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Deliverable 6.1

Carbon Capture and Storage Public Perception Factors: Literature Review and Open Issues

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Executive Summary

There are a lot of toolkits being produced to assist developers in devising public engagement strategies for carbon dioxide capture and storage (CCS). On one hand, this perhaps reflects the increasing number of demonstration projects that are or might be (depending upon whether political and financial commitments are met) coming to fruition and an even larger number of others that are in the planning stages, thus the increased need for practical, workable engagement ‘tools’. On the other hand, however, there is perhaps also a need to step back and think about what is driving the production of guidelines and toolkits in the absence of any consistent knowledge of the issue by the majority of our society. Toolkits pertain to a practical level to steps to be undertaken once decisions have been made: concerning CCS, in our society we are still far from this. On a general level society and the public are not even aware of the option of CCS, and when they are it is far from clear whether or not CCS needs to be adopted and at the pace advised from some stakeholders. At the level of governmental policies, in most cases, CCS is not yet integrated in energy planning; on a project level, a number of projects have met public consensus difficulties. Toolkits or guidelines might solve the problem of gaining consensus at the level of single projects, but how likely is this to happen and how can consensus be reached if our society has no definite position on CCS and the related environmental issues?

How can social science and the study of CCS public perception address this situation? Through evaluating existing literature on public perceptions of CCS and environmental issues more broadly, this review will identify key challenges and key approaches in the study of public perception of CCS. Following a brief review of public engagement toolkits, major CCS projects and key academic work into public perceptions of CCS, the review will discuss three main areas: values, trust, and context. The section on *values* is intended to set the scene for the discussion on trust and context, by arguing for a deeper consideration of the role that values play in shaping public perceptions.

The review then moves on to look at issues of *trust*. Once this idea of trust is ‘unpacked’, it is the assumptions upon which CCS sits that are of particular interest. That is, in order to ‘believe’ in CCS, publics have to buy into some rather large assumptions about climate change and the efficacy/safety of CCS, things that they cannot test empirically themselves. Trust is thus key in public acceptance of CCS, in particular publics’ trust in the experts who convey the message about CCS to them and sometimes make decisions on their behalf. Finally, *context* is explored. Publics rarely evaluate CCS in isolation, rather they consider the concept in relation to their own life experiences, histories and values. What is of particular interest here is the conceptual frameworks within which people make sense of CCS, that is, is CCS better made sense of in relation to climate change, energy production, pollution reduction or any number of other factors?

Toolkits are probably an effort to answer to the demand for solving (foreseen) public acceptance problems but producing toolkits is perhaps not addressing deeper issues (although of course for preparing toolkits some degree of social interaction, of research intervention, is needed – and thus also toolkits can contribute to building a social representation of the technology). We suggest that stepping back and providing people with the opportunity to

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interact on the very basis of reasoning of CCS can be more useful and helpful in developing the social process that enables society to make decisions.

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1. Introduction

This review is intended as a state-of-the art for Work Package 6 (Public Perceptions) of the EU-funded ECO₂ project. It forms Deliverable 6.1 for the project, and its core function will be to review relevant theoretical, methodological and empirical works pertaining to public perceptions of carbon dioxide capture and storage (CCS). CCS is a process for trapping the carbon dioxide (CO₂) formed by the burning of fossil fuel before it enters the atmosphere and storing it underground in rock formations. The reason for doing this is that CO₂ is the principal cause to climate change, which poses potentially serious (and, according to some, devastating) threats to people, wildlife and habitats worldwide.

Underpinning this review is an interest in the number of ‘toolkits’ that have emerged over the last few years for gauging public perception and building public engagement over CCS and low carbon energy technology more broadly. Whilst this is perhaps an indication of the number of actual CCS projects that are (or might be, depending on whether political and financial pledges can still be met in light of challenging economic conditions) coming to fruition, it also suggests this is a good point at which to take stock and reflect on how social science work into public perceptions of CCS can best be done – particularly in the absence of any consistent knowledge of the issue by the majority of our society (as confirmed by latest Eurobarometer report (ec.europa.eu, accessed 03/01/2012)). This review therefore aims to take a step back and consider the epistemological and methodological assumptions that might be bound up with producing a toolkit or set of guidelines. That is, what might the drive to produce very practical perception and engagement advice overlook in terms of how exactly the public perceive issues of climate change and transition to low carbon energy, and how might this way of doing research be linked to particular ways of thinking about how we ‘do’ social science research?

It is important to make clear that this does not mean this review is criticizing toolkits or those who produce them. Indeed, toolkits and guidelines can be extremely useful if used appropriately, and go a long way to offering practical advice for what are after all very real and very pressing issues. Toolkits, however, are probably an effort to answer to the demand for solving (foreseen) public acceptance problems but producing toolkits is not addressing underlying problems such as the lack of dialogue and public involvement in energy and CCS planning. We seek to highlight that stepping back and providing people with the opportunity to interact on the very basis of reasoning of CCS could provide useful experiences and information on how to support the social process that enables society to make decisions. Alongside the project of producing practical and applicable work, there is thus room to think about issues such as:

- how exactly do publics perceive issues such as CCS? On what terms (if any) do they talk about CCS?
- are researchers starting with the assumption that they know what kinds of issues publics and stakeholders are going to be concerned with?
- what theories and disciplines are we as researchers drawn to, and how might this affect our ideas on how to ‘do’ research?
- what assumptions about society are our preferred theories and methods based on, and what might happen if these assumptions were challenged?

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By doing this, the aim is to work towards appropriate critical reflection on the production and use of practical advice for public perception and engagement, so that when toolkits are called upon we can be sure they are the ‘right tools for the job’.

As well as giving an overview of key literature and projects pertaining to public perceptions of CCS, this review will thus also strive to delve into some of the theories and disciplines that might be helpful in conceptualizing issues of public perception. Following a brief review of public engagement toolkits, major CCS projects and key academic work into public perceptions of CCS, the review will discuss three main areas: values, trust, and context. The section on *values* is intended to set the scene for the discussion on trust and context, by arguing for a deeper consideration of the role that values play in shaping public perceptions. The key argument of this section is that, as recent practical experience has shown, public support or opposition is based on more than a balance of costs and benefits. Rather, it seems that publics’ perceptions of CCS are bound up with individuals’ and groups’ values, with their ideas of what an appropriate way is to use the environments they inhabit and what is an appropriate future trajectory for place, people and technology. The challenge this throws up for enquiry into public perceptions is to develop research strategies that can start to get under the slippery and elusive nature of people’s values, and to illuminate the ways in which CCS might sit within people’s much broader value systems.

With this in mind, the review then moves on to look at issues of *trust*. What is of particular interest here is unpacking the assumptions on which CCS sits. That is, in order to ‘believe’ in CCS, publics have to buy into some rather large assumptions about climate change and the efficacy/safety of CCS, things that they cannot test empirically themselves. Trust is thus key in public acceptance of CCS, in particular publics’ trust in the experts who convey the message about CCS to them and sometimes make decision on their behalf. At the same time, however, this review also warns against the dangers of making an automatic link between publics’ trust in people/processes and publics’ assessments of risk. That is, it is argued that instead of assessing the ‘goodness’ or ‘badness’ of CCS in terms of the risks it is perceived to pose, publics are perhaps more concerned with other issues such as the fairness or justice of the spatial distribution of any potential side-effects of CCS. The key upshot of this for public perceptions work is the continued need to take care not to enter the field of study with too many pre-conceived ideas about what publics are going to think or what they will be talking about.

Finally, the question of *context* is explored. As the previous sections suggest, publics rarely evaluate CCS in isolation, rather they consider the concept in relation to their own life experiences, histories and values. What is of particular interest here is the conceptual frameworks within which people make sense of CCS, that is, is CCS better made sense of in relation to climate change, energy production, pollution reduction or any number of other factors? The role that place attachment plays in affecting perceptions is also of interest, with people perhaps suggesting that the very notion of CCS jars – or in some cases sits well with – the history and character of the locale where the project is being proposed. Further, people express judgments and concerns through emotive expression. Careful attention to the concepts of practice and emotion thus has the potential to give analytical purchase on how public

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perceptions are formed through even very seemingly mundane actions and informal discussions.

Whilst this review does try to cover a wide range of ideas and thoughts from a range of disciplines and draw links between these, it is vital to acknowledge that this is by no means an inexhaustible guide to all of the literature available. There are always other ways of conceptualizing processes and ideas, and readers may well have come across similar ideas to the ones we discuss here, albeit couched in different language. Schwarz and Thompson (1990: 85) noticed this over two decades ago when reviewing different ways of conceptualizing thinking about energy, observing that “not one of these accounts refers to any of the others. They seem to have been arrived at independently and without any of the convergent pressures of mutual awareness.” Rather than attempting to provide an exhaustive review, then, what we prefer to do is to propose an approach that is consistent and coherent.

2. Summary of the available literature

Social research work carried out up to now has focused mainly on three areas: (1) surveys and interviews to detect public attitude (qualitative and quantitative); (2) case studies; and (3) production of guidelines and toolkits. A number of different approaches to the study of CCS public perception can be found in international literature (see, for instance, Ashworth et al, 2009; Bradbury et al, 2009; de Best-Waldhober and Daamen, 2006; de Best-Waldhober et al., 2009a, 2009b, 2011; Daamen et al., 2011; Itaoka et al, 2004, 2006, 2009; Reiner et al, 2007; Shackley et al, 2004 ; Shackley et al, 2005; ter Mors, 2007; Tokushige et al, 2007; Upham et al, 2011a; Upham et al, 2011b; Wallquist et al, 2009).

Depending on methods and strategies, it is possible to identify the following lines of research:

- qualitative research, focusing on interviews, focus groups and direct interaction (Shackley & Gough/Tyndall, 2002, 2005; Ashworth et al 2009; Bradbury et al, 2009; Upham et al, 2011a; Upham et al, 2011b; Wallquist et al, 2009; CSIRO Large Group Process, 2008/2009; Vercelli et al, 2008, 2010);
- research based on questionnaires in order to assess how communication of relevant information shapes people’s opinions (de Best-Waldhober and Daamen, 2006; de Best-Waldhober et al, 2009a, 2009b, 2011; Daamen et al, 2011; Ter Mors, 2007);
- quantitative studies based on statistical data analysis of questionnaires (Itaoka et al, 2004, 2006, 2009; Tokushige et al, 2007) ;
- analysis and meta-analysis of case studies (Ashworth et al, 2011; Desbarats et al, 2010; Dütschke, 2010; Feenstra et al, 2010; Hammond & Shackley, 2010) with the aim to design guidelines, toolkits and best practices to reach public engagement.

These research areas are summarised in Table 1:

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| Research area | Aims | Data collection techniques | Case studies using this approach | Key references |
|--|---|---|--|--|
| Qualitative research | Explore public perceptions and reasoning | In-depth interviews; focus groups; direct interaction | CSIRO Large Group Process; Tyndall Group Study in UK | Ashworth et al (2009); Bradbury et al (2009); Shackley et al (2005); Vercelli (2010) |
| Information choice questionnaires | Consider which kind of information forms most stable opinions | Questionnaires with information provided | Public acceptance of CCS in the Netherlands | de Best-Waldhober and Daamen (2006); Ter Mors (2007). |
| Statistical analysis of questionnaires | Explore which kinds of information correlate to positive perceptions of CCS | Questionnaires with information provided, statistical analysis of results | Public perceptions of CCS in Japan, nation-wide as well as specific sites in Tokyo and Sapporo | Itaoka et al (2004; 2006; 2009); Tokushige et al (2007). |
| Analysis and meta-analysis of case studies | Analyse early CCS projects to develop ideas about 'best practice' | Media analysis, stakeholder interviews, meta-analysis of event timelines | Ketzin/Beeskow in Germany, Barendrecht in the Netherlands, comparisons of global CCS projects | Dütschke (2010); Desbarats et al (2010); Hammond and Shackley (2010) |

(a) qualitative research based on interviews, focus groups and direct interaction

One of the key areas of enquiry into public perceptions of CCS has been the use of qualitative research techniques such as interviews, focus groups and direct observation and interaction. Such studies broadly seek to explore the ways in which people talk about CCS, how they tell stories about their relationship to the technology, and how they situate CCS within their broader life contexts. As this Work Package will be carrying out work in this vein (the reasons for this are given in Section 3), it is worth spending a little time reviewing the major studies to date in this area before going on to look at other areas of work into public perceptions of CCS.

-Bradbury et al (2009)/Wallquist et al (2009)

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To realize a CCS project, one of the main factors is community perceptions of technology. Bradbury et al. (2009) have identified the dimensions able to impact on the opinion construction of CO₂ sequestration, through focus groups conducted in three different areas.

The research has been conducted in three areas of the USA, geographically and culturally different: California's Central Valley; New Mexico; and Arizona and Ohio. The same protocol was created together by the three partners on the basis of existing studies, and it has been used in each area. Focus groups have investigated 7 areas: (1) societal concerns; (2) familiarity with climate change; (3) attitudes about potential climate change impacts; (4) familiarity with carbon sequestration; (5) reactions to carbon sequestration policy frameworks; (6) perceived advantages and disadvantages of carbon sequestration; and (7) attitudes towards potential safeguards to mitigate risks from carbon sequestration.

The Bradbury et al study criticizes literature that stresses risk perception. Building on socio-cultural theory and on the process of opinion shaping, the authors identify a number of key questions to build an idea about technology. These questions can be combined in three categories:

- How can we have a say in what happens? Who is in charge? Will the process be fair and will anyone listen to us?
- What will happen if something goes wrong? Can we trust the project developers and the government to take care of any problems? What have our previous relationships with these entities shown us?
- What is the benefit to our community? How does the proposed project fit into or improve our way of life?

In order to explore the perception of geological and oceanic storage, Wallquist et al. (2009) interviewed a sample of 16 subjects in Switzerland. Interviews have focused on what people think and believe about CCS, leaving respondents free to respond openly.

Before interviewing people, the participants received balanced information to avoid being influenced. With the aim of informing participants, some weeks before a 5 minutes video transmitted on TV about the Sleipner project was shown. Moreover, interviewers showed brief diagrams about the carbon dioxide production, capture and storage processes and a storage schematic plant. Furthermore, they explained that the storage will probably be at 1-2 km of depth under caprock in order to avoid leakage. Following this information step, interviewers asked to participants if they had heard about CO₂ capture and storage, allowing them to speak freely on CCS for about an hour.

Research showed results in line with previous studies. Interviewees consider climate change as a problem to fight, but they do not believe that CCS would be a reasonable solution, because enhanced CCS would disadvantage the development of alternative energies.

In conclusion the authors noted a greater focus on socio-economic risk compared to health and environmental risks. What marks the Wallquist et al (2009) work as different from other studies conducted so far is the attention shown by the respondents to the risk of earthquakes. However, this is perhaps due to the experience of this specific context, as since 2006 there has

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also been seismic drilling to test induced seismic phenomena in Switzerland.

-Ashworth et al (2009)

Ashworth et al. (2009) used a “large group process” in order to explore societal acceptance of energy technology and to assess the “large group” effectiveness for informing knowledge and changing attitudes. To this end, the researchers organized two workshops with a large group (up to 100 people) with general public. The workshops were organized in Brisbane and Melbourne.

On the day, workshop participants were assigned to different tables. Facilitators were organised to “host” each table of participants (6–8 people per table). These table facilitators were considered an essential component for enhancing each small group’s functioning by encouraging introductions, the discussions and attending to group process. At the start of the day, participants completed a questionnaire to assess their self rated knowledge and attitudes and collect the necessary demographic data. After this, table facilitators led small group discussions within their group around participants’ awareness of climate change and energy technologies. On completion of this discussion, an international expert in the field of climate change and energy technologies presented part one of the information session on climate change and energy. To ensure the material presented in this session was objective, it was collected beforehand through an advisory group comprising various stakeholders.

Then participants were asked to share their reactions to the information, their concerns and preferences for energy options, and also to identify what further information they felt was needed. Each group was given the opportunity to seek further information from the expert.

At the end of the day, participants were asked to fill out another questionnaire to assess changes in terms of knowledge and attitudes. As expected, CCS elicited the highest levels of uncertainty at the start of the workshop however, this decreased at the end. The workshop resulted in a large increase in those agreeing with the technology, with more than half the participants expressing some level of support for CCS, up from at the beginning of the workshop.

Participants’ key questions and concerns regarding CCS included:

- Have any studies been done on ways to use CO₂ emissions for practical uses thereby creating a recycling effect rather than just bury it?
- We need to know more about it before widespread application - Is it safe? What are the long-term effects? Is it a cover-up operation – will it give companies that invest in this technology the appearance of looking green without actually doing anything?
- CCS is not an answer but can be a bridge for other technologies. I thought it was bad but now I have changed my opinion.
- What is the payback period for building CO₂ sequestration? It brings jobs and progress but what is the effect on emissions?
- CCS is a pipedream; there is not concrete evidence of it working
- How far down the track is carbon sequestration? How soon can we implement it? How long can we use the special sequestration spots?

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Effectiveness of the workshop was identified by changes in knowledge and attitudes of participants, demonstrating how attention to the design of a ‘large group process’ can effectively contribute to the formation of knowledge and attitudes towards low emission energy technologies.

-Tyndall Centre

Some of the earliest studies into public perceptions of CCS were carried out by researchers at the Tyndall Centre (www.tyndall.ac.uk), under the aim of gauging early public perceptions of the then-emerging technologies. Gough et al (2002) used a focus group approach to explore the key public perception issues that came up in discussion, with the aim of thinking about CCS in relation to analogous technologies that generated strong reactions with the public. Whilst Gough et al found general support for CCS with these UK-based focus groups, concerns over the safety of CCS and over trust in the institutions overseeing CCS came to the fore. Shackley et al (2005) probed these issues further with a face-to-face survey and two ‘citizen panels’ conducted in Manchester and York. This research found that publics’ support for CCS increased slightly after being given information on the topic, however this was contingent of an acceptance of (a) anthropogenic climate change; (b) the need for deep cuts in CO₂ emissions; and (c) the presence of other mitigation technologies alongside CCS. Concerns about addressing safety issues again came to the fore.

-Vercelli and Lombardi (2008/2009)

A different approach has been adopted by Vercelli and Lombardi (2008, 2010), also stimulated by the general lack of knowledge about CCS, which introduces major limitations to more traditional lines of research. Aiming at facilitating the expression and detection of people’s thoughts and feelings regarding CCS, the work was focused on the direct relationship one could experience both with people participating to the pilot studies being conducted (with researchers, school children and a population living near natural gas emanations) and with other stakeholders present in the emerging CCS community. In this case, the interviews or other materials such as texts, drawings etc. were elaborated and considered not only in themselves but also as elements of the overall direct relationship between researchers and participants.

Vercelli and Lombardi believe that the perception of CCS will also be mediated by cultural schemes (Moscovici, 1961) rooted in people’s experiences related to social roles and education (Carli, 1987; Carli and Paniccia, 2003). Moving from these assumptions, and based on a psychoanalytic theory of mind functioning (Matte Blanco, 1975) which accounts for the conceptual and psychological interdependency of the researcher with the researched, Vercelli and Lombardi have explored the possible implications and intertwining of CCS perception with CCS communication. Perception of CCS will of course be heavily conditioned by the way it is understood, told, explained, communicated by those who are directly concerned with its study, development and implementation, included the social researcher herself. These studies have thus attempted to identify relevant dimensions in the relationship of different stakeholders with CCS through a systematic elaboration of the researchers’ relationship to them. Main findings, which indicate possible directions for further research, relate to

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- 1) dissemination of scientific information. Work with people in Italy living close to areas of naturally-produced CO₂ and research with primary school children showed the importance in dissemination of paying heed to the broader contexts within which CCS sits. That is, dissemination needs to pay heed to the political, social and cultural contexts that affect peoples' perceptions of CCS;
- 2) meaning elaboration processes. What this means is that effective CCS implementation requires a deeper understanding among publics of how single actions relate to much larger contexts such as climate change. Vercelli and Lombardi (2009) reflect on involvement in network joint research programmes in CCS, arguing that it is problematic to think about public 'acceptance' of CCS without considering how publics themselves conceive of climate change and the solution of problems. That is, what exactly does CCS *mean* to publics on their own terms?

(b) questionnaires to assess the views and knowledge of people after receiving information (ICQ)

Another area of research on communication and public perception is to understand how the information presented might influence the perception of CCS. This area of research uses ICQ (information choice questionnaires) to assess how the communication of information deemed relevant can build ideas and opinions, and influence people's attitudes towards a certain topic (de Best-Waldhober & Daamen, 2006; de Best-Waldhober et al., 2009a, 2009b, 2011; Daamen et al., 2011). The ICQ can be used with issues and problems that are not too complex for respondents, presenting only the information most relevant and on which there is greater agreement among the experts. Further, when people are given information about the issue, its consequences and potential solutions, it is essential that the information is valid and balanced.

ICQs have been used in recent years to investigate various issues relating to CCS. One of the first studies explored the attitudes that people might take after receiving information about the various technological options for using CCS (de Best-Waldhober & Daamen, 2006). The results showed people's misunderstandings about CCS and the favorable attitudes to the implementation of CCS they tended to form after receiving information. The authors share some concerns, however, about the interpretation of data from this study.

The earliest studies of this type considered only participants' opinions of CCS in isolation, not in comparison with other energy options. This issue was addressed in a subsequent study that compared CCS with other energy options for reducing CO₂ (Best-Waldhober et al., 2009a). Respondents were provided with information on seven technologies for the mitigation of CO₂. In comparison with other energy options, CCS enjoyed only limited support from most participants, although very few were completely opposed to it.

Furthermore, the results allow researchers to formulate hypotheses on the opinions of the public after they have been given complete information about the pros and cons, but these results do not allow current levels of support for CCS to be gauged.

Research by Daamen et al (2011) and de-Best Waldhober et al. (2009b) compares ICQs with other instruments used in research on social communication such as focus groups (Daamen et

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al., 2011). The authors of these studies argue that opinions formed through ICQs are more stable, consistent and robust than those formed through focus groups and traditional questionnaires (de Best-Waldhober et al., 2009b).

In general, all participants in the above studies who received information deemed important by experts using the criteria proposed by ICQ were shown to agree with the large-scale implementation of CCS. Although such information is a prerequisite in order to build an opinion on CCS, the research conducted with ICQs arguably does not take into account other factors involved in the construction of a favorable or unfavorable opinion, both individually and collectively, to CCS.

(c) quantitative studies based on statistical data analysis of questionnaires

Another area of work that has emerged with regard to analysing public perception of CCS is more quantitative work based on the statistical data analysis of questionnaires. Itaoka et al (2004, 2006, 2009) have administered public surveys in Japan concerning CCS, in both 2003 (Itaoka et al, 2004) and 2007 (Itaoka et al, 2009). The same questions were purposely used in both the 2003 and 2007 surveys. Paper surveys were administered in both Tokyo and Sapporo, and an online survey was available across the nation. Participants were selected at random to answer the questionnaires.

For the 2007 survey, several different versions of the questionnaire containing slightly different sets of information on CCS were used, the aim being to analyse the influence of the information provided on CCS (Itaoka et al, 2009). It was noted that public preferences for CCS seemed to decrease when information thought of as ‘neutral’ was provided, whereas groups provided with information on industrial or natural analogues tended to hold more positive views. Alongside descriptive statistics, path analysis was carried out on the data to identify key public perception factors. Itaoka et al (2009) identified these as: (a) risks and leakage; (b) effectiveness of CCS; (c) responsibility; and (d) fossil fuel use.

Tokushige et al (2004; 2007) similarly used statistical techniques to assess results gained from questionnaires, again considering how the provision of different kinds of information may affect public perceptions of CCS. They carried out questionnaire surveys with Japanese university students, designing their questionnaire on the basis that public perceptions of CCS would be influenced by five factors: risk perception, benefit perception, trust, perceptions of CO₂ geological storage and perceptions of global warming (Tokushige et al, 2007). Some respondents were provided with information on natural analogues, whereas others were given information on field demonstrations of CO₂ storage (participants were randomly allocated one kind of information or the other) (Tokushige et al, 2004).

Responses were analysed using confirmatory factor analysis, and changes in perceptions according to information supplied were analysed statistically (Tokushige et al, 2007). The authors argue their analysis shows that the factors they thought to be influential on perceptions of CCS do in fact explain acceptance very well, that perception of benefits was the key driver in determining acceptance, and that information on natural analogues greatly decreased risk perception (Tokushige et al, 2007).

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(d) analysis and meta-analysis of case studies

An emerging area in CCS public perceptions work is the analysis and meta-analysis of case studies. This sub-set of work continues to grow as early CCS projects and proposals begin to roll out. The aim of this kind of work is to design guidelines, toolkits and best practices for more effective public engagement, by evaluating the strengths and weaknesses of real-world engagement efforts. Two main strands to this kind of work can be identified: those that focus on one or a small number of case studies in-depth, and those that compare between many cases.

In terms of analysis focusing on one site, Feenstra et al (2010) and Brunsting et al (2010) explored the controversy over proposals for storage under Barendrecht in the Netherlands. The analysis of Barendrecht was carried out through interviews with key stakeholders involved with the Barendrecht case, through extraction of information from written resources, and through media analysis (Feenstra et al (2010)). Feenstra et al (2010) produced a timeline of key events in the Barendrecht case, using this to help their analysis. Recommendations about shortcomings in the engagement process were then made based on a combination of desk research and analysis of the empirical data.

Similarly, Dutschke (2010) looks at public perceptions of CCS over two different sites in Germany (Ketzin and Beeskow), and Meadowcroft et al (2011) analyse media reporting of the allegations of leakage on the Weyburn-Midale site in Canada. Key to such studies are the analysis of actual CCS projects or proposals and a focus on exploring why events played out in the way they did – often with the overarching aim of explaining how things may be done ‘better’ in future. Multi-method approaches are common in such studies, for instance Dutschke draws on media analysis, documentary analysis, in-depth interviews and site visits (Dutschke, 2010).

As for studies that consider a larger number of projects, Desbarats et al (2010) consider eight sites and cases spread across Europe: three in the UK, two in the Netherlands, two in Germany and one in Spain. The authors assessed communication materials and engagement strategies for each of the sites, using varying methodologies depending on what was deemed appropriate or possible for each of the case study sites. From this, recommendations for effective public engagement strategies for CCS were drawn, focusing largely on the importance of paying attention to local factors and the relationship between legislative issues and public perception. Hammond and Shackley (2010) reviewed a broad range of CCS projects from across the globe with the aim of synthesising thinking on public engagement and producing some broad guidelines for how all these ideas could be applied to the context of Scotland.

3. Summary of public perception factors

Public perception factors identified in literature up to now reflect a wide range of issues. Some of the main emerging themes include:

- a. Guidelines and/or toolkits to steer perception (the idea that developers and decision makers need to know what to do);

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- b. People think their own role is important, want to be involved (see for example the French case of Lacq where publics and stakeholders wanted to have direct interaction about the project, not through some representative association or similar (Ha-Duong et al (2010)));
- c. Transparency, honesty and fairness - values related to the process can be very influential for public perception of technologies and of CCS too.
- d. The whole issue of trust (characteristics of the different players, their history, history of the relationship with the public, etc.)

This Work Package will explore offshore storage as opposed to onshore activities. Much work to date has focused on issues associated with onshore CCS and there may be additional or different public perception factors pertaining to offshore storage. From the perspective of offshore wind at least, Haggett (2008) suggests that many public perception issues remain the same even when the technology is moved further away from publics. However, the health, safety and environmental implications of the possible leakage of CO₂ from sub-surface geological formations on- and off-shore would appear to be quite different and research is needed to clarify how public perceptions might differ between the two situations. The very small number of functioning CCS projects at present makes it hard to draw any substantive conclusions at this stage about how public perceptions of offshore CCS projects may differ to those for onshore projects, however we believe this is a key issue that requires attention as projects begin to roll out - as, indeed, is the possibility for publics' opinions of CCS more broadly to change over time as the technology develops and is deployed.

Further, people's perceptions of CCS might depend more on the association of CCS with something else – such as the continued use of coal for power generation to which some stakeholders and publics are opposed. This association could impede the potential role of CCS in reducing CO₂ emissions from other industrial sector emissions such as steel, cement, refineries, etc.

The research undertaken in this Work Package is intended as a research intervention into the collective process of understanding – that is, we aim to contribute to existing enquiry into how it is that publics come to understand CCS, building on this work to give a fuller picture of how people come to make sense of CCS. The research will be phased in a preliminary exploration of how people are at the moment making sense of the technology, through interviews with stakeholders and subsequent activities such as focus groups and the production of a short film. The aim of this is to find out more about how different inputs or interactive structures can contribute to the development of public perceptions and attitudes towards CCS.

Whilst doing this work, we will spend considerable time reflecting on the values that come into play when we as researchers engage in activities that entail interaction with publics. The implication of this is that we need to be careful to reflect on our own work, on the meanings it can assume for people and on the role of our institutions in shaping people's perceptions. We too need to pay heed as researchers to the basic values of transparency, honesty and fairness that are often discussed when relationships between publics and developers are explored.

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We aim to explore further the public perception factors found in the literature, assuming that the concept of *trust* will be a fundamental factor underpinning the characteristics of public communication activities, and that *context* will be a fundamental factor beneath the understanding of CCS in the global context.

To work towards this in practice, we will merge two complementary interpretative approaches:

- 1) A psychological one which will provide knowledge on cognitive and emotional processes that organize the way people make sense of CCS within specific relational and context conditions;
- 2) An approach drawing on sociology, science and technology studies and human geography which will provide knowledge on how people interpret content and organize arguments related to CCS, based on available theories that can be used to explain what we find.

To a considerable extent, these two approaches share many theoretical antecedents and are therefore based on similar theoretical understandings. Some overlap between the key principles of each approach is thus inevitable, however it is still perhaps useful to set out the starting points for each approach separately. The psychological approach to the study of public perceptions of CCS tries to understand public perceptions based on relationships, on how people relate to the theme and how we relate to them. Key facets of this approach include the ideas that:

- Perception is not “objective”;
- Social representations/cultural models organize the way we categorize reality (Moscovici, 1961);
- The way we categorize reality follows the rules of our two modes of mental functioning (symmetrical/unconscious and asymmetrical/conscious) (Matte Blanco, 1975)
- Social representations are ongoing processes;
- Social representations are generated by cognitive/emotional symbolization;
- Social representations orient our behaviour;
- Words we use (polysemia) provide a key entrance to the complex world of the generation and development of representations (Carli, 2002);
- The meaning of the words/discourse is revealed in the context;
- Relationships and contexts provide the framework for deciphering the meaning of words/discourse production;
- Working on texts produced within specific relations and contexts, insight can be gained on how people perceive the given issue.

The social science approach to the study of public perceptions of CCS that we will draw on here tries to understand how people’s perceptions are formed through social relations. Key to this approach is the idea that people do not form perceptions of CCS in isolation – rather, their perceptions are the product of the broader life contexts in which they live and the relationships with other individuals, groups and institutions that inform their thoughts. Some of the important aspects of this approach include:

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- People's perceptions are shaped across space and time;
- Issues can be 'framed' differently by different groups or individuals;
- It is often when framings of the same issue differ or don't quite match up that 'interesting' things start to happen;
- Perceptions are formed, challenged and/or reinforced in context – through discussion with other people;
- When people are dealing with new and/or unknown technologies, they tend to draw analogues to things that are familiar to them;
- People's perceptions are informed by embodied experiences – by the things they see, smell, touch and experience in their everyday lives;
- Seemingly 'irrational' anecdotal experiences or emotive expressions can often give great analytical purchase on what people's perceptions are and how they are shaped and negotiated.

4. Brief review of some key toolkits to date

Having discussed the theoretical principles underpinning our work package and the key areas of research into public perceptions of CCS thus far, we now turn to attempts to develop public and stakeholder engagement strategies in practice. The last few years have seen a proliferation of toolkits, guidelines and best practice strategies for engagement on CCS and low-carbon energy more generally. Some of the main examples of this kind of output include:

- **ESTEEM**: The ESTEEM Toolkit (www.esteem-tool.eu; Raven et al, 2009)
- **CSIRO**: Communication/Engagement Toolkit for CCS projects (2010), Commonwealth Scientific and Industrial Research Organisation (CSIRO). (Ashworth et al, 2011; Ashworth et al 2009)
- **WRI**: CCS and Community Engagement. Guidelines for Community Engagement, World Resources Institute, 2010. (WRI, 2010).
- **NETL**: Public Outreach and Education for CCS projects from the National Energy Technology Laboratory (NETL). (NETL,2009)
- **IISD**: Carbon Capture and Storage Communication Workshops, International Institute for Sustainable Development (IISD). (IISD, 2010)

(adapted from Hammond and Shackley (2010) and Breukers and Pol (2011))

It is worth noting that Breukers and Pol (2011) make a distinction between guidelines and toolkits. They see 'guidelines' as offering much broader, more generalized advice on the principles of engagement, and 'toolkits' as being much more focused and practically-oriented. (For instance, Ashworth et al's (2011) toolkit even includes sample advertisements that can be deployed to recruit participants). Breukers and Pol note that the WRI, NETL and IISD pieces are better classed as guidelines rather than toolkits. Alternatively, the distinction might be thought of as between products which provide precise procedural and behavioural indications (toolkits) at one end of the spectrum, and those which provide criteria that can be used for orienting processes and choices etc (guidelines) at the other.

Breukers and Pol (2011) found from interviews with developers that toolkits do not tend to be

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actively used, and that the implementing organizations are diverse. Breukers and Pol also suggest that a shared vision between partners and the internal alignment of vision are sometimes missing in the development of CCS projects. Nevertheless, Shove and Walker (2007: 766) argue that “(t)he very idea of deliberate transition management supposes some kind of orienting vision. In the field of environmental policy there is a tendency to assume that such an image exists and that it is defined and shared by a constituency of institutional actors.” When evaluating the efficacy of toolkits in gauging public perceptions and engaging publics, one must therefore question whether the idea of a ‘toolkit’ is even appropriate for every situation, and whether the notion of a toolkit (for some projects at least) rests on the assumption that different actors’ visions can – or even should – be aligned.

The very heterogeneity of CCS projects throws up all sorts of challenges for toolkits. Depending on who is ‘in charge’, different assumptions may underlie the project, and public perceptions may vary wildly (e.g. Dütschke, 2010; Brunsting et al, 2011). Alongside the project of producing very practical advice on how to gauge public perceptions and how to ‘do’ effective engagement through guidelines and toolkits, there is perhaps also room to take a step back and think about some of the broader processes surrounding public perceptions of CCS. Furthermore, given some of the assumptions that may be bound up with the production of a toolkit, it is perhaps also crucial to retain space to reflect critically on how social scientists themselves do research into public perceptions. For instance, what disciplines or theories do we as researchers subscribe to, and how might this affect the way we conceive of researching publics and the choice of research methods we make? Following a brief overview of major CCS projects and major academic public perceptions of CCS studies, this review will explore the themes of *trust* and *context* against the broad background of how perceptions of CCS may relate to people’s *values*.

5. Brief overview of CCS projects and research projects to date

Table 3: major CCS projects to date

| Case study, lead developer and project start date | Project type | Summary | Engagement Activities |
|--|--|---|---|
| Barendrecht, Netherlands, Shell. Project announced 2007. | Demonstration onshore CCS from oil refinery resides to hydrogen gasification plant | Local public opposition seriously impeded project | Early engagement was not followed by satisfactory provision of information, which caused major problems. Good engagement came later, but it was too late. |
| Greenville, Ohio, | Demonstration | Local opposition | Early |

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| USA, Batelle. Project announced 2007 | onshore CCS from bio-ethanol plant | stopped project | engagement, information gathering, public presentations, regular informal meetings. |
| Schwarzepumpe, Germany, Vattenfall. Construction began 2007. | Demonstration onshore CCS, oxyfuel. Storage site was not approved prior to capture project starting. | The oxyfuel and capture element had no opposition, but the capture site has been refused by local public. | Very little engagement. This was fine in the high trust/well known technology location; but not in the low trust/unknown technology location. |
| Lacq, France, Total. Announced 2007, began operating 2010. | Demonstration onshore CCS, oxyfuel. | Good engagement, good social fit, project went ahead as planned. | Open and transparent early engagement campaign, took all concerns seriously and dealt with all issues. |
| Ketzin, Germany, German Research Centre for Geosciences (GFZ). The project started 2004 and began injection 2008. | CCS pilot, onshore, research led. | Project went ahead as planned. Good social fit. | Early and comprehensive engagement. That developers were scientists was important for trust. |
| FutureGen, Illinois, USA, FutureGen Alliance. The competition was announced 2003, 2007 a winner was picked. | Commercial CCS, onshore, hydrogen gasification. | Communities competed to host this 'next generation' facility, and the \$2bn it brought. Mattoon, Illinois won. | Comprehensive early engagement in all sites, good information provision. As communities were self selecting, good social fit was more likely. |
| Weyburn-Midale, Canada, Petroleum Technology | Demonstration and research CCS and EOR project. CO ₂ | Running since 2000, long term data has been produced on CO ₂ | Very little information is available on engagement |

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|--|---|--|---|
| Research Centre (PTRC). Launched 2000. | from gasification facility. | behaviour and modelling. | activities. Very low population density and long history with oil and enhanced oil recovery (EOR) may account for this. |
| Peterhead, Scotland, Scottish and Southern Energy, BP. | Demonstration scale pre-combustion hydrogen power station, with offshore EOR (at Miller field) | The oil field was being decommissioned and the project relied upon a government subsidy which did not happen. BP pulled out of the project and the Miller field is now being decommissioned. | Early engagement at the pre-planning stage with council, local publics and interested parties were very positive, and media welcomed the project. |
| Carson, California, USA, BP. Project announced 2006. | Demonstration CCS onshore gasification and hydrogen power from petroleum coke with EOR. | Initial use of oil field below a densely populated area for EOR was abandoned in favour of an oil field site in a more rural area (Kern County). The official reason given was complications over the ownership of the field, though a local campaign against the storage plans may also have been a factor. | Extent of engagement strategy at Carson unknown, early and proactive in Kern county. Social fit is better in Kern county. |
| Milford Haven – Gloucester pipeline. Project began 2003, completed 2008. | 120 km natural gas pipeline, from Liquefied Natural Gas (LNG) terminals in Wales to end users in England. | Marred by safety concerns over the LNG terminals, opposition in three sites evolved, and issue became a political football. | Targeted and locally sensitive engagement was countered by the linking of national and local opposition groups, and modern safety |

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| | | | risks with historical grudges. |
| Rosspport, Co. Mayo, Ireland, Shell. Project announced 2000. | 90 km high pressure pipeline transporting gas from an offshore well to an onshore refinery. | Unsatisfied by safety evaluation and failed by democratic means, local concerns evolved into entrenched opposition. | Good quality engagement came too late, once opposition had become entrenched. |
| Gateway Gas Storage, Rampside Chesire, England, Stag Energy. Announced 2006, all permits obtained 2010. | Offshore gas storage in salt caverns, with onshore compressor. | Open and thorough engagement strategy, good social fit at the beginning of a new phase of developments contributed to a successful project. | Early engagement with stakeholders in pre-planning phase and public exhibitions stressing personal communication. |
| Saltfleetby, Lincolnshire, UK, WinGas. Announced 2006. | Onshore gas storage in a depleted gas field. | Local opposition due to greenfield site, dis-amenity and risk delayed project. Attempt now to gain permission from central government | Thorough engagement strategy including face to face meetings, public meetings and a citizens panel maintained cordial relations; but did not resolve dispute. |

(adapted from Hammond and Shackley, 2010)

Table 4: major public perceptions of CCS research projects (or projects with major public perception component) to date

| <i>Project title</i> | <i>Funding source</i> | <i>Research techniques</i> | <i>Case studies</i> | <i>Sample publications</i> | <i>Website</i> |
|----------------------|-----------------------|--|---------------------------|--|------------------------------|
| ACCSEPT | EU FP6 | Stakeholder workshops, large-scale stakeholder questionnaire | Pan-European stakeholders | De Coninck et al (2006); Shackley et al (2007) | www.accsept.org |
| NEARCO2 | EU FP7 | Surveys, focus groups, online | UK, Belgium, Netherlands, | Brunsting et al (2010); Upham and | www.communicationnearco2.eu/ |

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|------------------------------------|--------|--|---|---|---|
| | | discussion groups | Germany, Spain, Poland | Roberts (2011) | |
| SiteChar | EU FP7 | Surveys, in-depth interviews, media analysis, focus conferences | UK (Scotland) and Poland | | www.sitechar-co2.eu |
| CSIRO Large Group Process | GCCSI | Large group process – questionnaires, discussion groups | Australia (multiple site), Canada, Netherlands, UK (Scotland) | Ashworth et al (2009); Jeanerett et al (2011) | http://www.csiro.au/Organisation-Structure/Divisions/Earth-Science--Resource-Engineering/science-into-society.aspx |
| RISCS | EU FP7 | Questionnaire, targeted stakeholders | Norway, UK (injection sites); Greece, Italy, France (natural analogues) | | www.riscs-co2.eu |
| IEAGHG CCS Social Research Network | IEA | Knowledge sharing (n.b. not a project per se, rather facilitates sharing of public perceptions research) | Australia, Europe, USA, Japan and others | | http://www.ieaghg.org/index.php?/2009112027/social-research-network.html |
| ECO2 | EU FP7 | Interviews (experimental psychological techniques); discussion groups; ethnography. | UK, Italy, possibly Germany | | www.eco2-project.eu |

There are two social science literature areas which are of interest for understanding aspects of the study of CCS public perception: studies on values and on risk.

5. Values

Before proceeding to review literature pertaining to the issues of trust and context that the ECO₂ project will consider, it is useful to first of all set the context for current social science thinking on environmental issues. There has been in recent years a growing awareness of the role values play in shaping publics' perceptions of environmental technologies. In other words, there is an ever-increasing recognition that the way in which people perceive of things is a product of their whole life background rather than a simple balance of costs and benefits. Schwarz and Thompson (1990: 82-3) laid down this challenge for studies into energy, arguing

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that “we still need to think about what will happen when the hard scientist gets to work on something – the world’s energy future – that, of its very nature, is value-laden.” This section will set out some of the ways in which social science has in recent years sought to conceptualize public perceptions of environmental issues, laying the groundwork for the themes the following sections on trust and context will explore in greater depth.

(a) contemporary environmental debates and multiple knowledges

Luigi Pellizzoni’s characterization of contemporary environmental debates is a useful place to start when considering public perceptions of CCS. Pellizzoni (2003, 2004) suggests that contemporary environmental debates are marked by conditions of radical uncertainty, meaning that we cannot be certain about the spatial and temporal scales over which the effects of the issue in question will be spread. Pellizzoni also notes that contemporary environmental debates are characterized by the presence of many different ways of knowing and understanding the world (none of which are necessarily any more ‘right’ than the others), limited or non-existent public trust in ‘experts’, disagreement even among ‘experts’, and the potential for some conflicts to be so deeply entrenched as to be intractable. In this, parallels to the socio-cultural model of risk are clear to see.

Cases such as Barendrecht in the Netherlands (Feenstra et al, 2010; Brunsting et al, 2011) and Weyburn in Canada (Meadowcroft et al, 2011) illustrate that some if not all of the characteristics Pellizzoni identifies are applicable to public perceptions of CCS. The value of taking seriously the complexity of public perceptions of low carbon technologies becomes all the greater when one considers the links between CCS and climate change.

As Lynch (2008) puts it, there is the possibility for different ways of valuing the world to exist simultaneously in ways that may not be commensurable with one another. When considering public perceptions of CCS, then, it is important to remain open to the possibility that some publics or stakeholders may view CCS in ways that cannot be reconciled with those of others. By the same token, as researchers it is equally important to realise that the seemingly ‘irrational’ views of some people still need to be taken seriously, as they may be the product of a completely different way of thinking about the world.

Weber’s concept of world views (see Douglas and Wildavsky, 1982) is a helpful framework to conceptualize this idea. This notion of world views suggests that different people start with different assumptions about how the world is and form their opinions from there. Orr (1977), Goodman (1978) and Thompson (1984) (in Schwarz and Thompson, 1990), to name but three, take this idea into the domain of energy and natural resources, illustrating how differing conceptualizations about how the earth’s natural resources are distributed can lead to very real and practical forms of energy use behaviour (and associated policy prescriptions). In fact, Thompson (1984) even goes as far as to suggest that it is only very late on in the thought process that the idea of ‘energy’ is raised – most of the work that will determine one’s perceptions and actions has already been done by the world view one has!

What this means for public perceptions of CCS, then, is that some if not all publics’ opposition to, or support for, CCS is grounded in much broader issues of values and world views. People perhaps do not just weigh up the perceived advantages and disadvantages of a

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CCS project in isolation. Rather, they consider whether a project is ‘right’ or not in light of much bigger views they may hold about, say, what an appropriate way to treat the Earth is, how natural resources should be distributed or who has the right to decide how to manage a particular space. It is for this reason that Weston (1984) makes a division between values and preferences, suggesting that values run much deeper and are much more complex. Douglas (1992) too believes that people argue over different visions or notions of the ‘good life’, not the minutiae of a risk assessment.

Whilst the publication dates of some of the works cited above suggests that enquiry into values and world views is by no means a recent turn, it is a field of work that is still gaining traction. Indeed, in the context of science and genomics Wynne (2006) suggests that there is still perhaps an unchecked assumption that public concerns about ‘scientific’ developments are based in concerns over *risks*, and that the public can be brought ‘on side’ if there is better communication about risks. Wynne argues that this is almost a return to the much-maligned information deficit model, just as the same people calling for better risk communication are heralding the death of the information deficit model! The upshot of all this for study into public perceptions of CCS is perhaps not just to avoid assuming publics will be talking mainly about risk when they discuss CCS¹, but also to avoid making *any* overly-serious assumptions about how publics will discuss CCS before one starts empirical work!

Bielicki and Stephens (2008) indicate that more work needs to be done into the role that values play in conflicts over CCS, and McLaren (2011) mirrors Wynne’s concerns about focusing on risk by exploring issues of procedural justice underpinning CCS. Pendergraft (1998) suggests on the basis of survey results that the ideas of cultural theory can go some way to explaining how different responses to climate change may come to exist, and that exploring fundamental issues between cultures regarding perceptions of fairness and equity could be a useful step in conceptualizing non-coercive action against climate change. Empirically Feenstra et al (2010) on Barendrecht, Reiner and Corry (2011) on climate camps and Klimek (2011) on how Norway’s CCS plans are portrayed in the media all indicate that public perceptions of CCS run much deeper than a balance of risks versus benefits alone.

(b) epistemology and motivations for research

As alluded to above, issues of values and world views also raise pertinent questions about how we *do* research into public perceptions of CCS (or, indeed, any technology). Perhaps what public perceptions work into early CCS demonstration projects and/or proposals is starting to find out is that a toolkit or set of guidelines for public acceptance rests on the assumption that developers can ‘know’ what the public’s concerns are going to be. Toolkits and engagement strategies therefore run the risk of coming in with pre-formed ideas about what public perceptions of CCS are likely to be. As Wynne (2011) asks, are we presuming to know what the public is going to be concerned about and acting from there?

¹ This is not to say, of course, that publics will not talk about the risks of CCS. Indeed, the empirical work of Huijts et al (2007) and Oltra et al (2010) among others did indeed find that discourses of risk formed a major part of public perceptions of CCS.

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Although the development of engagement strategies lies outwith the aim of this work package, it is nonetheless still important to pay heed to the ways in which engagement processes can inform or even entrench public perceptions. For instance, Upham and Roberts' (2011) work with information films on CCS suggests that if publics start to believe that the aim of engagement is to convince them of a particular standpoint, then they are likely to turn against the proposal. It will probably be useful and important to put further effort into making explicit the different assumptions that lie within the development of toolkits/guidelines and related engagement strategies. Two orders of assumptions can be distinguished: those strictly pertaining to scientific methodologies (thus for example good communication tools rely on a number of theories etc); and those stemming out of specific motivations (answering to whoever is commissioning scientific work) and world visions (shared by specific groups or communities working on CCS).

This in turn raises two methodological challenges for public perceptions research in CCS. The first is simply – but importantly – to pay attention to the public engagement strategies deployed for particular CCS projects, and to consider how the nature of these strategies might act to re-form or reinforce public perceptions. The second is to strive to do research that does not approach communities with too many ideas about what public concerns about CCS are likely to be, but instead aims to unpack people's or communities' *values* and consider how these relate to perceptions of CCS. As Burgess et al (2000), Satterfield (2001) and many others show, however, values are very difficult to elicit and extremely challenging to form a full understanding of.

The fields of psychoanalysis, social psychology and discursive psychology offer helpful methodological tools for considering these broader processes within which people evaluate issues such as CCS. Potter (2010) explains that discursive psychology is a way of focusing on talk and text as social practices. What this means is that discursive psychology takes seriously the ways talk and text affect what people actually *do*. Rather than merely describing how people cognitively process, say, ideas of risk, the project of discursive psychology aims to look at how talk and interaction work within a person's broader life context to shape particular actions. Furthermore, Potter and Hepburn (2008) argue that discursive psychology can help to explore how knowledge and understanding are deployed, discussed and challenged in more mundane and everyday conversations. Given that empirical studies such as Oltra et al (2010), Terwel et al (2010) and many others all highlight the role that discussion with other people plays in shaping public perceptions of CCS, it would make sense to strive to build a fuller and more rigorous understanding of how exactly 'everyday' and 'mundane' conversation comes to inform publics' perceptions of CCS. In practice, this perhaps suggests a role for more ethnographic approaches to public perceptions of CCS, looking at how discussions over CCS filter down into everyday conversation and activities. Even if one does not elect to use the language and terminology of discursive psychology, the epistemological foundations it lays out in terms of foregrounding context, practice and action seem to sit well with the areas of public perceptions of CCS research that need to be explored.

Psychoanalytic theory also provides solid foundations for the exploration of the broad psychological and social processes that underpin the way people perceive and give sense to the reality they experience. In particular, the systemization of psychoanalytic principles of mental functioning proposed by Matte Blanco (1975) sets the scene for understanding the

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generative processes of social and cultural phenomena. It is in the proposed bimodal characteristics of the mind that the roots can be found for linking what appears, is explicitly shared and rationally recognized/able and what instead is there and nonetheless elusive, felt and determinant, but most often unaware. The link takes place through the social relationship with self and others, through its common elaboration making it explicit that “we” can gradually develop new meanings and representations. Social psychological theories such as the social representation theory of Moscovici (Moscovici, 1961; Farr and Moscovici, 1984) and motivational theories such as McClelland’s (1987), provide further theoretical input for understanding complex social processes and the interrelation between the cognitive and the emotional aspects of our perception, between individual and collective dimensions that produce a specific societal way to see a technology like CCS. Social representations are a system of ideas, values and practices providing individuals with a code for social exchange and for categorizing and naming various aspects of their world. Therefore, they facilitate communication and orientate individuals in their social world allowing them to master it. Representations are learned from the social context and, at the same time, are discursively constructed by individuals belonging to the context itself. Therefore representations are both the process and the result of social construction, constantly converted into a social reality while continuously being re-interpreted, re-thought, re-presented. Together, psychoanalysis (the modes of mental functioning), motivation theory (what drives behaviour) and social representations theory (how modes of mental functioning take form at social level) can provide an articulated framework of reference for devising interactive tools like interviews and focus or discussion groups and for analysing transcriptions or other textual materials (Carli and Paniccia, 2002).

To return to the question of how engagement may affect public perceptions, numerous empirical studies from outwith the field of CCS show the profound effects the nature of engagement can have on public perceptions of energy technology. What these studies also show is that publics and stakeholders are often keen to engage in discussion and that their opinions can play a useful role in evaluating emerging technologies. Haggett (2009) discusses public engagement over offshore wind, noting that fishing communities tend to prefer more informal engagement as opposed to the formalized deliberation settings usually put forward by developers. There is thus the risk that those preferring less formal engagement strategies may feel disempowered or disenfranchised – and thus are more likely to form negative perceptions – if the engagement strategy does not fit their world view, even if they are keen to engage in deliberation over the technology and its associated issues in the first instance. Cambrosio and Limoges (1991) see controversy or opposition as a form of constructive technology assessment, where looking carefully at why there is controversy or opposition can help to refine the technology in question (see also Rip (1987), Wynne (2002) and Genus and Coles (2005)). There is thus much value in thinking carefully about how to best engage publics and stakeholders, as effective engagement may help to build more positive relationships – and indeed may even help to contribute to critical assessment of the technology in question.

Adding further complexity to the challenge of understanding the impacts and/or effects of public perceptions are the multiple layers at which people may eventually take action (or not) should they make a decision about CCS. In other words, whilst there is a relationship between people’s perceptions of CCS, their deeper values and world views, and the actions they might

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take once they have formed a view of CCS, this is by no means easy to trace out. We want to understand public perception because it is relevant for understanding the issue of potential CCS impacts, and this understanding can in turn be useful for both stakeholders and publics affected by CCS. We assume that public perceptions can be studied in certain ways (that is, by appealing to certain theories, epistemological frameworks and techniques) and we can then make hypotheses about what people might do if they hold certain perceptions.

Reiner and Corry (2011) give a very strong illustration of this with their work on perceptions of CCS among participants at climate camps and NGO conferences. Reiner and Corry's work illustrates that CCS can, at base, fundamentally clash with some people's world views. What their study also illustrates, however, is that values do not always lead to similar courses of action – Greenpeace and climate camps are both values-driven, but tactically they are very different. The relationship between individuals' values and world views, and the views and values of the organizations with which they identify, must thus also be weighed up. Practically, Reiner and Corry also flag up some of the challenges of doing academic perceptions and engagement work with a diverse range of stakeholders, wryly noting the comment of one of their participants that 'anarchists never run to time' when evaluating how they did their field work.

Although the scope of WP6 is primarily perception as opposed to engagement, it is thus important to remember that engagement can feed back into perceptions – so to understand perceptions it is helpful to at least be aware of the effects engagement strategies can have. Additionally, whilst work that delves into publics' values and world views is by no means easy, there is no shortage of literature to suggest that getting under values is a worthwhile exercise. It is therefore important to devote time and energy to experimental methodologies that drive work in this area forward.

The quality of the scientific information that is disseminated beyond the scientific community may be partly related to the scientists own perception of their role in society (see Table 2). Those scientists who do not see it as their role to communicate to non-scientific audiences such as the public will be reluctant to spend time on such efforts. Yet, in a field such as CCS there is a need for expert involvement in communicating to stakeholders and the public. For instance, since CO₂ storage science is based on multiple disciplines' inputs, the willingness of researchers from different fields of research to discuss and integrate understanding can make a decisive difference in making explicit the meaning of knowledge and results. Such research integration, on the other hand, requires a considerable effort. Therefore the quality of information can improve when researchers recognize that their social role does not stop with producing the data but extends to making their meaning clearly understandable to non experts.

Whose role is it to provide the knowledge for society to make choices in order to solve environmental problems? Whose responsibility is it to unveil the meaning of that knowledge so that it is appropriately disseminated and interpreted? In the past decade or so, more scientists from many disciplines have come to take a clearer personal position towards serious problems facing society such as climate change. The claims of scientific objectivity and neutrality are sometimes at odds with these personal commitments. The way researchers, not just as individuals but as a community, will deal with these emerging needs and challenges might be very relevant for the availability and diffusion of critical information on

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environmental issues and in our case on specific aspects of the CCS technology such as safety, capacity, environmental impacts, etc.

| Table 2. The table shows how researchers view themselves and their role according to two different cultural models. | |
|--|---|
| Model 1 | Model 2 |
| 1. The researcher concentrates only on his/her field of expertise | 1. The researcher finds added value in interdisciplinary exchange and coordination |
| 2. Isolation (within specialty) | 2. Integration |
| 3. Somebody else takes care of how to use the knowledge that has been produced | 3. The researcher sees his/her own work as related to the scientific and social context |
| 4. Research meaning can remain implicit and/or confined | 4. The researcher is aware of the meaning of his/her own work for society, he/she feels the need to communicate it |
| 5. The researcher has to be objective and impartial, must not express his/her point of view | 5. The researcher is objective and impartial when clearly stating his/her point of view from a scientific perspective |

(adapted from Vercelli and Lombardi, 2008)

Concerning the collective processes of understanding and recognizing the meaning and role of CCS technology in our society, Vercelli's (2010) study with schoolchildren proved particularly interesting. Children were chosen on the hypothesis that their perception will be less heavily conditioned by previous knowledge and more open to new information. The activities and the relationship with the children, which continued over a period of two years, stimulated a more concrete motivation on their part to face pollution and climate change challenges and increased the consideration of one's personal potential in doing so. But what proved even more interesting was that the experience itself of finding new ways to communicate scientific information appeared to have started the whole process: in particular, the possibility to participate via an interactive context based on dialogue and enriched by everyone's participation and contributions. The context of communication can play a large role, therefore, in shaping how people will perceive a technology such as CCS. These findings will be taken into account when planning and organising research activities in this Work Package.

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7. A potted history of risk in the social sciences

Our research seeks to consider the contexts in which publics' perceptions of CCS sit and aims to avoid having too many pre-conceived ideas about the areas public perceptions may be grounded in. As Wynne (2006) believes, much science communication is still based on the (perhaps incorrect) assumption that publics are going to be primarily concerned with the techno-scientific risks of technologies.

We thus want to be cautious to avoid making too many links to scholarly literature on risk (or, indeed, any one field) at this stage. Nonetheless, it is important to briefly acknowledge that the concept of risk has informed, and continues to inform, much work on environmental issues and technologies to date. The differing conceptions of risk also stand as fine examples of how different assumptions about how society works can manifest themselves in very particular epistemological assumptions and research strategies. Furthermore, given this Work Package's focus on trust and context, it is interesting to note that with many technologies (CCS in particular) the idea of risk is more related to people or institutions than to technologies itself.

Different conceptualizations of risk lay different sets of epistemological foundations upon which studies of risk are based. In other words, the way one conceives of risk will affect the kinds of questions one asks and the way in which one goes about finding out about risk in practice. What follows is an extremely basic overview of some different conceptualizations of risk and their associated epistemological frameworks. It is vital to acknowledge that many variations exist within and between each conceptualization, and that academic disciplines may move between these frameworks. Lupton (1999) also acknowledges this, but suggests scholarly studies of risk can be divided into three very broad categories:

- The *cognitive science* approach is traditionally favoured by fields such as epidemiology, statistics, psychology and engineering. Epitomised by the work of Slovic (1987), this approach generally sees risks as objective entities that can be measured independently of social and cultural factors (but does acknowledge that social and cultural factors can distort these). Risks are thus the result of a cognitive process, meaning that humans 'calculate' risks within their minds. The epistemological framework that this approach favours is one that asks what risks exist, how they can be managed, and how people cognitively process risks;
- The *socio-cultural* approach tends to be favoured by disciplines such as cultural anthropology, philosophy, human geography and science and technology studies. This way of thinking follows the idea that although risks do exist independent from social and cultural processes, these risks are inevitably mediated by social and cultural processes and cannot be known in isolation from these. It can loosely be divided into the *risk society* and the *cultural-symbolic*. The *risk society* school of thought (Beck, 1992; Giddens, 1990) favours enquiry into the relationship between risk and the structures/processes of contemporary society, and into how risks are conceived of differently in various cultural contexts. Subscribers to the cultural-symbolic perspective tend to explore issues such as how some things come to be explored as risks and not others, what the context is in which risk sits, and how psychological and social processes work together;

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- The *social constructionist* approach holds that no risks are naturally-occurring, i.e. everything we think of as a ‘risk’ is only seen as such because social, cultural and historical processes lead us to think of it as a risk (Ewald, 1991; Hall, 1997). This way of thinking tends to be seen more in the fields of sociology of knowledge and the sociology of science and technology, or among ‘post-structuralist’ ways of thinking in the social sciences. The kinds of questions this approach may lead one to ask could concern how discourses and practices around risk work to ‘construct’ risks.

From this, it can be seen that under each broad perspective on approaching the study of risk in society, there are epistemological assumptions that rise out of the conceptualization of risk one has. In turn, there is the strong possibility that the way in which one does research about risk on any topic – including public perceptions of the risks of carbon storage – is contingent on the assumptions one subscribes to about the nature of risk. Opening up these epistemological foundations to critical scrutiny could reveal much about the extent to which the outcomes of academic study into public perceptions of CCS serve merely to re-produce the (perhaps not entirely correct) assumptions underpinning them.

It is perhaps important to acknowledge that risk is a big part of the CCS literature, and indeed much empirical work, has participants talking about risk – Huijts et al (2007) and Oltra et al (2010) both note participants’ concerns about the unpredictability of risk. Making the claim that risk is perhaps not the whole story of public perceptions of CCS is thus not to deny that risk does feature heavily in participant accounts. Despite the strong focus on risk in the social sciences, particularly with regard to environmental issues, it is however just as important to make clear here that risk is by no means the only lens through which public perceptions of CCS can be viewed. Wynne (2006) expresses concern that science communication still tends to start with the assumption that publics are going to be concerned mainly with the risks of scientific developments. The question of whether there is more to public perception than risk will be re-visited later in the review, with a particular focus on issues of fairness and justice. Thinking about assumptions underpinning research, we would also be interested in understanding *why* it is that developers/researchers/publics speak of risk, not the fact in and of itself.

8. Trust

(a) the framing of CCS and climate change

Broadly speaking, the project of CCS is usually proposed in the context of decarbonisation. In this perspective, if we do not accept that anthropogenic climate change is occurring and that CO₂ emissions have to be cut, then there is very little point in doing CCS. Indeed, as Oltra et al (2010: 698) note, “(m)assive reductions of CO₂ emissions from coal power plants and other industries are the key benefits of CCS put forward by its promoters.” Under this line of argument, the public’s view of CCS as a viable and effective low-carbon technology thus depends on the acceptance of a number of assumptions that most people cannot test themselves. For instance: (a) that climate change is taking place; (b) that we need to drastically reduce CO₂ emissions ; and (c) that CCS can be undertaken safely if it is done ‘properly’ (among many others). McLaren (2011) flags up the last of these points in particular

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as something that is often taken as a ‘given’ when developers engage with publics. Shackley et al (2005) argue, with reference to empirical work with citizen panels, that public acceptance of CCS depends on acceptance of anthropogenic climate change, the need for deep carbon cuts and also the belief that CCS is necessary to achieve this – by no means a small request.

At the same time, however, it is worth noting that carbon reduction is perhaps not the only justification for CCS. There is perhaps potential for CCS to be discussed in terms of climate change, enhanced oil recovery (EOR) or even the idea that CO₂ is a pollutant that should be minimized or managed in the same manner as other pollutants are. Indeed, we seek to remain open to the possibility that participants may have any number of ways of conceiving of the reasons for CO₂, and we hope to create an open environment where they can express these reasons freely. No matter what the grounds for CCS, however, questions about the assumptions that publics must ‘buy into’ and which people or organizations are trusted still hold.

It is important to note that ‘assumption’ as referred to above does not imply the acceptance or rejection of the science underpinning climate change. Rather, it primarily means that as the vast majority of people cannot for themselves ‘test’ that climate change is happening or that CCS can be done safely (due to the spatial and temporal scales, not to mention demands on finances and expertise, involved), they have to act on the ‘assumption’ that information put forward by the scientific community or other stakeholders is correct. Markusson et al (2012) neatly encapsulate this idea in the following diagram, viewing CCS as the ‘top’ of a pyramid with many layers which have to be accepted:

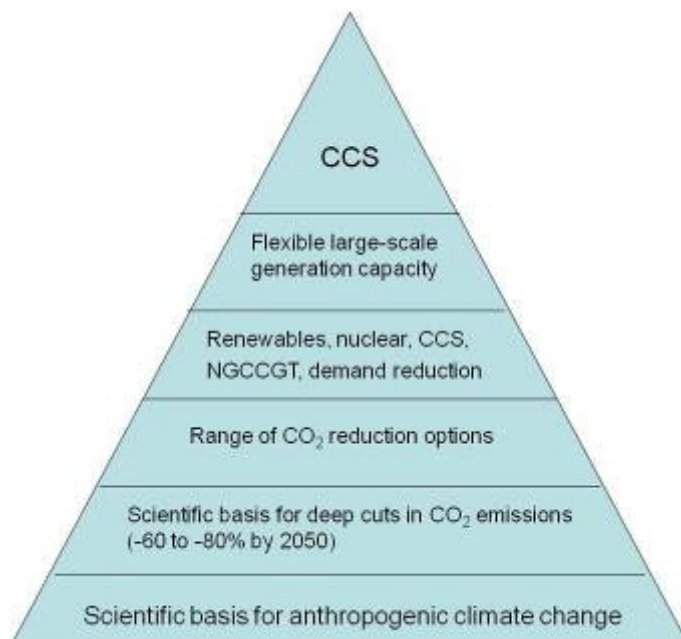


Figure 1: basis for public acceptance of CCS (Source: Markusson et al, 2012)

There is some connection here with the Edinburgh Strong Programme approach developed in science and technology studies (Bloor, 1976; Barnes et al, 1996), which holds that in

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explaining why a particular scientific theory comes to be accepted as true, social scientists should not try to look towards the objective ‘truth’ or otherwise of the scientific claims. Although the aim in this Work Package is to seek to understand how publics and stakeholders (not social scientists) come to form views of CCS, the idea of moving beyond a technical notion of ‘the truth’ as the legitimation for beliefs nonetheless still provides a useful lens through which to view public perceptions of CCS. That is, because it is so difficult for publics themselves to ‘test’ whether CCS is a viable or ‘true’ solution to the problems of climate change, their acceptance or rejection of CCS is unlikely to be based on the scientific and/or technical viability of the technology. In other words, because many publics are unlikely to possess an in-depth knowledge of the underlying science and technology, public acceptance of the technologies and theories is unlikely to be based on scientific merit. Rather, questions such as how the technology is presented to the public, how it is justified and whether or not the institutions behind it are trusted perhaps may well have much greater explanatory power. Indeed, Shove and Walker (2007) call for greater exploration into the cultural and political assumptions underpinning transition management strategies such as (arguably) CCS. This suggests that in order to build an understanding of public perceptions of CCS, work has to continue to be done into whether or not publics ‘buy into’ the assumptions on which CCS rests, and more importantly why they ‘buy into’ these assumptions or not.

Perhaps, then, what is needed from scholarly work into public perceptions of CCS is more enquiry into the extent to which the cultural, scientific and political assumptions underpinning CCS *are* actually accepted by the public. Particularly where policy is concerned – albeit in the realm of energy and fossil fuel extraction, Schwarz and Thompson (1990: 92) argue that “(w)ith the help of just a few large and largely unquestioned assumptions about how the world is, you can come up with a hard science estimate [...] that will clearly demonstrate that your chosen policy is far and away the best (perhaps, even, the only) one available.” This is not to say that decision makers and developers consciously marshal ‘assumptions’ in this way, just to say that it must be remembered that the rationales for many low-carbon energies rest on a series of assumptions about the trajectory the world and its climate are taking. What happens, however, if publics begin to question these assumptions, or even refute them outright in the first instance? Alternatively, what if publics conceive of debates over decarbonisation and CCS in an entirely different language to policy makers? In the following section, the potential for discourses of fairness and justice (as opposed to risk) will be discussed.

Whilst talking about the ideas that publics must take on board if they are to ‘accept’ CCS or at least form positive perceptions of it, it is important also to register the spatial and temporal aspects that must be reckoned with. The temporal scales on which climate change and CCS takes place (particularly the permanence of carbon storage) are much longer than the human lifespan, raising challenges in terms of envisioning future scenarios – not to mention, of course, the ethical issues surrounding responsibilities to future generations (Gardiner et al, 2010). The difficulties publics may have in imagining geological space can also shape perceptions, Feenstra et al (2010) suggesting in the case of Barendrecht at least that public opposition was further entrenched by misunderstandings over the depth under the ground at which carbon was stored.

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(b) publics and ‘experts’

‘Experts’ play a pivotal role in shaping public perceptions of any technology or environmental issue. There is no shortage of literature that problematises a simple distinction between ‘experts’ and ‘the public’ (see, for instance, Beck, 1992; Wynne, 1992; Pellizzoni, 2003), and Midgley (1989) suggests that what should be aimed for is for publics to be able to think critically, make their own decisions and challenge expert knowledge. Nevertheless, O’Neill (2007) reminds us that the public cannot – and indeed have no right to – be expected to be ‘experts’ on every aspect of every situation. O’Neill thus sees the issue for publics as knowing when they have to defer decision-making to someone else, and knowing who to trust to provide them with appropriate information.

Michael (1992) refers to this as a ‘delegation of responsibility’. Through exploration of public awareness of the dangers of radon gas in the home in south-west England, Michael suggests that in some cases, publics accept that they do not have enough expertise to decide a course of action by themselves, therefore they delegate responsibility to experts who advise them of what to do based on their ‘expert’ knowledge. On the other hand, however, one must also not overlook the possibility that publics *do* want to get involved with technical or scientific knowledge. Irwin’s (1995) concept of citizen science goes right to the heart of this issue of publics building their own understandings of scientific issues, and Wildavsky (1997) makes a similar point about how quickly graduate students were able to get to grips with the key aspects of a technical debate. Bennett and Smith’s (2007) analysis of a Scottish citizen’s jury on genetics and insurance further illustrates the risk of underestimating publics’ abilities to learn, take on and deploy for themselves new information.

The implications of this for public perceptions of CCS mainly concern publics’ perceptions of experts, and of ‘science’ itself. What is of interest is to explore further the extent to which publics delegate responsibility for making decisions about CCS to experts, versus the extent to which publics have a desire to get involved with the technical aspects of the discussion themselves. At the same time, of course, it must not be forgotten that ‘experts’ are not a homogenous group (Lynch, 2008), and the factors affecting publics’ perceptions of an ‘expert’ require further attention.

Another open issue here is the very provision of information itself. That is, how do publics perceive the very fact that they are being given information about CCS – a topic they have perhaps never heard of previously? If information is provided, there is the possibility for publics to think that there is the need to worry or at least think carefully about the implications of CCS, i.e. that its safety and viability is not taken for granted. On the other hand, a lack of information provision could equally be interpreted as deliberate secrecy, the notion that there is ‘something to hide’ or that developers do not want publics to get involved. Regardless of the content and nature of information presented to publics about CCS, then, the very act of giving information can shape particular public perceptions. These perceptions are then further informed by the aim and content of the information, which could take a number of forms such as giving people the knowledge to make decisions for themselves, providing information strategically to make CCS seem acceptable, or highlighting the technical risks/social injustices of CCS.

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(c) beyond risk?

A large amount of work on environmental technology and CCS more specifically to date has focused on issues pertaining to risk. Bradbury et al (2011) have produced thorough work on communicating the risks of CCS, and Oltra et al (2010) explore in considerable depth participants' perceptions of risk with regard to CCS. By contrast, Wynne (2006) expresses concern that science communication perhaps falls into the trap of assuming from the outset that public concerns about science will be based on risk alone. With this in mind, other factors besides risk that can influence trust and public perceptions of CCS warrant exploration.

Ashworth et al (2006) observe that perceptions of CCS are more positive when there is a climate of trust in discussions between experts and members of the public, and also when there is a perception that the public will be involved in the debate on CCS and climate change. Gross (2007) likewise argues – in the context of the wind farm planning process in Australia – that participants were more likely to view the outcome as 'fair' (whether they agreed with it or not) if they felt they had been treated fairly in the deliberation and engagement process. Both these examples illustrate that public perceptions of low-carbon energy depend not just on an assessment of the risks, but also on the chances publics perceive they have to voice their concerns. What this may suggest in the context of CCS – and is thus something to perhaps watch out for as demonstration projects roll out – is the potential for public perceptions to be less strongly negative if the engagement process is perceived as 'fair'.

On the other hand, and linking back to the preceding sub-section on publics and experts, is the possibility for sufficient trust to negate the expectation of a process as being fair and transparent. That is, if there is sufficient trust in the institution or individual behind the proposal to work out the 'best solution', then publics may not have any reason to expect the process to be fair and transparent. Porter's (1996) concept of trust in numbers explains this idea well, showing that calls for greater transparency in decision-making processes often come at the same time trust decreases. Dütschke (2010) discusses the perception of the Ketzin CCS project in Germany as being perceived as a government science project and thus something that was met with low opposition – in this, it can arguably be seen that as trust in developers (the German scientific community) is high, then the project is able to proceed with relatively little calls for discussion or transparency.

Allied to fairness is justice. Public perceptions of environmental issues may be affected by perceptions of whether the proposals at stake are just or not. Dobson's (2003) ecological citizenship model raises the possibility for citizens to act in certain ways towards the environment because they wish to see justice done. What Dobson is getting at here is that people may make or support environmental decisions that are not in their own personal interests because they wish to see justice done. Hayward (2006) further elaborates this idea by extending the concept of rights and responsibilities to ecosystems as well as humans. Hayward suggests that as well as having rights to derive certain elements from ecosystems (such as natural resources), people also have a responsibility to consider other humans and non-humans and act in a resourceful manner.

Whilst Dobson and Hayward both talk in largely theoretical terms about ecological citizenship, there is very definitely the possibility that publics do consider issues of justice

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when they evaluate environmental issues – CCS being no exception. Justice itself can take several forms, for instance spatial – Debanné and Keil (2004) explore the spatial aspects of water management in South Africa and Canada, raising the issue of more socially mobile communities having privileged access to water. McLaren (2011) considers some of the procedural justice questions that may arise with CCS, linking into the points above about fairness in process.

What is interesting to consider here is the ‘identity’ participants adopt when assessing and forming perceptions of CCS. Sagoff (1988) talks about a distinction between considering the environment as a ‘citizen’ in the public sphere and a ‘consumer’ in the private sphere, with different concerns coming to the fore depending on which identity one speaks through. When publics form and articulate their perceptions of CCS, then, there is a possibility that they may not be thinking about potential costs and benefits to themselves, but instead speaking as ‘citizens’ and basing their perceptions on the justness of the distribution of any potential negative effects of CCS. A good example of this notion of fairness can be seen in the Moray area of Scotland. The Moray region has a long association with the UK oil and gas industry, and also has significant potential for offshore wind generation and suitable geology for CCS. Nonetheless, Brunsting et al (2011) found that whilst most stakeholders were not outright opposed to CCS or renewable energy, they felt that the Moray area had already ‘done its bit’ for UK energy provision through the oil industry. Questions of perceived fairness and the spatial distribution of the ‘costs’ of CCS thus have the potential to affect public perceptions in areas that may have appropriate physical geography for CCS.

9. Context

(a) scale and agency

Gardiner et al (2010) suggest that the huge temporal and spatial scales involved in discussions over climate change make it difficult for people to make sense of climate change in relation to their own lives. To put it differently, the complexity of climate change discussions can make it very hard for publics to see an ‘audit trail’ between their own actions on one hand and these seemingly much bigger problems on the other. Given the points made in the previous section about the very big assumptions people have to buy into about climate change if they are to see CCS as a worthwhile pursuit, the effects of this apparent mismatch across scales could seriously affect public perceptions of CCS.

Shove and Walker (2007) suggest that what is needed in this regard is some kind of ‘illusion of agency’, something that gives publics the sense that their own practices are making a difference. Rip (2006: 94) likewise believes that “illusions are productive because they motivate action and repair work, and thus something (whatever) is achieved”. van Lente and Rip (1998) similarly discuss the significance of scenarios and expectations in driving forward technology, the idea that some kind of larger narrative or vision is necessary to give people something to strive for. Garvey (2008) offers an alternative explanation, putting forward the concept of consistency as a way round this challenge of linking up scales – people should act at smaller scales in ways that are first and foremost *consistent* with their values, beliefs and worldviews.

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The question that arises from this is thus one of how publics are led to trust that climate change is happening and that the activities of individuals and small groups have a part to play in its mitigation. What are the implications of accepting that people have to buy into the assumption that climate change is happening in order to view CCS as worthwhile? In places where CCS has been received favourably, it may be useful to try to get under the kind of ‘local repair work’ (Shove and Walker, 2007) that has been done to ensure publics follow the assumptions about climate change and CCS. In other words, what steps are taken to make visible the links between individual actions and global processes? At the same time, however, it is important to reflect critically on this distinction between the ‘local’ and the ‘global’ and not to treat these as different scales that can easily be separated out or viewed in isolation from each other. Indeed, Swyngedouw (2004) coins the phrase ‘glocalisation’ to reflect the intertwining of processes at different geographical scales. The challenge for this Work Package is thus to be sensitive to the ways in which seemingly localized arguments for CCS (such as job creation, continuing the narrative of a place or similar) might be couched in or linked to much larger scale discourses.

(b) ‘doing’ climate change mitigation

Watson (2011) argues for the importance of taking seriously practice in discussions over climate change. Watson puts forward the idea that as behaviours to mitigate climate change will ultimately have to be carried out by people doing things, it is crucial to explore how practices are shaped and – more importantly – how they can be changed. In short, how do people actually *do* climate change mitigation (including CCS) and how can their practices be informed?

Watson and Shove (2008: 70) explain that “theories of practice emphasise the tacit and unconscious levels of knowledge and experience through which shared ways of understanding and being in the world are established, through which purposes emerge as desirable, and norms as legitimate.” To put this bluntly, public perceptions are formed, reinforced and negotiated as people go about their daily lives. This sits well with the points made in the ‘values’ section about people viewing issues in light of their broader world views, the slight addition here being that perceptions are not only formed as a result of thought processes but also as the result of practices. The key question arising from this is, therefore: to what extent does CCS permeate people’s daily lives? And, conversely: how do people’s practices help to shape their sensibilities towards something like CCS? How might people’s practices inform their views on what, if anything, is an appropriate course of action to take to mitigate the effects of climate change.

Pragmatically, this focus on practice may also help to yield the biggest savings in energy consumption. Anderson et al (2008) are of the opinion that it is much easier and more efficient to make energy savings at the ‘demand’ side than the ‘supply’ side (though many other energy analysts would have a different perspective). Understanding people’s practices, and understanding how these can be changed in end users, may in turn lead to larger and quicker energy savings. It is important to note, however, that the case of CCS is perhaps a little different to the practical examples Watson and Shove (2008) and Watson (2011) propose. These papers deal with DIY and ‘everyday’ climate change behaviours respectively – things where publics can themselves take practical actions. Publics are highly unlikely to

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‘do’ CCS themselves, so the value of the notion of practice here lies perhaps in looking at the practices that lead to the formation of perceptions on CCS – discussing, campaigning, witnessing and so on.

Issues of time and trajectory are also key to understanding the acceptance of new technologies and practices (Shove and Walker, 2007). Schwarz and Thompson (1990: 92) hold that “what we do today largely depends on how we interpret the past, and our interpretation of the past will, to a considerable extent, be shaped by the futures that our desires have already created.” CCS is no exception here, and its perception by publics is likely to depend on the trajectories of technology and place that have gone before. Bradbury et al (2009) see past experience as an important aspect of community perspectives on CCS, noting that if people have been treated unfairly in the past they are less likely to be amenable to something like CCS. O’Neill, Holland and Light’s (2008) exploration of the narrative trajectory of place similarly sees the resolution of debates over the future course of activity in an area as being something that may be worked out by weighing up the narratives that have gone before and deciding what is the most appropriate way forward in light of these trajectories.

In other words, place – and people’s relationships to place - matters. Bickerstaff et al’s (2002) exploration of public responses to the foot and mouth crisis in Devon found that publics’ concerns were often grounded in the sense that what was going on was somehow unnatural or ‘out of place’ for the area. Bickerstaff and Walker (2003) in turn argue that positions or standpoints that may seem irrational can often be explained when one situates such viewpoints within the context of the relationship to a particular place. What this might mean for CCS is that public perceptions may be more positive in areas where there is a history or narrative trajectory that sits well with the idea of CCS – for instance, a history of the sea as a provider or a history of natural resource extraction and dependency. Whilst O’Neill, Holland and Light do concede that the narrative trajectory model may not be appropriate for more complex issues such as climate change, it is a useful heuristic tool to conceptualise the more localized debates going on within climate change discourse such as the siting of CCS.

Nevertheless, Geels and Kemp (2007) observe that trajectories can take years to unfold, and Shove and Walker (2007) believe that trajectories may be too complex or fragmented for decision makers to respond to or ‘manage’. This suggests that the concept of narrative trajectories is of limited value if the aim is to engage with communities and shape opinion. As a means of *understanding* how existing perceptions have been formed and how future perceptions might pan out, though, the idea of narrative trajectories still has significant explanatory power. Building on the challenges laid out in the ‘values’ section, a methodology that can start to identify narratives of place and technology and link these in to public perceptions thus seems useful.

(c) senses and emotions

People’s perceptions of CCS might also be shaped through embodied experience. Irwin’s (1995) idea of citizen science emphasizes the way people come to form their own understandings of processes and of potential risks, looking in particular at how embodied experiences shape public understandings. Irwin gives the example of residents living near to a chemical works in England to show how sensuous experiences – in this case smells perceived

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to come from the works - led to understandings of safety and environmental effects that were at odds with official accounts. Wynne (1992) similarly considers – with reference to Cumbrian sheep farmers post-Chernobyl – how embodied experience can shape understandings of environmental effects that are very much at odds with ‘official’ discourses.

This is something that will be especially important to pay attention to as early CCS projects start to ‘roll out’. The case of the Kerr Farm on the Weyburn-Midale demonstration site in Canada (Meadowcroft et al, 2011) stands as a strong example of how members of the public can, through their own experiences, form their own conceptualizations of how ‘safe’ or ‘right’ a CCS project is. These fragmented, partial and yet still valuable embodied experiences people have can be pivotal in shaping their sensibilities towards a particular technology. Whilst the small number of CCS projects already in operation makes it hard to gather empirical data on the role of the senses in shaping public perceptions of CCS, these sensory accounts are something that will have to be taken very seriously if a full understanding of public perceptions of actual CCS projects is to emerge.

Sitting alongside the above point about the taking seriously of sensuous experiences of technologies is the role of emotions. Social science, in particularly human geography, has in recent years started to give more credence to the emotional and affective aspects of deliberation. Cass and Walker (2009) argue for the significance of emotions in environmental deliberation, holding that emotions are all too often dismissed as ‘subjective’ or irrelevant. Cass and Walker believe that the emotional judgments people express are just as important as more seemingly ‘rational’ arguments put forwards such as risk, safety or economics. Indeed, in keeping with Douglas’ (1992) view that what people are discussing is differing notions of ‘the good life’ rather than the minutiae of a risk assessment, it could be argued that looking at the emotions people display when discussing something like CCS is a good way to ‘tap in’ to the slippery values and world views (Weston, 1985; Burgess et al, 2000; Satterfield, 2001) that shape their perceptions.

Useful interpretative tools here are the concepts of emotion, affect and atmosphere. These concepts offer the potential to give much analytical purchase on how people’s perceptions of CCS are shaped in practice, in particular the ways in which people’s values and world views play off against cues from the world around them. Askins (2009) offers a clear definition of emotion and affect, noting that *emotions* are what she feels and *affect* is what intensifies her response or her capacity to be affected. What is key in this is that the nature of the context one is situated in has huge potential to shape (or affect) one’s response to an issue. As Thien (2005) puts it, affect is the ‘motion of emotion’. The question that arises out of this, then, is perhaps: where people come to express very strong views for or against CCS, what are the things that have set these views in motion and caused them to be magnified? Getting under this could be a useful step in further understanding factors affecting public perceptions of CCS.

Also helpful for considering how emotion and affect work in practice is the idea of *atmospheres*. Anderson (2009) suggests atmospheres are a space of tension in-between, somewhere that emotion and affect merge – it is through atmosphere that emotions are informed by affects. Anderson argues that it is through an atmosphere that a represented object will be apprehended and take on a certain meaning – so it follows that it is through an

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atmosphere that publics will view CCS, and it is through this atmosphere that CCS will come to take on a certain meaning. As with emotion and affect, illuminating the links between atmosphere and meaning could go some way to furthering understanding of how public perceptions of CCS are formed, shaped and negotiated.

In terms of how emotions might play out in particular places, in the context of other energy technologies such as wind farms and electricity pylons Devine-Wright (2009) sees a focus on place values and place attachment as being more helpful than traditional NIMBY models of explanation. Devine-Wright argues that opposition to energy developments can be better understood in terms of disruptions to emotional attachments to place and to place identity processes. Devine-Wright and Heath (2010) study opposition to offshore wind farm proposals in North Wales, noting the disjuncture between perceptions of places represented in terms of scenic beauty on one hand and 'industrial' wind farms on the other. Whilst Devine-Wright and Clayton (2010) believe that the multiple levels of specificity and scale involved make a monolithic framework for exploring the links between place, identity and behaviour impractical, they do call for greater methodological and conceptual integration on these issues.

To attempt to take these ideas into the context of public perceptions of CCS, after accepting that we need to take seriously the role of emotions and associated place values in environmental decision-making (and cases such as Barendrecht show that people's emotive judgments can have serious and profound effects on the success of a project), we therefore need to think about how these emotions are formed and intensified in context. Ways in which this could be done in practice may include considering the nature of public information events, exploring the arguments people put forwards when discussing CCS with one another, or thinking more broadly about how the notion of CCS fits into narratives of place, place identity and place values. In this WP the two interpretative approaches mentioned above will both explore emotions through the study of narrative and relational dimensions produced or created by different stakeholders when considering and interacting about the CCS technology.

The complexity of emotional, affective and contextual issues surrounding publics' perceptions of CCS requires careful, intensive and sustained study. This is a huge challenge for any toolkit or set of guidelines, in that it is very difficult to imagine the whole range of emotions researchers may come across, and/or the challenges publics face in imagining future scenarios at much bigger temporal and spatial scales than their own lives. Rather than attempting to provide some sort of protocol for dealing with the full range of emotional issues that may be encountered, what we would instead suggest is that when preparing a toolkit, one should provide clear explanations of how crucial it is to understand the emotional scenario and emotional dimensions of public views on CCS. With this should also come a reminder about the importance of having people with experience of researching emotions and place attachment, who can advise on the specific factors affecting each project.

10. Conclusion

Understanding of the social aspects of CO₂ storage potential impacts easily appears as an issue of risk and indeed risk emerges in social science research on CCS and in people's arguments. Bradbury et al (2011) and many others before them have discussed in depth

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different ways to think about public perceptions of risk: spanning from a concept of objective to one of subjective and to a totally constructed idea of risk. To this, however, we could add that a focus on risk as a determinant of public acceptance of CCS perhaps overlooks - or at least downplays - the significance of a whole range of additional factors that can influence public perceptions of technology.

This review has flagged up questions of the role of values, conceptions of justice and/or fairness and emotional/embodied experience among others as examples of these additional factors. Indeed, empirical studies to date do suggest that whilst risk *is* indeed a major factor informing participants' discussions and perceptions of CCS, it is by no means the only factor. Risk is but one of several frames through which participants can build and negotiate their perceptions, and one could argue that an over-zealous focus on risk from the outset could result in the formation of perception and engagement strategies that rest on the assumption that publics are going to be concerned about the risks of CCS.

The review started by laying the ground for what follows with an exploration of questions of values. It was suggested that perceptions of CCS perhaps go right into people's world views and values, and cannot be reduced to a mere cost-benefit exercise. This raises two key challenges for research. The first of these is to think through methodologies and techniques that can start to tease out people's values and the links between values and CCS; this is no mean task given the slippery and complex nature of values. However the philosophy behind discursive psychology has been suggested as a useful way to link up people's talk, actions and broader thought processes. The second challenge is to reflect carefully on the values that are bound up with researchers' preferred theories and methodologies. What this means is to allow space and time to think through the way the theories we as researchers subscribe to see society, what kinds of data collection and analysis techniques these might lead us towards, and what types of conclusions we might draw out as a result. In other words, attention needs to be paid to the assumptions about 'the public' and 'society' that are inherent in different epistemological approaches, and to what might happen if the kind of society we meet in the real world does not match the one our theories expect to find.

Trust and context were then explored as two main areas where values play out. Building on the notion of assumptions running through the values section, the assumptions publics must 'buy into' in order to see CCS as a useful and fruitful exercise were questioned. CCS is being proposed at the moment in the context of climate change mitigation - from this perspective, for publics to be on the side of CCS they must trust the assumptions that climate change is taking place, that decarbonisation must happen, and that CCS is a safe and effective way of doing this. As publics cannot prove these things for themselves due to the demands on time, finances and expertise involved, they must trust that these underlying assumptions are correct. Nonetheless, in keeping with the aim of this Work Package to create an 'open' space for participants to be able to discuss CCS freely, it will be crucial to remain open to the possibility that publics and stakeholders may conceive of CCS in very different terms other than climate change mitigation.

Similarly, the issue of publics' relationships with experts was explored, especially the question of whom publics trust to deliver information on issues they cannot fully understand, and who is trusted to make decisions on behalf of publics. This in turn throws up questions of

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public involvement in deliberation processes, and flags up the potential for public perceptions of CCS to be grounded in the fairness or justice of the planning process rather than an assessment of the risks involved.

In terms of context, different contextual scales shaping perceptions were discussed. This in itself raised one of the biggest questions running through climate change social science literature at present, namely the challenge for people of linking up their own everyday experiences with much bigger and broader discourses of global climate change. The theory of practice was explored as a means of thinking through how broader discourses manifest themselves in everyday life, that is, how do people actually *do* climate change mitigation? In a similar vein, the significance of place in shaping feelings – both positive and negative – towards CCS was noted. Place values can trigger strong emotional responses in people, and conversely can also perhaps help to envision CCS as an appropriate trajectory. The importance of taking seriously the body, and the embodied experiences of technology in place that people have, was flagged up as something that will have to be given particular attention as early CCS projects start to roll out. How does one start to account for the anecdotal, fragmented and embodied accounts that people might use to form their assertions that something is ‘not right’ with a place as a result of the commencement of carbon storage? Whilst beyond the scope of this review and this Work Package, careful consideration of the ways in which people actually practice climate change mitigation and how their concerns are informed by sensuous, embodied experience could feed into understandings on how better to carry out engagement work.

Alongside this, as researchers we too need to reflect critically on our backgrounds, contexts and practices. To which schools of thought do we subscribe? How does that affect how we do our research? How in turn might that affect the kinds of results and outputs we get? What might happen if some of the assumptions on which the public perceptions work we do turns out to be more problematic than we thought? These are by no means easy questions to answer, but taking time to think through the epistemological foundations on which our work rests could – if not giving a fuller picture of the worlds our participants inhabit – at least make visible some of the inconsistencies, silences and slippages and allow these to be accounted for or worked round.

Lastly, it is worth reiterating the value of this work, particularly given the very real and pressing nature of climate change and the urgency with which workable solutions may have to be implemented. To return to Schwarz and Thompson (1990: 101), they argue that “(t)he deep reality that cultural theory enables us to get to grips with is our diverse involvements in the one world we all inhabit.” In other words, there is one ‘real’ world out there, but people imagine and understand it in different ways, and these different understandings can lead to different courses of action – which can have very real effects. McShane (2008) suggests – in the context of environmental philosophy - that getting clear what matters and why, will help with some of the difficult decisions that lie ahead, and whether it is with CCS or another low-carbon energy technology, the likelihood is that as energy issues increase in magnitude in coming years, so too will the proportion of the public directly affected by the decisions that have to be made. Taking time now to reflect on how exactly publics’ perceptions of energy technologies are shaped, what publics’ concerns actually *are* and how these issues play out in

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practice can help to ensure that time and energies are directed to the most appropriate areas in some of the very pressing challenges that lie ahead.

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