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Near CO_2 Participation and communication near CO_2 capture and storage operations

Public Perceptions of CCS: the results of NearCO$_2$ European Focus Groups

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EXECUTIVE SUMMARY

This report presents the findings from a study into European public perceptions of Carbon Capture and Storage (CCS) as determined through six focus groups, one held in each of the UK, the Netherlands, Poland, Germany, Belgium and Spain. The development of opinion and the emergence of concerns were observed via phased exposure to a specially-commissioned DVD, which provided an overview of CCS technology, its rationale and associated debates, supplemented by additional information on national energy mixes. In general there was a high level of commonality in opinion and concerns across the six countries, with only minor differences. The concerns that emerged were not allayed by the information provided. On the contrary, there was evidence of a shift from initial uncertainty about CCS to negative positions. CCS was generally seen as an uncertain, end-of-pipe technology that will perpetuate fossil-fuel dependence. Furthermore, the participants were far from convinced that CO_2 can be stored securely for thousands of years. We infer that the case for CCS as a bridging tool to a lower carbon future, and reassurance on the risks posed by CO_2 leakage, will need to be made convincingly if the general public are going to accept CCS. The research also revealed that the majority of the participants were unfamiliar with the concept of CCS and sceptical of information that they consider originating from industry or government. An essential, though challenging lesson for communicating information about CCS is the need to improve the level of trust between the general public and the key advocates of CCS, namely government and industry.

1. INTRODUCTION

For over ten years, researchers have been investigating public perceptions of CCS, and in most respects the findings have been consistent. From the days of early work (e.g. Gough et al, 2001; Gough et al, 2002; Shackley et al, 2005), studies completed internationally have tended to find that publics are unfamiliar with CCS technology relative to other greenhouse gas mitigation options, though this is changing over time; that publics tend to prefer energy efficiency, renewable energy and to some extent nuclear power over CCS; that they have specific concerns about the safety and reliability of CCS; but that despite this, if given enough information, the majority will express somewhat reluctant acceptance for CCS, principally as a bridging technology away from fossil fuels (e.g. Reiner et al, 2006; van Alphen et al, 2007; Tokushige et al, 2007; Ha-Duong, 2009; de Best-Waldhober et al, 2009; de Coninck et al, 2010; Oltra et al, 2010; Fleishman, 2010; Roberts and Mander 2010). To this general picture, other studies have added detail on specific influences: for example, the role of gender in relation to risk perception by stakeholders (Stephens et al, 2009); and the way in which communication about CCS to the public may be rated as more trustworthy (though not necessarily more persuasive) when stakeholders from a variety of backgrounds are involved in communicating about CCS in collaboration, rather than separately (ter Mors et al, 2009). There is also a growing body of literature which looks specifically at a variety of ways of delivering information to the public on CCS and the impact that different approaches have on their perceptions (e.g. Roberts and Mander 2010 and the present report).

The reluctant acceptance of CCS has resonances in the changes in British public views of nuclear power, in part paralleling the growing understanding of the significance and urgency of climate change (Bickerstaff et al, 2008). Yet it is important to bear in mind that at present there are not any fully functional CCS projects operating in Europe. As a result few studies have been able to explore public opinion of CCS in relation to prospective or actual CCS capture, storage or transport. Where this has been possible, trust in statutory decision-makers, developers, other actors and planning processes are key factors involved in public perceptions (Huijts et al, 2007; Desbarats, 2010 and Desbarats, forthcoming). Despite this, Shackley et al (2009) were surely justified in observing that efforts at understanding, engaging and communicating with the European public and wider stakeholders on CCS have been weak (Shackley et al, 2009).

With this in mind, the EC-funded 'NearCO2' project was commissioned in the period shortly prior to the funding of twelve CCS demonstration projects in Europe, in order to inform communication and engagement practice. Work Package 4 focused on developing and testing multimedia material for informing the public about CCS. Six focus groups were held, one in each of the following countries: the UK, the Netherlands, Poland, Germany, Belgium and Spain. The development of opinion and the emergence of concerns were observed via phased exposure to a specially-commissioned DVD, which provided an overview of CCS technology, its rationale and associated debates, supplemented by additional information on national energy mixes. More specifically, Work Package 4 and this report address the following research questions:

- How (if at all) do attitudes develop and change, both in response to specific information introduced through the course of the discussion, and as a result of the discussion as a whole?
- In what ways, if at all, do attitudes to CCS, climate change, energy demand and energy supply vary between the groups?
- In what ways, if at all, do perceptions of risk vary between groups?
- In what ways, if at all, do perceptions of CCS debates vary between groups?
- In what ways, if at all, does the development of attitudes and risk perception vary between groups?
- What, if any, demographic and other correlates are evident in the pre/post questionnaire?

NearCO2 work has been designed with an acute awareness of the role of information framing when eliciting and testing public responses. For the present study, previous public perceptions work that sets CCS in the context of climate change urgency and alternative technologies is particularly relevant (e.g. Fleishman, 2010). More generally, the literatures on risk perception, science and technology studies, social psychology and others arguably suggest that public perceptions of CCS are unlikely to be a special case: despite CCS having particular characteristics, public perceptions of CCS are likely to be amenable to understanding within existing conceptual frameworks. However, as this study clearly demonstrates, this does not mean, that applying such frameworks can secure public acceptance: informed understanding can help to formulate appropriate responses to public objection, but it cannot guarantee to achieve any particular end in terms of energy policy. Furthermore, it is clear that both the method of delivering information and the perceived trustworthiness of the source will be critical factors in determining public perception.

The report consists of five sections. The first section provides an overview of the current literature on public perceptions of CCS, with particular reference to studies that have provided information to research participants as well as eliciting their opinion. The second section explains and justifies the methodology used in the research. In the third section the results of the focus groups are presented. In the fourth section the results are discussed with specific reference to the research questions outlined above. Finally the fifth section aims to close the research-policy loop, summarising the findings of the study, making some concluding comments and considering the implications of the findings for future CCS communication strategies.

2. PREVIOUS RESEARCH ON PUBLIC PERCEPTIONS OF CCS

Here we present an overview of some of the studies relevant to the present one. We are selective and do not attempt comprehensive coverage. In Europe, public awareness of CCS is relatively low (De Best-Waldhober et al, 2006, 2008; Ha Duong et al, 2009; Reiner et al, 2006): this can largely be explained by the fact that currently there are no fully operational CCS projects. As a result, the general public lack a practical reference point with which to understand the nature of CCS. However, it is anticipated that CCS technology will be deployed across Europe over the next ten to twenty years. As the public become more aware of the technology, public perceptions are likely to become a major factor in determining the success or failure of the technology. As DeConinck et al (2009) concluded, there are no major scientific, technical or legal barriers to CCS, but rather it is appropriate economic incentives and suitable regulatory measures that are necessary if it is to be implemented. Furthermore, experience with previous social conflicts relating innovative energy technologies has shown public perceptions to be highly significant for implementation. From a communications and consultation perspective, CCS presents a significant challenge, given that the technology does not have a long-standing implementation history or representative datasets on the risks posed by underground storage.

While research analyzing the impact of communications on public acceptance on CCS is relatively recent, there is a developing literature. Not surprisingly, many studies emphasise the importance of message content on public opinion. Several studies show that individuals' reactions to CCS is influenced by the provision of information (e.g. Ashworth et al, 2009; Itaoka et al. 2004, 2006; Shackley et al 2005; Sharp et al, 2006; Tokushige et al., 2007; Van Knippenberg & Daamen, 1996; Roberts and Mander 2010). For example, after hearing from experts about CCS, focus group participants in the studies by Shackley et al (2005) became more negative about CCS. However, studies rarely reveal exactly what aspects of information motivate participants to change their opinion. An Australian study has used a large group process for engaging the public on energy sources and technologies with a low emission profile (Ashworth et al, 2009). After a morning of carefully developed, multi source information given by experts and an afternoon of deliberation, participants were on average more positive towards CCS. Similar results were achieved during a recent study in the UK which utilised citizen panel methodology to provide lay participants with the opportunity to engage with experts in a variety of different fields related to CCS. It was clear that a key factor in the outcome was that by the end of the process the participants had developed a relationship with the experts and were confident that they could trust the information they had provided (Roberts and Mander 2010).

Continuing the important theme of trust, numerous studies have concluded that even when the public appear to accept the need for CCS in principle, they have doubts about the institutions that would be involved in overseeing the process (Gough et al 2002; Roberts and Mander 2010). Given the high level of mistrust in scientific knowledge relating to climate change, convincing the general public of the benefits of CCS, and in particular those who live and work in areas which are likely to be affected by deployment presents a significant challenge. This is clearly demonstrated in Germany where the first fully operational CCS

pilot-plants, at the time of writing, have yet to secure storage facilities due to substantial local opposition.

Consequently, a number of factors need to be considered when planning to communicate the costs and benefits of CCS to the general public. Central to the process will be engendering trust in both the science behind the technology and in those tasked with operating and regulating the capture, transport and storage of CO_2. There is an emerging body of literature which is exploring how the presentation of information (and possibly more importantly), those who present the information, may influence public perceptions of CCS: e.g. Siegrist and Cvetkovich (2000) and Huijts and Midden (2007). Such studies indicate that feelings of trust (trust in government and trust in industry) lead to more positive and less negative effects towards CCS, and that these effects in turn influence the perception of risks and benefits and the acceptance of CCS.

Similarly, Dutch work has focused on the relationship between trust in information sources and acceptance of CCS. The study has identified that information provided by NGOs may be seen to be more trustworthy than that supplied by industry (Terwel et al 2009). Along similar lines experimental research conducted by ter Mors et al (2009) demonstrated that communication about CCS to the public is more likely to be effective when multiple stakeholders communicate about CCS in collaboration instead of doing so separately. The rationale here is that the stakeholders involved are perceived as having different goals and interests in CCS - therefore, the contrasting information given in collaborative setting is seen to be more reliable in its own terms. Another Dutch study on CCS opinion suggests that, given enough information about the rationale for CCS, people will reluctantly agree with its implementation on a large scale (de Best-Waldhober, 2008; de Best-Waldhober et al, 2009a; de Best-Waldhober et al, 2009). It should be noted that the information used in the latter study came from over twenty experts from differing backgrounds and positions on CCS and that this was made clear to participants. The study also illustrates the way in which people, not surprisingly, will provide researchers with opinions on a topic about which they know very little – in this case alternative CCS-power plant options (ibid). Such opinion is apt to be unstable, easily changeable and unreliable as a predictor of their views once they are better-informed (ibid). This reluctant acceptance of CCS has resonances in the turn in British public views of nuclear power (Bickerstaff et al, 2008).

The results from a French survey on public perceptions of CCS showed that in response to key questions about approval or opposition to the use of CCS in France was influenced by provision of information about the technology and the potential consequences of CO_2 leakage. Prior to exposure to information about CCS, only 6% of the respondents could accurately define the technology. After being given a basic introduction to CCS 59% approved of the technology, which reduced to 38% after they had been informed about the risks involved (Ha-Duong, et al. 2009)

It may appear that there is an element of contradiction between these studies, particularly in relation to the impact of information on perceptions of CCS. However, we suggest that these contradictions can at least in part be explained by the differences in information source, content, quantity and processing. That said, because studies vary across multiple

dimensions, the general picture of mixed results on message content cannot be narrowed down to identifiable, particular aspects or the interplay of these.

As the Bradbury et al (2009) work highlights, it is also important to remember that other factors, external to the information provided on CCS, are likely to contribute to individual perceptions. US work has found that past experience with government, existing low socioeconomic status and/or a desire for compensation may influence individual perspectives on CCS. In some circumstances, the benefits of CCS to the community may be more important than the concern about the risks of the technology itself. Bradbury et al (2009) confirm the role of receivers' attributes as well as project features, as part of the context in which the communication takes place. This is further illustrated by the study of Oltra et al (2010) which showed that information needs as well as opinions not only varied in relation to socio-demographic variables, attitudinal variables, and the content of the information delivered to study participants, but also in relation to local contingencies such as industrialisation of the area and how the technology was framed in the group discussion (demonstrating the influence of social interaction).

Any discussion regarding the communication of information on CCS needs to take into consideration the potential impact of the media. However, to date, very little research has been undertaken into the role that the media plays in informing public perceptions of CCS. The CCS-related literature that does exist also makes use of research findings on the role of the broadcast media in informing perceptions of other emerging technologies. Thus, focusing on the new and emerging technologies of human genetics, genetic modification and nanotechnology, Hughes et al (2008) found that focus group participants relied on the media to provide general information about a new topic, introduce ideas about its risks and benefits, identify supporters and opponents and structure the debate. In the UK citizen panels exploring public perceptions of CCS highlighted that the media would be an important source of information concerning the technology and could control the discourse (Shackley et al, 2006). A number of participants in these panels also expressed doubt over the ability of the media to understand the technology and to communicate an appropriate level of scientific information.

An unpublished study (Gough and Mander et al), focusing on the media representation of CCS in national papers, highlights that although CCS is gaining representation in the press, it is still subject to considerably less media attention than other low carbon supply technologies such as renewables or nuclear. The study examined the role of newspapers in the development of knowledge and understanding amongst the lay public, within the context of a broader communication system. Through a series of guided reading interviews with regular readers of national newspapers in the UK, it explored the way in which readers select, interpret and respond to such articles. Although readers perceived print media as a useful information source, reading about CCS in the print news media was found to only partially improve readers' understanding of CCS, often raising further questions for readers. Readers were conscious of bias in newspaper reporting and of the political stance of individual papers and assimilated content in a selective manner. The study identifies factors that influence communication on CCS and suggests that newspapers serve a more subtle function than simply the immediate transfer of information, namely the gradual shaping of opinion over time. Furthermore, it highlighted the way in which, due to the technical nature

of CCS, providing people with written material without an opportunity to discuss issues arising and to ask questions may not be the most optimal form of communication.

3. METHODOLOGY

In the present study, the research method centred on focus groups with pre- and post-group questionnaires, with public responses stimulated by a DVD as described below. As a method of opinion elicitation and exploration, focus groups have the characteristics of being social and discussion-based (Morgan and Spanish, 1984). As Bryman (2001:338) argues, focus groups allow the researcher to develop an understanding of why people feel the way they do. It is possible to allow *"… people to probe each other's reasons for holding a certain view"* and as the debate moves on, participants may end up discussing issues which would not have come up in an individual interview. Therefore focus groups are helpful in elicitation of a wide variety of different views in relation to a particular issue (ibid.). Furthermore, of particular importance for the current research, focus groups provide an environment where the participants can learn and absorb new information (Bedford and Burgess 2001).

Focus groups are not intended to provide data that is nationally representative in terms of statistical significance, but are commonly used alongside large scale surveys, where resources permit. With or without such surveys, they provide insights into participants' thinking in participants' own terms. Focus groups are susceptible to a variety of influences, particularly the interventions of the facilitator and vocal participants (Stewart et al., 2007). While this may present a problem, depending on the purpose of their use, it can also be seen as mimicking aspects of natural or everyday conversations.

Focus groups allow responses to topics or products to be explored with a degree of facilitator control that can be varied to suit the research objective. The intention here was to provide the groups with identical, carefully-defined information and to channel discussion along the lines of pre-defined prompts, but to allow discussion to flow within these constraints relatively freely. As such, the context was, while not a close simulation of everyday life, and certainly not as close as an ethnographic design would be, still moderately similar to a real-world situation in which the participants might be exposed to and discuss news or factual information about CCS.

Six focus groups were held in spring 2010 and participants were representative of national populations, not drawn from carbon storage localities (actual or planned). There were 58 participants in total, approximately equally split among the six groups. The primary objective was not to investigate the perceptions of people who have already been exposed to CCS information, but to investigate the development of opinion through the course of being exposed to new and additional information on CCS, with a view to informing communications strategies. A standardised prompt and information sheet was given to the facilitators to encourage common questioning, and the application of a pre- and post-focus group questionnaire was used to support further inferences on opinion and opinion change. Recruitment and facilitation was by a commercial market research firm and facilitators had no specialist environmental or CCS knowledge. This is in contrast to the main alternative facilitation method of closely moderating discussion, correcting misapprehensions and responding to participant questions with scientifically defensible information. A characteristic of the first approach is that it creates an atmosphere that somewhat resembles natural settings in which people may first come across CCS, such as in newspaper articles or television programmes, without the presence of specialist information support

and in which participants may feel more able to express spontaneous opinion than in the presence of those that they regard as experts.

Also central to the focus groups was a specially-commissioned, multi-lingual DVD that explains CCS in the context of climate change and other energy options. The film (to be available at http://www.communicationnearco2.eu/home/) is intended to be relatively neutral and provides an overview of arguments for and against CCS, including citizen concerns about health and safety. The DVD is divided into several chapters, with discussion questions provided on-screen at the end of each chapter. The 'CCS story' builds progressively through the film, to elicit a phased response and to enable the influence of additional information to be observed. Responses were also sought to supplementary textual and graphical information provided after the DVD, specific to the national energy mix of each focus group, explaining why it will be difficult to avoid the use of CCS in Europe even with a major expansion of renewable energy and energy efficiency.

The level and quantity of information provided to the participants reflected the time constraint of two hours and was based upon the assumption that participants would know nothing about CCS. The intention of the DVD was to expose participants to contextual as well as CCS-related information in stages, so that the evolution of opinion could be observed and lines of discussion to evolve without close moderation, in order (as said) to simulate real-world conditions of people being exposed to information on CCS and then discussing it with non-experts. Neutrality was largely interpreted as being consistent with majority scientific opinion. In this regard, the IPCC was used as a benchmark source: anthropogenic climate change is conclusive; a wide range of lower carbon energy options are likely to be helpful in avoiding 'dangerous climate change' through the reduction of greenhouse gases; and CCS has considerable potential in this regard, whilst at the same time being associated with a variety of non-trivial uncertainties (IPCC, 2005, 2007). Nonetheless we did also give expression to a somewhat stricter interpretation of neutrality by including, towards the end of the DVD, statements from opponents and advocates on the perceived limitations and benefits of the technology.

In addition to the focus groups, the participants were asked to complete a questionnaire before and after the discussions, with questions intended to aid observation of the evolution of opinion and identify differences and commonalities between the groups. The post discussion questionnaire also included questions regarding the quality of the material presented in the focus groups. The research design rationale, facilitation guidance, DVD voice-over script, supplementary energy mix material and questionnaires, as provided to the market research firm, are all available in an accompanying Appendix.

The research generated a large amount of both quantitative data from the questionnaires and qualitative data from the focus group discussions. The data from the questionnaires was input to SPSS to produce descriptive statistics. Frequency tables and cross-tabulations provide an overview of how the participants' perspectives changed as a result of the focus group discussion and the relationship between their attitude towards climate change and opinion on CCS. These trends were then used as the starting point for the qualitative data analysis.

Analysis of qualitative data can be problematic and often uses less structured processes than those used by quantitative researchers. Miles (1979) describes qualitative data as an *'attractive nuisance';* the attractiveness comes from its richness, the nuisance from the difficulty of finding analytical paths through it. The key to successful analysis of qualitative data is the careful coding of the data. The audio recordings of the focus groups were therefore translated into English, transcribed, entered to *AtlasTI* qualitative research software. *AtlasTI* provides a useful tool for the systematic analysis of data and allows the researcher to assign codes to segments of text; these codes can then be grouped, annotated and linked together to develop lines of argument. The software is particularly useful for projects with multiple case studies, as it helps provide a degree of standardisation when identifying themes and comparing groups.

The pre- and post-questionnaire results need to be interpreted cautiously and in context. Some of what we observe, particularly differences between nationalities, may be specific to the particular location or respondents involved. WP2 of the NearCO_2 project is undertaking larger scale regional and national opinion surveys, the results of which are intended to be representative of the larger population surveyed. This does not hold for the questionnaire results reported here. Small-scale qualitative and quantitative studies provide an indication of what *may* be found in terms of opinion and opinion change, rather than an indication of what is statistically likely to be found under the same controlled conditions. Studies with small numbers of participants exchange the higher certainty and replicability obtainable with large scale, controlled studies, for more detailed information on the variety of possibilities. Conversely, large scale studies exchange depth and nuance for reliability under particular, constrained conditions. Both methods have their strengths and weaknesses, which is why both are commonly used, when resources permit.

4. RESULTS

4.1 RESPONSE TO INFORMATION PROVIDED

As identified in the literature review, previous research into public perceptions and understanding of CCS has shown that a key factor in determining public perceptions is the way that information is presented. Consequently an essential element of the research was to ascertain what the participants thought of the information used to prompt the focus group discussions. While the questionnaire ratings indicated that participants were generally positive about the quality of the information provided, it was also clear that most felt that they would need a lot more information, probably from a wider range of sources, before they felt able to make a firm decision on CCS. The latter was not unexpected, given previous experience. Providing sufficient information would be possible but would require a different research design (e.g. citizens' panels or a detailed information choice questionnaire). In terms of participants' views on the information provided, 71% agreed that the information was neutral and balanced (21% were neutral on this); 77% thought the information was clear (18% were neutral); 73% thought the information was appropriate (22% neutral). However, 50% were neutral on whether the information was misleading (14% agreed, 36% disagreed), again indicating a considerable level of uncertainty. This was supported by responses to the final question, which asked whether the information was insufficient: 74% agreed and 13% disagreed. In short, participants considered the information to be of good quality but insufficient in and of itself to help them come to a firm conclusion.

4.2 THEMES EVIDENT IN THE DISCUSSIONS

A broad range of themes emerged in the focus group discussions and were identified through the coding process. These are listed along with the frequency of their occurrence, in Figure 1. Whereas Figure 1 shows all themes, regardless of whether they were mentioned in only some of the groups, Figure 2 shows only those themes that were raised in all of the groups. Figure 3 then shows the relative contribution of each group to those shared themes. Notable observations include: some 50% of the 'confusion' references are in the UK group; some 35% of the CCS cost references are in the German group; the small percentage of positive CCS references in the Spanish group; the small percentage of trust in government, government approach and individual self-efficacy (impact) references in the Polish group; and the relatively large number of trust in science references in the Netherlands group.

Figure 1 Semi-prompted CCS discussion themes by frequency (all groups)

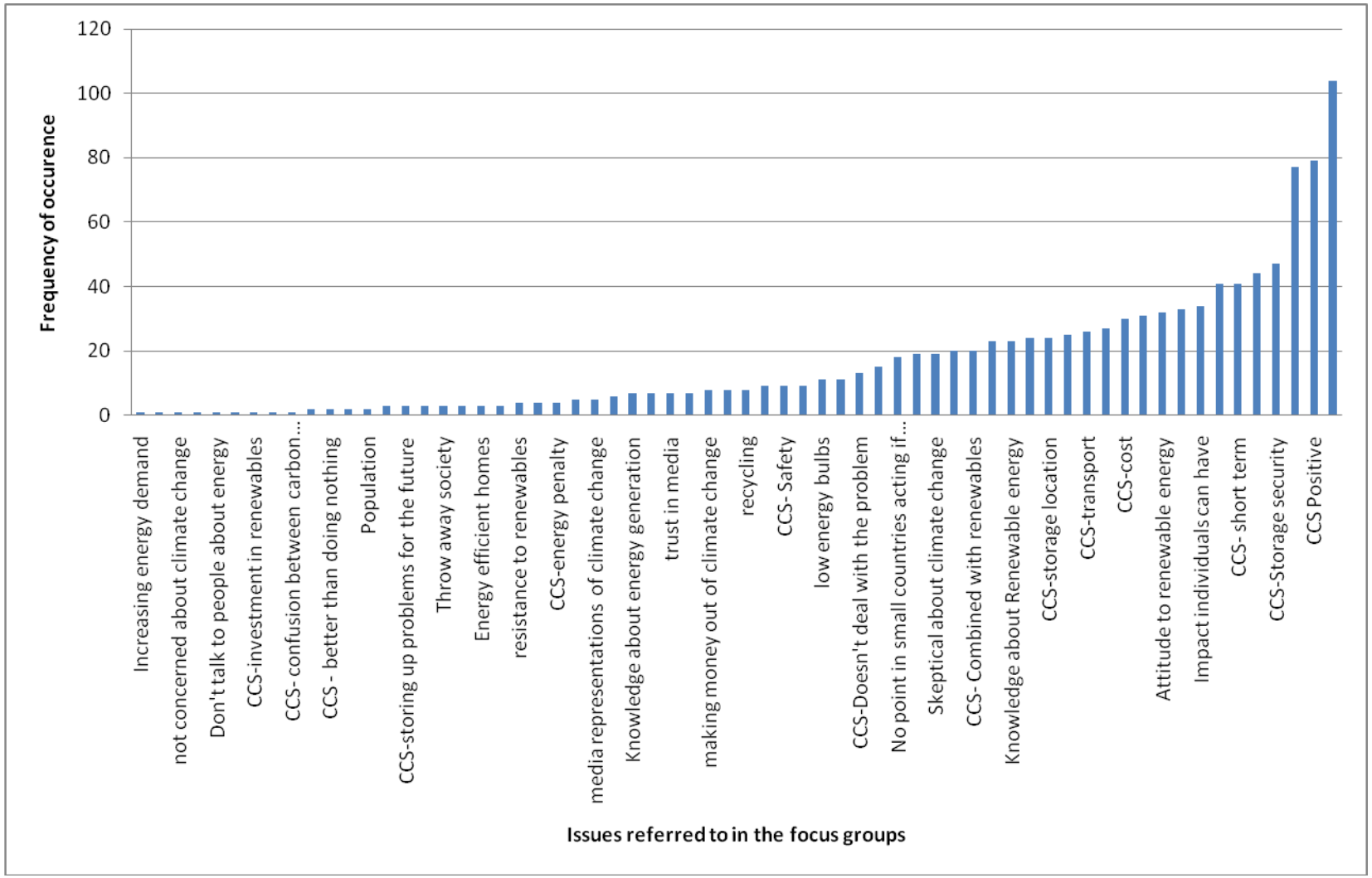


Figure 2 Frequency of topics referred to in all groups: contextual and CCS-specific

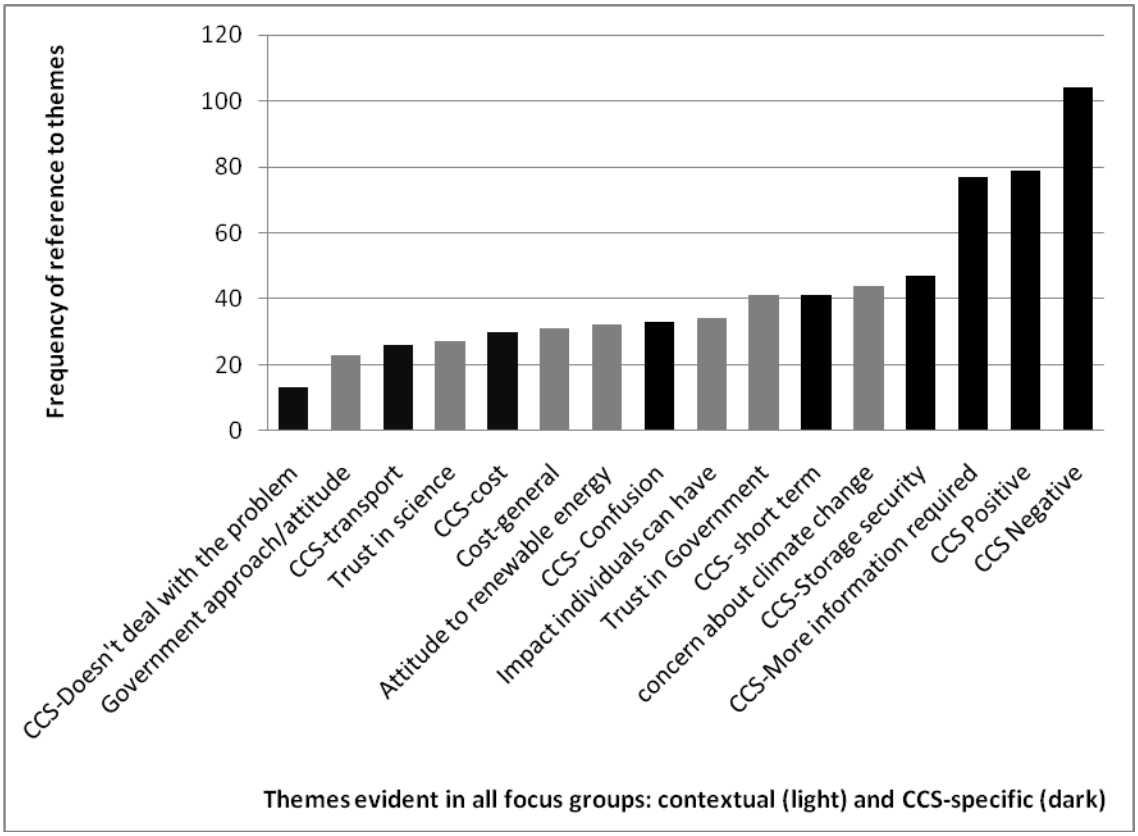
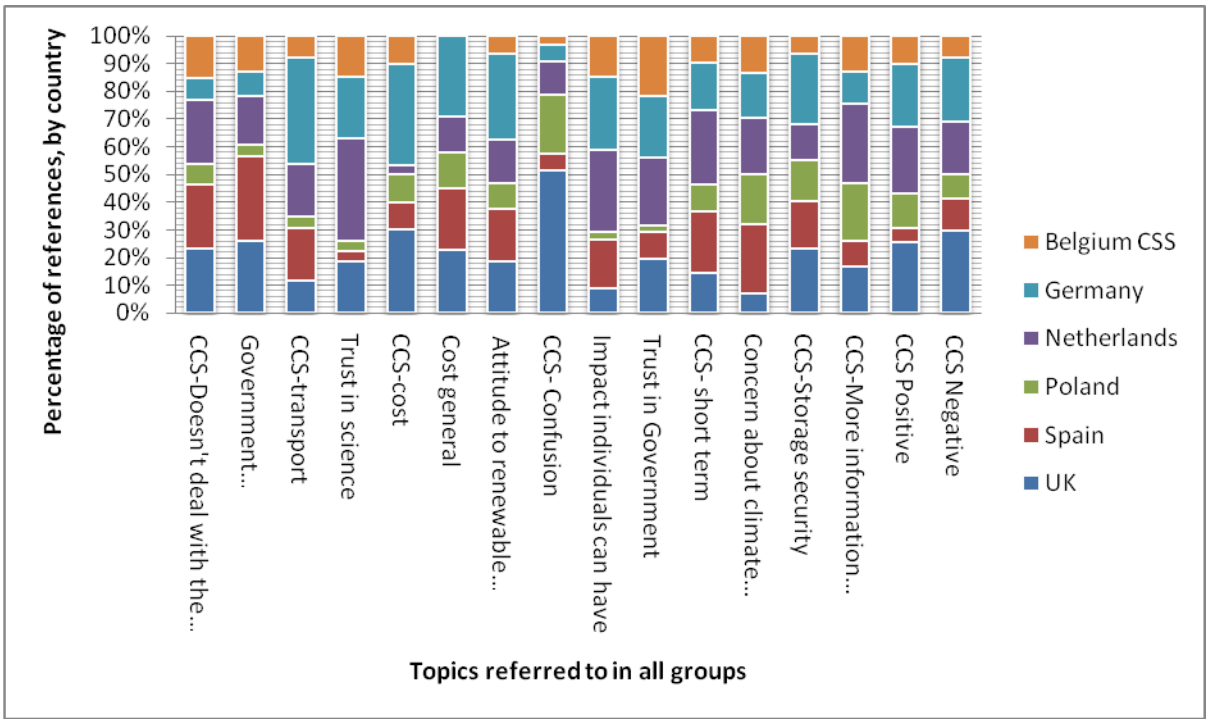


Figure 3 Relative contribution of each focus group to topic reference frequency



4.3 NOTABLE CONTEXTUAL THEMES

4.3.1 GENERAL ACCEPTANCE OF CLIMATE CHANGE

With the exception of the Netherlands group (40%, for which there is no obvious explanation), 70-100% of the participants of each group stated that they were concerned about climate change in the pre-focus group questionnaire and this was also reflected in the focus group discussions. The discussions about climate change in the Netherlands group centred on the 'climate-gate' debacle that emerged just before the UN COP-15 climate change conference in Copenhagen (for scientific discussion, see e.g. (Heffernan, 2010)). It was clear that a number of the participants had been heavily influenced by the associated debates evident in the news media.

The participants in the Spanish focus group appeared particularly concerned about the impacts of climate change and repeatedly referred to the particularly hot summers that they had experienced recently and the increasingly regular water shortages. Across all of the case studies, much of the discussions about climate change focused around the scale of the problem. In particular, many of the respondents felt that there was very little they could do as individuals or even as individual countries to tackle climate change. In all of the focus groups (except for Poland) the participants continually commented that they felt there was little point in 'us' taking action, as countries such as China, India and the USA are unlikely to pull their weight.

4.3.2 THE HIGH SALIENCE OF ENERGY COST

According to the results of the pre-workshop questionnaire, in all the cases but Spain, the most important factor in determining which electricity production methods should be used was 'cost' (the Spanish participants considered helping to prevent climate change the most important). Indeed, participants in the UK, Germany and Poland, thought that the costs associated with CCS were a major disadvantage of the technology. While in repeat focus groups, it is likely that cost would recur in all groups as an issue, here the Polish focus group was particularly concerned about cost: participants strongly felt that Poland was still a relatively poor country compared to other European nations and didn't have the money to invest in new technologies. Furthermore, the strongly held view across all of the groups was that there is only a limited amount of money to spend on developing new energy technologies and that it would be better if money was invested in renewables.

Indeed, concerns about the costs associated with both CCS and renewable energy technologies represented a significant area of debate in all the focus groups. There was a general consensus that new low carbon energy technologies will be expensive and in general people were unhappy about the prospects of higher energy bills. The Polish participants were particularly concerned about rising costs and pointed out that many people in Poland were already struggling to pay their energy bills. More specifically participants in all countries were concerned that the financial risks associated with CCS were significantly greater than those associated with renewable technologies. Participants in the German and Belgian groups were concerned that if we invest in CCS now we still have to invest in renewables in the future, and there was a general feeling that in the long run it would be cheaper to invest in renewables now. Furthermore, participants from the UK and Germany were particularly concerned about the long term costs of monitoring the stored CO_2. These debates about cost led to further discussions about who should pay for new CCS technologies; there was a consensus that if CCS was to be deployed the bill should be predominately met by the power companies. However, the participants were equally sceptical that this would be the case, and felt it would inevitably lead to higher energy bills.

4.3.3 USE OF TECHNOLOGY ANALOGUES

The general lack of knowledge about CCS held by all of the participants led many of them to use existing technologies, which they were more familiar with as a frame of reference. Unsurprisingly, these frames of reference differed according to the local contexts. In the UK, Spain, Netherlands, Poland and Germany a direct (and unprompted) comparison was made between the storage of nuclear waste and the storage of CO_2. The Chernobyl nuclear power station disaster was quoted numerous times in Poland, Belgium and the UK. In Poland the participants appeared to be particularly nervous about nuclear waste, as Poland had suffered as a result of the Chernobyl disaster. These fears about nuclear waste appeared to transcend to the disposal of other waste products from power generation. In some respects, this may be interpreted as providing further evidence that many of the participants failed to properly understand the nature of CO_2. Nonetheless, one could also see this as an instance of associative reasoning based on the properties that stored CO_2 and nuclear waste do share: storage underground, the need to ensure isolation from the wider biosphere and the involvement of at least multi-century timescales. In contrast a number of the participants from the UK argued that when people talk about nuclear power they automatically consider it to be dangerous because of Chernobyl. However, they went on to conclude that it was actually a relatively safe method of power generation and gave several examples, including Sellafield and Dungeness nuclear power stations in the UK which they felt had good safety records. This line of discussion eventually led some of the participants to argue that if the technology was in place to safely operate a nuclear power station, CCS should also be able to run safely.

In Belgium, Germany and the UK, the examples of natural gas storage and transport were introduced by participants as a point of reference to help them visualise what the transport and storage of CO_2 would entail. In the UK and Germany there was a general feeling that if natural gas could be stored safely and transported to people's homes, then the same should be possible with CO_2. However, in Belgium, the Ghilenghien gas pipe explosion which killed 24 in 2004 was used as an example of how dangerous gas pipelines could be.

4.3.4 PERCEPTIONS OF CCS RISKS

As observed above, risk perception has become a key area of interest in understanding public perceptions of CCS. The NearCO_2 focus group participants were concerned about a wide range of risks associated with the technology and these may be classified into three groups: physical risks (i.e. concerns about safety), financial risks and governance risks (i.e. concerns about the way the technology will be managed). While there were some differences in the ways that the participants conceptualised risks relating to CCS across the six countries, the commonalities were more evident.

In terms of physical risks, the participants in all groups were most concerned about the storage aspect of the CCS chain. In total concerns about the risks involved with storing CO_2 were raised 58 times across all the focus groups, compared to 24 times for transport and 3 times for the process of capturing the CO_2. In particular, there was a general consensus that it would be impossible to guarantee that the CO_2 wouldn't leak out and that there is a danger that storing CO_2 could lead to significant problems for future generations. Many of the conversations focused on the potential impact of any leakage and were largely driven by the confusion about the nature of CO_2 identified above; a number of the participants appeared to think that CO_2 is highly flammable and/or explosive (which it is not, though while not combustible, it would be pumped and stored under pressure). In Poland and the UK specific concerns were also raised about the impact of future tectonic movement of stored CO_2. These concerns about the dangers CO_2 leakage prompted extensive discussions about locations for CO_2 storage. While the majority of participants were unhappy about any form of storage and particularly storage near their homes, others felt that providing appropriate risk assessments were conducted it might be acceptable to store CO_2 offshore. The post-focus group questionnaire revealed that 53% of the participants would be more accepting of offshore storage than storage on land. There was an interesting debate between a number of the participants in both the Polish and Dutch focus groups, with some arguing that they felt storing CO_2 offshore would be a safe short term solution and others arguing that 'dumping' waste at sea was dangerous as we don't know enough about the marine environment to predict the impact of leakage.

4.3.5 TRUST ISSUES

Risks associated with the governance of CCS also provoked a high level of debate and represent another major challenge for future public acceptability. The focus group data indicated that many of the participants trusted neither government nor industry to manage CCS objectively and safely. According to the post-focus group questionnaire, only 25% said that they trusted either government or industry in relation to CCS. There was a general sense across all the focus groups that both industry and government were predominately interested in making money and less concerned about whether CCS represented the best solution to the CO_2 problem. Scientists were regarded as a more reliable source of independent information on CCS but there was concern that governments and industry were unlikely to act on scientific advice if it went against their interests. It was felt that governments were under a huge amount of pressure from oil industry lobbyists to find ways to extend our reliance on fossil fuels. Furthermore, a number of people from the UK and Spain commented that when it comes to environmental issues, governments seem unable to either make or stick to international agreements. This led to a number of people arguing that there would be no point in a few countries developing expensive CCS projects without some kind of guarantee that high polluting countries such as the USA, India and China would also implement the technology. Participants from Belgium argued that CCS could potentially work across Europe providing sufficient leadership could be provided by the European Union.

4.4 ATTITUDE CHANGE IN RESPONSE TO INFORMATION EXPOSURE

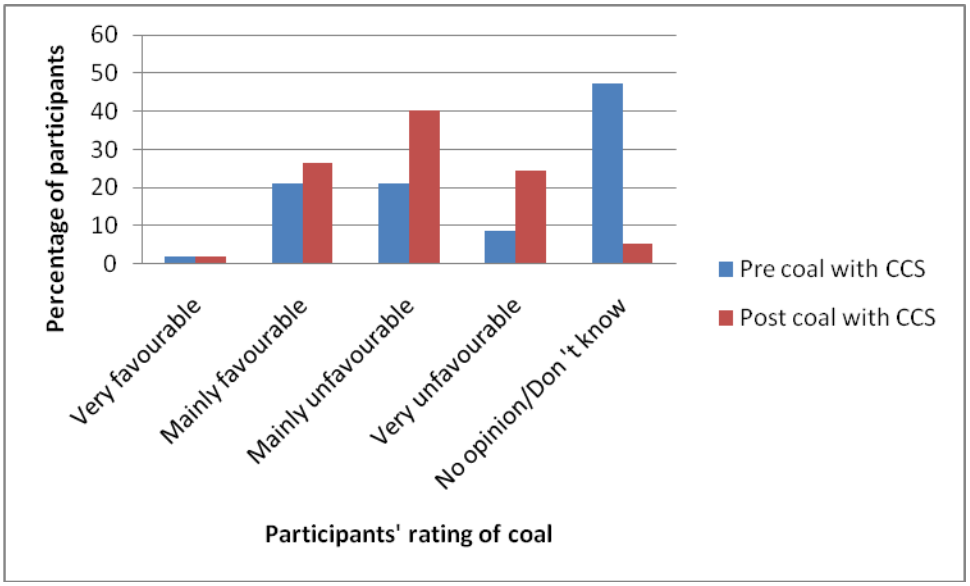
While the account provided of CCS was, in so far as possible, scientifically-defensible, it was anticipated that the focus group participants would bring their own frames of reference to the issues and that they would likely raise a variety of concerns. What was not known, was how these responses would develop through the course of being provided with an increasing level of information, how these responses might differ between national groups and how initial perceptions might shift in response to information exposure.

The pre-questionnaire provided an indication of the contextual environmental attitudes of the participants: more people said they were concerned than not concerned about a wide range of environmental issues (acid rain; air pollution; climate change; damage to the ozone layer; deforestation; household waste disposal; lack of access to green spaces; species extinction; pesticide and fertiliser pollution; river, lake and sea pollution; radioactive waste; road traffic; use of non-renewable resources). Participants viewed renewable energy (bioenergy, solar, wind, wave, tidal and hydro-electricity) more favourably than coal and nuclear. The majority viewed natural gas as mainly favourable.

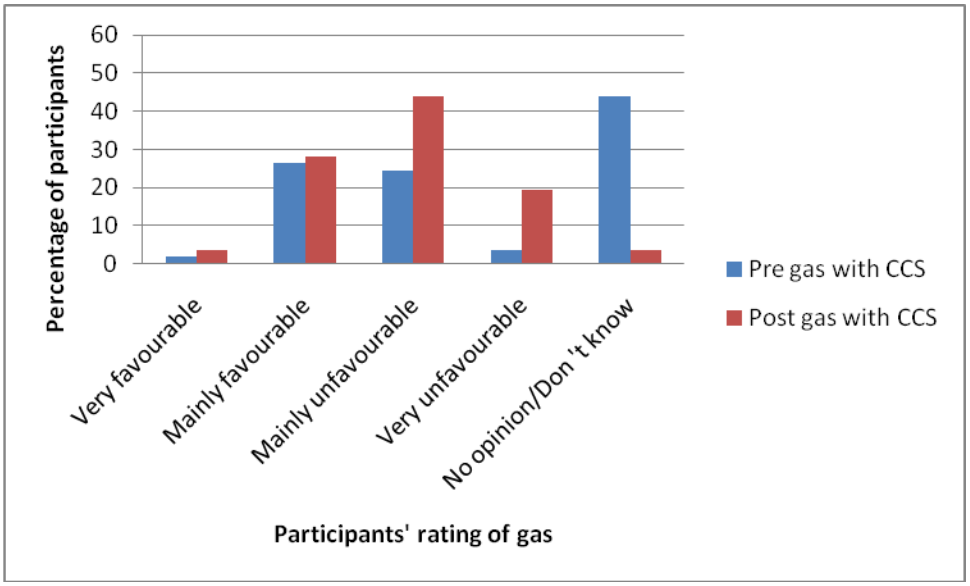
Comparing the pre and post focus group questionnaire answers regarding attitude to climate change revealed a surprising trend. While there was a consistent pre and post agreement by the majority (25/55) of participants with the most precautious of the climate change attitude options (the risks of climate change 'far outweigh the benefits'), after the focus groups, in total a sizeable minority (16/55: 29%), including 9 more individuals than before the groups, either agreed with the statement that the benefits of climate change either equalled the risks of climate change, or agreed with the statement that the benefits of climate change exceeded the risks. In other words, there was not only a persistent disbelief in the non-significance of climate change, but a shift in that direction.

Furthermore, there was also an aggregate pre-post shift from no opinion/don't know to negative opinion for attitudes to both gas and coal CCS: see Figures 1a to 2b. After the discussion, while the percentage of people who were 'mainly favourable' in their attitude to coal and gas CCS remained similar to before the discussion (i.e. a little over 20%), most of those in the no opinion/don't know category shifted to a 'mainly unfavourable' and 'very unfavourable' stance. Before the focus groups, opinion was fairly evenly split between unfavourable and favourable attitudes for coal CCS and gas CCS, with a large no opinion/don't know response for both. There was no corresponding pre/post change for the several renewables and the pre/post change for nuclear (Figures 3a and 3b) was the reverse of that for CCS: the aggregate level of undecided nuclear opinion shifted to an increase in the number of those favourably disposed to nuclear. It is also notable that, of the range of energy options, coal and nuclear elicited the most evenly divided opinion: whereas a sizeable majority were in favour of other options, opinion was fairly evenly split on coal and nuclear, though bio-CCS elicited a very large no opinion/don't know response of 58% and post-focus group opinion shifted to the negative from an initial no opinion/don't know position. This was more likely through the association with CCS than through any considered understanding of bio-CCS.

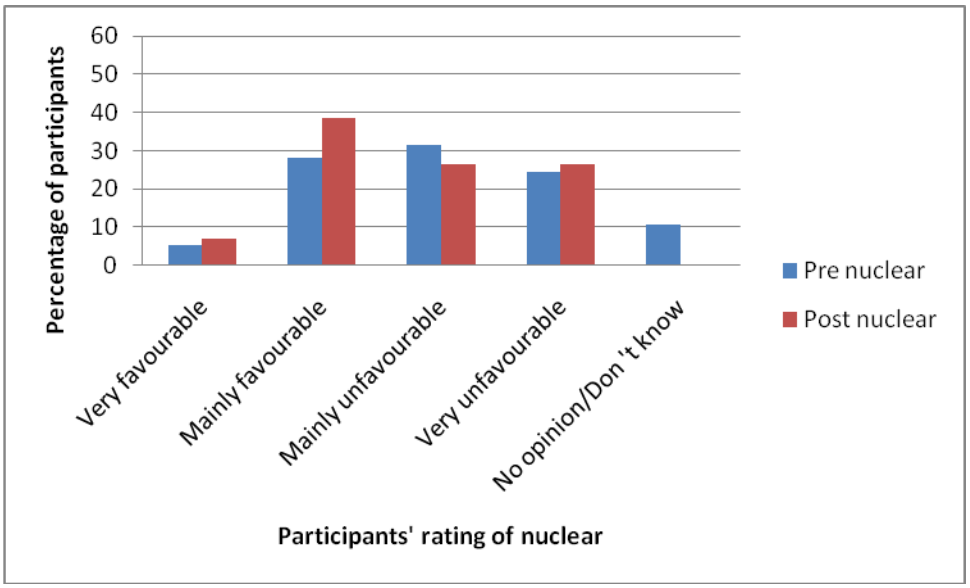
Figures 1a and 1b Coal CCS: a shift from undecided to negative opinion after film and discussion



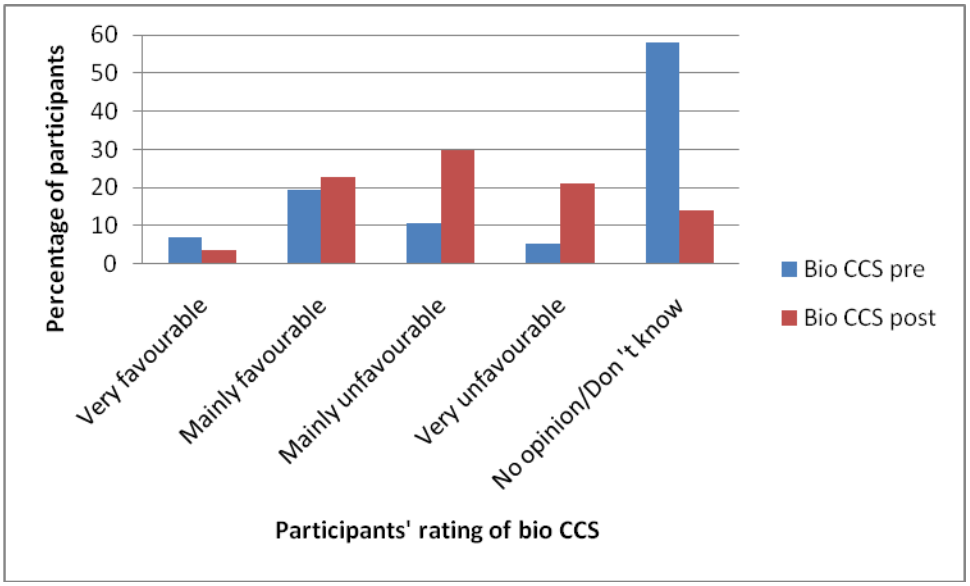
Figures 2a and 2b Gas CCS: a shift from undecided to negative opinion after film and discussion



Figures 3a and 3b Nuclear power: a shift from undecided/negative to positive opinion after film and discussion



Figures 4a and 4b Biomass CCS: a shift from undecided to negative opinion after film and discussion



Prior to watching the DVD, participant attitudes to CCS were largely consistent across all of the countries. People were clearly interested in the potential of the technology but concerned about the risks involved, particularly related to the long term storage of CO_2. As the discussions about CCS developed and more information was provided, opinions on CCS started to become more diverse between the six countries. However, the overwhelming concern that participants didn't have enough information to make a decision remained constant across all the case studies. Participants from the UK and Netherlands were most supportive of the technology – though it is not known whether this would hold in repeat studies. In particular, Dutch and UK participants thought that it represented a useful short term tool for reducing emissions while renewable technologies were developed. Participants from the remaining four groups appeared to become more negative and confused about the technology as they were provided with information. In Germany, Spain, Poland and Belgium, the participants repeatedly asked questions suggesting (as referred to above) that they understood CO_2 to be flammable, explosive and toxic (e.g. 'What happens if it explodes?' 'Will it pollute the earth's core?'). These confusions stimulated further conversations that went on to dominate much of the discussions, illustrating the importance of moderating information provision where possible, highlighting misconceptions that may be amenable to mitigation with more specific information provision, but also illustrating the more general problem of multiple interpretations of information released 'in the wild'.

4.5 Post-focus group opinion on CCS

The more detailed post-focus group questions on CCS reflected the qualitatively-expressed views, concerns, uncertainty and occasional contradiction. An example of contradiction can be seen when comparing the level of support for CCS (Figure 5) with participant opinion on whether CCS should be included in National Energy Policy (Figure 6). While over 60% of the participants did not support CCS, over 50% felt CCS should be included in national energy policy. Furthermore, while 56% participants agreed with the statement: 'I think that our government would not allow CCS to go ahead if they thought that the risk of substantial leakage was high' (though a sizeable 27% were neutral), 80% agreed with the statement: 'if I lived near a carbon dioxide storage site, I'd be very concerned about leakage, with only 10% neutral.

As Figure 7 shows, the participants were less equivocal about the need for more information. This represents a central finding from the research and is likely to explain some of the contradictions in the data reported else where. It is clear that by the end of the focus group many of the participants were left with unanswered questions about CCS technology and the way it would be implemented. Figure 8 relating to the questionnaire data demonstrates that although the participants had concerns about all aspects of the CCS chain, concerns about storage were the most prominent; this was

also reflected in the qualitative findings. However, Figure 8 also shows that the participants were less concerned about undersea storage than storage under a residential area.

Figure 5: Level of support for CCS at the end of the focus group

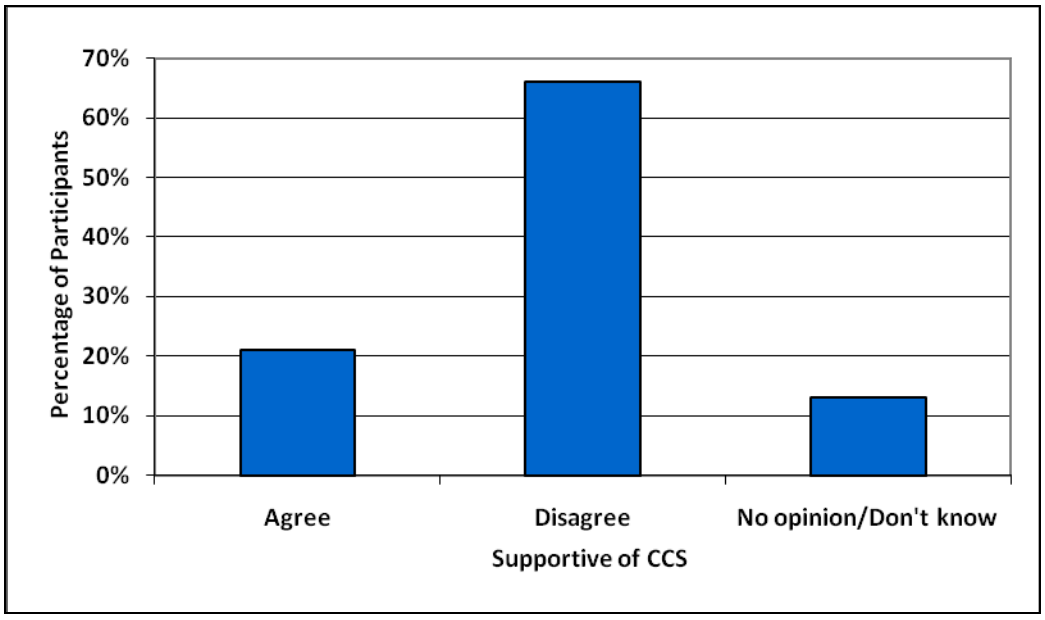


Figure 6: Percentage of participants supportive of including CCS in national energy policy in the short term

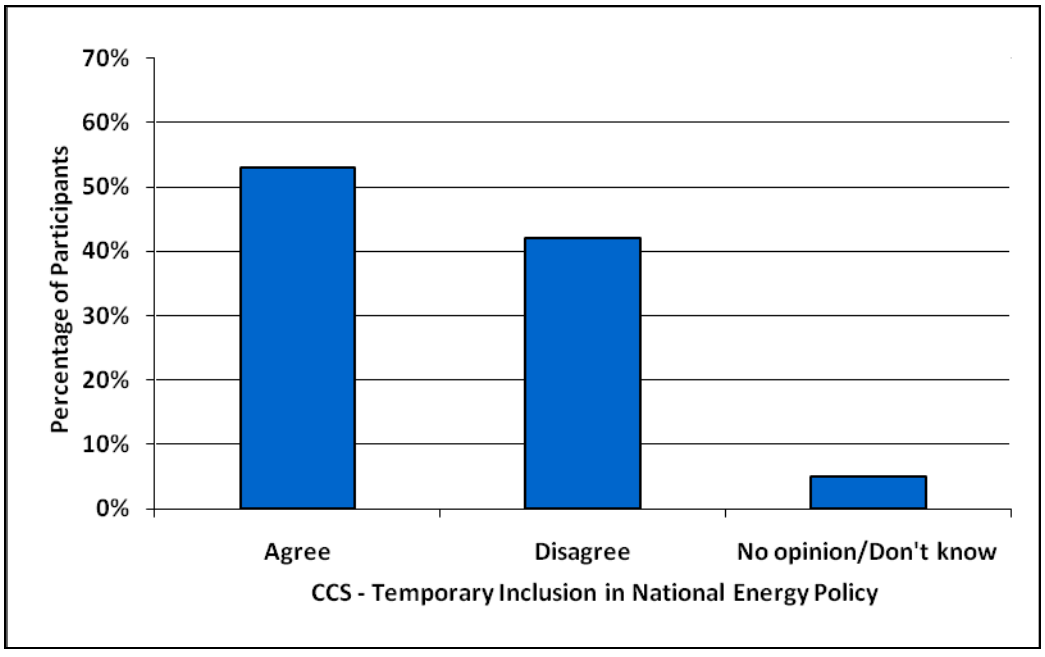


Figure 7: Percentage of participants requiring more information about CCS

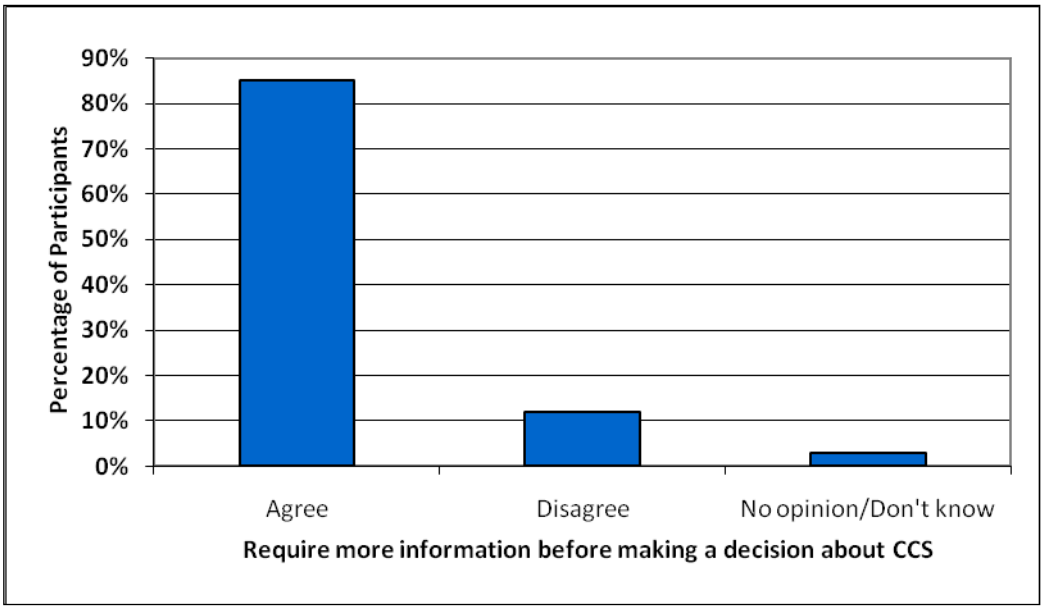
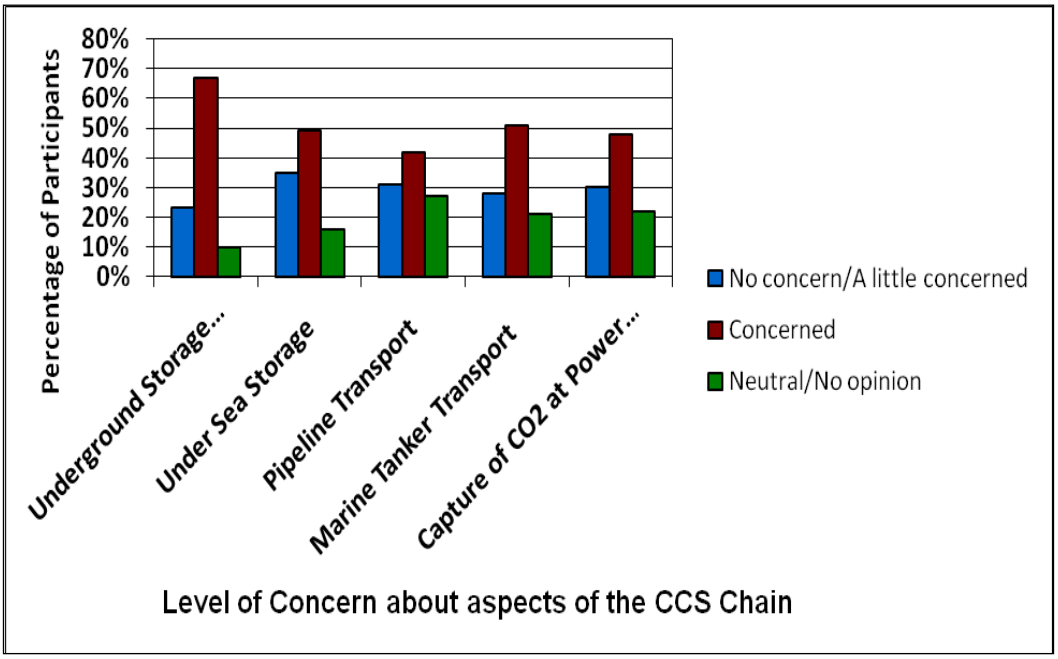


Figure 8: Level of concern about different stages in the CCS chain

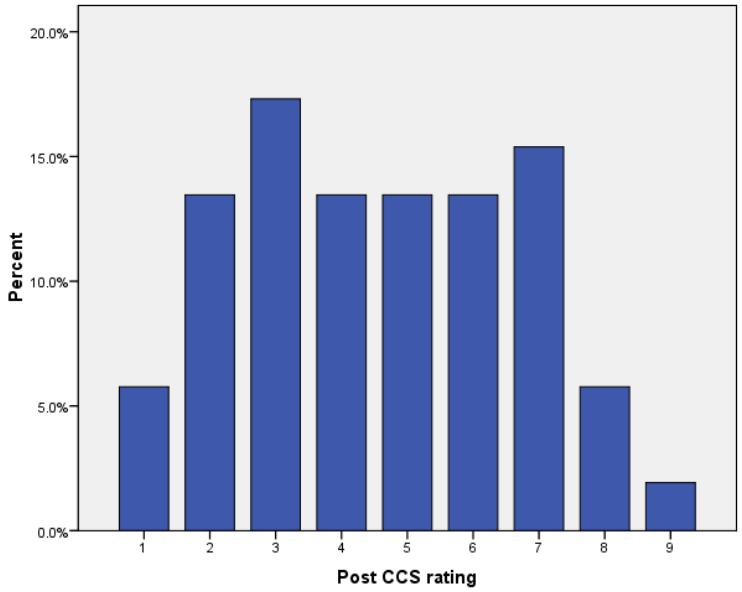


The post-focus group questionnaire supported one of the key messages from the focus groups, namely that a lack of trust in the institutions that would be tasked with implementing and monitoring CCS. Only 25% of the participants agreed with the statement: 'I think that our government can be relied upon to monitor and manage carbon dioxide storage in the long term', with 36% being neutral on this and 39% disagreeing. Trust in industry's capability was similar, with some 27% agreeing that 'industry can be relied upon to monitor and manage carbon dioxide storage in the long term', 38% neutral and 36% disagreeing.

A final question on attitudes to CCS then asked for an overall rating of the technology on a scale of 1-10, where 1 was the worst rating and 10 the best rating. The response (Figure 9) approximates a normal distribution, with a mode of 3, a median of 4.5 and a mean of 4.58, indicating a spread of opinion among the participants.

Figure 9 Overall end-of-focus group rating of CCS

(10 = highest positive rating; 1= lowest negative rating. N=57. Mean = 4.58)



Only a third considered that the focus group had provided them with enough information to decide whether CCS should be used within Europe (32% yes, 68% no). Cross-tabulation shows no strongly positive or negative association between participants considering that they had been given enough, or not enough information, and their rating of CCS. Rather, believing that not enough information had been given was associated with rating CCS in the relatively large range of 3-7 out of 10, i.e. either side of the mean. This may be again interpreted as a state of open-mindedness or uncertainty, compared to having come to a firm conclusion.

5. CONCLUSIONS

Overall, the focus groups confirm that many of the key findings of previous qualitative studies of CCS perceptions do still apply across several European countries. To reiterate: the general public are relatively unfamiliar with CCS, they have a preference for renewable energy over CCS; they have significant concerns relating to the risks involved with storing CO_2 and they lack trust in government or industry to make the right decisions about future deployment of CCS. In terms of international comparison and the influence of contextual issues, the difference in opinion between countries was minimal and many of the same issues occurred in all of the groups. However, there was some evidence to suggest that local contextual issues have some impact on perspectives even at this high level of discussion (i.e. in contrast to siting-specific opinion). For example, a gas pipe explosion in 2004 in Belgium made some of the Belgian participants nervous about transporting CO_2 through pipelines. The research also revealed that the cost of deploying CCS and plans for its relatively short term use may also be barriers to public acceptance. A further significant finding, though not wholly unexpected, was that not only do people have a very low level of understanding about CCS but, they have very little knowledge of the nature of CO_2. This appears to have played a major role in participants' thinking about CCS and contributed to a significant number of the participants turning against the technology. It is notable that this concern was more related to flammability and explosion than to asphyxiation.

In general, these findings are consistent with the increasingly popular discourse emerging from the 'risk society' literature, which suggests that the perceived risks of new technologies often have far greater potential to undermine deployment than risk as scientifically-determined. As Giddens (1999) argued: 'society is becoming more pre-occupied with the future (and safety)'. Consequently, people's initial response to a new technology or phenomenon is often dominated by concern. As Beck and Kropp (2007) note, today it is almost trivial to state that risk is a social construction. While this raises many questions about the nature of risk, which we will not address here, suffice it to say that risk perception has become culturally highly significant and that risk perception by the public has in many ways come to be more socially significant than risk in the probabilistic sense, as calculated by expertise (which is not to suggest that technical expertise should set the only terms of reference for decision-making in this context).

That perceived risks tend to have a major impact on public perceptions of new technologies has important implications for the development of communications strategies on CCS. The primary stimulus for the focus group discussions was (in our view) a relatively neutral DVD that explained the climate change problem, the challenges involved in producing low carbon energy and the CCS process. Although the participants did (in so far as observation permits) understand the DVD, this information also prompted them to ask further questions about the technology, to which answers were not accessible at the time. The focus groups were facilitated by professional facilitators

who, although provided with a common and pre-defined script, had little knowledge about CCS, and who were not expected to be able to answer environmental questions or correct CCS-related misconceptions as they arose. This created a relatively naturalistic setting resembling a real-world situation, in which people are exposed to information on a new topic and to others' variously-informed opinions. This is clearly very different to controlled psychological experiments, or to settings in which there is close moderation of discussion (as in, for example, a recent, as yet-unpublished citizens' panel study of public perceptions of CCS in the UK by Tyndall Manchester, involving experts who were available to answer questions as they arose - see Roberts and Mander 2010).

Studying public opinion in a relatively natural context (though admittedly not as natural as an ethnographic method would permit) has provided complementary information on the short-term evolution of public opinion on CCS following new exposure and on the particular ways in which concerns can amplify and develop in directions that to some extent involve misconception. While it should not be assumed that correcting these misconceptions would necessarily lead to public support for CCS, the research design has revealed the need to reinforce and supplement information provision with trusted and timely mediation and interpretation. This should in principle be possible in site-specific and generic communications contexts. More difficult, perhaps, is the identification of exactly who such trusted experts might be, given the diversity of the public and the limited number and backgrounds of people who can speak with authority on the subject. There is also the added complication of (to some extent inherent) scientific uncertainties relating to storage and leakage. Nonetheless, validation and confirmation of the general principle of the need for trusted and informed mediation of CCS messages, in addition to the observation that CCS-related public concerns are relatively generic and shared across Europe, remain the key contributions of this particular study.

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