CCS rather than any advantages.

The laddering, or the introduction by the moderator of questions to delve deeper into a special topic, played a role in generating discussion, but it is noticeable that the DB had its own dynamic. Laddering was useful as moderators in online focus groups can very precisely follow how the group conversation is evolving. The moderator is able to address a specific topic where more discussion is needed. In this sense, introducing questions and comments were useful to deep in some idea, to confront views from different participants, to explore new topics or to ask very specific questions (e.g. did you visit the web of the project). It allowed a more reflective discussion. However, the DB had a very active dynamic. From a moderator view, new entries generated substantive data. Then, participants' reflection on new entries generated a useful group discussion. Throughout the day, this process took place two or three times, as new participants engaged in the debate.

Not surprisingly, risks and costs of CCS were a main topic of discussion. But interestingly and maybe due to the fact that participants are first giving a reflective individual response, positive comments on CCS projects were very present in the debate and influenced the general tone of the debate.

7.4. Conclusions

The DBs did, to a large degree, confirm and extend the findings from previous research on public

perceptions of CCS, as well as our own findings from WP4 and the survey results presented in Chapter 5. In particular, the WP4 focus group study found that participants were relatively unfamiliar with the technology and very often as well about the nature of carbon. Additionally safety concerns were very much in the forefront, coupled with doubts about whether these safety concerns could be adequately addressed, either because of a cynical view of Spanish or Polish state and industry actors, or on a deeper level exemplified by Japan, over whether adequate safety can be achieved even in principle. There was also in both studies a strong preference for alternative energy technologies or concentrating instead on energy efficiency to lower emissions. Costs were seen as a clear issue; if CCS projects want to achieve acceptance, it needs to be made clear and transparent not just who pays for it, but also who stands to profit from it, as both these emerged as clear concerns in both focus groups and the survey itself. Finally, there was a clear underlying theme in both DBs about the general lack of information about the projects and opportunity for locals to be part of the decision making process.

The obvious climate change and pollution control benefits of CCS were not much discussed, which however does not signify that participants were unconvinced by these arguments, in fact these arguments seem to have trailed off because there was large agreement on the need to lower emissions and hence the benefits of CCS. Other often mentioned benefits such as those to local employment or energy security were seen as more contentious and thus elicited more argument – this on balance may have made both conversations seem more negative towards the technology than they actually were. The worries about safety, costs and information provision were however still very substantial:

Knowledge, information and participation
Participants on the whole did not feel very knowledgeable about the technology or the; in many cases the survey was the first place they have heard about it. Concerning the particular projects this was even more pronounced as many participants had not previously heard about them, even though many of them live in the general area. There was therefore a general feeling of frustration about the process of information provision, with participants complaining that there is not enough useful information around, and that they needed a survey to be prompted to find out more. As one participant noticed, while there was a local discussion evening organised in their area about the project, it was not particularly well publicised itself, and they only heard about it afterwards.

The survey itself, as well as the DBs, was generally perceived as a positive experience by the participants. While participants did not much report that the questionnaire changed their opinions about CCS, as might have been feared, this was largely because participants didn't know enough beforehand to have an opinion. The experience of taking part in the survey however prompted participants to discuss CCS with colleagues, neighbors or family and can therefore be argued to have had a positive impact itself on raising awareness and critical discussion of CCS among participants and their acquaintances.

Risk and safety
Safety was seen as a major issue throughout the DBs. Acceptability of CCS is clearly contingent on worries about safety being met adequately. This however may prove a problem since many concerns about safety are very difficult to answer. The timing of the DBs is important here, since they were held during the week immediately after the earthquake and subsequent tsunami in Japan. The events that unfolded there are of clear significance to perceptions of the risks of large-scale energy infrastructure, especially infrastructure which even without natural disasters is often seen as potentially unpredictable and thus risky.

Though the Fukushima nuclear plant was built in an area that was known to be prone to earthquakes, the fact that a single, unpredicted and unpredictable natural disaster can completely

take people unawares and in the end render all careful risk management strategies futile bears a clear lesson for CCS projects and any possible assurances about safety: we can always imagine things to turn out worse than expected, and even professional "worst case scenarios" may turn out to be too conservative. The events in Japan thus provided a ready frame with which participants could articulate fears about unknown or unpredictable risks. With that in mind, participants were understandably nervous and distrusting of official reassurances of safety, which may not be able to capture risks that are of level 4 or 5 in the classification we present in chapter 2. This echoes the influential "risk society" literature (Beck 1992, Giddens 1999) which argues that contemporary society is more safety and risk conscious and focuses on the more intangible and unpredictable risks of "the unintended consequences of technology" which technological expertise will find hard to address through traditional methods. This is stressed by the point that Japan was seen in both countries as a technologically advanced and safety conscious country, which made any safety doubts even worse because both Spain and Poland were perceived to lag behind technologically, Poland was even described as "backwards" by one participant. There was general doubt in Poland even without the discussion of Japan, whether the country's institutions or companies would be able to deal competently with CCS (a sentiment which was also apparent in the survey itself, which was held before events in Japan).

Costs

In many ways the discussions concerning the economic values of CCS were the most complex, since they were used both as arguments for and against the technology. In Spain, the potential costs of CCS are perceived as a significant drawback by some participants, who question the high investment costs in the context of budget restrictions. On the one hand, CCS was seen as bringing new employment to the area, thus re-invigorating it (though it was also argued that any employment would need to go to trained experts who would need to come from outside so that CCS would not benefit the local population as much; see also the main survey open questions). CCS was also seen as keeping local coal industry in business which would be a clear benefit for the community, though this was also contested by participants who argued that we need to get away from our reliance on coal. On the other hand, a worst case scenario was painted by one Polish participant who thought CCS would lead to a depopulation of the area by concerned citizens, and the only remaining people would be those working on the project. Tourism, though not a major part of the local economy would plummet as well.

It was clear to participants that CCS, which is basically an add-on to existing coal technology will introduce costs to the production of energy, which makes the extra cost of CCS more intuitive to grasp than any extra costs incurred for example by wind or even nuclear power. There were clear concerns about who would have to shoulder those costs: It would either be consumers through higher energy prices, or general taxpayers through government (or EU) support of the project. In both cases, participants thought that ultimately they would have to pay for it, and while these concerns were not seen as show-stopping, it was still clear that participants expected clear and well defined benefits and safety assurances if they were to agree to it. Coupled with these concerns it was also often seen that people will profit from it (why else would energy companies be keen on this), and therefore CCS easily projected an image of industrialists and politicians profiting at the expense of ordinary people.

Appendix 7.1 – Dialogue Board Discussion Guide

Theme 1: *Assessing the arguments and underlying motives pro and contra CCS.*

- What are your main arguments for and/or against CCS?

- Could you elaborate on these arguments? →What are your motivations? Why are these arguments so essential or relevant for you? Could you say more about why you find these arguments important?
- Could you please give the most important/ most essential motivations (by highlighting or by typing the keywords of the motivations)?
- Could you please give a clarification for these essential motivations? And will you provide us with some illustrations/examples hereof?

Theme 2: *About the questionnaire*

- General question: Are there any issues arising from the questionnaire that you would like to comment on?
- Did you know about the project before you filled out the questionnaire, and did it change your opinion in any way?
- Did you feel that you needed more information about CCS or the project after filling out the questionnaire, and/or did you actively seek out some more information? If so, where did you go? What made you chose those particular information providers?
- Did the survey prompt you to discuss CCS or the planned project with friends, family or work colleagues?
- Now that you have had some time to think about it, what are your thoughts about the project?
- Do you feel strongly enough about it to actively campaign for or against it?
- Do you feel in general that local opinion is taken into account enough when large infrastructure projects are being planned? Is there anything that you think should be done by local and national politicians and the developers that they are currently not doing within the consultation process?
- Do you think the local community would generally be better or worse off if the project goes ahead?

Theme 3: *About CCS and climate change in general*

- Could you give us some general thoughts about CCS?
- Do you think CCS is a good way of combating climate change? (and why)
- Do you think CCS is a good way of addressing energy security issues (and why)
- Do you think CCS is a particularly risky technology, compared with other energy options? (and why)? Would the risk issues be lessened for you if the storage is off-shore rather than on-shore, considering that CO2 would still need to be transported from the power plant to the sea?
- Should CCS be developed further if we assume the risk issues can be answered adequately, or are there any other factors that need to be addressed?
- What images or metaphors come to mind when you think about CCS? If you had to explain CCS to relatives or friends, how would you present it?
- Do you think Climate change is one of the big problems facing society today? Has your opinion changed over the past year?

8. Effects of text and visual depictions of CCS on processing, risk perceptions and attitudes: An Experiment.*

* This chapter was written by Suzanne Brunsting, with contributions from Hauke Riesch, Marjolein de Best-Waldhober and David Reiner. The authors thank Kenshi Itaoka and Aya Saito from the Mizuho Information and Research Institute for giving us permission to use their visual as a basis for this experiment.

8.1 Introduction

It is commonly assumed that information about complex topics such as new energy technologies or technical processes is easier to understand for a general audience when textual explanation is accompanied by visuals. Based on this assumption, recent advances in graphical technology have led to substantial investments in the creation of innovative, multimedia environments in which users can interact with information. Taking for example the process of CO2 capture, transport and storage, companies take efforts to foster public understanding of this novel energy transition technology by providing imagery ranging from simple static overviews to animated, interactive three-dimensional depictions.

However, little is known about how any of such graphical representations actually influence information processing, understanding, and attitudes. Although research confirms that visuals can enhance understanding of a complex issue, it is not always well understood which elements of visuals sort which effect. Therefore, taking CO2 injection as case, we designed an experiment that aims to increase understanding of the conditions under which combining textual and visual information fosters information processing about a complex, unfamiliar technology and how this in turn affects comprehension, risk perceptions, and attitudes.

An analysis of currently available visuals revealed that textual information about CO2 injection is often accompanied by a visual that does not convey the same information. One example of such 'incongruence' is the depth of injection. In text often the precise depth will be mentioned, e.g. 1,000 meters. However, depth of injection is often visualised such that the CO2 storage seems much closer to the surface, e.g. 10 meters rather than 1,000 (see Figure 8.1).

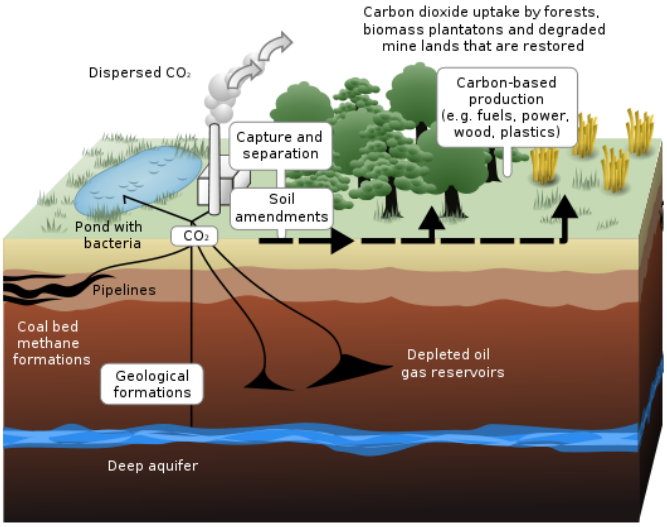


Figure 8.1 *Carbon sequestration explained. Obtained from Wikipedia:* http://en.wikipedia.org/wiki/File:Carbon_sequestration-2009-10-07.svg

Observations from the field, e.g. at public meetings in Barendrecht (the Netherlands) where onshore CO2 injection was being planned (Desbarats et al 2010), indicate that not understanding depth of injection may induce worries about consequences of CO2 leakage. Residents of Barendrecht perceived a risk from onshore CCS in relation to the CO2 being beneath their neighbourhood. This is despite the gas being stored at least 1km down, so that any leakage (if at all possible) would have to work its way up to them.

It is therefore important to investigate if estimates of depth are indeed related to perceptions about CCS such as the risk of leakage, and if so how information aiming to explain the depth of CO_2 injection to a lay audience should be designed to get this message across. Does a precise indication of depth in either text of visual lead to a better depth estimate than a vague indication? And what happens when one of these information sources, either text or visual, contains a less precise depth indication than the other (and is thus incongruent)? To which information will people then adhere? Little is known about this, but we do know that preferences to process textual and visual information differ by individual. Some individuals prefer one over the other whereas others are equally good or bad at processing both types of information. These preferences can be measured with verbalising and a visualising scales. Given this variation in information processing preference, one could argue that textual and visual information should be 100% consistent to enable people to comprehend the information regardless their preferred processing style.

Central to this research are the following questions:
(1) How does precision in indicating the depth in either the text or the visual influence estimates of injection depth?
(2) How does congruence versus incongruence in textual and visual indication of depth influence a viewer's estimate of injection depth?
(3) To what extent does estimated depth influence perceptions of the technology, in particular perceived safety and attitude towards CO2 injection?

The following hypotheses are tested:

H1a The more precise the indication of depth in the text, the better the respondent's estimate of depth, in particular for those respondents who score highly on the verbalising scale.
H1b The more precise the indication of depth in the visual, the better the respondent's estimate of depth, in particular for those respondents who score highly on the visualising scale.

H2a Congruency between text and visual as opposed to incongruency improves the respondent's estimate of depth.
H2b. Congruency between text and visual as opposed to incongruency improves respondents' ability to process the information and will thus improve memory of the visual, perceived understanding of CCS, attitude towards the stimulus, perceived fit between text and visual, attitude towards the information, and interest in further information.

H3. The deeper respondents estimate the injection, the more positive their attitude towards CCS, the lower risk perceptions of CCS and the lower perceived personal relevance of CCS.

8.2 Method

8.2.1 Design and materials

To test whether accurate portrayal of scale in either textual information, visual information, or both makes a difference to people's understanding of the technology and their perceptions of CCS such as safety of storage, we used a 3x3 experimental design with two factors. First, textual description

of depth of injection (absent, ambiguous, precise). Second, visualisation of depth (absent, ambiguous, precise). This resulted in 9 conditions which are displayed in Table 8.1. The stimuli are listed in Appendix 8.1.

Table 8.1 *Experimental conditions.*

	Textual indication of depth		
Visual indication of depth	Absent ("underground")	Ambiguous ("deep underground")	Precise ("1,000 meters or deeper underground")
Absent	Congruent	Text-only	Text-only
Ambiguous	Visual-only	Congruent	Incongruent
Precise	Visual-only	Incongruent	Congruent

Three textual conditions were developed explaining the background and process of CCS. They were similar in every respect except for the accuracy of indication of depth:

- Absent: only mentioning the storage is "underground"
- Ambiguous: containing a more vague description of the depth ("deep underground")
- Precise: stating the exact depth of storage similar as displayed in the visual (e.g. 1,000m)

Three visual conditions were developed displaying the depth of CO_2 injection. They were similar in every respect except for the accuracy of indication of depth:

- Absent: no visual displayed
- Ambiguous: injection obviously too shallow, indicated by familiar landmarks
- Precise: scaled visual – when measured with a ruler, injection is exactly 1,000 meters deep

The visuals have been derived from a visual used in previous research (see acknowledgment – results of this research are forthcoming and cannot be referenced yet). The visuals are static as movement would have added another variation to the experiment. Furthermore, they are two-dimensional showing CO_2 injection from the side. In practice, we often encountered 3D half from the side/half from above perspective. In such visuals, however, the proportions are distorted. To enable people to estimate depth, familiar landmarks were included: A tree, a car, and a power plant. One of the visuals showed depth of storage 'accurately' – assuming the power plant on the surface including the chimney is 50 meters high, onshore injection is exactly 1,000 meters deep. The other visual clearly shows depth 'inaccurately' which was achieved by inflating the landmarks and shortening the injection shaft. Since the experiment was conducted online, the stimuli were designed to fit 800*600 pixels to display properly on most computer monitors without requiring respondents to scroll.

8.2.2 Respondents

A market research firm was hired to recruit a representative sample of subjects from the UK population in terms of age, sex, education, and region. 473 people participated in the research, however only 429 of them provided reliable responses. Of the respondents included in the analyses, 219 were males and 210 were females. Mean age was 41.77 (SD = 13.40) and ranged from 18-65.

8.2.3 Procedure

The experiment was conducted online and respondents could participate from their home computers. They first received the stimulus, which was followed by a short questionnaire. On average, the experiment took respondents 18 minutes to complete (SD = 52.50)

At the start of the experiment, respondents were explained that the research aimed to investigate their opinion about a technology called carbon dioxide capture and storage (CCS). They were explained that they would be shown a section of a booklet about energy-related technologies containing a brief introduction to CCS. They were told that they could take as much time as they

wanted to look at the information, but that to ensure some degree of exposure it would take 10 seconds for the <next> button to appear. As soon as this button appeared, respondents would be able to click through to the next screen and start the questionnaire.

Measures

Control variables

Prior Knowledge of CCS. To test for differences in prior knowledge of CCS, respondents were asked to indicate how much, if anything, they knew about Carbon Capture and Storage (CCS) before participating in the experiment. Answer options ranged from 1 (never heard of/don't know) to 5 (quite a bit). Because this variable had little variation with 53% of the sample answering never heard of/don't know, knowledge of CCS was dichotomized into 0 (never heard of/don't know) and 1 (at least heard of).

Prior knowledge of CO_2. To obtain an objective indicator of prior knowledge about CCS before the experiment in addition to self-reported knowledge, respondents were given statements about CO_2 and were asked to indicate if these statements were either true or false. The correct answers to the statements could not have been derived from the stimulus materials, which did not contain information about features of CO_2. Incorrect scores were subtracted from correct scores, resulting in a variable ranging from -4 to +4. By this principle, people who indicated that all of the 8 statements were false scored 0.

Prior knowledge of effects of CCS. To obtain an objective indicator of prior knowledge about CCS before the experiment in addition to self-reported knowledge, respondents were given statements about CCS and were asked to indicate if these statements were either true or false. The correct answers to the statements could not have been derived from the stimulus materials, which did not contain information about the effects of CCS. Of the statements, 2 were true and 4 were false. Incorrect scores were subtracted from correct scores, resulting in a variable ranging from -4 to +2. By this principle, people who indicated that all of the 6 statements were false scored -2.

Depth estimate

Depth estimate. To check if manipulation of depth had succeeded, respondents were asked to estimate how deep (in meters) the CO2 would be stored underground. The choice of meters was made because, even though British people are usually more familiar with feet for measuring everyday heights, meters are frequently used alongside feet in media outlets such as the BBC as well as in school science lessons. We can therefore assume that most respondents are familiar enough with meters, whereas feet are not very well understood by foreigners living within the UK.

Individual processing styles

Verbaliser scale. Preference for processing verbal information was measured with 4 items derived from an existing measurement instrument (Kirby, Moore, & Schofield, 1988), e.g. "I enjoy doing work that requires the use of words". The items formed a scale (Alpha = .80). To investigate the effect of a low versus high score on the verbaliser scale, respondents were divided into two approximately equally large groups whereby those scoring 2.25 or less were assigned to the 'low' verbalise group.

Visualiser scale. Preference for processing visual information was measured with 4 items derived from an existing measurement instrument (Kirby, Moore, & Schofield, 1988), e.g. "I like newspaper articles that have photos". The items formed a scale (Alpha = .63). To investigate the effect of a low versus high score on the visualiser scale, respondents were divided into two approximately equally large groups whereby those scoring 2.25 or less were assigned to the 'low' visualise group.

Stimulus processing and evaluation

Memory of stimulus. To check for depth of processing, 4 questions were asked to measure how well respondents remembered the information they just saw. Correct scores were summed

resulting in a total score ranging from 0-4.

Understanding of CCS. To measure self-reported effects of the stimulus on perceived understanding of CCS, Respondents were asked: "At present, how well do you feel you understand the process of Carbon Capture and Storage (CCS)?" Answer options ranged from 1 (not at all) to 5 (completely).

Attitude to Stimulus. To determine respondents' perceptions of the stimulus, 5 questions were asked in which respondents were asked to indicate to what extent they felt the information about CCS has helped them to get a better understanding of the technology, to form an opinion of the technology, how they rated the quality of the information, the quantity of the information, and how interesting they found the information. These items, which were all measured on 5-point scales, formed a scale with an Alpha of .86. Scores on the items were summed and divided by 5 to create one indicator of attitude towards the stimulus.

Perceived fit between text and visual. To check whether incongruency between text and image would influence how helpful respondents perceived both text and visual to be in understanding the CCS technology, three questions were asked only to people in visual conditions: (1) How helpful did you find the visual about CCS to understand the technology?; (2) How helpful did you find the text about CCS to understand the technology?; (3) To what extent do you agree or disagree with the following statement? The text and the visual supported each other in explaining CCS. The items, all measured on 5-point scales, formed a scale with an Alpha of .87. Scores on the items were summed and divided by 3 to create one indicator of perceived fit between text and visual.

Attitude towards the information. This was measured using 8 adjective pairs on a 7-point scale, e.g. 1 (unattractive) to 7 (attractive). Respondents were asked to each time choose the description that best reflected their opinion about the information by clicking the response option close to that description. Factor analysis revealed that this scale had two dimensions which were labelled *relevance/interest* (Alpha = .80) and *clarity/reliability* (Alpha = .86).

Interest in further information. A link to the project page was provided at the end of the survey, not only as a service to respondents but also to register how many respondents per condition would click the link and to see if there would be any significant differences.

Perceptions of CCS

Attitude towards CCS. This was measured using 5 adjective pairs on a 7-point scale, e.g. 1 (positive) to 7 (negative). Respondents were asked to each time choose the description that best reflected their opinion about the information by clicking the response option close to that description. The adjective pairs formed a good scale (Alpha = .89).

Risk perceptions CCS were measured by giving respondents 8 statements about possible consequences of using CCS and by asking respondents to rate the likelihood of these consequences, e.g. "CO2 will acidify the underground drinking water". Of these items, which were all measured on a 5-point scale, 7 formed a good scale (Alpha = .84) and were combined. The item that did not scale, "The safety of a CO2 storage site can be sufficiently guaranteed", was analyzed separately. The item was recoded to make a higher score represent stronger disagreement with the statement similar to the other risk perception statements.

Personal relevance of CCS was measured with the items "Would you mind if a CCS project was planned in the area where you live?" (1 = very much to 5 = not at all) and "Do you think plans for CCS in your area would have a positive or negative impact on your area?" (1 = very negative to 5 = very positive). The option to answer "don't know" to this question was reinterpreted as being neutral and thus scoring 3. Besides to prevent loss of cases in the analyses, this was also done to end up with a more or less normal distribution for this variable. The items did not form one scale. Therefore, minding CCS in the area and estimating the impact of CCS in the area were analyzed separately.

8.3 Results

8.3.1 Sample overview

No significant between-group differences were found in age, sex, education, or region, thus ruling out these variables as alternative explanations for results.

8.3.2 Prior knowledge

No significant between-group differences were found for any of the prior knowledge measures, ruling these out as alternative explanations for results. 227 respondents (53%) report they had never heard about CCS before reading the experimental stimulus. Most people know some to a lot about the characteristics of CO_2, with 126 people (29.3%) identifying three correct statements and 88 people (20.6%) identifying all four true statements. The mean score on the scale which ran from -4 to +4 was 2.27 (SD = 1.39). However, effects of CCS are much less familiar with 72 (16.7%) respondents correctly identifying one correct answer without ticking any false statements and 27 respondents (6.3%) identifying both of the correct answers without ticking any false statements.

8.3.3 Estimates of injection depth

Tables 8.2 and 8.3 show labels of conditions and mean depth estimate per condition. The colours immediately reveal a pattern: estimates of depth are most accurate in text-only conditions and least accurate in visual-only conditions.

A GLM comparing text-only with visual-only conditions reveals a significant difference, $F(1,190) = 17.52$, $p < .001$, Eta Squared = .08.

The third-deepest estimate is made by respondents receiving precise textual and ambiguous visual information whereas the third-shallowest estimate is made by respondents receiving precise textual and precise visual information. One explanation for this is that people do notice when a visual is or is not to scale. When it is not to scale, they will rely on textual information. When it is to scale, they will try to base their depth estimate on visual information but get it wrong, resulting in worse estimates even when there is a depth indication in the text as well. Apparently the landmarks do not help people – the car and tree are too small and the power station is not estimated to be at least 50 meters high but smaller.

Interestingly, Table 8.3 shows that when people are given no estimate of depth at all, their mean estimate is 869.33 which is pretty good. Apparently, offering information about depth of injections will in some cases negatively affect depth estimates. Below we explore this further.

Table 8.2 *Experimental conditions*

	Textual indication		
Visual indication	• Absent	• Ambiguous	• Precise
• Absent	Congruent	Text-only	Text-only
• Ambiguous	*Visual-only*	Congruent	Incongruent
• Precise	*Visual-only*	Incongruent	*Congruent*

Table 8.3 *Mean estimates of meters per condition*

	Textual indication		
Visual indication	• Absent	• Ambiguous	• Precise
• Absent	869.3	1355.5	1336.8
• Ambiguous	*663.6*	786.6	1096.7
• Precise	*557.2*	837.3	*741.1*

Lowest estimates
Highest estimates

8.3.4 Hypotheses testing

H1a The more precise indication of depth in the text the better respondents' estimate of depth, in particular for those respondents who score high on the verbalizing scale.

To check for main effects of text, a variable with 3 values was created: Value 1 was assigned to conditions in which a textual indication of depth was absent; value 2 to conditions in which the textual indication was ambiguous; value 3 to conditions in which the textual indication was precise.

Running a GLM a significant main effect of text was found, F (2,419) = 4.87, p = .01, Eta squared = .02. A precise text leads to the deepest estimate of depth in meters, followed by an ambiguous text, followed by absence of depth indication in text. The post-hoc test did not reveal a significant difference between the precise (1057.40) and ambiguous (997.76) indication, but both conditions differed significantly from the condition in which indication of depth was absent (700.37), p = .05.

In addition a significant interaction effect was found with the verbaliser scale, F (2, 419) = 4.64, p = .01. The found main effect of textual preciseness is only found for high verbalisers. Low verbalisers estimate the depth of injection the deepest when presented an ambiguous text, followed by a precise text. Furthermore, when presented a precise text, which explicitly states that depth of injection is 1,000 meters or lower, low verbalisers still estimate depth on average below 1,000 meters (M = 973.02, SD = 121.288). These results indicate that low verbalisers have processed the textual information less carefully, as their low score on this scale would predict. No significant interaction effect was found with the visualiser scale, F(2,419) = .58, *ns*.

This means that H1a is accepted. The more precise indication of depth in the text the better respondents' estimate of depth, however this effect is only found for respondents who score high on the verbalizing scale.

H1b The more precise indication of depth in the visual the better respondents' estimate of depth, in particular for those respondents who score high on the visualising scale.

To check for main effects of visual information, a variable with 3 values was created: Value 1 was assigned to conditions in which a visual was absent; value 2 to conditions in which the visual was

ambiguous; value 3 to conditions in which the visual was precise.

Running a GLM a significant main effect of visual was found, F (2, 419) = 6.54, p = .00, Eta squared = .03. A precise visual leads to the shallowest estimate of depth in meters, followed by an ambiguous visual, followed by absence of visual information. Post-hoc tests revealed that the absence of a visual leads to significantly deeper estimates (1181.62) than the presence of either an ambiguous (853.49) or precise (712.58) visual, p = .05.

In addition, we investigated possible interaction effects between visual depth indication and processing style. No significant interaction effects were found with either the verbaliser scale, F (2, 419) = 1.45, *ns* or the visualise scale, F(2,419) = .71, *ns*.

This means that H1b is rejected. The presence of a visual worsens respondents' estimate of depth, and the more precise indication of depth in the visual the worse respondents' estimate of depth. This effect is independent of processing style.

H2a Congruency between text and visual as opposed to incongruency improves respondents' estimate of depth

Running a GLM checking for main and interaction effects of textual and visual information, again main effects for both textual and visual information were found but no significant interaction effects, F(2,420) = .57, *ns*.

To further explore the effects of congruency versus incongruency, a variable with 2 values was created: Value 1 was assigned to conditions in which visual and textual information were congruent; Value 2 was assigned to conditions in which visual and textual information were incongruent. Text-only and visual-only conditions were left out of this analysis, as well as the condition in which both textual and visual depth indications were absent. Running a GLM with the 4 remaining conditions (n = 188) again revealed no significant effect, F (1,186) = 1.64, *ns*. Contrary to expectations, however, depth estimates are better for incongruent than congruent conditions.

This means that H2a is rejected. Congruency between text and visual as opposed to incongruency does not improves respondents' estimate of depth. Rather it appears, although not significantly, that incongruency fosters understanding of depth.

H2b. Congruency between text and visual as opposed to incongruency improves respondents' ability to process the information and will thus improve memory of the visual, perceived understanding of CCS, attitude towards the stimulus, perceived fit between text and visual, attitude towards the information, and interest in further information.

To examine the effects of congruency versus incongruency on information processing and appreciation of the stimuli, a t-test was performed with congruency as independent variable and the following dependent variables: memory of the visual, perceived understanding of CCS, attitude towards the stimulus, perceived fit between text and visual, attitude towards the information, and interest in further information. Means and standard deviations are reported in Table 8.4. Correlations are reported in Table 8.5. No significant differences were found for any of these variables. The t-test was then repeated for visual-only versus text-only conditions. This revealed one significant effect for interest in further information. At the end of the survey, respondents who had been exposed to visual-only indication of depth clicked on the provided link to the project website significantly more often (8% of the group) than respondents who had been exposed to text-only indication of depth (1% of the group), t(120.93) = -2.46, p = .02.

Table 8.4 *Impact of congruency on memory, understanding, attitude and interest*

	Mean congruent	SD congruent	Mean incongruent	SD incongruent
Memory of the visual	2.57	1.23	2.80	1.27
Perceived understanding of CCS	3.02	1.06	3.03	1.19
Attitude towards the stimulus	3.54	0.88	3.66	0.92
Perceived fit between text and visual	3.78	0.93	3.84	0.94
Attitude towards information clear	3.75	0.86	3.84	0.94
Attitude towards information relevant	3.45	0.85	3.54	0.86
Interest in further information	.02	0.14	.03	0.18

Table 8.5 *Correlations between memory, understanding, attitude and interest*

	1	2	3	4	5	6
1. Memory of the visual						
2. Perceived understanding of CCS	.26					
3. Attitude towards the stimulus	.19	.57				
4. Perceived fit between text and visual	.27	.57	.84			
5. Attitude towards information clear	.34	.51	.75	.80		
6. Attitude towards information relevant	.22	.31	.59	.57	.58	
7. Interest in further information	.09	.00	.06	.06	.09	.14

This means that H2b is rejected. Congruency between text and visual as opposed to incongruency does not affect respondents' ability to process the information and does not influence their evaluation of the stimulus. However receiving only a visual and no textual indication of depth does enhance interest in further information.

H3. The deeper respondents estimate the injection, the more positive their attitude towards CCS, the lower risk perceptions of CCS and the lower perceived personal relevance of CCS.

Correlational analyses were performed to relate estimates of depth to attitude, risk perceptions of CCS and perceived personal relevance of CCS. Results are displayed in Table 8.6 and with correlations varying between -.04 and .08 we have to conclude that depth estimates on the one hand and attitude towards CCS, risk estimates, and perceived personal relevance are completely unrelated.

Table 8.6 *Values and correlations for variables relating depth to attitude, risk perceptions and perceived personal relevance*

	Mean	SD	1	2	3	4	5	6
1.Estimate of depth	915	1161						
2.Attitude CCS utility and safety	3.64	0.84	.08					
3.CCS in area	3.07	1.22	.07	.53				
4.Impact CCS	2.83	1.15	-.04	.50	.45			
5.Risk perception CCS	2.96	0.75	.02	-.38	-.50	-.17		
6.Safety CCS	3.15	1.01	-.04	-.50	-.41	-.48	.24	
7.Interest in information	0.04	0.20	.03	.08	.09	.08	-.13	-.08

Looking at the correlations between the dependent variables, significant correlations are observed between attitude towards CCS and perceived personal relevance. The more positive people's attitudes the less negative they respond to the idea of having a CCS project nearby. Furthermore, the more positive people's attitudes towards CCS, the less negative impact they expect of a project nearby. A more positive attitude and a lower personal relevance are also significantly related to a lower perceived risk of CCS.

This means that H3 is rejected. Respondents' depth estimate of the injection of CO_2 is unrelated to their attitude towards CCS, risk perceptions of CCS, and to perceived personal relevance of CCS. However, a more positive attitude towards CCS is related to less perceived risk and lower personal relevance.

8.4 Discussion

Top of Form

Explanation of findings

The main effect of textual information on people who score high on the verbalising scale is easy to understand: In the absence of indication in the text it is entirely up to the respondent to figure out how deep the injection is. If it is stated that the underground storage is 'deep', then that gives some idea, but a specific number obviously gives the best indication. This, however, apparently only makes a difference for respondents who score high on the verbalising scale which indicates they enjoy processing texts. For respondents who do not particularly enjoy processing texts, a more precise depth indication in text does not necessarily lead to a better depth estimate.

This implies that it will not necessarily be of help to everybody if a text communicates how deep the injection is – this is only helpful to those who like to read. Fortunately, the data also show that people usually are already very good at estimating depth when clues in text are absent. Unfortunately, we did not find that visual information improves respondents' estimate of depth,, whether they score high on the visualising scale or not . On the contrary –visual information can apparently be confusing. Present results have shown that the presence of a visual, whether accurately or inaccurately scaled, leads to worse estimates of depth than the absence of a visual.

Furthermore, congruency between text and visual as opposed to incongruency does not improves respondents' estimate of depth. Rather it appears, although not significantly, that incongruency fosters understanding of depth.

Comparing the results for all conditions, these findings can be explained as follows:

- In the absence of a visual, people logically fall back upon the text, and their depth assessment depends upon it. This explains why text-only presentation leads to the best estimates.
- When the text is accurate but the visual is ambiguous, it will be clear to most people that the scale is incorrect. Assuming that most people correctly take the picture to be a schematic overview, they will largely ignore the depth indication in the visual and will rely on the textual information to make a depth estimate. This explains why the third best estimate was made in the precise text / visual ambiguous condition (incongruent). By contrast, the combination precise visual / exact text (congruent) leads to the third worst depth assessment. Apparently people think the visual is accurate, but they don't read an injection depth of 1,00 meters in it. Further research is recommended: A question should be added to determine whether people see the picture as "schematic" or representing "true proportions".

- When a text lacks a depth indicator and people have to base their interpretation on the visual alone, then we see that a properly scaled image leads to a relatively shallow assessment. In an ambiguous picture that effect is slightly less bad. The estimate based on an image is between 500 and 700 meters. Apparently, people estimate the power station shown in the visual is not 50 meters high, but smaller. In future research it may be interesting to test with CCS experts how deeply *they* estimate CO2 injection to be in accurate visuals. If even "experts" have no idea how big a power plant is this may be confirmed as a possible explanation.

There are yet other possible explanations for the failure to find that visuals enhance depth estimates:

- People find charts difficult to read. Even aided by landmarks on the surface, they cannot correctly estimate the depth of the injection shaft.
- The experimental manipulation was not strong enough. When the visual is printed out and measured with a ruler, then the CO2 is indeed 1,000 meters deep when you assume the plant including chimney is 50 meter high. However, many people may not know how high a factory is. A car and a tree on the other hand may be too small to extrapolate along the injection shaft in one's mind. To enhance the visual, it possibly should have displayed a ruler, as, for example in the diagram produced by Shell. Trees or factories could then be placed next to the ruler to give additional clarity on height. In their visual, Shell used stacked representations of the Euromast tower[228]

Implications for communication

The results of the study lead to some tentative recommendation for communication: we cannot assume that people correctly interpret a chart or diagram, whether or not to scale. Charts and diagrams are suitable to demonstrate the technical process to people, but visualizing how deep the CO_2 is stored in a way that people will understand is difficult. Findings from the present experiment suggests that this is hardly worth the effort – get it wrong and depth estimates will worsen. It is much easier and much more effective to mention depth of injection in text, bearing in mind that this will be only improve the understanding of depth for some people whereas on others it will have no effect. The only reason the present experiment provides for using only visual and no textual indication of depth is that it apparently enhances interest in further information when offered.

Should communicators about CCS fear after reading these results that particular combinations of textual and visual information in use by their company may induce wrong depth estimates, remember the conclusion from this experiment that respondents' depth estimate of the injection of CO_2 is unrelated to their attitude towards CCS, risk perceptions of CCS, and to perceived personal relevance of CCS. A more positive attitude towards CCS is related to less perceived risk and lower personal relevance, but attitude is apparently unrelated to how deep people think the CO_2 is put underground.

Depth of injection was central to the present experiment because it was thought, based on previous observations in a.o. Barendrecht, that this may affect risk perceptions and attitudes. Present findings do not demonstrate such a relation. It remains an interesting topic for future research if and how correctly knowing about aspects of CCS does relate to risk perceptions and attitudes.

Remaining questions

This is a preliminary analysis of the experiment and more needs to be done:

- One interesting finding that should be explored in more detail is that depth estimate is unrelated to self-reported prior knowledge about CCS. This finding can be interpreted in multiple ways

[228] The visual can be found at : http://www-static.shell.com/static/nld/downloads/co2/technique/barendrecht_euromast.pdf

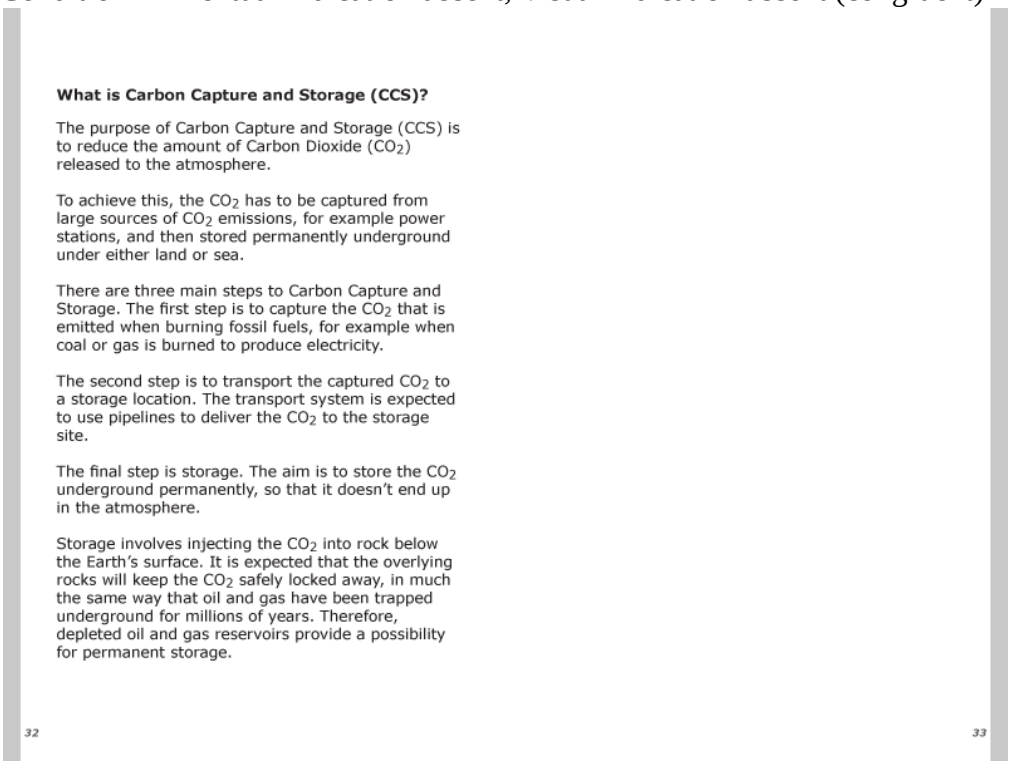
and requires further consideration.

- Another finding that requires further investigation is that respondents who score low on verbalising generally make better (deeper) depth estimates. The effects of verbalising and visualising are not straightforward and require further exploration. It would for example be interesting to check for differences between individuals who score high on both the visualising and verbalising scales versus individuals who score low on both scales. Because these scales are unrelated it would even be possible to test a 4 group scenario: high-high, high-low, low-high, low-low.
- Yet another interesting idea for additional analyses is that the difference between conditions lies in the variation in estimate of depth rather than in the absolute mean. In precise and/or congruent conditions, less variation could be expected in the estimate of depth because respondents have precise and/or more consistent clues about the correct answer. Subsequently, one could hypothesize that less variation in depth estimate is related to less variation in perceived risk, attitudes, etc. This would demonstrate that being certain of the answer is more influential than the answer per se and would provide an argument for using precise and/or congruent stimuli in explaining CCS to reduce feelings of uncertainty.

Luisteren
Fonetisch lezen

Appendix 8.1 – Experimental Stimuli

Condition 1 – Textual indication absent, Visual indication absent (congruent)



What is Carbon Capture and Storage (CCS)?

The purpose of Carbon Capture and Storage (CCS) is to reduce the amount of Carbon Dioxide (CO_2) released to the atmosphere.

To achieve this, the CO_2 has to be captured from large sources of CO_2 emissions, for example power stations, and then stored permanently underground under either land or sea.

There are three main steps to Carbon Capture and Storage. The first step is to capture the CO_2 that is emitted when burning fossil fuels, for example when coal or gas is burned to produce electricity.

The second step is to transport the captured CO_2 to a storage location. The transport system is expected to use pipelines to deliver the CO_2 to the storage site.

The final step is storage. The aim is to store the CO_2 underground permanently, so that it doesn't end up in the atmosphere.

Storage involves injecting the CO_2 into rock below the Earth's surface. It is expected that the overlying rocks will keep the CO_2 safely locked away, in much the same way that oil and gas have been trapped underground for millions of years. Therefore, depleted oil and gas reservoirs provide a possibility for permanent storage.

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Condition 2 – Textual indication ambiguous, Visual indication absent (text-only)

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Condition 3 – Textual indication precise, Visual indication absent (text-only)

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Condition 7 – Textual indication absent, Visual indication ambiguous (visual-only)

What is Carbon Capture and Storage (CCS)?

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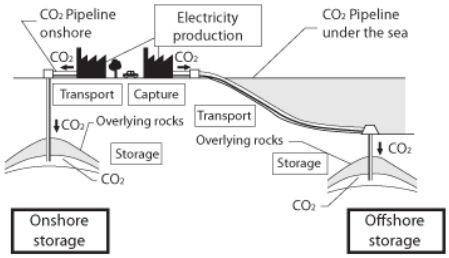

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Condition 8 – Textual indication ambiguous, Visual indication ambiguous (congruent)

What is Carbon Capture and Storage (CCS)?

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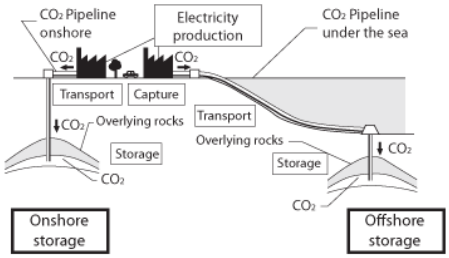

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Condition 9 – Textual indication precise, Visual indication ambiguous (congruent)

What is Carbon Capture and Storage (CCS)?

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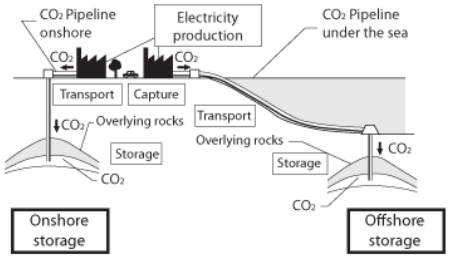

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Condition 4 – Textual indication absent, Visual indication precise (visual-only)

What is Carbon Capture and Storage (CCS)?

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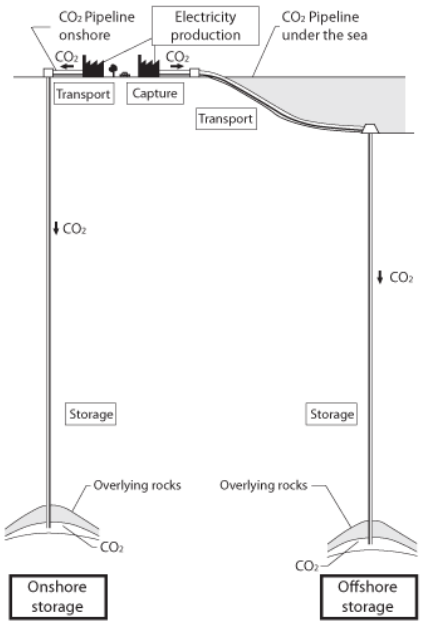

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Condition 5 – Textual indication ambiguous, Visual indication precise (incongruent)

What is Carbon Capture and Storage (CCS)?

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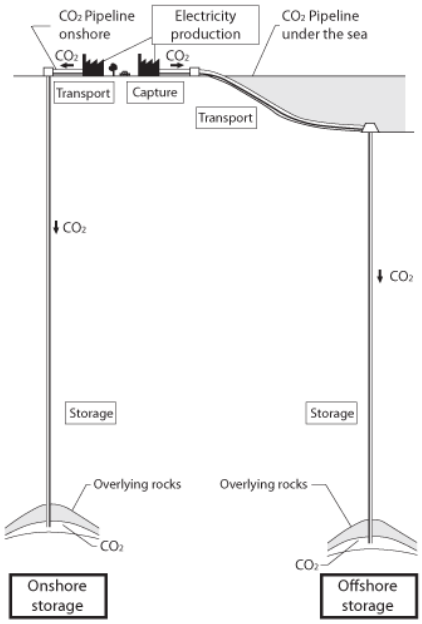

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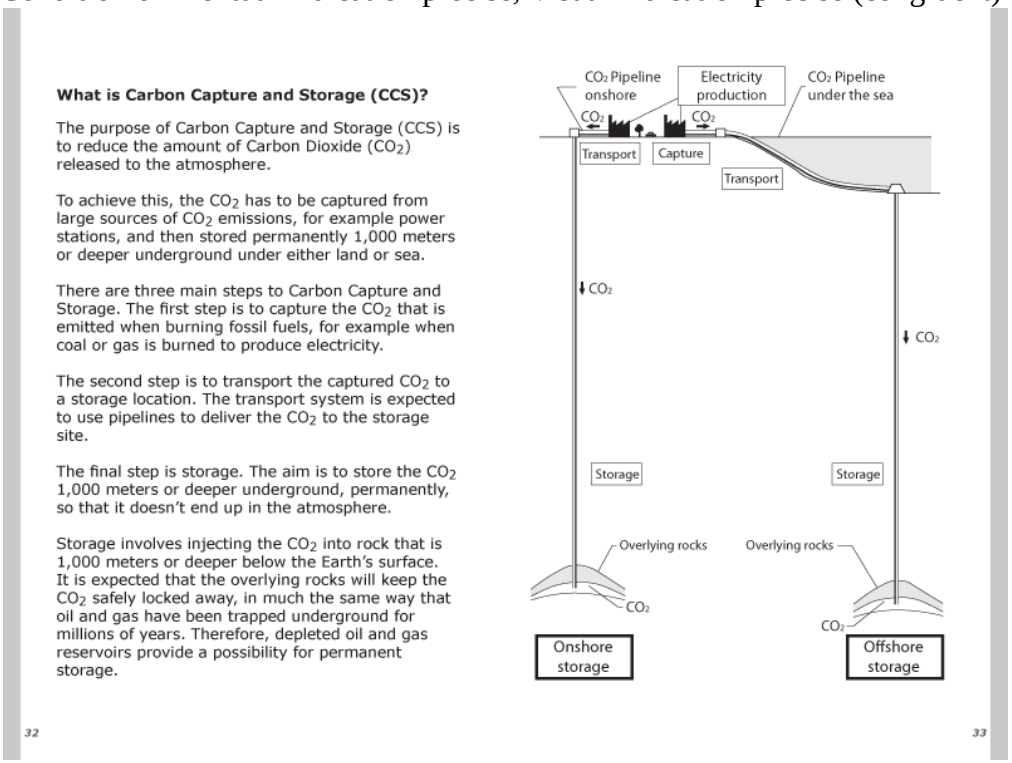
Condition 6 – Textual indication precise, Visual indication precise (congruent)



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Appendix 8.2 – Experiment Questionnaire (for UK participants)

[Page 1: Introductory text

The aim of this research is to investigate your opinion about a technology called Carbon Capture and Storage (CCS). Your answers will be used to improve national and local information provision about CCS. Your answers will be treated confidentially and cannot be traced back to you.

The research is part of an international project funded by the European Commission. We are independent academics based at the Energy research Centre of the Netherlands and the University of Cambridge. We will provide a link to our project page at the end of the survey.

Next you will receive some information about Carbon Capture and Storage (CCS), followed by a short questionnaire. The research will take about 15 minutes.

Please don't use your browser buttons to scroll back or forward in the questionnaire. Use the buttons in the questionnaire only.

Thanks very much for your participation.

[start research]

Demographics

We start the questionnaire asking a few personal questions

19. How old are you? (Type numbers only. For example, if you are 30 years old, type: 30) [options between 0-99, don't categorize]

20. Are you male or female?
- Male
- Female

21. What is the highest level of education you have achieved? (If still studying select the highest level achieved so far)

- GCSE/O-level/CSE
- Vocational qualifications (=NVQ1+2)
- A level or equivalent (=NVQ3)
- Bachelor Degree or equivalent (=NVQ4)
- Masters/PhD or equivalent
- No formal qualifications
- Other

22. What region do you live in?

- East Anglia
- London
- East Midlands
- West Midlands
- North East
- North West
- Northern Ireland
- Scotland
- South East
- South West
- Wales
- Yorkshire and the Humber
- Other
- Don't know

[Page 2: Pre-exposure Instructions.

On the next screen you will be shown a section of a booklet about energy-related technologies which contains a brief introduction to the technology Carbon Capture and Storage (CCS). Take as much time as you like to look at the information. The screen will be locked for the first 10 seconds, after which a <next> button will appear. When you are done, click the <next> button to move on to the questionnaire. If necessary, scroll down to find the [Continue] button.

[next]

[Page 3: Exposure to experimental condition.]

[on screen: one of the 9 visuals as delivered. No resize and no use of pop-ups. Respondents who

have a screen resolution of at least 1024*768 should not have to scroll to see the visual]

[To ensure every respondent pays at least some attention to the stimulus, please enable the <next> button after 10 seconds.]

Prior Knowledge check

1. Before reading the information on the previous page, how much, if anything, did you know about Carbon Capture and Storage (CCS)?

- o A great deal
- o A fair amount
- o Just a little bit
- o Heard of CCS but know nothing about it
- o Never heard about CCS
- o Don't know

Depth of processing

2. In the field below please write down what, if anything, you found particularly striking or surprising about the information you just saw.

[open field – answer not required]

3. This question is to check what you remember of the information you just saw. Please select the response option you think is correct.

According to the information you just saw, what is the purpose of Carbon Capture and Storage (CCS)?

To improve the quality of energy from power stations
To reduce the amount of CO_2 released to the atmosphere
To prevent the CO_2 from polluting the surroundings of the factory
To store the CO_2 for future use
Don't know

4. This question is to check what you remember of the information you just saw. Please select the response option you think is correct.

According to the information you just saw, by what process is CO_2 prevented from entering the atmosphere? [Single]

It is captured when it comes to the surface as a result of oil and gas mining and then transported to storage locations under the seabed
It is captured from the air or from oceans and then transported to storage locations deep underground
It is captured from large sources of CO_2 emissions and then transported to storage locations deep underground
Don't know

5. This question is to check what you remember of the information you just saw. Please select the response option you think is correct.

Which sources of CO_2 emission were mentioned in the information you just saw?

- o Coal and gas fields
- o Power stations
- o Cars and trees
- o All of the above
- o Don't know

6. This question is to check what you remember of the information you just saw. Please select the response option you think is correct.

Which possibilities for underground storage were mentioned in the information you just saw?

- o Deep layers of clay
- o Depleted oil and gas reservoirs
- o Onshore and offshore water reservoirs
- o Don't know

Manipulation check

7. How deep (in meters) would you estimate the CO_2 will be stored underground?

___ meters [open numeric answer]

General knowledge check (should not differ between cells)

8. The purpose of Carbon Capture and Storage (CCS) is to reduce the amount of Carbon Dioxide (CO_2) released to the atmosphere. Below are some statements about CO_2. These can either be true or false. Please tick all statements about CO_2 that you think are true. [Multiple]

- o CO_2 influences the climate
- o CO_2 is explosive
- o CO_2 is in the air around us
- o CO_2 is a greenhouse gas
- o CO_2 is radioactive
- o CO_2 is needed for the growth of plants and trees
- o CO_2 may cause cancer
- o CO_2 causes smog
- o None of the statements are true

9. According to you, what will be the effects of reducing the amount of CO_2 released into the atmosphere? The answers below can either be true or false. Please tick all statements that you think are true. [Multiple]

Reducing the amount of CO_2 released into the atmosphere will:

- o Improve air quality
- o Limit climate change
- o Protect the ozone layer
- o Limit the global rise in temperatures
- o Prevent acid rain
- o Reduce water pollution
- o None of the answers are true

Attitude Stimulus

10a. At present, how well do you feel you understand the process of Carbon Capture and Storage (CCS)?

Not at all O O O O O Completely

10b. The following question asks for your opinion about the information in the booklet you saw. Please click the answer that best describes your opinion.

To what extent do you feel the information about CCS helped you to get a better understanding of the technology?
Not at all O O O O O Very much

10c. The following question asks for your opinion about the information in the booklet you saw. Please click the answer that best describes your opinion.

To what extent do you feel the information about CCS helped you to form an opinion about the technology?
Not at all O O O O O Very much

10d. The following question asks for your opinion about the information in the booklet you saw. Please click the answer that best describes your opinion.

How would you judge the quality of the information?
Very bad O O O O O Very good

10e. The following question asks for your opinion about the information in the booklet you saw. Please click the answer that best describes your opinion.

How would you judge the quantity of information?
Insufficient O O O O O Sufficient

10f. The following question asks for your opinion about the information in the booklet you saw. Please click the answer that best describes your opinion.

How interesting did you find the information?
Very uninteresting O O O O O Very interesting

11a. The following question asks for your opinion about the information in the booklet you saw. Please click the answer that best describes your opinion.

How helpful did you find the visual about CCS to understand the technology?
Not at all helpful O O O O O Very helpful

11b. The following question asks for your opinion about the information in the booklet you saw. Please click the answer that best describes your opinion.

How helpful did you find the text about CCS to understand the technology?
Not at all helpful O O O O O Very helpful

11c. The following question asks for your opinion about the information in the booklet you saw. Please click the answer that best describes your opinion.

To what extent do you agree or disagree with the following statement?

The text and the visual supported each other in explaining CCS
Completely disagree O O O O O Completely agree

12. Below you see pairs of words describing the information you have received about CCS. Please choose the descriptions that best reflect your opinion about the information by clicking the response option close to that word. The closer your answer is to one of the words, the better that word describes your opinion.

I think the information about CCS was:

Attractive	O	O	O	O	O	O	O	Unattractive
Unclear	O	O	O	O	O	O	O	Clear
Appealing	O	O	O	O	O	O	O	Unappealing
Relevant	O	O	O	O	O	O	O	Irrelevant
Unreliable	O	O	O	O	O	O	O	Reliable
Hard to understand	O	O	O	O	O	O	O	Easy to understand
Of concern to me	O	O	O	O	O	O	O	Of no concern to me
Confusing	O	O	O	O	O	O	O	Informative

Attitude CCS

13. Below you see pairs of words describing CCS. Please choose the descriptions that best reflect your opinion about CCS, by clicking the response option close to that word. The closer your answer is to one of the words, the better that word describes your opinion.

I think Carbon Capture and Storage is:

Positive	O	O	O	O	O	O	O	Negative
Good	O	O	O	O	O	O	O	Bad
Unsafe	O	O	O	O	O	O	O	Safe
Useful	O	O	O	O	O	O	O	Useless
Harmful	O	O	O	O	O	O	O	Harmless

Personal relevance of CCS

14. Would you mind if a CCS project was planned in the area where you live?

Not at all	O	O	O	O	O	Very much

15. Do you think plans for CCS in your area would have a positive or negative impact on your area?

- o Very positive
- o Slightly positive
- o Slightly negative
- o Very negative
- o No impact at all
- o I don’t know

Risk perceptions of CCS

16. Below are some statements about possible consequences of using CCS. The likelihood of these consequences is debated, but we are interested in what you think. For each of the statements, please indicate how unlikely or likely you think these consequences are.

a. CO_2 will acidify the underground drinking water

Very unlikely	O	O	O	O	O	Very likely

b. CO_2 will leak from the storage site to the surface
Very unlikely O O O O O Very likely

c. A CO_2 storage site may be the target of a terrorist attack
Very unlikely O O O O O Very likely

d. A CO_2 storage site may explode under high pressure
Very unlikely O O O O O Very likely

e. A CO_2 leak will suffocate people and animals nearby
Very unlikely O O O O O Very likely

f. Even when it stays underground, CO_2 may impact ecosystems on the surface
Very unlikely O O O O O Very likely

17. To what extent to you agree or disagree with the following statements?

a. The safety of a CO_2 storage site can be sufficiently guaranteed
Strongly disagree O O O O O Strongly agree

b. CCS has too many risks to public health
Strongly disagree O O O O O Strongly agree

Verbalizer/Visualizer scale (personality variable – possible covariate)

18. Now we would like to ask you some questions about you and your preferences for processing information.

Please indicate to what extent the following statements apply or do not apply to you personally.

I enjoy doing work that requires the use of words
Completely applies to me O O O O O O O Does not apply to me at all

I like newspaper articles that have photos
Completely applies to me O O O O O O O Does not apply to me at all

The old saying "A picture is worth a thousand words" is certainly true for me
Completely applies to me O O O O O O O Does not apply to me at all

I enjoy learning new words
Completely applies to me O O O O O O O Does not apply to me at all

I can easily think of synonyms for words
Completely applies to me O O O O O O O Does not apply to me at all

I find maps helpful in finding my way around a new city
Completely applies to me O O O O O O O Does not apply to

me at all

I have a better than average fluency in using words
Completely applies to me O O O O O O O Does not apply to me at all

When I read books with maps in them, I refer to the maps a lot
Completely applies to me O O O O O O O Does not apply to me at all

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Questions and Comments
23. Please let us know if you have any other comments about CCS or our survey
[open-ended question]

Close
Thank you very much for participating. If you like to know more about Carbon Capture and Storage or about our research please visit the project website: www.communicationnearco2.eu

[register which respondents click this link:]

9. Summary and Conclusions

The survey and focus groups clearly show that issues of trust, the nature of the risk perceived, the role of information providers and especially the media and the local characteristics of the project all play a large role in the formation of public attitudes towards Carbon Capture and Storage. The four areas identified in chapter 1 overlap considerably, particularly the information source and role of the media, though for the purposes of these concluding paragraphs we try to present them separately.

Preliminary: Knowledge of CCS
In keeping with almost every other survey on CCS, knowledge – both self-assessed and "actual" - of CCS was fairly low. On average, about 43% of all respondents in five countries indicated that they never heard about CCS, whereas 46% knew a bit about the technology while only 10% responded they knew quite a bit about CCS. These percentages, however differ slightly for five surveyed countries. The most knowledgeable were German respondents and the least informed seemed to be British respondents. However, in the UK only 3% of those respondents who indicated that they know about CCS "quite a bit" do not know what CCS is supposed to do, which is the lowest percentage among five surveyed countries. On the other hand, 29% of Polish and Spanish respondents who answered that they know about CCS "quite a bit" answered negatively to the statement that CCS is supposed to deal with global warming and climate change problem. Also, it is interesting to note that about 40% of those who indicated that they knew about CCS "quite a bit" answered that CCS is supposed to reduce "ozone depletion" rather than global warming or climate change. This indicates that in countries such as Germany or the Netherlands where CCS has been a nationally controversial issue that was much discussed in the national media, awareness of CCS was heightened without however considerably heightened understanding of CCS. While the UK

respondents, where there has been relatively little media exposure of CCS, were less likely to know about it, those who did had a better understanding.

The relatively low levels of knowledge about CCS (both self-reported and "actual") that the survey found consistent with previous surveys were also accompanied by a general feeling in the dialogue boards where participants were often frustrated that they were not able to get much good information on CCS.

Attitudes towards CCS
Attitudes towards CCS in the survey tended towards positive in general. Thus, 17% of respondents in all five countries are very favourable towards CCS whereas only 3% are very negative about the technology; overall 68% were moderately to very favourable towards CCS. Cross-country comparisons show that respondents in Poland and Spain are more supportive of CCS than respondents in the Netherlands and Germany. As we expected given the larger media profile of recent CCS controversies have had in the Netherlands and Germany, Dutch and German respondents were least supportive of CCS than respondents from the other four countries. Attitudes towards the specific local projects were somewhat less favourable; 11% indicated they were very positive while in total 60% were between moderately and very favourable. Again, German and Dutch respondents were least positive.

9.1 Source of information and role of the media

Information sources and trust
Interactive websites were the most preferred source of information about CCS in the majority of surveyed countries – the UK, the Netherlands, Poland and Spain. German respondents tended to indicate that National/international NGOs are the most likely source of information about CCS. Respondents think that university scientists are the most trustworthy source of information regarding CCS while national/international NGOs were the second most trusted source of information. Cross-country differences in terms of trust in various sources of information somewhat resembles national differences in choice of information. Thus, respondents from four countries – the UK, the Netherlands, Poland and Spain – indicated that they trust university scientists the most; German respondents trust national/international NGOs the most. As the choice of information source, 21% of all German respondents indicated that university scientists/scientific publications is the most likely source of information which is one of the highest percentages among all five countries; however, in terms of trust only 15% of German respondents said that university scientists are the most trustworthy source of information (which is the lowest percentage number across five countries).

Respondents' trust in national and local media is quite low compared to environmental NGOs, friends and family and local government; however, trust in the European Union is surprisingly higher than trust in national or local media. Respondents' trust in developers and energy companies is lower than in the national or local media. Higher level of trust in European Union is explained by extremely high trust from Polish respondents in the European Union. Trust in the project developers is correlated to more favourable view on CCS in general. It was also found that there is a relationship between trust in the project developers and respondents' view about the local CCS project.

Particular expressions of distrust in information providers and other CCS stakeholders such as politicians and the developers were found in the open questions, where some respondents failed to see any advantages to CCS other than those to politicians or "their friends". These responses were most prevalent in Germany.

Respondents did not as a whole tend to either trust the news media particularly, nor did they indicate that they would use them to seek out further information. While the media scored higher in terms of trustworthiness and likely further information source than politicians and developers, it did less well than NGOs or scientists.

However, as the dialogue boards showed, participants thought that the news media had a significant role to play in spreading awareness about the technology and the particular projects in the first place. It therefore plays the important role of "agenda setter" which enables the public to get to the point where they would want to search for more information – in other words, if people are not aware of a technology or development, they will not be able to search for more information about it, and it is therefore the news media which sets the agenda.

Access to information

In general, over a third (35%) of all respondents disagreed that they could get all the information they required regarding new local developments in their area whereas 31% of all respondents agree with the fact that they can obtain necessary information concerning local projects. The disagreement with this statement is mostly driven by German and Polish respondents' negative views. On average, 10% of respondents of all five countries indicated strong disagreement that they can obtain the necessary information concerning local projects whereas only 4% of respondents strongly agreed that they can gain access to needed information. This pattern varied across national surveys. Dutch and Spanish respondents were most confident that they can get information concerning new local developments.

The general view that information about CCS projects is difficult to find was more clearly illustrated from the dialogue boards, where the issue was discussed at length. The general lack of trust in being able to find reliable information indicated in the survey also translated to the particular CCS projects that dialogue board participants were seeking to find out more on afterwards as only very few had even heard about the project before filling out the survey. Participants generally felt that information was sparse and inadequate, and that more dissemination needs to be done through the mainstream media so that people get to be aware of it in the first place.

Effect of information provision in the survey
After additional information (particularly about risks and safety issues of transporting and storing of CO2) was provided to respondents, their view on the local CCS project shifted to more negative. Furthermore, the additional information has created further uncertainties to respondents concerning their attitudes towards CCS.

Cross-country comparisons of respondents' attitudes towards the local project shows that there are differences in respondents' views regarding the CCS project both before and after receiving additional information. Thus, on average, Polish respondents indicated the highest support of the CCS project whereas German respondents were among the most sceptical. In general, the negative effect of additional information holds for all five countries.

Also, it is interesting to note that the number of respondents who did not know about CCS technology and indicated that they were "neutral" before receiving additional information (24%) was reduced when they were provided with more information about "safety" of CCS technology (20%). On the other hand, the effect of more "safety" information on those who knew about CCS and indicated that they were neutral is marginal (20% before vs 19% after).

This in a way echoes the findings of the WP4 focus group study (Upham and Roberts 2011) who

found that attitudes towards CCS shifted towards sceptical and more uncertain after the focus groups were shown a DVD about CCS which was designed to give further impartial information. It does however go counter to the finding of Itaoka et al. (2004) who found that further information tended to increase support for CCS.

These contrary results indicate that, probably unsurprisingly, the type of information provided is in itself very crucial to how its effects play out. Though we tried both in the DVD and the information provided in the survey to be factual and neutral about the risks and benefits of CCS, it appears that the risk and safety elements of the information found more resonance with the participants than the positives.

Effect of the survey on dialogue board participants
Dialogue board participants have reported that while they generally had little previous knowledge of the projects and CCS in general, filling out the survey prompted many of them to discuss the issues with friends, colleagues and neighbours. They did not think that the survey in itself influenced their opinions about CCS either positively or negatively, but this was mainly because they had no prior opinion due to being relatively unaware of the technology. The survey did however highlight to those who did try to find out more, that there is little useful information out there about the respective projects and even CCS in general. This caused a certain amount of frustration that was evident in the discussions.

9.2 Characterisation and perceptions of risk

A statistical relation between respondents' perception about unpredictable risks of CCS technology and their trust in industry and national governments/politicians was found to be significant. Thus, 7% of all respondents who trust in industry strongly disagreed that "completely unforeseen events can happen in relation with CCS projects that even experts cannot anticipate" whereas only 2% of all respondents who do not trust industry strongly disagreed with this statement. On the other hand, only 28% of all respondents who trusted in industry agreed with this statement compared to 51% of all those who do not trust in industry. In other words, those who trust in industry tend to be more risk conscious regarding CCS technology. Respondents who have higher level of trust in national politicians are more risk conscious than those who trust national politicians less.

Interestingly, we found that there is a statistical relation between perceptions of risks of CCS and where respondents live (i.e. distance between respondents' and either the capture site or the storage site). Those who live far from the project's capture or storage site tend to be more risk conscious than those who live near the planned facility.

Regarding acceptance of CCS though, a statistical relationship between distance of the respondents to the project sites (capture and storage sites) and their view on the local CCS project was found to be significant. Within the range of 300 km from the project's site there is a linear (negative) relationship between distance and attitudes towards the project. Thus, those who live close to the project sites are in general more negative towards the CCS project compared to those who live farther from these sites.

The qualitative parts of the research indicated that safety was one of the main worries that participants had about CCS – even those who were more supportive of the technology insisted that CCS would only be acceptable provided that adequate guarantees about safety can be met. What exactly those guarantees would need to be is not exactly clear, since accepting guarantees as adequate in turns depends very much on trust in the developers, and as the survey has shown, that

may not generally be very high. Another problem is with the nature of the risk: as we have argued in chapter 2 there are qualitative differences between uncertainties, and while the finer grained 5-fold distinction did not come out very clearly, there was nevertheless a clear difference between the lower levels of uncertainty and the higher ones, indicating a difference between perceived uncertainties as presented for example in professional risk assessments and "deeper" uncertainties such as "unknown unknowns" which experts will not be able to foresee. In the qualitative phases of the research, these unknown unknowns were expressed through frequently voiced worries over "long-term" risks: Because CCS is a relatively new technology, there are no long-term studies possible in principle, and considering that the safety and success of CCS is contingent on the carbon staying in the reservoir indefinitely, long-term studies that might conceivable alleviate these concerns are not even theoretically possible. This is compounded by the human element in the overall uncertainty. Not only do the unforeseen and unforeseeable events include possible accidents, unqualified workforces and unreliable operators and government regulators, but because of the very long-term nature of CCS, it is impossible even for very competent and trusted governments and operators to guarantee the competence of their future counterparts. Compared to these fears, terrorism or future wars were mentioned but not very frequently.

Next to the human element of the unknown unknown risks, the fear of unknown reactions with the local geography, or of uncertainty over our scientific knowledge about the behaviour of CO2 in the storage reservoirs was voiced frequently. Finally, there are possible natural catastrophes which are not foreseeable either. As the dialogue boards were held in the week after the Japanese earthquake, the possibility of natural disasters overwhelming even the most carefully designed safety procedures was clearly in respondents' minds, particularly since there have recently been minor earthquakes in the Belchatów area. It is of course difficult to envisage how these discussions would have been conducted if the Japanese earthquake hadn't happened, however from looking through the open questions and the survey answers on the question on "unexpected" risks, it is clear that these worries were there to begin with, and the Japan provided a ready-made reference frame through which participants could voice their concerns.

9.3 Importance of local contingencies

Social capital

We found a statistical association between trust in local actors (i.e. local media, local/regional politicians and local NGOs) and how much time respondents spend on certain social activities. On average, respondents who spend more time on social activities tend to trust local actors more than those who spend less time on social activities.

It was also found that there is a statistical association between view on CCS in general and on the local project and how much time respondents spend on certain social activities. On average, respondents who spend more time on social activities tend to have more positive view on CCS in general. Likewise, those who spend less time on social activities tend to have more negative view on CCS in general. Similar relations are found between respondents' view on the local CCS project and their social activities.

Social capital in the survey was measured by asking respondents about their social habits – this of course is only measuring the social capital of individuals rather than of a specific area. However as has been highlighted in the literature on social capital, the manner and frequency with which people is also a characteristic of an area. Policy interventions, such as the current UK government's "Big Society" agenda, are aimed often at increasing social capital in society as a whole, with the hope that this increases trust levels with decision making stakeholders as well as enhancing democratic participation. As our survey has shown, in relation to CCS, social capital is a strong indicator of trust in the planning process and as such influences the local acceptability of new projects.

Previous experience with infrastructure developments and fairness in the planning process
Respondents' previous experience with infrastructural projects is reflected by asking whether respondents were aware of a particular project. Though this "experience" question was absent in the German and Polish surveys we found that there are statistical relations between respondents' previous experience with infrastructural projects and their trust in national as well as in local and regional politicians. However, statistical association between previous experience and trust in project developers were insignificant.

A statistical relationship between respondents' previous experience and their view on CCS in general was found to be significant; however, correlation between previous experience and respondents' view on the local CCS project was insignificant. Respondents who were aware of previous infrastructure projects tended to be more positive about CCS in general.

Clearly therefore, as expected, previous local experience with similar large infrastructure projects influenced how people feel about new developments. This was also indicated by the answers to the question about whether respondents felt they had been treated fairly in the past: Respondents who agreed with the statement that the local community had been treated fairly in past developments and that the current planning process gives sufficient voice to the concerns of local residents were more likely to be positive about the local CCS project.

Nature of the project: Onshore/offshore
There is statistical association between onshore/offshore storage projects and respondents' attitudes towards the local CCS project. In those countries where onshore storage projects are planned respondents tend to have more negative view on the local CCS project than in those countries with planned offshore storage.

Relations between respondents living in countries/areas with a previous history of coal mining (UK, Spain, Poland and the capture site in Germany) and their view on CCS in general and the local project in particular: 19% and 13% of all respondents living in countries with "previous history" are very favourable about CCS technology in general and the local project respectively whereas only 8% and 4% of all respondents living in countries with such a history supports CCS in general and the local project respectively.

Respondents who strongly agree that the current planning process gives sufficient voice to local concerns and that they were treated fairly in the past tend to have more positive view on the local CCS projects.

This was of course rather unsurprising, given that safety concerns were found to be one of the most prevalent reasons why respondents would be negative about CCS, and offshore storage means that there would be fewer or no residents living near the storage site. This was emphasised for example by some of the Dutch respondents who in the open questions favourably compared the ROAD project with the abandoned Barendrecht one because it is offshore. In the other country with a planned offshore project, the UK, many respondents were similarly listing the offshore aspect of the project as one of the positives, even if there was no previous UK onshore project to compare it to.

Local familiarity with the coal industry
We expected that through associative reasoning and social representations and local identities, one possible factor influencing local opinion about CCS would be familiarity with the coal industry, i.e. areas familiar with either mining or coal fired power stations. This generalisation of course also hides even finer grained local differences: Whereas coal mining in the South Yorkshire / Humberside region in the UK would be viewed in a positive and even slightly nostalgic light within

an area still economically suffering from the decline in the industry, the surface lignite mines in the Lausitz region were more destructive to the local community and therefore not quite seen in the same light as coal mining in South Yorkshire. This was to an extend shown also in the open questions, where German respondents commented on destructive effects of coal mining, something that was absent in the UK responses.

This caveat aside, nevertheless we found that respondents where the project are planned in areas familiar with the coal industry were more favourable about the CCS projects than other respondents.

9.4 Other factors influencing attitudes towards CCS

Associative reasoning, social representations and identities
Though not an effect of local contingency as such, the effect that association with coal has on perceptions on CCS is also reflected by the correlation between respondents who have a favourable attitude towards coal as an energy source and attitudes towards CCS: the association between respondents' attitudes towards coal as energy source and their view on CCS technology was found to be significant, respondents who were favourable towards coal were also more likely to view CCS positively.

Also, respondents' perception about "environment" as the national priority and their attitudes towards CCS was significant. 6% of all respondents who are "very unfavourable" towards coal as energy sources indicated that they are also "very unfavourable" of CCS technology in general. This is 3% more than those respondents who are "very favourable" of coal (3% of these respondents indicated that they are "very unfavourable" of CCS in general). On the other hand, respondents who indicated that they are very favourable of coal are far more supportive of CCS (34% indicated that they are "very favourable" about CCS) than those who are unfavourable of coal (20%).
The relationship between respondents' attitudes towards CCS in general and the local project is negatively associated with respondents' perception about importance of "environment" – those who do not know consider environment to be a national priority are in general more supportive of CCS technology.

CCS thus clearly gets interpreted and conceptualised as part of a wider worldview or identity: As Corry and Riesch (forthcoming) argue, the way environmental NGOs problematise CCS is dependent on how they view the problem of climate change as a whole (i.e. whether it is a technological problem or a societal problem), and as such the fairly novel idea of CCS will be anchored to previously familiar concepts as to fit within a wider worldview. People who have a negative view of coal will see CCS with negative connotations, similarly those who believe the problem of climate change is a societal rather than technological one (which is often the standpoint taken by environmental campaigners) will view see a purely technological solution like CCS as not actually addressing the important issues.

Distance to project
The distance from which respondents lived from the capture and/or storage sites influenced attitudes towards the project, although the effect was marked only within around 200 km, indicating that living close to the project influenced respondents to have more negative views towards CCS while the effect becomes less marked the further out we go. This is of course not a very surprising fact, though: Since the qualitative phases of the research indicated that safety concerns were the most prevalent worry respondents had about CCS, living close to the project would of course heighten the feeling that CCS safety is of personal relevance.

Stakeholders on CCS
The stakeholders included in the survey were sceptical of CCS in general and hostile towards the local CCS project in particular (although this finding is exacerbated by the fact that the majority of stakeholders were from Germany, which was the least popular project across the five countries surveyed). NGO representatives in particular viewed the local project very unfavourably. Stakeholders demonstrated significantly higher levels of genuine knowledge than the public, but they also overestimated their knowledge since over three-quarters claimed to know "quite a bit", but barely half correctly identified climate change as the sole objective of CCS.

9.5 Conclusions and recommendations

The research presented in this report points to some clear conclusions with respect to public attitudes towards CCS that should be kept in mind if future dialogue on CCS is to be conducted in a productive manner.

Clear communication and efficient dissemination of information
Respondents were generally dissatisfied with the amount and quality of the information about CCS and local projects in particular. The media play a role in drawing attention towards projects, but is by itself not the preferred source of information. Those currently providing the most information on CCS projects are developers and the European Union and not only are neither trusted, but neither are even widely consulted. The most trusted source of information are university scientists and local NGOs and local media are most likely to be perceived as placing priority on the local community. Unfortunately, scientists have no incentive to develop materials in a manner that is useful to the public and the public will tend to use interactive sites such as Wikipedia as the first port of call, even though they are recognised as less trustworthy. Therefore, governments, developers and the energy industry more widely need to engage in the slow process of building up accessible materials working together with scientists and civil society. Where CCS projects have become more controversial, notably in Germany and the Netherlands, the public is more likely to consult multiple sources and to seek more information about the project.

Clarity about the nature of the risks associated with CCS, including honesty when and where knowledge is less secure
The nature of the risks associated with CCS is often a matter of perspective. Public worries about safety can often include the "deeper" uncertainties which conventional risk assessments will find hard to address: Future unknown unknowns could include earthquakes, the diligence of future generations to safely operate storage facilities, or other unforeseen risks that experts are not aware of. Addressing these fears may be a difficult task, but they are perfectly rational responses by worried residents and need to be kept in mind when communicating risks. Honesty about where unknown uncertainties lie may go a long way in establishing trust between local residents and developers, particularly if the process involves local groups and independent scientists.

Nature and locality of project is important
Clearly each CCS project has so many individual properties and contends with local contingencies which means they need to be evaluated on a case by case basis – factors we looked at in this survey include social capital and familiarity with the coal industry as part of the local environment and onshore/offshore as part of the nature of the project. These factors have an influence on how a CCS project will be received by the local population and therefore gathering a detailed knowledge-base of the local area, the interests and wishes of local residents needs to go hand-in-hand with early dissemination and engagement efforts.

Procedural justice
Trust in planners, politicians and developers is crucial for public acceptability. As we have found, heightened trust in developers to provide impartial information and taking local concerns seriously as well as heightened perception that trustworthy and relevant information is easily available is correlated with a higher approval rating for CCS. This may lead to the somewhat counterintuitive conclusion that planning laws which take local opinion into account from the beginning may be more successful in getting projects off the ground than planning laws where projects of "national importance" are decided on a national level. Practicality aside however, there is also the moral argument that people need to know that local concerns are being taken seriously and that they have a voice in the planning process. Feeling of past mistreatment or unfairness of the current planning process are both strongly linked to opposition to local CCS projects. Independent of the details of or merits of any individual CCS projects, local opposition may stem from perceptions of past or current fairness.

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11. WP2 Questionnaire (for UK respondents)

Ask stakeholders for location/postcode

0: Sections for different stakeholders

What best describes your position?
a) Journalist
b) Representative of non-governmental or civil society organisation
c) Politician/elected official
d) Civil servant/government official
e) Other, please state: _____-

0 (a) for journalists

0a1: How many years have you been in journalism?
[<1 yr, 1-5 yrs. 5-10 yrs. 10-20 yrs, >20 yrs]

0a2: Which part of the media are you most involved in?
[print journalism, radio, television, web, other]

0a3: What best describes your position within your organisation?
[science/environment, general news, local affairs, business, editor, other]

0a4: What percentage of your stories have science and technology as their main topic?

0a5: What percentage of your stories have energy and environmental issues as their main topic?

0 (b) for NGOs

0b1: What is your primary focus?
[energy technologies, climate change, natural resources, water, land use, Other, please state:_____]

0b2: How long have you been working/engaged in this field?
[<1 yr, 1-5 yrs. 5-10 yrs. 10-20 yrs, >20 yrs]

0 (c) for politicians (**COUNTRY-SPECIFIC)**

0c1: How long have you served on the [planning/land-use] committee?

0c2: What percentage of your committee's time deals with siting of major infrastructure?

0c3: How would you characterise the local community involvement in the local decision making process? Where 1 = not involved at all to 7 = very involved

0 (d) for civil servants

0d1: How long have you worked in the area of [planning/land-use/environment]?

0d2: What percentage of your time deals with siting of major infrastructure?

0d3: How would you characterise the local community involvement in the local decision making process? Where 1 = not involved at all to 7 = very involved

Members of the Public directed here by TNS:

Ask public for location/postcode

1: Background attitudes and knowledge

(All groups answer §1)

1.1 Which are the three most important issues facing the UK **(change as appropriate)** today?

a) Unemployment
b) Crime
c) Healthcare
d) Economic Situation
e) Environment
f) Climate change/global warming
g) Asylum seekers/ immigration
h) Terrorism
i) Education
j) Taxes
k) Foreign affairs
l) Budget deficit
m) Energy Security
None of these

1.2 What is your overall opinion about the following energy sources? (on a scale from 1-7, where 1=very unfavourable and 7 = very favourable, don't know)

a) Energy created from biomass (coming from: solid waste, wood, food waste, landfill gases, alcohol fuels such as ethanol, and energy crops such as soya)
b) Coal
c) Gas
d) Nuclear power
e) Solar power
f) Wind

1.3 Have you heard about "Carbon capture and storage" (also known as "Carbon capture and sequestration")?

No, never heard ____
A little bit ____
Yes, quite a bit ____

1.4 To the best of your knowledge, which of the following environmental concerns is “carbon capture and storage” or “carbon capture and sequestration” supposed to reduce? [choose all that apply]
a) Toxic waste
b) Ozone depletion
c) Global Warming or Climate change
d) Acid rain
e) Smog
f) Water pollution

2: Carbon Capture and Storage (CCS), general

2.1 General Information

Currently, most energy is generated using oil, natural gas and coal. For example, in some European countries the percentage of electricity generated from these sources is close to 95%. It is expected that in the next 50 years the majority of our energy will still come from oil, natural gas and coal. The burning of oil, gas and coal for energy production is one of the major sources of carbon dioxide (CO_2), though in addition to energy production, CO_2 is also produced by other industries such as cement and steel. Experts think that as a result of CO_2 concentrations building up in the atmosphere the average temperature of the Earth’s atmosphere in the year 2100 will be 1.4 to 5.6 degrees Celsius higher than in 1990. This temperature increase is caused by CO_2 emissions all over the world, not just by emissions from European countries. The increase in the average temperature will have a number of consequences which could influence the lives of many people. All over the world there will be more extreme weather events such as extreme rainfall and storms.

One way to reduce CO_2 emissions is to ensure that when energy is produced by, for example, burning coal and natural gas, less CO_2 is emitted to the air. This can be done by capturing the CO_2 and storing it for a very long time deep underground, for example in depleted gas fields. This method is referred to as CO_2 capture and storage (CCS). If the CO_2 is safely stored, it is not released into the atmosphere, and therefore cannot contribute to the greenhouse effect. Experts estimate that CO_2 capture and storage could provide between 10% and 55% of the total worldwide effort to reduce emissions until the year 2100. As a result, considerable effort is going into the development of CO_2 capture and storage.

How does the removal of the CO_2 work? When coal and natural gas are burnt for energy, CO_2 is produced. This CO_2 can be captured with various techniques. Then the CO_2 can be transported as a liquid to underground storage sites via pipelines. CO_2 can be stored in storage sites, both onshore and offshore. These storage sites can be depleted oil or gas fields, where most of the natural gas or oil already has been extracted. The CO_2 can be pumped into these depleted oil or gas fields. Also, the CO_2 can be stored in deep coal layers that are too deep to mine. Finally, CO_2 gas can be stored in so called ‘saline aquifers’, which are deep rock formations that are like sponges filled with salt water.

There are potential CO_2 storage sites in onshore Europe and under European seas (e.g., the North Sea, the Black Sea, and the Mediterranean Sea). Demonstrations in Europe and other areas in the world—for instance the Sleipner field in Norway, the Weyburn field in Canada, and the K12 field in the Dutch part of the North Sea,—have shown that the capture and underground storage of CO_2 is feasible.

2.2 Please indicate on a scale from 1-7 what you think of CCS in general where 1= very unfavourable and 7 = very favourable

3: Local plans

One leading proposal for capturing carbon dioxide (CO_2) is planned for a new coal-fired power plant in Hatfield near Doncaster in Yorkshire. This project has already received support from the European Economic Recovery Programme of £150 million. Provided that planning and

implementation proceed as planned, the plant, which is comparable in size to other large coal-fired power plants, could begin operating by the end of 2015 and would capture several million tons of CO_2 per year. The captured CO_2 would then be transported annually via pipeline 100 miles onshore from the Hatfield power plant up past Scunthope to Theddlethorpe on the Lincolnshire coast and then a further 200 miles offshore to a depleted natural gas reservoir which is more than 1,000 meters below the North Sea.

3.1 What do you perceive as the major advantages of this proposed project?
(Free text)

3.2 What do you perceive as the major disadvantages of this proposed project?
(free text)

INCLUDE MAP HERE

3.3 Please indicate on a scale from 1-7 what you think of this project, where 1= very unfavourable and 7 = very favourable, don't know

3.4 What other questions would you have about such a project? (Free text)

4. Additional Information on CCS

When substances like coal, natural gas or biomass (wood) are burnt for energy, CO_2 is produced. In power plants with CCS up to 90 % of the CO_2 can be captured using various techniques. There are few public health issues associated with CO_2 capture itself (described below). A major environmental concern is that the capture process imposes an 'energy penalty', which means the plant with CCS requires roughly 25% more energy to produce the same amount of electricity.

After capturing the CO_2, it can be transported to storage sites. Any transport of liquid or gaseous substances can result in leakage, e.g. releasing CO_2 into the air. One danger for public health is accumulation of CO_2 in low-lying areas or cellars since CO_2 can cause discomfort or even suffocation at high enough concentrations. The chance of this happening is very small, since there is many years experience with pipelines which are monitored for leaks. In comparison with other options for transporting CO_2 like trucks or ships, pipelines are the least costly approach to transporting large quantities of CO_2. Once stored, the CO_2 might leak away, but the quantities are likely to be extremely small. **(COUNTRY-SPECIFIC→)** According to experts, the UK has sufficient storage capacity to avoid CO_2 emissions from power plants and similar large sources for more than 50 years by injecting CO_2 into such storage sites.

The next questions will be about how you perceive possible benefits and risks of CCS in general

4.1 Please describe your opinion of the following statement on a scale of 1 to 7 where 1 = strongly disagree and 7 = strongly agree

a) CCS is an important way of reducing carbon dioxide (CO_2) emissions from fossil fuels such as coal and natural gas and industrial sources such as cement production
b) CCS will buy time to allow society to shift away from fossil fuels and towards renewable energy sources such as wind and solar
c) CCS will allow new industries to develop

d) CCS will encourage new jobs in the local area
e) CCS projects will have a negative impact on housing prices
f) Funding CCS projects will impose a heavy cost on the economy
g) Funding CCS will increase our electricity bills
h) Funding CCS will be cheaper than investing in renewable energy sources

4.2. Please indicate your level of concern about the following possible consequences of CCS in general where 1 = very concerned and 7 = not concerned at all

a) CO_2 will leak from the storage site into the atmosphere
b) CO_2 will leak from the storage site into the surrounding countryside
c) Injecting CO_2 will result in minor earthquakes ("induced seismicity")
d) Support for CCS will divert funds away from renewable energy sources such as wind and solar
e) CCS will be a cynical way for energy companies to look green while it allows them to continue burning fossil fuels.

4.3 Please indicate the extent to which you agree with the following statements in relation to CCS on a scale from 1-7, where 1 = strongly disagree and 7 = strongly agree, don't know)

a) Environmental organisations should be involved in assessing the safety of CO_2 storage and transport
b) The public should be involved in assessing the safety of CO_2 storage and transport
c) The uncertainties associated with CCS are similar to those associated with gas extraction
d) Current estimates of likelihood of leakage from underground storage sites are accurate
e) Experts disagree over the methods used in their risk assessment for CCS
f) Some of the scientific assumptions used for the risk assessment for CCS are wrong
g) Completely unforeseen events can happen in relation with CCS projects that even experts cannot anticipate
h) Completely unforeseen events can happen in relation with CCS projects that nobody can anticipate

[Q-sort]

4.4: All in all what is your view on the development of the planned **UK** CCS project described above on a scale from 1-7, where 1 = strongly opposed and 7 = strongly supportive, not enough information)?

4.5: **(For stakeholders only)** How likely do you feel that there will be significant deployment of CCS technologies in the next decade **in the UK**? [1=very unlikely to 7=very likely, 1-7 scale, don't know]

4.6: **(For stakeholders only)** What is your opinion of potential public perceptions regarding CCS, **in the UK?** [1-7 scale, 1=strongly oppose to 7=strongly supportive]

4.7: **(For stakeholders only)** Which factors do you think are most likely to influence public perceptions regarding CCS **in the UK**?
Please mark all those statements that you agree with.
The views of major opinion formers, e.g. the media, politicians and NGOs
Success or failure of early projects
The perceived urgency of responding to climate change

Evidence of the security of storage
Impact on electricity prices
Local siting issues involving the public which lives close to CCS developments (infrastructure and storage sites)
Unsure

5. Information sources and Trust

5.1 Level of agreement with statement: "I can get all information I need regarding new local developments in the area" **(for all except journalists)**
(on a scale from1-7 where 1 is strongly disagree and 7 is strongly agree)

5.2: Where would you go to find more information about the CCS project?
(on a scale from1-7 where 1 is very likely and 7 is very unlikely)

a) national/international NGOs (Greenpeace, WWF etc)
b) local NGOs/community groups, residents' associations etc.
c) Friends, neighbours, family
d) national media
e) local/regional media
f) national government
g) local/regional government
h) the internet (blogs, wikis etc.)
i) university scientists/scientific publications
j) the developers, energy companies etc.
k) EU
l) others, such as: _____

5.3: Which of the above would you trust most to give you impartial information? (1-7 scales for each organisation + don't know

5.4: In general, who would you most trust to take concerns of the local public seriously? (1-7 scale, where 1=not seriously and 7=very seriously)
a) national media
b) local media
c) national politicians
d) local/regional politicians
e) the project developers
f) national NGOs
g) local NGOs
h) the European Union

5.5: Level of agreement with statement: "I am likely to seek further information about this project" on a scale of 1-7 where 1=strongly disagree to 7 =strongly agree

6 Community Engagement

6.0 **(public only):** I would be sorry to move out of my neighbourhood/community, and leave the people who live there.
1-7 scale where 1 = strongly disagree and 7 = strongly agree, don't know

6.1 **(public only):** Please look carefully at the following list of voluntary organisations and activities and say: (i) which, if any, do you belong to? [tick all that apply]

a) Social welfare services for elderly, handicapped or deprived people
b) Religious or church organisations
c) Education, arts, music or cultural activities
d) Trade unions
e) Political parties or groups
f) Local community action on issues like poverty, employment, housing, racial equality
g) Third world development or human rights
h) Conservation, the environment, ecology, animal rights
i) Professional associations
j) Youth work (e.g. scouts, guides, youth clubs etc.)
k) Sports or recreation
l) Women's groups
m) Peace movement
n) Voluntary organisations concerned with health
Other groups

6.2 **(public only):** We are going to ask how often you do certain things. For each activity, would you say you do them every week or nearly every week; once or twice a month; only a few times a year; or not at all?

a) Spend time with friends
b) Spend time with colleagues from work or your profession outside the workplace
c) Spend time with people at your church, mosque or synagogue
d) Spend time with people in clubs and voluntary associations (sport, culture, communal)

6.3 **(public only)**: Which of the following, if any, have you done during the last twelve months?
a) Contacted a politician or another elected representative
b) Worked in an interest group or social organisation
c) Attended local consultation meeting
d) Worn or displayed a particular political campaign badge/sticker
e) Signed a petition
f) Taken part in a lawful public demonstration
g) Boycotted certain products
h) Deliberately bought certain products for political, ethical or environmental reasons
i) Participated in strikes
j) Voted in national elections
k) None of these

7. Procedural Justice

7.1. Do you believe that, in general, the current planning process gives sufficient voice to the concerns of local residents? [1-7, Strongly agree to strongly disagree, unsure]

7.2 **(for public only)**: Agreement with the following statements (1-7; Strongly agree to strongly disagree, don't know)

a) I would be willing to be involved in the decision making process about local CCS projects
b) I would like a representative of the public to be involved in the decision making process about local CCS projects

7.3 **(for public only):** Have you been involved in providing your views with regard to the siting of infrastructure projects? [Yes/No]

7.4 If yes, please describe your involvement [tick all that apply]:
a) Contacted a politician or another elected representative
b) Worked in an interest group or social organisation
c) Attended local consultation meeting
d) Signed a petition
e) Taken part in a lawful public demonstration
f) Other (___)

7.5 Do you believe that your local community had been treated fairly in past developments? [on a scale from 1-7, where 1 = strongly disagree to 7 = strongly agree, don't know]

[Add Country-specific questions here]
7.6 Are you aware of the Aldbrough gas storage facility? [yes/no]

7.7 Did you approve or disapprove of this facility? [on a scale from 1-7, where 1 = strongly disapprove to 7 = strongly approve]

7.8 Why? [free text]

9. Media preferences

9.1 Which newspapers do you read regularly (check all that apply)

The Times
The Guardian
The Independent
The Sun
The Daily Mail
Financial Times
Daily Mirror
Daily Star
The Daily Telegraph
Metro
Daily Express
Yorkshire Post
Other/Regional Newspaper (specify:__)
None

9.2 **(for public only)** What type of news stories do you read regularly (check all that apply)

a) Business;
b) National news;
c) International news;
d) Regional/local news;
e) Sports;

f) Science and environment;
g) Opinions and editorials;
h) Entertainment news
i) Others (specify:__)

10. Demographics

10.1 Gender: male/female

10.2 Age (18-99)

10.3 Education:

(UK-Specific) What is the highest level of education you have achieved? (If still studying check for highest achieved so far)
GCSE/O-level/CSE ____
Vocational qualifications ____
A level or equivalent _____
Bachelor Degree or equivalent _____
Masters/PhD or equivalent _____
No formal qualifications ____
Other _____

10.4 **(for public, politicians and NGOs)** Can you describe your political ideology (where 1 = extreme left and 9 = extreme right, not applicable/refused)

10.5 **(for public only)** Would you please indicate the group in which you would place your household's total gross monthly income from all sources before tax and other deductions? **(COUNTRY SPECIFIC)**

Up to £650
£651 to £970
£971 to £1300
£1301 to £1700
£1701 to £2200
£2201 to £2800
£2801 to £3400
£3401 to £4200
£4201 to £5700
over £5700
refused