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Deliverable 6.3 – Identified public perception factors

Core factors and processes in the public perception of CO_2 geological storage: the ECO_2 study on the Italian and UK contexts

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Executive summary

Research has been conducted in the ECO2 project to identify the core factors and processes which determine the public perception of CO_2 geological storage, attempting to advance the state of the art by investigating in-depth psychological and psychodynamic dimensions. The aim was not only to build upon previous work to describe and explain the present representations of the technology, but rather to try to identify the constitutive elements that influence them. To this end, different methods and approaches were used in Italy and Scotland, from Emotional Text Analysis to the Voice Centred approach, from psychodynamic elaboration to cognitive approach analysis.

The widespread situation in Europe and internationally, which finds people having a low awareness of the technology, was confirmed in both countries studied, as was the common difficulty in getting acquainted with CCS. The distance that people feel from the topic, its technological characteristics, the plans for its inclusion in emission reduction strategies, and the projects for its implementation seems to be the most important determinant of public perception. This is not only related to a lack of knowledge, background or awareness but also to the remoteness of a technology which cannot be directly perceived and whose justification is related to themes, like climate change, which appear to be rather confusing for many people.

However, moving beyond the core feeling of a lack of connection to the topic, different reactions were observed in the Italian and UK contexts, also in relation to the different research settings. In a listening and empathic context where people can interact with experts the proposition of CO_2 storage as a topic raises interest, as was the case of the Italian focus groups, and relates to many aspects, that involve not only the technology and its safety but also ecologic, economic, political, societal and educational issues. Instead when people are presented with a variety of themes for discussion under the banner of the need for deep carbon cuts, a situation which is much nearer to reality, they will not choose to focus on CCS, as the experience of the Scottish panel indicates. They prefer to focus on themes or technologies which are smaller-scale, more tangible and within the realm of socio-technical experience since these technological systems appear more relevant and interesting and ones that they feel they can act more easily upon (i.e. have agency in relation to) (domestic energy efficiency and district heating systems are examples).

People develop an interest in the technology when they are given the space and time to explore it. A dedicated context and relationship with experts helps develop impressions and ideas as well as explicit questions and doubts. This kind of process, which produces an 'informed public', as experimented in the ECO2 project, can be of great benefit for researchers trying to understand perceptions and for all stakeholders wanting to better comprehend what is relevant for the population and how these needs can be met. However, it is important to be aware that interest in the technology is not spontaneous and this, in turn, implies that most people, unless facilitated, will use quick forms of reaction and thinking and possibly discard the idea without ever properly considering and analysing it. This specific condition for CCS apprehension, needs to be taken into account as an important factor that influences public perception and it should direct communication efforts to finding effective (and scientifically sound) messages that could appeal to quick and intuitive forms of thinking.

Generally, themes that are touched upon when people become engaged and are given the opportunity to reflect, bring to the forefront an awareness of the complexities and uncertainties

involved in decisions on whether or not, or how, the technology should be implemented. There are a number of wider issues that are raised. With regard to the technology the informed public is looking forward to a better understanding of: i) the compatibility of CCS with the development of renewables, ii) the real costs and who is going to pay for them, iii) the implementation timeline (including transport and pipeline networks), iv) means of verifying correct operation, site management and closure, and v) liability and management issues. More generally CCS does not escape diffuse diffidence towards decision making mechanisms, which still do not manage to sufficiently involve people. It also poses serious questions about the present relationship with nature and the use of resources, the ethical implications of what is meant to be a bridging solution (are we really solving the issue or just patching up the symptoms?), the fairness and equal distribution of costs and benefits of different technological options, and the safe, correct and honest management of industrial plants and resources.

The recommendations section of this report discusses potential facilitating factors that could help stakeholders looking to empower a scientifically informed exchange on the technology between the different sectors of society. Fundamentally, dissemination about CO_2 geological storage should happen within contexts that encourage people to explore and make use of both quick and slow thinking and which also provide an opportunity to elaborate emotional reactions, through contact with experts prepared for communication with the public.

Creating such opportunities, with the participation of different stakeholders, such as politicians, operators, public authorities, researchers and civil society organisations, could support the development of a more advanced understanding of the possible role of CO_2 geological storage in our society. In specific situations, such as the implementation of a CCS facility, this approach could help decision making processes and the roll out of projects.

Introduction

This report presents an overview of the findings produced during the ECO2 research project on the public perception of the geological storage of CO_2. In the first part it introduces the reader to the context of the research and its reasons, the problems that the researchers tried to address and the main results and recommendations. In the second part a synthesis of the underlying work performed in each of the two countries, Italy and UK, is given.

Request in the call and how we addressed it

The research programme was written answering to the call "The ocean of tomorrow" (published 30th July 2009) on the topic: "Sub-seabed carbon storage and the marine environment". There were three topics for the call, and associated themes, to be implemented jointly to meet the challenges of ocean management. The other two topics focused of climate change impacts on economic sectors in the Arctic and vectors of change in marine life, while the themes included Food and Fisheries, Energy, Environment, Transport, Socio-economic sciences and Humanities. As can be seen this represents a very broad contextual framework, placing the work to be done in relation to many important choices and considering the topic in all its different aspects, from technical to humanistic. It was in this broader perspective that we developed the research programme, aiming to improve understanding of public perception of CO_2 storage, in relation to the meaning it could assume for our society. CCS is a technology which is meant to reduce CO_2 emissions and therefore limit the impacts of climate change on the marine environment. However, offshore storage could in itself have an impact on the marine environment and on other offshore activities. With reference to the precautionary principle, the call also invited the study of the potential effects on marine ecosystems in case of CO_2 seepage and to investigate novel aspects as compared to hydrocarbon extraction. This was what colleagues in the other ECO2 work packages aimed to investigate. Could CCS adversely affect marine life? This important goal of the project was complemented by the attention to the human side and to understanding how the issue could be seen by the people. It is in fact well recognized that impacts have a psycho-social component and need to be considered not only with regard to technical parameters but also with regard to subjective evaluation of the different stakeholders and the public. In this context the present research was proposed, building on existing research to improve our understanding of public perspectives on the technology and its possible interaction with and within the marine environment. This was also realistic since at the time there were advanced projects for offshore storage in Scotland (Longannet coal power plant with storage in the North Sea at the Golden Eye site) and in Italy, the planned transformation of the Porto Tolle power plant included CCS with offshore storage. It was therefore important to gain insight on the "human factor" and in particular on how the subjective perception of the technology would place CCS with respect to the natural environment and its interaction with marine life. The study was therefore designed to help, as much as possible, people's own perspectives to emerge through explorative activities and an approach which would favour free expression of the participants (either through how participants discussed an issue or by allowing participants to have some say over what issues they chose to discuss in detail).

The general context: the situation when we started

In 2009 Carbon dioxide Capture and Storage - CCS seemed a very promising decarbonisation option and many activities were on-going to make it happen. The European Directive for the Geological Storage of CO_2 was published in 2009, after a preparation process with the participation of many research institutes. The Zero Emission Technological Platform was arguing the case for the implementation of 10 to 12 demonstration projects in Europe to be up and running by 2015, in order for CCS to be commercially viable by 2020. Based on this plan the European Industrial Initiative on Carbon Capture and Storage was launched. CO2GeoNet, the European Network of Excellence on the Geological Storage of CO_2, created under the European Commission auspices and FP6 funding, was transforming into a legal, no-profit association to provide a scientific reference body to ensure safe and scientifically based implementation of CO_2 storage in Europe. The IEA Greenhouse Gas R&D Programme was fostering worldwide exchange and dissemination on CCS. During the Greenhouse Gas Control Technologies Conference - GHGT9 in Washington, Jae Edmonds of the Joint Global Change Research Institute affirmed: "Preparations for the IPCC 5th Assessment Report have indicated that meeting low carbon stabilization limits is only possible with CCS". The research community was called upon to create appropriate scientific guidelines that would assist developers and ensure operational safety together with public support. However there were also signs of uncertainty or barriers to the implementation of CCS. First of all, the timing issue was coming to the fore, as elegantly said again at GHGT9 by David Hawkins, of the National Resources Defence Council: ''When should we start building commercial CCS projects? Five years ago". The lack of public participation in the development of the technology was rapidly becoming a risk for first movers. Greenpeace assumed a negative position towards CCS as detailed in their 2008 report titled "False Hope" and protests started around the Barendrecht project in the Netherlands that would eventually lead to its cancellation. Also on the technological side, a similar challenge was being faced. Although a number of studies pointed out that CO_2 storage was a relatively safe technology, as was also stated previously in the 2005 special IPCC report on CCS, this was not felt to be sufficient for policy makers and the public in an environmental perspective and particularly in the light of the precautionary principle. An important motivation for the work on public perception was therefore to understand why it seemed so difficult to overcome diffidence with regard to CCS and whether there were good reasons, that were possibly being neglected, for stakeholders' lack of confidence and for the public's, real or imagined, lack of interest in, and potential hostility towards, the technology.

What we knew and didn't know – Issues under study

When we started work on the ECO2 public perception studies our objective was to produce a deeper understanding of the meaning and potential value of CCS, and of CO_2 storage in particular, for the European citizen, starting from our own two countries. A number of studies had already investigated numerous aspects related to the understanding and communication of CCS. These studies were often born from worries about "public acceptance": the fear that people might refuse the technology and oppose, at the local level, its implementation. Many of them addressed the needs of operators, or sometimes the local authorities, in dealing with the introduction of the technology in a specific location. In some cases circumstances did raise resistance in the population and many social science studies tried to address these difficulties and provide support to enable better communication between project developers and lay citizens or other local stakeholders. Reframing of the issue was key in many studies, highlighting how the "public acceptance" perspective implied a

"not acceptable" passive role for the public and an inappropriate request to social researchers, as if they were supposed to help in forcing or manipulating public opinion towards acceptance of CCS installations. Reframing was also useful to gradually open the horizons of the complex interactions between the technological and the social and political aspects of CCS (Meadowcroft & Langhell, 2009; Markusson et al., 2012). An important achievement of this sector of research has been the development of a thorough understanding of people's concerns (Bradbury, 2012). This helped us understand, for instance, that risk was important but not the main determinant in the public perception of the technology. Other aspects were relevant for people like trust, fairness, context and framing of the issue as well as, at the local level, the quality of the communication activities, familiarity with industrial operations, reliability of the authorities, etc. (ibid.). It also became clearer and clearer that good decision making and communication processes could greatly reduce the risks of conflict at the level of project implementation. This led to the preparation of communication and outreach guidelines specifically suited for CCS projects (e.g. NETL 2009; WRI, 2010; Hammond & Shackley, 2010; GCCSI, 2011; Breukers & Pol, 2011). However, the more work that was done, the more uncertain the overall status of the technology appeared. Communication tool kits and best practice indications could not address the needs of everyone, from decision makers to members of the public, to better understand whether the implementation of the technology makes sense. The situation was, and still is, particularly challenging due to a general low awareness of the technology (European Commission 2011) and to the complexity of interaction between different choices for the energy mix. More work was needed to better understand the broader criteria, the possible evaluation of CCS-specific issues that citizens would make, and consequently the possible drivers of public opinion towards interest and support for the technology (or preference for competing options). In ECO2 we therefore aimed to study more global processes and values and the related critical need to listen to people's perspectives (Mabon et al. 2012), also from an ethical point of view (reviewed in Mabon et al., 2014)), of the societal process of elaboration and decision making on CCS. Based on this, the Italian and UK research teams developed a coordinated research programme, to explore the complexities of CCS public perception that emerged from previous studies within the framework of an explorative paradigm, and merging different methodologies ranging from psychoanalysis to discourse analysis.

Main outcomes

Italian team

1) **Conditions for the establishment of a relationship with the topic of CO_2 Storage**. Within the limits of this experience it has been demonstrated that people can develop an interest in the technology and in the discussion of the issues related to its adoption, when the conditions that we have identified with the individual interviews are met. This can be done by: creating an environment where people can be active and their contribution is valued; supporting them in exploring the connections of the technology with everyday life; providing easily accessible information and being available for questions and explanations; taking measures to overcome the remoteness and the common top down approach of the experts; and addressing the need of collective spaces for discussion of these complex issues. By doing so we have found that people, who had started off feeling quite distant from the topic, managed to establish a good relationship with it in terms of interest and topic relevance (independent from what their final opinion was). Many of them stated that when they had first heard what the theme of the group meeting was they thought it would be boring, to later discover that it was not. Of course, this was most evident with the long term group. This kind of environment has not only allowed people to get "nearer" to storage but also to explore the complex issues related to it. The long term group arrived to develop a rather sophisticated form of competence, which emerged for instance in the role-playing exercises. Participants were able to constructively and collectively reflect and reason, coming to a mature and complete point of view on the technology.

2) **Key role of the characteristics of the decision making processes.** The experience with the one-time focus groups confirms the hypothesis that people's perceptions are influenced by the characteristics of the decision making processes. When people learn that decisions about the implementation of the technology have been made without any involvement of the population, they feel their role and possible contribution is undervalued, and tend to become reactive, to be less able to explore and reason on the issue. The results provide a specific confirmation of what is known from previous studies about the importance of getting people involved as early as possible. This clearly was shown to apply not only to people living near potential storage sites but also more generally, something which at the moment seems to have escaped common stakeholders' considerations and policies. The findings also seem to support the hypothesis that many of the problems and controversies around CCS implementation stem from the very scarce involvement of the population and are independent from the technology's real relevance or potential role, from its "goodness" or "badness". The very way in which the technology has developed outside of the public domain seems to create a strong (potential) bias in public perception, so that a serious consideration and evaluation of the technology becomes rather unlikely. If we add all the other challenges that we found during analysis of the individual interviews regarding the lack of appropriate spaces and satisfactory relational contexts for exchange (many of which CCS probably shares with other technological issues), then it is not surprising that CCS awareness is progressing so slowly in European society. Based on these findings it is probably justified to say that, given the important role that CCS could play in reaching the emission reduction targets, creating the conditions for wide societal involvement

and evaluation of the technology is probably an indispensible step to verify whether or not it makes sense to continue with investments in the technology.

3) **How the establishment of a relationship with the technology develops (process)**. Based on the outcomes of both the individual interviews and the focus/in-depth groups it has been observed that when people establish a relationship with the technology they go through a number of phases whose sequence can be iterative, is functional to the exploration of the polysemy of the situation and is a way to manage the often intense emotional pressure people feel when confronted with a topic that escapes simple categorisation (and concerns life-important dimensions). (1) People try to understand what this new concept is about and they manifest curiosity, often asking questions that can help connect it to something real and concrete. (2) Doing so they begin to realise that the thing is complicated, that it is not easy to establish its potential impact and meaning for the energy system and the fight against climate change. (3) Therefore they go on asking (themselves) questions on a number of issues like costs, relations with renewables, impacts, long term issues, world issues, etc. (4) Then the thought of implementation comes up and they start to worry about control and monitoring issues and about the risk of illegal speculations which are frequent on major works and infrastructures. (5) But is storage really necessary? People feel caught in an emotional dilemma, between the need to reduce emissions (which also presents a high level of uncertainty) and the uncertainty of whether CCS could be a good move. (6) People feel under pressure, time and space is required to understand and reduce the polysemy. Being able to share provides relief, helps progress, even if it does not yet bring a clear conclusion. (7) People look to those in charge, trying to find more elements for orienting themselves. What are they doing? Why they are not being really active? If they are not showing interest in the technology why should the citizens? This process sequence is an attempt to describe different elements of the relationship with the technology which can also appear simultaneously or in a different sequence, or as an undifferentiated whole. The exercise can help give stakeholders a global and at the same time detailed perspective to better understand the different challenges that the topic of CO_2 storage poses to members of the public.

4) **Usefulness of the understanding of emotional dimensions for the development of dissemination materials.** Understanding emotional dimensions through a qualitative study, such as the one undertaken in this project, can provide valuable insight into what important elements should be considered and/or included when designing dissemination tools for complex technological issues like CO_2 storage. Also the complexity of the process is reduced as the emotional analysis helps to identify the many different facets and provides clear guidance in terms of feelings in addition to that based on concepts.

UK team

The most salient findings from this study centre around the different thought processes used to form perceptions of CCS and the closely connected issue of socio-psychological distancing of members of the public, from CCS. Some of the key results which have informed this interpretation include:

- Members of the public and some stakeholders will not willingly discuss CCS; some even actively divert attention from the discussion

- CCS is a difficult topic to communicate, in part due to the many arguments which need to be presented in order for a person to make an informed judgement on the issue, and the current lack of awareness about CCS

- Many existing CCS communication materials (primarily graphics) lack a human perspective and therefore produce socio-psychological distance between members of the public and the issue of CCS

- Other, more visible or tangible energy technologies, such as wind, hydro and solar power are more appealing to members of the public in energy discussions because their impact on a person's everyday life is easier to visualise (this is a product of the distant spatial and temporal scales of CCS, and the social distance from large power plants, pipelines and offshore infrastructure)

- The repeated use of analogues by members of the public, in a range of the research processes, demonstrated that members of the public need to be able to identify a connection with a technology in order to be able to evaluate it (the analogue functions as a heuristic or as scaffolding by which to approach the object).

- Effective communication films appealed to the emotions and familiar attributes which can be connected somehow to CCS (and energy issues in general): making connections to personal aspects in people's lives

Understanding the use of cognitive and emotional mechanisms such as heuristics and thinking according to System 1 and System 2 (Kahneman, 2011) for forming judgements, is important in allowing researchers and communicators to determine how values, context, knowledge and personal experience will influence the perceptions formed about CCS. Tangibility and agency were identified as important criteria in allowing members of the public and stakeholders to engage with the issue of CCS. For members of the public to engage with and discuss a topic, it needs to be something which both appeals to their personal and/or collective values, and which they can visualise within the context of their own personal and collective situations (tangibility). A sense of agency is necessary to enable members of the public to invest (in terms of time, effort) in something which, on the surface, may seem abstract and inconsequential to them. They must be able to see the relevance of the technology as well as understand their role in its deliberation, in order to feel responsibility in providing their perceptions. These insights should be used to design communication and engagement tools which are targeted towards specific users and which address the needs of the user, rather than (or as well as) the needs of the researchers, planners, CCS advocates and developers. In this way, a greater awareness of and engagement with CCS can be established.

An improved understanding of the way in which people develop perceptions of CCS, and the factors which affect the development of perceptions has allowed us to make a number of recommendations for effective communication and engagement on the issue. These include:

1. Be aware of the sources people might draw on to help them form a judgement about CCS – they are likely to affect their perception, and are also likely to change between individuals and between groups.

2. Pay careful attention to the way people are engaged or asked to provide their judgements on CCS. This could affect the cognitive and emotional processes which come into play in decision-

making (e.g. a survey may only capture System 1 response; a long interview or opportunity to formulate thoughts in own time and privately may get much more in-depth evaluation).

3. Materials prepared for communication should be designed with the user, not the communicator, in mind. Images should be appeal to personal/community and human aspects and be more user-facing. Considering the life-world starting points of a target audience (individuals and communities) can help to make the link between CCS and peoples' lives more explicit.

4. Be prepared to target communication strategies at different audiences, e.g. those familiar with CCS/industry, those who are unaware of it; and be prepared to accept criticism constructively and address the issue rather than be defensive. This may require the preparation of a number of different forms of communication/engagement methods or tools for engaging with different groups on the same issue.

5. Be clear and transparent about what people can (and, just as importantly, cannot) contribute to a process and demonstrate to them how they fit into that process.

General recommendations for CO_2 storage projects

Public involvement in the planning and development of CCS projects is required by legislation to meet the principles of the Aarhus Convention and as part of a project's Environmental Impact Assessment. The European Directive on the geological storage of CO_2, however, only requires that Member States make available to the public environmental information relating to the geological storage of CO_2, while a more detailed provision of information about real projects and guidance on how to approach this is lacking. Since members of the public have the opportunity to scrutinise and/or object to CCS development plans as part of an Environmental Impact Assessment, which is required for any new project, it will therefore be important to provide stakeholders with useful elements for setting the grounds of a constructive exchange with the public, to avoid public opposition which can lead to the delaying and cancellation of projects as has happened in the past, for instance in the Netherlands and in Germany. However guidance in the area of public engagement needs to take into account the fact that each project's situation is unique and there is no proven recipe that can be applied. The benefits of an open and humble exploration of how to approach public engagement cannot be overestimated. Such an exploration, underpinned by an understanding of public perceptions, how they change, and what affects their formation, will allow stakeholders to effectively involve the public in the process.

Through work carried out as part of the project, ECO_2 has characterised public perception and identified current gaps in public and stakeholders' relationships with this technology. The perception of CO_2 geological storage is limited by scarce information and the lack of societal debate on how the energy mix can influence the development of the energy system in the long term. Within this framework, we have identified that the success of single storage projects, in terms of public perception, hangs on wider and more general issues as much as on the good and safe management of each individual project's procedures. Awareness, understanding, and approval of CCS are limited, but necessary, if CCS is to be deployed extensively in Europe to reduce emissions from power and heavy industry sectors. Early geological storage projects carry the burden of demonstrating efficacy, cost effectiveness, safety and environmental integrity to the public. People who learn for the first time about this technology frequently express interest in existing cases in order to form a judgement on the technology.

The level of public understanding of the overall role of CCS is key and messages to be communicated should include: the specific contribution of CCS, its role within the context of other low carbon options, understanding of costs, and safety and implementation issues at the local level. Policy makers and other stakeholders should find a way to learn together on these issues and in this process they could greatly benefit from the involvement of members of the public in the discussion . What is still unclear to the public is: i) the compatibility of CCS with the development of renewables, ii) the real costs and who is going to pay for them, iii) the implementation timeline (including transport and pipeline networks), iv) means of verification of correct operation, site management and closure, and v) liability and management issues. Finding answers to these questions requires not only technical expertise but also consideration of complex socio-economic factors. The inclusion of members of the public in the discussion could be key to increase the sense of involvement and ownership of technology evaluation processes and their outcomes. This will help make the issues more understandable to the general public and non-technical stakeholders at both the global level as well as for individual CCS projects.

Key findings from ECO_2 public perception studies

- **There is an urgent need for policy makers and technical stakeholders to better define the role of CCS with respect to other technologies in a low carbon energy mix**
- **Scarce communication about CCS hinders the possibility for the public to develop awareness and understanding of the technology and its possible contribution to reducing CO_2 emissions**
- **When communication on CCS takes place it often lacks a sufficient level of tangibility or ownership for the public to get engaged**
- **Real projects can help make CCS more tangible. There is curiosity and interest for existing projects all over the world, thus the importance for pilot or demo projects to share their experience with the public**
- **Perceptions of CCS should not be seen in isolation, they are related to the perception of other energy and climate discussions and are influenced by values, context and experience**
- **Because of how we learn and form perceptions, careful attention must be paid to the way in which we engage the public – this affects the way in which they come to an opinion on CCS**
- **The main question among the public we engaged with was around whether CCS is worthwhile, rather than around concerns about a specific project.**
- **Policy and implementation developments around CCS would benefit from a more active role, and therefore a greater feeling of agency of all stakeholders including the public**

Dissemination tools

The work conducted on public perception in ECO_2 has also produced specific tools that address some of the challenges of CCS communication and which can be used by the stakeholders to raise interest and to support reflection and understanding on this technological option. First of all the issue of language and jargon was considered, trying to identify the relevant terminology and provide, as much as possible, simple definitions. A widely used, and first of its kind, **CCS Glossary** has been developed and is available on the project homepage (http://www.eco2-project.eu). Secondly, the lack of visual material that could raise interest for the technology was considered, especially with the young generation. This led to the production of a **short film**, designed according to the indications coming from the research on how to make the topic interesting for the lay public: **"CCS a bridging technology for the energy of the future", now available in four languages** (Italian: https://youtu.be/0sWpLlBj3Rk; English: https://youtu.be/RDU_PTKll_g; German: https://youtu.be/krAa3w3FxK8; French: https://youtu.be/Li-vMd9iaKw). The film introduces the concept of CCS and invites the viewer to reflect on the issue and get involved. Finally, given the importance of the understanding of public perception issues for communication between technical stakeholders and the general public, a main objective was to make the results of the work conducted in WP6 accessible to all. A specific report has been created where the outcomes of the public perception work are presented in a **quick and easy-to-read lay report: "The Geological Storage of CO_2: and what do you think?"**, that can be downloaded at http://oceanrep.geomar.de/29076/. This report can be useful to answer the frequent need of an entry point to the understanding of public perception issues for many non-specialist stakeholders, policy makers, authorities, or operators. At the same time, its main contributor, the public, will find some reflection and recognition of its perspectives, which could provide a base for further exchange and for reciprocal understanding of all stakeholders. Through collaboration between WP6 and the IEA Greenhouse Gas Programme, we also wrote a series of **Briefing Notes on CCS**, intended for stakeholders and informed / curious members of the public who are willing to devote 30 minutes of their time in reading each of the Notes. No prior expert knowledge is assumed, but a general technical understanding is likely to help comprehension of the Briefing Notes.

The research work in Italy

Introduction

It is a common experience of authorities and operators that the introduction of technological innovation can elicit difficult discussions and strong reactions from the public, what is often termed as an "emotional" reaction. This usually finds many people unprepared and feeling powerless and can be difficult to resolve. A holistic approach, which includes consideration of emotions, can thus bring an interesting contribution, helping people and stakeholders to better understand such reactions and to find more satisfactory routes for technological innovation.

The study carried out in Italy, based on a clinical psychological approach and focused on the elaboration of emotional dimensions (Carli&Paniccia 1981; Carli 1987, Carli&Paniccia 2003, Vercelli&Lombardi 2009, Vercelli 2010), aims to raise awareness about the feelings that characterise the perception of CO_2 geological storage. It is a research-intervention approach, where the study of societal emotions is not a purely intellectual exercise, but rather it implies involvement at the emotional level by the participants and researchers. This has different implications for the different actors. On the side of the researchers it requires a specific competence to work on social emotionality through their own emotions: it is thanks to the ability to feel what people feel when confronted with the topic, and to elaborate on this, that knowledge is produced. On the side of the participants it implies a willingness to take part and share from a personal perspective. Finally, on the side of the end-user of the research results, it calls for an open and empathic comprehension by connecting to the emotional dimensions emerging from the study not only with thinking but also with feeling. Through the establishment of new connections with (unconscious) emotional dimensions new insights can take place, helping the stakeholders better understand perception of the technology.

It might be useful to clarify that with this study we do not aim to directly address public acceptance or risk communication issues, although the outcomes can shed light on why those issues are raised. We limit our work to providing hypotheses and hints for reflection on the deeper psychosocial dimensions implied in the development of this technology and its public perception and evaluation. Hopefully this will help improve our overall understanding of the role CCS can play from the public's point of view.

Methodology

Related to the introduction of technological innovation, and of CCS in particular, themes like decision making processes, risk communication, public acceptance and communication issues are the object of study of many disciplines. With regard to psychology, this happens mostly based on a cognitivist perspective. The present study supports an enlargement of views by the inclusion of the study of emotions and relational dimensions in a psychodynamic and clinical psychology perspective. The proposed research intervention approach integrates psychoanalytic and psychological contributions. It borrows from psychoanalysis the rigour of the setting, understanding of unconscious emotional aspects, and subjective and inter-subjective dynamics (Codignola 1977; Matte Blanco 1975; Carli 1987; Codignola, Kohut 1959, 1984, 1986; Orange et al. 1997). From psychology it derives the study of motives and social representations (McClelland 1987; Moscovici 1961, 1976; Farr&Moscovici 1984); group dynamics (Lewin 1947, 1947b, Burnes 2004, Burnes 2004b Carli and Paniccia 1984); and empathic approaches for communication and psychological connection

with self and others (Gendlin 1962, 1982, 1997; Rosenberg 1999; 2003). The main assumption relevant for this study, which finds different but complementary support in most of these theoretical references, is a social, not individualistic construct of perception, which includes cognitive, emotional, relational and contextual dimensions. Further key elements that are essential for the present work and which closely refer to the epistemological foundations of clinical psychology (Carli 1987 bis; Grasso et al. 2003, 2004; Lombardo 2005; Carli and Giovagnoli 2011) are the following:

1) The importance of context in relation to the perception of the technology: the way the technology is perceived cannot be well understood separately from the consideration of the wider societal context within which the perception takes place
2) The central role of the relationship between the researcher and the object of study: it is the reflexive observation of the researcher's own experience of such relationship that provides guidance for the development of the research activities
3) The definition of protocols and/or specific conditions within which the research activities take place, be it an interview, a focus group or a questionnaire, which respect relational requirements coherent with the theoretical framework
4) The focus on the characteristics and/or evolution of the symbolic-representational dimension that characterizes the perception.

Within this methodological framework, the first objective of the research work was to create situations and contexts that would allow for the establishment of a relationship with members of the public to explore the perception of CO_2 geological storage. A relationship characterized, as much as possible, as equal and empathic, so that people would feel at ease to consider the technology, openly discuss their thoughts and feelings, take the chance to jointly reflect on a topic which is vast, complex and controversial. A relationship which would help people contact their deepest feelings and concerns, permitting researchers to listen and gradually develop awareness of what is important to people when it comes to CCS and why.

Individual interviews

Method: A total of 51 free association interviews were conducted in Italy in the spring and summer of 2011, with the goal of detecting a range of ways to perceive CO_2 Geological Storage, based on their affective symbolisation. The group of interviewees was formed with a non-probabilistic method, from people self-selecting into the survey. People included were considered to have some knowledge about the geological storage of CO_2 based on their own self-assessment. Since we were interested to the general public's perception of the technology, professionals in the field of CCS were excluded from the sample. Some variables were used to guide the sample formation in order to detect a possible variability of cultural characteristics within the given context. These variables either related to storage itself, like living in storage/no storage areas, on the coast rather than inland (as the research was focussed on offshore storage), or to more general aspects like living in urban vs. rural areas, in northern/central/southern regions of the country.

The interviews were meant to provide to the interviewees an opportunity to illustrate and ponder their ideas about the technology, elaborating both affective states and rational evaluations. The approach was based on the psychoanalytic method of free association to allow full expression of the interviewee and listening by the interviewer to enable the detection of emotional and unconscious dimensions (Matte Blanco 1975, 2003; Hollway&Jefferson 2000; Carli 1987). The interview protocol defined the setting for the interview relative to the research context: funding by the European Commission of a research project on the potential environmental impacts of the geological storage of CO_2 and more specifically the study of the perception of this new technology. The interview

started with the question “Can you please tell me what you think about the geological storage of CO_2” and interviewees were encouraged to speak freely about the subject without any further input from the interviewer, apart from generic support and encouragement to express themselves. The protocol for the interview was agreed with the UEDIN research team, establishing a common procedure so that the text produced would fit with both methods for analysis, in the case of the Italian interviews the ETA-Emotional Text Analysis (Carli, Paniccia, 2009) which allows for identification of social emotional dimensions. Interviews were transcribed and the text was prepared for ETA and processed with cluster analysis using the T-LAB software (Lancia 2013). Results were analysed to identify the relevant emotional dimensions and psychosocial representations corresponding to each cluster of words.

Results: The Emotional Text Analysis of the 51 Italian interviews with people having some knowledge of CCS has identified 4 thematic areas (corresponding to the clusters) which bear emotional relevance for the context under study: storage as part of the energy world; information processes and needs; storage and science in the context of humans’ relationship with nature; lifestyles, consumerism and future perspectives. No differentiation was found with regard to the chosen variables (living in storage or no storage areas, inland or coastal, central, northern or southern Italy, urban or rural) reflecting what at the moment appears to be a common culture to the entire sample. Let’s take a look at the four dimensions identified. 1) The “cost” of energy. Storage is related to energy production as something complex which involves systems that appear remote and top down. In this respect it can be rather abstract, not something people can have a say in, or feel committed to act upon. There is a pressing need for energy which however has high costs for the country, and this is felt like a burden not only in economical but also in psychological terms. Storage is part of the overall effort to do something about this problem, renovating the energy system, but it seems more part of the problem than of the solution and thus probably less convincing with respect to other technologies, which are imagined as being able to produce clean and abundant energy and thus better meet the needs of innovation. 2) The need of in-depth understanding. The people interviewed perceive the issue as something complex which requires in-depth understanding to be able to truly evaluate the advantages and risks of the technology. This is something which takes time and effort and it is uncertain how it can be done, particularly since the topic is elusive and can also be scary. Asking for information seems to underlie a need for reassurance, more than an interest in the information itself. However the request of information appears as a separate dimension with respect to the previous one related to energy, to the more operational context, something which could make it an abstract exercise. This also stresses the idea of a separation between the people and those who decide and operate the technology; no relationship also means no possibility of being reassured, and people seem to say that it’s difficult to be reassured only by those who study it, like researchers. 3) The central role of the relationship with nature. Here storage needs to be understood with respect to humans’ relationship with nature. This dimension relates to the possibility of being creative in finding ways to reconcile what is seen as forcing nature to ensure our life-style with the vital need of preserving the planet. Science can be responsible for creating unbalance but also a better life and new equilibrium in the relationship with nature. Storage could be part of the effort to protect natural resources. The issue of storage is related here to determining how it fits with the need of equilibrium between our life-style and our relationship with nature. This seems to be a point of strength, an important resource, in psychological terms, but there is the shadow of human destructive potential. 4) Lifestyles and future perspectives. This is an area where a greater involvement of the anonymous citizen seems to emerge, related to the present way of life based on consumption and economic well-being, especially for future generations, and the fear of losing it. There is the perception that the consequences of the present lifestyle can be dramatic, but also the

idea that each one is involved in solving the problem. CCS here seems to evoke guilt feelings with regard to what people are doing that has created the conditions for CCS to be necessary. The meaning of these four dimensions can be further understood through an analysis of the relationship between them (corresponding to the factors). Energy appears as a world on its own, following its own logic and detached from the people, as if it was only an economic-industrial and policy matter; in this respect it is difficult for people to understand how to establish a meaningful relationship with the topic of storage. A second factor connects the need of a deeper understanding with the raising conscience that if we need CCS it is because of the lifestyle we are living, a lifestyle which requires urgent re-consideration. There are two poles, one about becoming active and the other about producing understanding, two aspects of the same dimension that is stimulated by the topic of storage, with information being at the moment predominant as it is easy to appreciate given the low level of dissemination on the technology. The third factor is a more environmentally oriented axis, that connects the need of understanding with the centrality of nature. Something uncertain (the problem escapes our comprehension, do we really need this technology?), as opposed to the certainty that life means nature and finding an equilibrium with it, through compatible ways of life, of which storage could be part.

The energy area remains detached from the others, strongly characterised as an issue of power and high level stakeholders. Apparently, while environmental aspects are felt as needing better understanding through information and science, the hard facts of energy have either the face of power or that of coping with everyday needs and decisions. Maybe this last area is the only one where people feel they can engage.

Thanks to the individual interviews we managed to understand some important dimensions that seem to influence the perception of this technology and which gave us important clues for the subsequent research activities and on how to produce dissemination materials to progress in the work on public perception. In particular, we used the outcomes from the individual interviews to design a short film for introducing CCS to the younger generation.

Group meetings

Focus/in depth discussion groups (long term and one-time group meetings): The Italian team conducted different kinds of group activities with members of the public, to explore how different settings and a different level of opportunities to interact on the topic of CO_2 geological storage would influence the perception of the technology. A long term group was established which met 7 times and four different groups that met only once were organised, for testing an experimental hypothesis developed on the basis of the individual interviews.

The clinical psychological approach adopted for the study allowed for more understanding of how people establish a relationship with the topic and of the emotional characteristics of such a relationship, in relation to the research context and the specific setting for the meetings with the participants. The exploration of deep and emotional dimensions in the public perception of CO_2 storage was supported by the design of a group setting which would favour the participants' expression, by creating a positive and encouraging relational context with the experts conducting the groups. All groups were formed by a sub-contracted marketing research firm, through random sampling with respect to sex, age, education and occupation. The subjects were filtered and admitted to the study only if having interest in the topics of energy and environment (with the exclusion of professionals in the field of energy or environmental activists).

Long term group meetings

Method: A cycle of 7 meetings was conducted with a group of 15 citizens, to introduce and discuss the geological storage of CO_2. The meetings were centred around the questions and interests of the participants on the different facets of the technology, providing expert input and exploring together the complex issues raised by the participants. The setting was meant to support active input from the participants and included role-playing exercises on storage licensing and decision making on a case of offshore versus onshore implementation. The possibility to participate in an extended number of meetings and the proposed relationship with the experts, characterised by a horizontal approach leaving plenty of room for questions and direct exchange, encouraged the participants to reflect on issues that were unusual to them, learning collaboratively, experiencing in the group how to build meaning around complex issues. Outcomes from ECO2 research on potential impacts and activities related to the Sleipner case study were part of the technical input.

The group activities followed the flow that was initiated with the first meeting, during which the scope of the work was presented and the technology introduced. Then the participants were asked to formulate their questions regarding the technology, in a brainstorming fashion, and the questions were ranked in order of importance for the participants. Based on this input, the work of the subsequent sessions was organised. The questions were analysed and grouped in different categories. The majority of the questions belonged to topics that could and were covered by experts, regarding storage and capture, impacts, existing experiences etc. Then there was a group of questions that were named “complex questions”, which involved issues that have no easy answer, questions that could not be answered by one expert but rather required a joint effort. For instance: “what would be the risks should we not implement it?” or “is it more convenient to go through storage or to go directly to renewables?” etc. These questions were made the object of careful consideration within the group, exploring them and giving the participants the time to reflect on them together. The work on the questions raised by the participants continued throughout, but was particularly the focus of meetings 2, 3 and 4. During meeting 5 a case study was presented, the Sleipner experience, which was also studied with the ECO2 project, as an opportunity to better understand the possible impacts. Then a role playing exercise took place on the licensing process. In meeting 6, again with role playing, the issue of onshore versus offshore was explored. The role playing exercises helped the participants feel more directly involved. Meeting 7 was mainly dedicated to elaborating the group’s position and feed-back.

Results: The reaction of the group was very positive in terms of collaboration, interest and even enjoyment. The participants, who at the beginning were quite new to CO_2 storage, developed an interest in the technology and gradually became “experts” on the topic, overcoming the initial sense of remoteness and technical distance. They considered the experience useful to inform other citizens and some of them felt that after this experience they had a role in the dissemination of the technology. Their final point of view on CO_2 geological storage was quite different in terms of quality and complexity compared to that of the one-time focus groups.

The topics raised were common to both the long term and the one time groups but the long term group had much more time and different opportunities to explore, discuss, and interact with the experts and within the group. The longitudinal setting allowed for a continuous production and re-organisation of meaning; the participants were interested, concentrated and collaborative learning

took place. The exchange in the group helped people stay in a relationship with the complexities of the topic, without the need to immediately find solutions, developing a competence in reflecting on issues that the participants declared unusual for them to think about. The situation stimulated the participants to become more active, asking themselves what their possible role could be with regard to this technology and its adoption. Also a relationship with the experts developed within the framework of a reciprocally active role and a common construction of the outcomes. Thanks to the initial space for questions, which decided the flow of work from the participants' perspective, and the general and continual availability of the experts to interact and answer any query, the participants realised they were not being treated as "empty glasses" that need to be filled with top down information and they took an active role in the information process. In this context a number of notable experiences could take place. In this group, like in the one-time groups, diffidence was present, but the development of a collaborative relationship with the experts and the opportunity to reason and reflect together helped the group develop trust in its own ability to deal with the issues being discussed. A rich variety of questions, doubts and reflections could be manifested and explored. Gradually the technology became familiar to the participants and it was striking to see the competence they expressed during the role playing exercises, as they played the roles of industry, authorities, citizens and experts. At the same time it was interesting to see the group touch and develop awareness about the complexity of such decisions and more generally of the issues of energy, climate change, emissions reduction and the introduction of a new technology.

The final expression of the group on CO_2 geological storage and its implementation reflects the group's wide perspective, touching on the reasons for doing it (the need to reduce CO_2 emissions, revolutionise factories' fumes), concern over economic aspects, importance of global application, need of thorough information (especially at the school level), and the need of a European directive for creating an equal situation for European goods, with respect to goods coming from abroad where different limits to CO_2 emissions apply.

One-time group meetings

Method: Four focus groups were conducted with 12 participants each, which met once. The objective was to test the hypotheses developed with the Emotional Text Analysis of the previously conducted individual interviews. These hypotheses related to the influence of different levels of involvement in the decision making processes and the impact of different characteristics of the relational environment (different mixes of frontal or interactive exchange modes). All the groups followed a similar progression. The topic of CO_2 geological storage was introduced by skilled researchers and the participants had the opportunity to ask questions; then a group discussion ensued, at the end of which the group prepared a written expression of the group's opinion, which was to be included in the report to the Commission. Small but significant variations differentiated the groups, the main one being related to the status of the technology: something that was already part of the European strategy for reducing emissions (already decided - D) or something still being considered (not yet decided - ND), thus stressing different aspects of the real situation. Also the reasons of the Commission for funding the study were presented in a slightly different manner. In the decided group it was to facilitate information and communication to the citizens to prepare for the technology implementation; in the not decided group, to involve the citizens to verify the opportunity to support this technology. Finally the forecast of the IEA about the contribution of CCS to emissions reduction was presented in a slightly different manner: CO_2 storage "will" (decided) or

"could" (not decided) contribute in a cost-effective manner to 20% emission reduction in a 2050 perspective.

Results: Interesting similarities and differences were observed both in the relationship the groups developed with the topic and in the relationship among the participants. All groups were curious about the technology and expressed a positive appreciation of it, although there were uncertainties about whether or not it was a good choice and about implementation, with a general concern being voiced about correct procedures and public interest. This was emotionally challenging and yielded different reactions. The ND groups felt the responsibility but also the burden of providing an opinion, also given the limits of the situation. Therefore the ND groups took a more reflexive approach and were more able to explore the topic and connect it to their life-world, particularly on the economic side. For the D groups instead, the difficulty of the topic was worsened by the emotional situation. The D groups were disappointed that they had been informed about the technology only after decisions had been made. This not only resulted in diffidence, negative reactions and concern about local issues (Nimby reaction), but also reduced the capacity of the groups to explore the topic and find a common conclusion. The final opinion for the Commission reflects the different experience. The two Not Decided groups produced coherent papers and managed to find a common perspective. The first one recognised the value of the technology and its application in Europe. It focused on concerns about implementation, because of the large amounts of money involved (doubts on the willingness to invest; risks of corruption; worries over competence of operators and correct project management), especially with regard to Italy, with respect to other European countries. The second Not Decided group expressed interest for the technology and its positive value for the environment. However perplexities were raised about safety and possible risks (geological, ecological, political and related to citizens' health). This group reported having explored in particular the topic of costs-benefits in relation to the implementation of the technology, which is seen as necessary. The two Decided groups came to less coherent conclusions. The first one felt a strong contradiction between the need to start immediately with the technology and concern that it could negatively impact the development of renewables (and continued use of fossil fuels). The long term verification of the technology was also an issue. The second Decided group, which was also the only one with which a frontal setting was used, instead of a circular one, encountered large difficulties in finding a common perspective. It is better to say, this proved impossible, and can also be seen in the graphic aspect of the group's paper, with different participants writing different pieces of it. This was the only group where the participants were unable to come to an agreement on what to write. Conflict and strong differences surfaced that the members of the group did not manage to reconcile and as a result the group expressed itself in a rather confused manner. A strong focus was on the impact on the local communities and disappointment in the delayed involvement of the citizens on the part of the Commission.

Focus groups questionnaire

Method: At the end of each one-time focus group and the long term cycle group the participants were asked to fill in a questionnaire, to collect additional information about how they felt with regard to their relationship with energy and climate issues, CO_2 storage and their participation in the groups. Likert type scales were used. Some of the items were composed with expressions or judgements found in the individual interviews. Personal involvement, subjective and objective knowledge of CO_2 storage, perception of potential benefits and costs, concerns, evaluation of the

information received were tested. The questionnaire was kept anonymous to allow the respondents the freedom to report eventual negative reactions independently of the good relationship established with the researchers holding the meetings.

Results: The results of the questionnaire confirm the hypothesis made at the stage of individual interviews concerning the difficult relationship people have with energy transition problems, climate issues and involvement in decision making mechanisms. The majority of the respondents (59,68%) are dissatisfied with their involvement in energy decisions, however the distribution does not show a statistically significant tendency, as if there was still too limited an awareness for people to take position on this point. The three groups present comparable results[1] for sense of agency with regard to energy and climate issues, subjective and objective learning rate about CO_2 storage, expected benefits of storage, worries (with some notable exceptions), opinion on investment in the technology and participation in the group experience. They value their own contribution for the development of a low carbon society, for reducing pollution, for reducing the waste of resources, for the development of sustainable life-styles (all with χ^2 $p<0.001$), while they don't think they can have much influence on energy production (χ^2 $p<0.02$), climate change, greenhouse gas phenomena, or the development of renewables (all with χ^2 $p<0.001$). With regard to the benefits of storage the respondents agree that it can bring benefits for the environment, for employment (both χ^2 $p<0.001$) and for everyday life (χ^2 $p<0.018$) but costs for the citizens (χ^2 $p<0.007$). The data don't show a definite position with regard to economic benefits at the local level, although it is seen as an opportunity of development at local level (χ^2 $p<0.004$). Storage is seen as something that can contribute to a better future, that will work together with other measures and that can bring a renewal in the energy system (all χ^2 $p<0.001$). When it comes to worries the ones which rank highest are: concern over prevalence of private interests with damage of collective interest, concern with regard to correct monitoring and operation, concern about the impact of leakage on the ecosystem (all χ^2 $p<0.001$). The respondents were satisfied with their participation and considered the information received clear; the experience was enjoyable, interesting and important; they felt the need for more information and were interested to go more in-depth on the topic (all χ^2 $p<0.001$). With regard to costs, the participants think that people are interested in the topic of energy cost (χ^2 $p<0.001$) and after participating to the meeting they mostly feel worried for the costs (χ^2 $p<0.005$) but there is a significant difference, for some items, between the groups. The Decided feel less aware of the costs (χ^2 $p<0.035$), while the Not Decided are more convinced that storage can bring costs for the citizens (χ^2 $p<0.029$) and increase the cost of energy (χ^2 $p<0.039$) . Both the Decided and Not Decided are worried that storage could be costly and not efficient, but this does not apply to the long term group (χ^2 $p<0.018$.)

On some questions significant differences could be established between the Decided and Not-Decided groups. The ones who were told that the implementation of CO_2 storage had already been decided were more prone to think that it was not a safe technology (χ^2 $p<0.05$), that it was like sweeping the dust under the carpet (χ^2 $p<0.018$) and that it was a ploy to continue the use of fossil fuels (χ^2 $p<0.02$). As previously indicated they were also less thoughtful and aware about the costs

[1] The majority value their own contribution for the development of a low carbon society (46.77% somewhat important, 35.48% very important, χ^2 (3)=31.29 $p<0.001$).

for citizens and the possible increase of the cost of energy. This seems to indicate that people that feel excluded from decision making can have a negative psychological reaction to the technology independently, without even considering its advantages or disadvantages for the citizens (all groups having been exposed to the same kind and level of information). Opposition seems to take a generic, in principle, form.

Dissemination film and questionnaire

Method: A short film, "CCS – A bridging technology for the energy of the future", was produced to introduce the concept of CO_2 storage, targeted to a young audience but potentially interesting for the lay public overall. The film was created taking into account many inputs from previous work both at the level of concepts and of the way to present them. Building on many years of communication work of our multidisciplinary laboratory on the topic of storage, a selection and thorough refinement of key concepts was undertaken, particularly considering the results from the individual interviews (need to find ways to facilitate the establishment of a relationship with topics perceived as remote, need to support active involvement of the citizens, etc.) and the media workshop performed by the University of Edinburgh (lack of humans in CCS videos, lack of user-friendly explanations, etc.). An innovative approach to science dissemination through storytelling was adopted and a visual and intuitive approach privileged: the technical content was mostly embedded in the cartoons and the communication of the key concepts was prioritised with respect to realistic representation (for instance with regard to the carbon cycle). The objective was to stimulate interest and curiosity about the technology. At the end of the video the spectator is stimulated to reflect on his/her own point of view about the issues raised and the technology just introduced. The opportunity was given to the viewers to express their reactions by answering a questionnaire developed for this purpose. The questionnaire includes questions to understand the emotional reaction to the video, the perception of the technology and the interest raised on CO_2 storage and related topics. The video and questionnaire have been used to introduce CO_2 storage in high school classes to 708 students of the areas of Rome and neighbouring provinces.

Results:

The results of the questionnaire indicate a positive reaction and present all significant values χ^2 $p<0.000$.. The video seems to fulfil its objective of stimulating interest and curiosity about the technology and related issues. After seeing the video a high percentage of students feels curious (80,1%, of which 59,3% somewhat, 20,8% very curious) and a large majority have found the experience important (81,3%, of which 57,1% somewhat, 24,2% very important) and interesting (84,2%, of which 55,4% somewhat, 28,8% very interesting). They also found the information given in the video understandable (86,4%, of which 40,1% somewhat, 46,3% very understandable). Most of them agree that the themes covered in the video stimulate interest and curiosity (78,0%, of which 53,0% somewhat, 25,0% strongly agree), that they are issues we need to take charge of (87,8%, of which 44,3% somewhat, 43,5% strongly agree) and that concern us all (87,8%, of which 37,5% somewhat, 50,3% strongly agree). With regard to the topics they would like to know more about, there is high interest for new energy technologies (87,1%, of which 39,7% somewhat, 47,5% very much), functioning of the energy system (78,5%, of which 48,2% somewhat, 30,2% very much) and CO_2 storage (75,5%, of which 50,8% somewhat, 24,7% very much), followed by pollution related to energy production (71,7%, of which 51,3% somewhat, 20,4% very much), access to energy in the world (70,3%, of which 46,9% somewhat, 23,3% very much) and, last one, information on how the sub-surface is constituted (49,2%, of which 31,9% somewhat, 17,2% very much).

Discussion and Conclusions

In developing the results of the study coherently with its design, we did not aim to see whether people accept or don't accept CCS, whether they have a positive or negative perception, be it well informed or not informed at all. Instead we focussed on how people establish a relationship with the idea of CO_2 storage and associated technologies and on what can transform storage from something "unknown" to something that people can make sense of, thus enabling them to evaluate its possible role for reducing emissions.

The interviews allowed us to highlight the main emotional dimensions that seem to be related to the public perception of CO_2 storage. Based on this we were able to structure an experimental situation to test what seemed to be a critical determinant: the quality and degree of involvement of the citizens in the decision making process. The test produced interesting results, indicating that significantly different psychosocial dynamics can take place as a function of how the situation is perceived from a relational point of view. The relational context (in this case the most meaningful aspect is the indirect relationship with the Commission) can affect the consideration of the technology in a substantial manner. A relational context that communicates consideration of the opinion of the citizens and freedom of choice corresponds to a more reflexive attitude and consideration of the technology within the group. In contrast, a relational context that puts the citizen in the condition of "accepting" what has already been decided makes consideration of the technology more difficult and creates confusion and division in the group. A negative and critical perception of the relationship appears to be more relevant than the perception of the technology in itself, although of course it also affects it. One way in which the relational context seems to impact perception of the technology is by influencing the cognitive performance of the group, limiting its ability to explore and make coherent use of the information given. In other words, the group seems to be less able to reason and evaluate the technology on the basis of factual information. This aspect of the group experience is of particular interest because it could explain, at least in part, the obstacles that are often observed, for instance in public debates, to a rational discussion that takes into account different sides of an issue. The results of the focus groups questionnaire also seem to support this interpretation, since the participants in the D(decided) group tended more than others to agree with statements which associate the CCS option with deceptive intentions, like sweeping the dust under the carpet or a ploy to continue using fossil fuels.

Time is another important variable which has proved to make a difference in how perception develops. The complexity of the topic requires time. The discussion cannot be strictly limited to the technology, since it inevitably needs to deal with many related themes, like the reasons to implement it, trust in implementation processes, etc. This is not a technology which has an immediate appeal nor can it be quickly understood. However, the time difference is important not so much because with more time more information and learning can take place. Rather it is the transformation of CCS into a "familiar" topic that constitutes the most interesting mechanism. In other words, quality time dedicated to the technology also needs to be quantitatively significant to overcome the sense of remoteness and distance with regard to this technology.

Another fundamental aspect in the process of becoming "familiar" with the technology is the realisation that finding an answer to many questions might be impossible, at least for the time being. In this respect, the opportunity to ask the questions at all and the collective effort to try to address

them, emerged as something really useful and important for both the participants and the researchers. This is one of the most interesting observations coming from the research experience and results. The possibility of establishing a relationship, within the research context, which allowed joint exploration of questions and related ideas, doubts, fears, etc. raised by learning about the technology, provided the experience that was needed to understand that such an exploration: 1) answers a need; and 2) opens up new perspectives on issues that are frequently discussed in professional CCS circles (in addition to offering pertinent insights on the more static aspects of the participants' perception of storage). The consequences, in terms of understanding public perception, are manifold. Not only does it clearly show that public perception should be considered in dynamic terms, not as something static, but rather as something that is sensitive to the context and relationships within which it develops (an opinion which is in the process of being formed and changed rather than something with given characteristics). But it also indicates that by giving due attention to emerging needs we could improve the chances of a productive exchange on CCS, thus helping society make decisions about it. The study of perception through interaction with the public, as adopted in this project, has been shown to have good potential for new insights into what can help facilitate a serene discussion on the technology as well as wider cross-cutting societal issues relative to the introduction of innovative technologies and/or their implementation.

The experience with the long term group has particularly shown that the process of understanding problems together and building meaning together can be as, if not more, important than the content that is being exchanged about the technology in determining the relationship that will be developed with the topic. Among other interesting aspects, one that should not be underestimated is the motivating function that such a process can trigger. We have seen both in the individual interviews and in the groups that people tend to find it difficult to relate to such a technical energy theme like CCS and that this is often associated with a feeling of frustration. The study, and particularly the work in the long term group, gives support to the hypothesis that people will overcome such a sense of frustration and get involved in useful and interesting exchanges, provided that appropriate time, space and relational conditions are created. Work done in this direction could form a basis for a constructive exchange which could help stakeholders, like policy makers, better understand public perspectives and concerns towards CCS.

With regards to the issue of onshore versus offshore storage there is again a certain level of complexity that needs to be taken into account. The findings of this study, made within the Italian context, indicate that the issue of onshore/offshore is not very meaningful in itself and that there are many other aspects that come into play (although a certain tendency to prefer offshore storage was observed). It is probably something that needs to be analysed case by case; there is no clear priority of one over the other but rather some criteria have emerged which might make people choose. Therefore the choice of onshore or offshore would be better placed in terms of the choice of criteria to be used and priorities to be made. In this respect it would be key to undertake further study and, more in general, give people the possibility of making decisions on which criteria to include and which priorities to privilege.

Another aspect that was abundantly covered in the group exchanges regards the issue of costs-benefits. What is most noteworthy of this discussion is that there doesn't seem to be much balance in the consideration of costs and benefits. The costs receive overwhelming attention while the benefits are more difficult and complex to demonstrate. This in fact also constituted a bottleneck in

the group discussion. It doesn't help that, in the social context, those organisations who think it is worthwhile to spend money on CCS are mostly far and remote to individuals. For example, if we look at how the different social components perceive or seem to perceive the costs-benefits of CCS, we see that there are big differences between the position of organisms like the European Commission or the International Energy Agency-IEA, the national governments, industrial operators, civil society organisations and the citizens. The IEA or the European Commission, for instance, indicate that CCS is a cost effective solution for reducing emissions, while citizens see clearly the costs but feel quite unsure about the benefits. What makes for such a big difference and how can the gap between these positions be filled in the absence of a direct relationship which could more easily help understand the different perspectives and motivations? What could appear to be just an issue of lack of knowledge takes on a completely different meaning when we look at it from a subjective perspective? It is nearly impossible for people, under the present conditions, to understand the reasons why organisms like the IEA state that CCS is a cost effective solution, not just because people don't have the knowledge but because it is so hard to find a way to psychologically connect to them, something which would open the way to knowledge exchange. In this area there is ample room for further research and investigation.

The outcomes of the research activities confirm, and further demonstrate, what previous research has already indicated about the importance of getting people involved prior to decision making. Also the usefulness of the interaction between the public and expert stakeholders that many studies had already investigated has been confirmed. Further insight into why this is relevant and how it could be achieved have been produced in this work. This study can help us better understand the factors and processes that influence the perception of CO_2 geological storage.

Overall, there is interest in the technology when people have the opportunity to reflect on it and when it is introduced to them in a manner which takes into account emotionally relevant dimensions. But more than storage itself, what seems to raise the interest of people is technological innovation and the idea that something can be done to face important challenges of our time. This could be seen in the focus groups and is also evident in the response of the young students.

People perceive research and the existence of new technologies being tested as something important for society and in this respect CCS could also be seen as an entry point, however unusual, to the discussion on climate, energy and future lifestyles.

The research work in the UK

Executive Summary

A number of tasks including interviews with Stakeholders and industry experts, a Citizen Panel, interviews and focus groups with media and science communication professionals, a case-study of a CO_2 release experiment and a films analysis were used to determine public perceptions of CCS in relation to personal context and values, cognitive and emotional thought processes, experiences, and communication techniques.

The stakeholder interviews demonstrated that while most of the stakeholders were aware of CCS, the level of understanding about the process, and the meaning of the process to each stakeholder, varied widely. What CCS meant to the stakeholders could be assigned to one of six categories: opportunity; threat; bridging technology; ambiguity; impartiality, and preference to discuss other issues. While for most participants, the main meaning of CCS was fixed around either environmental, social, economic, technological or political issues; most interviewees made reference to the other aspects within their discussion and almost all referred to the importance of political leadership for CCS to succeed. Essentially, most participants considered CCS to be one component of a varied 'energy mix', which also focuses on sources of renewable energy as well as on energy produced through the burning of fossil fuels.

The key findings from interviews with those involved in science (and potentially CCS) communication centred around the topics of technical maturity of CCS; risk; costs; regulation; portraying the 'whole' story when underpinning knowledge is limited; pollution and waste disposal issues. CCS is considered a difficult topic to communicate due to the multiple arguments which need to be portrayed. Focus groups with science communicators and students of science communication identified a relationship between experience and perspective: the experienced science writers were more sceptical about CCS and the effectiveness of its communication, than were the Masters level students. What was striking to both groups was the lack of human perspective in much of the widely used CCS imagery. This was highlighted as a major barrier between the public and their connection with CCS.

The Citizen Panel highlighted a distinct reservation among the participants to discuss and offer opinion on CCS. The panel members preferred to transfer responsibility for judgements on CCS to those whom they believed had the expertise, knowledge or authority to impact upon the CCS decision-making process. A lack of connection to the technology in terms of tangible influences on peoples everyday lives was identified as one of the main reasons for this lack of willingness to discuss the topic, and participants chose, at every opportunity, to divert the discussion to topics with which they could identify and about which they felt a sense of agency (such as renewable energy technologies, energy conservation improvements at home or political leadership in carbon emission reductions). Participants repeatedly used analogues connected with their everyday lives to reformulate and understand issues, or to explain points they were making.

The use of analogues and pieces of information obtained previously were also important mechanisms in the processing of knowledge for those members of the public who commented on an experimental CCS project in Scotland. Participants showed evidence of carrying preconceptions or concerns from one context into their judgement of another, even when the two issues were not directly comparable thus demonstrating the importance of understanding peoples' experience, values and context, when gauging perceptions. Participants with a moderate level of knowledge about CCS demonstrated a stronger perception of the importance of risk and uncertainty than those

who knew little about the technology. Dissatisfaction in a communication process can manifest as an opposition to the specific technology. However, familiarity with a technology, a developer or a field of research can allow members of the public and stakeholders to connect with and more readily support a development such as CCS: this was demonstrated through the general support for the CCS experiment which was the subject of our study in Scotland. This is not to endorse the 'information deficit' model of science communication, but rather to emphasise the role of institutional connections between communities and research organisations and companies in building-up reputation and trust in information, projects and plans.

Interviews with industry professionals revealed that developers and project communicators anticipated very limited awareness of CCS among members of the public and some stakeholders. The exception to this is for those members of the public who are familiar with CCS or other related industries (e.g. the oil and gas sector, power generation sector), within their day to day environments. The lack of awareness and engagement was attributed by some interviewees, to the spatial distance of (offshore) CCS to members of the public, and the consequential difficulty in connecting with the technology on a personal level. The similarities in the industrial professionals' perspective of public perceptions, to the empirical research done on public perceptions, indicates that they (the industry professionals) have a good understanding of public attitudes towards CCS, at least in some respects. In terms of how perceptions affect CCS, all interviewees agreed that they can enable or disable a project, with Barendrecht being the key example given. Concern was raised about the leadership in promoting the benefits of CCS being left to the developers. A number of interviewees noted that politicians needed to show more support for CCS in general (rather than specific projects), in order to win public confidence for the industry.

The most effective CCS communication films used simple images and avoided mixing narration with the images or animations, instead using music to invoke various emotions. They also used analogues and cues to help the viewer engage with the message being portrayed and to visualise the message or issue within contexts familiar to them. Tapping into emotion was an important target for the more effective videos – those which incorporated humans into the 'story' and communicated the impacts on and of society, were more engaging than those with a technocratic or environmental focus. Those films with a clear message, theme or story line were more engaging than ones which simply presented a list of facts. In almost every film, images were used which mis-represented some part of the process (such as a depiction of CO_2 storage at the depth of only a few tens of metres).

Understanding the use of cognitive and emotional mechanisms such as heuristics and thinking according to System 1 and System 2 (Kahneman, 2011) for forming judgements, is important in allowing researchers and communicators to determine how values, context, knowledge, thought processes and personal experience will influence the perceptions formed about CCS. Tangibility and agency were identified as important criteria in allowing members of the public and stakeholders to engage with the issue of CCS. For members of the public to engage with and discuss a topic, it needs to be something which both appeals to their personal values and/or experience, and which they can visualise within the context of their own personal situation (tangibility). A sense of agency is necessary to enable members of the public to invest (in terms of time, effort) in something which, on the surface, may seem abstract and inconsequential to them. They must be able to see the relevance of the technology as well as understand their role in its deliberation, in order to feel responsibility in providing their perceptions. These insights should be used to design communication and engagement tools which are targeted towards specific users and which address the needs of the user, rather than (or as well as) the needs of the researchers, CCS advocates, planners and developers. In this way, a greater awareness of and engagement with CCS can be established.

Methodology

The methods and topics selected were heavily influenced by the post-project start cancellation of the offshore CCS projects in the UK and Italy. The Scottish Power / Shell project in Scotland was cancelled in October 2011, after several years of detailed Front End Engineering and Design (FEED) studies. The intention of the Scottish team had been to study the public engagement activities of the Scottish Power / Shell project. This was to include focus group / discussion group work and also ethnography, based upon participant observation at public engagement events. When the Longannet project was cancelled 6 months after the start of ECO2, the Scottish team had to re-think their approach. Most significantly, they were unable to proceed with participant-observation as there was now nothing to participate in or to observe. Whereas an actual project under construction would have enabled an in-depth evaluation of real-world responses, the team had instead to create its own groups for discussing CCS.

Tier 2 Stakeholder Interviews

A total of 38 open-ended interviews were conducted with environmental professionals from a range of backgrounds, between summer 2011 and spring 2013, within Scotland and England (Yorkshire and Teesside). The locations were chosen to represent areas with different levels of exposure to CCS. The sample of interviewees was selected to represent individuals from public and private sectors who had some professional stake in CCS, but who were not directly involved in its development. This included representatives from environmental NGOs, fisheries federations, local councillors in areas near to proposed projects, researchers, etc.

Each interview began with the same question: "What do you think of when you think of carbon dioxide capture and storage", after which the interviewees were allowed to discuss all of their thoughts on CCS and the interviewer interjected only to regain momentum in the discussion. The open-ended nature of the interviews meant that the interviewer had a number of topics to cover, rather than a set list of questions. This allowed a free-flowing discussion which was necessary for the subsequent textual analysis of the transcript by University Roma 'La Sapienza'. Furthermore, it allowed focus to remain on what the interviewees themselves wished to discuss, rather than being directed by the interviewer. This is particularly important for CCS given recent concerns in the literature over an excessive focus on risk and assumptions about how the public may perceive CCS (Terwel et al, 2012; Bradbury, 2012; Mabon et al, 2014).

Interviews were transcribed and analysed using a grounded theory approach (Crang, 1997), in which common and distinct topics of discussion were identified for each interviewee. Transcripts were each read three times: the first to gain a holistic understanding of the conversation, once to identify key points relating to CCS and once to identify themes and relationships within the conversation. This approach was designed to allow all relevant aspects of the transcript to be identified and themes recorded.

Media Focus Groups and Interviews

Technical reports on CCS produced by the IEAGHG were analysed with the aim of producing non-technical documents for stakeholders and members of the public. Eight topics were identified within the IEAGHG documents: environment; leakage; costs; infrastructure; legal issues; public, context and opinions. The information needs of the intended audience (i.e. science and technology writers, journalists, communicators; those involved in curriculum development and local council members) were then established using interviews and focus groups with representatives of the intended audience. One focus group involved a range of science writers and professional communicators, both in the traditional and new social media. A second focus group was held with

students who were undertaking a masters-level course in Science Communication. The interviews and two focus groups aimed to address a number of questions: Who are the intended audiences? Which topics are of interest? To what extent are the key concepts understood? How is information accessed, interpreted and absorbed? How should information be presented?

Based upon the findings of the interviews and focus groups, the Briefing Notes for stakeholders and interested members of the public were prepared which addressed: Setting the scene for CCS – Human-caused climate change; Brief history of CCS development and current status; Matching CO_2 sources with potential storage sites; How is CO_2 Captured?; Costs of CCS; Infrastructure needs for CO_2 transport; What naturally occurring CO_2 in rocks can tell about CO_2 storage; CO_2 storage mechanisms and site selection; Impacts of leakage from onshore and offshore storage sites; Monitoring the safe storage of CO_2; Legal issues around CCS; Public perceptions of CCS. Briefing notes were typically around 2000-3000 words, and made use of diagrams, figures, text boxes and photographs. Additionally, a number of information sheets were prepared for those stakeholders and members of the public who were interested but less technically informed. These were around 500 words in length and were dominated by illustrations, diagrams and photographs. The full set of Briefing Notes and Information Sheets were disseminated by both the IEAGHG and ECO2 websites.

Citizen Panel

A Citizen Panel (CP) was established as a series of discussion groups with the same group of people (17 in total), which took place for two hours, on alternative weeks, for 12 weeks (i.e. a total of 6 sessions and 12 contact hours). The aim was for the CP to discuss climate change, climate change mitigation and the wider energy debate for Scotland, including the role of CCS. The panel was started from the 'Life-World' perspective of the participants, which allowed the CP members to start their thinking and learning process from a point with which they were comfortable, rather than from a technically-defined starting point set out by climate change science or engineering. This allowed the CP members to feel comfortable with the process and to empower them to shape the process as they wished. The participants were given the freedom to define which issues they wished to discuss and learn more about. This allowed the researchers to determine where CCS featured in their articulation of a modern energy mix, and in their current framing of the energy and climate debate.

Participants were selected from the Edinburgh area by a professional polling firm and were intended to represent a range of socio-economic contexts, although they were not intended to be a representative sample of the population of Edinburgh: this would not be possible with such a small number. Rather, the perspectives provided were intended to be a 'snapshot' of a reasonably diverse group of the public in the Edinburgh area. Members of the public directly involved in the energy industry or members of environmental NGOs were filtered out to avoid presence of already strong opinions on the topics being discussed. Furthermore, the emphasis for the researchers was on the learning and development processes of the panel members, rather than their initial awareness and perceptions of CCS – which were very limited for the CP members at the start of the process.

The Citizen Panel met six times and the meetings were structured as follows:

Meeting 1: Exploring the life-world position of participants through breakout groups.

Meeting 2: Presentations on climate change and carbon mitigation options, given by researchers, and including a facilitated Q&A session.

Meeting 3: Continued Q&A and discussion from previous meeting. Discussion by panel members around further information requirements – identification of potential speakers for future meetings.

Meeting 4: Presentation on CCS. Presentation on University Central Heating and Power system as an example of low-carbon infrastructure.

Meeting 5: Question Time format session to discuss Climate Change Act (2009) Scotland, with a former Scottish Civil Servant involved in implementation of the above Act, and the Director for Renewable Energy Projects at Scottish Power plc. (a major energy company in Scotland and one-time promoter of the Longannet CCS project).

Meeting 6: Development and answering of key questions which the panel members saw as relevant for progressing debate on climate change, energy and CCS.

The formal meeting process was followed by telephone interviews, in which the reflections of the CP members on the process and on how they perceived their development as a result of the process, were sought. In addition, all write-ups of CP members perspectives were offered to the CP members for further commenting and approval.

QICS Assessment

A social science analysis of the QICS (Quantifying and monitoring potential ecosystem Impacts of geological Carbon Storage) project was carried out in 2012. The QICS project involved an experimental release of CO_2 in the Ardmucknish Bay, Argyle, UK. The social science component involved an analysis of the public engagement activities being carried out as part of this (potentially controversial) experiment, including i) a passive observation of two QICS public engagement events and ii) interviews with SAMS (Scottish Association for Marine Science) staff, local stakeholders and community members aware of the experiment (following the experimental release) to examine the factors driving perceptions of off-shore CO_2 storage (Mabon et al., 2015). The interview data was supplemented with findings from informal discussion held at a local farmers market, at which one ECO_2 researcher hosted an information stall. Additionally, the contents of online news articles (and associated comments) about the project were evaluated to compare the themes arising in the small scale interview process, with the wider discussion on the topic.

Analysis was based on an adapted version of the Doucet and Mouthner (2008) 'listening guide', in which interview transcripts were read four times to gauge: i) interviewers' own responses, ii) the way the interviewee talks about themselves, iii) how the interviewee talks about relationships, and iv) the wider themes the interviewee raises (Mabon et al., 2015). Themes identified were gathered from interviews, field notes and online media notes.

Industry Professionals Interviews

Semi-structured interviews were conducted with nine professionals in the CCS industry. These included representatives from CCS developers (Shell), energy companies (SSE, EON), research, development, communication and promotion institutions (IEA, ETI, CCSA), service providers (National Grid UK) and industry (BP, Tees Valley Unlimited). The interviews were carried out between August and September 2014, over the telephone or in person. Questions were designed to address two main themes: i) the views of technical experts and professionals in the CCS field, on what public perceptions are, regarding CCS, and what is likely to influence those perceptions, and ii) their industry's current communication/engagement practices, and their reflections on those approaches.

Contents analysis of the responses to each interview question were carried out in order to identify individual's attitudes to public perceptions of CCS and approaches to communication and

engagement. Grounded theory was then used to determine themes and commonalities between the interviewees' responses.

Films Analysis

A number of on-line, publically available CCS communication films were reviewed in order to analyse the way in which CCS is currently being communicated through visual media. The findings of this activity were combined with findings from the above tasks to develop a number of recommendations on how to use our knowledge of how people learn and form judgements, in informing future visual communication initiatives.

Following Philo and Happer's (2013) suggestion that "research on visual media should employ visual methods", the chosen films were viewed systematically by two researchers according to a number of pre-defined categories of analysis. The films were viewed three times. First, to note general impressions, second to make detailed comments on the specified categories, and third to discuss observations as a team. The categories for analysis were chosen according to important aspects of the learning process (some informed by general scientific understanding, some informed by findings from previous research tasks). These included: graphics; music; narration; theme/message; content; bias; audience/level of technical complexity; accuracy/errors/representation, framing of CCS in relation to other energy technologies and overall impression. The overall effectiveness of each film was evaluated and recommendations developed for future film production in CCS communication.

Results

Tier 2 Stakeholder Interviews

Although there has been extensive research into the public perceptions of CCS, less is understood about the perceptions of stakeholders and particularly those who are not directly involved in CCS, but who have the potential to be involved or who have an interest in the process (termed 'Tier 2 stakeholders': Shackley et al., 2007). Interviews with Tier 2 stakeholders revealed a number of themes about attitudes towards CCS. While some Tier 2 stakeholders demonstrated a limited understanding of the CCS process, they had an awareness of CCS as an emerging technology which may require their future attention. For others, CCS is a topic about which they possess in-depth knowledge concerning its implications for one or more fields, including environment, society, economics and policy. Furthermore, some interviewees suggested that they did not have a 'good' understanding of CCS, but went on to describe it in considerable detail. This suggests that how people define understanding varies among individuals, and this may have a bearing on how knowledge and opinions are communicated to others.

After describing their often limited perceptions of CCS, many participants quickly shifted to a discussion of wider energy, climate or environmental issues. This could be a consequence of limited knowledge of CCS, a perceived lack of relevance of CCS at present, and/or an attempt to set CCS in a broader context of climate change mitigation, energy renewal and environmental change. Essentially, most participants considered CCS to be one component of a varied 'energy mix', which also focuses on sources of renewable energy as well as on energy produced through the burning of fossil fuels. In some cases, interviewees side-lined CCS very early in the conversation and explicitly focused on discussing other issues (focused around societal matters or alternative energy technologies) which they claimed to be most salient at present (the most common example being employment issues for an area and considering CCS primarily in terms of jobs it may create or negate).

Few participants took a view which considered the whole process of CCS, instead, most focused on one specific aspect, which was generally reflective of their professional context. For example, the NGO-based interviewees were concerned about environmental disruption and leakage risks, while political representatives were concerned with employment opportunities and social or community impacts of local infrastructure. However, most participants voiced opinions on the political implications or constraints at some point in their discussion, indicating that some issues affect most people, while others are influenced by personal or professional context and values.

Many participants seemed to be aware that technological development and implementation required a long-sighted perspective in order to be able to design, implement and monitor the implications of a process such as CCS. They also noted that most people do not operate on these timescales, for example, politicians focus on what will be beneficial to their campaigns (timescales of less than five years), while individuals and members of the public may think on timescales of a few years: the foreseeable future. Therefore, some interviewees felt that successful implementation of a project could be hindered by the contrasting and limited outlooks of those involved.

Attitudes towards CCS varied among the interviewees and have been categorised according to six themes: CCS as an opportunity; CCS as a threat; CCS as a bridging technology; ambiguous feelings about the value of CCS; impartiality on the subject of CCS, and finally, a preference to not discuss CCS but to divert the conversation to alternative topics. Individual themes were rarely exclusive for an individual, and for most interviewees, one of these categories could also be applied as a 'secondary attitude', e.g. ambiguity about the value of CCS as the prime attitude and tending towards CCS as an opportunity as the secondary attitude.

Media Focus Groups

Interviews (professionals: lawyers, financiers, insurance brokers, science communicators and educators, local councillors)

Within the UK interviews, key findings centred around topics such as technical maturity of CCS; risk; costs; regulation; portraying the 'whole' story when underpinning knowledge is limited; pollution and waste disposal issues. Professionals such as lawyers, financiers and insurers will tend to rely upon their clients for much of the detailed information they require. They also rely heavily upon intermediaries – i.e. agencies, information brokers and networks of professionals which sort through and evaluate technical and scientific information. Hence, communicating to professional groups is a matter of getting information with the appropriate level of detail and context to such intermediaries. As for science communicators, the key message was that CCS is a difficult thing to communicate about because of the number of different arguments which have to be presented and accepted before arriving at the conclusion that CCS could be 'the' or at least 'an answer'. The importance of being open with the public about uncertainties and unknowns and not to 'dumb-down' the science was highlighted. Local councillors seemed more concerned about onshore pollution, with focus on capture, rather than transport, of CO_2.

There was limited knowledge about the nature and uses of CO_2, and an even greater limitation in knowledge about the existence and technological details of CCS. Concerns for CCS centred around issues of leakage, monitoring, environmental impacts, impacts on investment in renewable energy technologies, cost and legal implications/regulation. When describing communication requirements, the following were considered as important: trustworthy source; accessible format; references to multiple sources; list of experts in the field; up to date, ability to reproduce/share information with

others. More information would be beneficial on costs, regulation, long-term liability, policy requirements, role of government vs industry.

Focus groups (one with professional science writers, communicators and journalists; one with MSc students in Science Communication)

In the UK, the students were, in general, more positive and optimistic than the science writers who were more sceptical about efforts to communicate CCS and, to some (varying) extent, about CCS itself. A common theme in both groups was that most images and representations of CCS come across as very technical, with an absence of people and lacking, in general, a 'human-side' – this changes the image of CCS 'doing something good for the environment', to being potentially bad for the environment – i.e. industrial, technical and unfamiliar. Commonly accepted images within the CCS community can easily be misinterpreted, even by professional science writers. Compounding this is the use of technical terminology, which also distances people from the process of CCS and generates misinterpretations. There is a lot of emphasis on geological storage features in diagrammatic representations of CCS. However, this assumes geological knowledge on the part of the reader, which is often not the case. Economic figures and analogues are not always helpful for the reader in understanding implications of CCS and therefore suggestions were made to consider readers' needs before designing communication materials. Different organisations communicating the same message can be received differently (e.g. academics and NGOs may be trusted more than industry).

Citizen Panel

Meeting 1: The 'life-world' approach was constructive in that it indicated broader themes to be deliberated later in the Citizen Panel. This helped the facilitators understand the opinions, interests and preferences people have in their everyday lives as well as in relation to their local environment and ongoing change, but also allowed them to draw initial conclusions for the anticipated topics of climate change and energy futures. There was a focus in discussion on the perception of central issues as they manifest at the local level (i.e. the Edinburgh and Lothians area). Local and familiar examples were consistently used as reference points to frame and explain complex issues and to locate them in the everyday lives of the participants. During this open discussion, issues of lifestyle, wellbeing, financial security and quality of life dominated over environmental, energy and climate issues.

Meeting 2: The presentations in this meeting helped to build the participants' knowledge on the nature and relevance of climate change. Participants expressed surprise at the urgency of the climate change issue, and subsequently, the limited visible action being taken on the issue. Questions focused on renewable and nuclear energy sources, local implementation issues and global justice issues. The concept of CCS (which had previously been unfamiliar to all participants) was received with mild interest. Initial questions were formulated around analogues, such as hydraulic fracturing, and focused on issues of CO_2 storage safety. There was a general absence of voluntary discussion of CCS, although one member actively requested further information.

Meeting 3: A survey conducted between meetings 2 and 3, and the discussion in session 3, indicated that many of the participants experienced a change in attitude towards climate change, in response to the information provided in Meeting 2, and the associated discussions. This change included an increased concern about the issue of climate change, and about national and international efforts (or lack of), to mitigate effects. A small number of participants expressed some scepticism over the role of climate mitigation proposals, including CCS. The proportional role that Scotland can play in comparison to countries such as China, India and the US, raised a number of questions and was the focus of much discussion. The local implementation of policies and practices related to climate

change dominated the debates of the Panel and prevailed over the discussions of particular large-scale mitigation strategies and energy types, such as renewables, CCS or nuclear power. Topics suggested for further discussion included: national enforcement of climate change measures; low-carbon strategies and local implementation; the Climate Change Act (2009) Scotland; renewable energy technology implementation and CCS.

Meeting 4: During the presentation on CCS, most participants took some interest in the technology and its applicability within Scotland and the UK. For most participants, the use of CCS in climate change mitigation was clear from the presented information. However, perception and understanding of the technology, the state of the art, practical deployment and real-life reference points remained obscure, abstract or idealistic. Participants expressed difficulty in envisaging how CCS would become operational and what its impacts would be. The topic of CCS was not received with much enthusiasm and panel members tended not to perceive it as an emerging technology, or as something which would be effective in significantly reducing CO_2 emissions, at present. Questions focused on practical examples, applications, regulation, investment motives and risks associated with storage. Analogies were used in this situation to draw conclusions and judgements (e.g. a comparison to the Deepwater Horizon oil spill in the Gulf of Mexico).

Conversely, the presentation on the University of Edinburgh's Combined Heat and Power system was well received and engaged the panel members fully. The participants welcomed the tangible and (compared to CCS) small scale example in envisaging how to reduce carbon dioxide emissions. Panel members expressed a keen interest in the potential for further applications of the technology within new and existing developments in Edinburgh, and offered suggestions about how the technology could be more widely implemented.

Meeting 5: Questions for the Q&A session were based around i) the Climate Change (Scotland) Act 2009 and ii) the wider role of companies in meeting carbon emissions and renewable energy targets. The Citizen Panel members engaged enthusiastically in the Q&A and resulting discussion. There was some limited discussion of CCS which was centred around the practical limitations of implementing CCS, including difficulty in retro-fitting power plants, and the energy requirements for running CCS infrastructure. As a result of this discussion, the Citizen Panel members appeared to take an even more critical approach to CCS. A summary of the key insights of the CP is as follows:

- Awareness and knowledge of CCS was limited at the outset of the process. There was some interest from a small number of group members which led to the inclusion of a presentation on the topic. Despite this, when asked to specifically comment on the role of CCS and renewables in reducing emissions, the CP focused their answer on renewable technologies. When pressed further about the role of CCS, few group members responded, but those who did suggested that it was a technology so far removed from themselves and their daily experiences, that it was not something of great concern to them or that they felt able to comment on. Instead, technologies and initiatives which affect their homes, bills and employment were the ones which received most of their attention.
- The Panel expects the Government to implement a top-down approach to management of carbon emissions reduction. When asked about how members of the public can be encouraged or assisted to make changes to reduce their carbon emissions, the group as a whole called for more direction and regulation from the government. The role of the Scottish Government and energy companies in assisting businesses and individuals to reduce carbon emissions was a topic of significance to the Panel.
- While confidence in Scotland's ability to achieve its self-imposed carbon emission reduction targets is low, some Panel members believe that Scotland has a responsibility to carry on working towards these targets and to showcase its commitment and its approaches to the rest of Europe. Conversely, some group members considered Scotland to be 'too small' to

make any significant difference to carbon emissions, regardless of how committed it was to meetings its targets.

- The group used a range of examples and analogies to illustrate the arguments they were making (e.g. the UK smoking ban to demonstrate that they believed practice would be adopted naturally over time if the government used strict legislation to enforce initiatives to reduce carbon emissions). Another example used was of the (re)-building of a shopping centre in Edinburgh which they believed should have only received planning permission if it was designed as a low carbon energy building – it was suggested this should be applied to all new developments.
- The use of everyday and familiar examples demonstrates how individuals use existing knowledge and experience to frame their perspectives on an issue. For example, solar panels were mentioned a few times as examples of renewable energy technology that the panel members are familiar with. This highlights a potential problem for trying to engage the public with CCS developments, which may not impact upon them directly.

Meeting 6: Six questions were formulated and agreed with the Citizen Panel members, which were designed to frame the opinions of the group members on topics of climate change mitigation and carbon emissions. The responses are summarised below and are the collective group's response to the questions.

Question 1 Are Scotland's 2020 carbon emission reduction targets realistic? The overall consensus stated that the target set out by the Scottish Government (to reduce carbon emissions by 42% by 2020) was not achievable. Responsibility for reducing carbon emissions lies with the individual, not just with the government. One member strongly disagreed with the answer that was formulated within the group and felt that we are led 'from the top and by people with the money'.

Question 2 What measures should be taken at the local level (household/town/urban district scale) to address climate change? It is important for people to take small, collective steps on an individual level in order to achieve wider benefits. These steps should be supported by incentives from councils and governments. On a slightly larger scale, it would be beneficial to offer incentives for the adoption of community/local renewable energy production. Increasing awareness (e.g. through focus groups) and making targets achievable would also encourage individuals to take steps towards addressing climate change. When voluntary change is not happening, it may be necessary for the Government to lead more strongly. Most participants claimed to be open to a more rigid enforcement of changes by the government. Some participants thought that enforced changes would, in time, become common practice. However, one suggested that there will always be individuals who resist change, but good practices should be inherent within any government movement. Enforcements for small businesses were also proposed.

Question 3 What is the role of (i) renewable energy technologies, and (ii) carbon dioxide capture and storage, in reducing carbon emissions? How does CCS compare to other low carbon energy technologies if we consider all to be equally expensive? Renewables were considered to be favourable as a way of reducing CO_2 emissions compared to CCS as they do not produce carbon dioxide and do not require fuel inputs to work. CCS is considered to be a good solution to reducing carbon dioxide emissions, in theory, but it is costly to set up and the extent of its true effects may be limited. CCS was considered to be one of a range of options, not a standalone solution. Government subsidies should support CCS - because the activities of energy companies are profit-driven, and CCS is not currently profitable, then CCS cannot be established without the aid of subsidies or supporting schemes.

CCS does not feature highly in the concerns/opinions that people have in the technology options for reducing carbon emissions. There are other technologies and initiatives which are more tangible

and achievable, while CCS is 'distant and unclear'. Due to the limited public knowledge of CCS and its current progress, the public may not be fully convinced of its merits and the processes involved. Therefore, CCS must be made more understandable for the wider public, if it is to become a key part of the solution to reducing carbon dioxide emissions.

Question 4 What is the role of large and small businesses in reducing emissions and tackling climate change? For large, international businesses, it was suggested that they are led from their head offices and therefore, their behaviour must also be changed via a top-down approach. Smaller businesses may need more support in reducing emissions and in developing effective incentives for good practice or penalties for non-compliance. Government officials should be appointed to monitor the measures taken by businesses to reduce carbon emissions and instances of non-compliance with regulations or missing targets should be recorded. Support could also be provided from the government in the form of advice on how to reduce carbon emissions. There was much discussion about the role of energy efficiency, particularly in new homes and buildings. There should be more support for housing improvement (energy efficiency and energy production from homes, e.g. micro-gen) from both energy companies as well as the government.

Question 5 How can people be encouraged to change their behaviour to tackle climate change and reduce carbon emissions? What role should the government play in encouraging behavioural change? The government should lead on instilling behaviour change – by raising awareness of the issues. This would help individuals to understand the effects of particular activities and for the government to make known which activities should be prioritised in reducing emissions. If the government could provide information to contextualise these activities in terms of their relative carbon emissions, individuals would be better placed to make decisions for themselves regarding how to reduce emissions. It was suggested that the government should work closely with energy companies to change their (market-driven) attitudes through encouragement and incentives or legislation to penalise. Incentives should be offered to individuals or small groups, for behaviour change.

Question 6 What is Scotland's role in tackling climate change? Should we be leading the world, or should we be following the practice of other countries? Part of the group believed that Scotland is too small to have a global impact, while others noted that it is our responsibility to at least try to make changes and to share our ambitions with others. Therefore, it is important that we both lead and share the practices of others. It is important to demonstrate to the EU what Scotland is doing to tackle carbon emissions and energy issues. Climate change should be made a priority for the Scottish Government.

QICS Assessment

Three themes emerged from this study: i) how people learn about issues such as CO_2 storage, climate change and their environment; ii) how people evaluate questions of uncertainty and risk, iii) the importance of timing and framing in engagement.

How people learn about climate issues

People draw on 'familiar' or analogous information in order to help them make sense of abstract or unfamiliar problems. Members of the public and stakeholders were found to remember some pieces of information accurately, and others were remembered partially, inaccurately, or were misinterpreted. People drew on information they had received elsewhere in order to inform their initial perceptions of CCS. When details are partially or mis-remembered, this can lead to perceptions of CCS which are not grounded in best available knowledge. However, these are the perceptions upon which people act. Participants showed evidence of carrying preconceptions or concerns from one context into their judgement of another, even when the two issues were not directly comparable (e.g. concern about an onshore CCS project in the US affecting judgement of an

offshore experiment in the UK). It was also found that personal understandings and personal experiences of one's local environment can be used in shaping a judgement and were found, in this case, to contribute to a more cautious stance to offshore CO_2 storage (Mabon et al., 2015). The use of analogues is important in forming perceptions: it was found that personal experiences can assist people in understanding new and complex phenomena (e.g. using understanding of known risks of marine pollution in one's local environment to evaluate the relative risks of CO_2 release in that same environment).

How people evaluate questions of uncertainty and risk

Some members of the public engaging with the QICS experimental CO_2 release in Scotland (at the public information talk) were willing to hold discussions of high technical, moral and ethical complexity, despite possessing limited scientific information on the matter (Mabon et al., 2015). They raised a number of questions focused around risk and transferability of knowledge from a small-scale experiment to a large-scale CCS implementation. In contrast, members of the public engaged at the farmers market admitted to having limited knowledge about the CCS process, but also limited concerns about its implications. This suggests that with an increase in knowledge (before reaching the point of being regarded as 'knowledgeable' on CCS') comes an elevated perception of risk and uncertainty (i.e. an increased understanding of the limitations and shortcomings of the technology/process, etc.). Discrepancies between interpretations of the term 'uncertainty' between scientists and knowledgeable members of the public were identified within this study. These can cause conflict or mis-interpretation of risks. While scientists accept, embrace and account for uncertainty, members of the public or stakeholders may take it to mean there are great and unreconcilable risks, and refuse to accept an uncertainty as reasonable.

The importance of timing and framing in engagement

The QICS public information meeting and interviews with research scientists signalled that it is very complicated for developers or researchers to engage the public before they have found an appropriate site for a project or experiment (primarily due to the sheer volume of people that would need to be engaged if looking at a range of possible sites). However, announcing that a project has been decided upon at the first engagement meeting can cause upset or offence to the affected members of the public (as expressed by several meeting attendees). This can lead to objections which are rooted in a dissatisfaction in the way the affected members of the public have been treated, rather than in concerns over safety, risks, economics, etc.

Ultimately, the familiarity that a community shares with an industry or developer in their area, and whether similar experiences in the past have been positive or negative, have a strong influence on the public and stakeholder response to such developments. In the case of the QICS project, the fact that the Scottish Association for Marine Science (SAMS) enjoys a long-standing reputation for quality scientific research, is a major employer in the local area, with many of its researchers living in the local area, led to generally high levels of support and trust for the QICS experiment (Mabon et al., 2015), despite the relatively unfamiliar nature of the specific experiment.

Industry Professionals Interviews

Industry professionals believe that public awareness of CCS (and understanding of the technology) is low or non-existent, with the exception of locales around test sites and proposed sites (main examples for UK were Peterhead and White Rose projects, and around the Teesside industrial hub). One interviewee (a CCS developer) noted that within such areas, the provision of information about CCS had resulted in an increase in public support for the technology. Support for CCS is believed to be indirect – i.e. because of its potential to provide employment and investment in an area, rather than its environmental or energy-related impacts. One interviewee suggested that CCS does not engage people in the way hydraulic fracturing or nuclear power generation do, because it is offshore

and distant to them. There was reference to the different perspectives that UK residents have in comparison to mainland residents, and a warning to not act too strongly in the UK, based on European responses to CCS projects. The implementation of an overland pipeline for the White Rose project was cited as being the likely most controversial aspect of CCS in the UK, due to its route across rural land which has previously been unaffected by industry. Other potential concerns were expected to be around leakage, induced seismicity and storage integrity issues. Many of these findings echo the findings of the perceptions work which has engaged directly with the public and stakeholders, suggesting that industry professionals have a good understanding of public attitudes towards CCS.

According to the industry professionals interviewed, factors which affect public perceptions of CCS include the perceptions of key community members (politicians, media, pressure groups); threats and benefits which are personal to an individual, rather than societal impacts; outputs from early CCS projects will be strong shapers of public opinion; perceptions of other energy technologies (hydraulic fracturing, nuclear energy). In terms of how perceptions affect CCS, all interviewees agreed that they can enable or disable a project, with Barendrecht being the key example given. Public interest can also be beneficial for the wider CCS industry as it will attract political support. Public perceptions of climate and energy related issues are thought to be dependent upon other contextual and value-based issues which people have to deal with at a given time – for example, the financial crash diverted attention away from climate change and therefore also from CCS. Industry professionals seem to be aware that they must learn from previous or similar cases when developing public engagement strategies – popular examples for illustrating this has been the public response to hydraulic fracturing and the BP Horizon Deepwater oil spill.

Concern was raised about the leadership in promoting the benefits of CCS being left to the developers. A number of interviewees noted that politicians needed to show more support for CCS in general (rather than specific projects), in order to win public confidence for the industry. CCS developers feel they are taking a large financial risk with CCS and do not want to add to this a public relations risk. Communication and engagement were considered to be essential in order to raise awareness and gain public and political support.

Films Analysis

The CCS communications films varied in quality, message and approach. The most effective ones used simple images and avoided mixing narration with the images or animations, instead using music to invoke various emotions such as panic, fear, calmness, uncertainty, etc. They also used analogues and cues to help the viewer engage with the message being portrayed and to visualise the message or issue within contexts familiar to them (e.g. by showing volume of coal, oil, gas used per day, against a backdrop of Manhattan (New York City) – a landscape which is familiar to many). Tapping into emotion was an important target for the more effective videos – those which incorporated humans into the 'story' and communicated the impacts on and of society, were more engaging than those with a technocratic or even environmental focus.

In a number of the films, a 'subliminal bias' was evident, in which the film stated that it was providing an impartial information source on CCS, but in which some bias for or against was unintentionally evident (by giving disproportional amounts of attention to CCS, or not offering any information on alternatives, such as renewables, presenting renewables as 'clean and green' and CCS in a highly technical manner, or insufficiently addressing the concerns and limitations of CCS). Those films with a clear message, theme or story line were more engaging than ones which simply presented a list of facts. In almost every film, images were used which mis-represented some part of the process (such as a depiction of CO_2 storage at the depth of only a few tens of metres), or images which provided an impression of a carbon extraction-processing-storage cycle which was continuous

(i.e. suggesting that CO_2 was immediately deposited back into the location from which the coal/oil/gas had been extracted). It is believed that in most cases, these mis-representations are a result of producers aiming to portray complex, technical information to uninformed audiences. However, such portrayals can have significant effects on the perceptions people form about CCS, particularly if such films are the first impression of CCS which people get.

Discussion

Fast and slow thinking: Systems 1 and 2

The mixed and changeable response of many of the research participants in this study (and particularly in the Tier 2 Stakeholder Interviews component) is indicative of a transition between thought processes, described by Kahneman (2011) and Tversky and Kahneman (1974) as 'System 1' ('fast thinking') and System 2 ('slow thinking'). System 1 thinking uses intuitive thought (expertise and heuristics), in addition to automatic mental activities (perception and memory), to make quick judgements on an issue. This fast thinking is characterised by quick, effortless non-voluntary operation; neglect of ambiguity and suppression of doubt; a bias to believe and conform; focus on existing evidence and overlooking of absent evidence; substitution of an easier question for a more difficult one (i.e. heuristics) and narrow framing of decision problems, in isolation from one another (Kahnemann, 2011). For many of the Tier 2 Stakeholder Interviewees, the question "What do you think of when you think of carbon dioxide capture and storage" is one which incited an initial rapid response, a snap judgement, on the issue (System 1), but which incited the participants to go on to consider the issue in depth and call on existing knowledge, contextualised by their values, to evaluate and reform (if necessary), their initial judgement (System 2).

System 1 thinking can be utilised by those who are required to make a judgement on an issue about which they have limited information. This may include members of the general public (Tier 3 Stakeholders, (Shackley et al., 2007), and some members of Tier 2. In the absence of their own knowledge or expertise on the issue of CCS, they draw on other sources, such as the knowledge of others whom they trust, or their own knowledge about a subject which they believe to be analogous:

"I think of geological storage, so, you know, deep underground, I'm sort of vaguely aware that there were, there was talk about storage at the bottom of the oceans but that that has problems with acidification." Interview SCO17

"I don't know why the reasoning is, and why they're trying to capture it really. I think it was probably on the news I think I heard something about it....If there was a leak it would all bubble up, wouldn't it, and leak back into the atmosphere? Well I suppose if there's a, well it's a bit like a poison really" Interview SCO23

This fast thinking process can also be employed when participants are asked to form a judgement quickly: in this case, they may provide a quick 'fast thinking' response, and then reflect upon the question in more depth. This is characteristic for interview environments, in which respondents may feel they are expected to answer the question immediately. The following quotes are taken from the same interview, the first is an immediate response to the question, and the second is the evaluation of the question in more detail:

"That it's a good thing! Because I think there is an end goal, particularly in Scotland and the western world of trying to move to renewables, but that's not going to happen any time soon… and to be able to do that in my opinion, in the relatively short term CCS is the only opportunity because we have the

infrastructure and capability, technology and some of the knowledge to be able to do that....."

"It's feasible, but with the main problem is it is, is cost, because it's first and f-, kind of an industry in its infancy, everything at the beginning costs more and that's where that, the, not the problem but the difficulty, the hurdle to overcome is, otherwise industry would be doing it anyway" Interview SCO03

In contrast to the fast thinking brought about by System 1, System 2 offers a 'slow' thinking process which affords attention to mental activities of evaluation and processing. Associated with System 2 thinking are the subjective experiences of agency, choice and concentration (Kahnemann, 2011). It stops us from hastily acting upon the judgement offered by System 1, and makes us consider the issue more deeply before responding. It therefore requires conscious attention and if that attention is distracted, this slower, deliberate thinking will cease. Consequently, System 2 thinking is used by those who have the capacity (knowledge) to delve deeper into a problem and deliberate the options for that problem before coming to a conclusion. For CCS, such individuals include Tier 1 stakeholders (for whom decision-making about CCS is their job and therefore must be thorough), as well as many Tier 2 stakeholders, who have some vested personal or professional interest in CCS and pursuing this interest depends upon their considered evaluation of the process.

Systems 1 and 2 do not operate exclusively of each other and an individual does not select whether to use System 1 or 2 in addressing a problem, rather, System 1 is employed involuntarily and System 2 comes into play when System 1 is about to (or already has) lead to an error, utilising logic and statistics (provided the relevant knowledge and skills exist), which System 1 does not account for (Kahnemann, 2011, 25). Tier 2 stakeholders tend to concern themselves heavily with uncertainty when questioned about CCS, and many were ambiguous in their judgement of the technology. It is evident here that during the course of the interview, such participants were testing out their own judgement through a cognitive process – System 1 provides them with initial answers to the question of 'what they think of CCS', but System 2 is then used to address the complexities of the question – to consider the uncertainties associated with the approach, and develop a more cognitive or logical response to the question. In the following quote, System 1 is evident through the use of a tallying heuristic (renewables meet the most cues because they are *"a better solution than...."*) and equality heuristic ("*we need a bit of everything*"). However, by considering the benefits of CCS, the limitations, and the alternatives, the thinker is presenting a cognitive deliberation (System 2) within their interview response, based on their knowledge of CCS and of related options. They are evaluating CCS as they speak.

"I think that, whilst it's probably necessary, it [CCS] *doesn't solve the real problem... To me it* [renewable energy] *seems like a better solution than just taking the carbon that we emit, continuing to emit at such high levels and then putting it in the ground. […] So I suppose my answer really is we need a bit of everything, and I am sure there is a role for it somewhere, but I think more emphasis should be on reducing the emissions."* Interview YH08

While those who engage in System 1 thinking only (i.e. Tier 3 and some Tier 2 stakeholders) have limited knowledge of a subject and therefore draw on heuristics which allow them to shift the question or the topic (e.g. recognition/fluency, satisficing or equality heuristics), those who engage in deeper thought (many Tier 2 stakeholders) do engage in System 1 thinking using heuristics such as take-the-best, tallying, equality and caution (and potentially imitate the successful), but then use the initial responses brought about by these heuristics to build upon and question the details of their response. A 'gear change' can be seen for many of the interviewees in this study which shows them

presenting one opinion, but then also taking account of, and balancing the importance of, another opinion, within the argument.

There is no distinct relationship between dominance of System 1 or System 2 characteristics and the categories of 'CCS meaning' that were assigned to each interviewee (opportunity; threat; bridge; ambiguity; impartiality). The exception to this is for those who chose to focus on topics other than CCS during their interview – all of these participants demonstrated System 1 characteristics only, when speaking directly about CCS. Instead, they diverted focus to another topic about which they did possess knowledge/understanding, and often demonstrated the use of System 2 for evaluating their alternative topic (e.g. they identified that CCS is capable of reducing CO_2 emissions, then moved the discussion on to the role of other technologies in achieving this task). Within the group of interviewees, there were varying levels of involvement with and expertise of CCS. There was a clear relationship between the level of expertise on CCS and the use of System 2 thinking, thus suggesting that System 1/System 2 thinking is more strongly influenced by level of expertise than by what CCS means to an individual.

For those engaging System 1 thinking, the use of heuristics was apparent in many cases. A heuristic is a simple procedure which helps people to find adequate (but sometimes imperfect) answers to difficult questions (Kahnemann, 2011) which they do not have the knowledge, skills or experience to answer directly or which are intractable. The use of heuristics can generate behaviour and decisions (or judgements) for inference, choice, group deliberations or moral issues (Todd and Gigerenzer, 2007). However, many issues which require us to make decisions or form opinions are not straight forward and the type of heuristic to be used is not always apparent, or there may be multiple appropriate heuristics. Within this study, the most common approaches were to use recognition, familiarity and fluency heuristics. When interviewees experienced difficulty drawing on their own knowledge to evaluate CCS, they transferred their attentions to something that they associated with CCS – usually other energy or climate issues. They would then frame their perception of CCS based on how it compared to the other topics being discussed (e.g. representativeness), or use the questions that they have about an alternative technology and transfer them to CCS:

I don't know a great deal about them [CCS]*, but non-fossil fuels, very controversial one particularly in Aberdeenshire is wind power. […] It's a heated debate in relation to will they do the job, are they economically viable, what's the long term future, the subsidies are too great, will they ever pay back the taxpayer for their investment into the technology, do they work, what about their maintenance in the long term, decommissioning, so on and so forth?"* Interview SCO13

Many of the interviewees suggested that the continued development of renewable energy technology was preferable to widespread or long-term implementation of CCS because thinking long-term, this is the most sustainable option and has the greatest environmental benefit:

"It would be better if we could reduce the amount of CO_2 we were doing rather than, you know, finding unusual places to dump it." Interview SCO09

This is characteristic of the 'take the best' and 'tallying' heuristics, while some interviewees demonstrated use of the satisficing heuristic (e.g. in which CCS is seen as a necessary, but not necessarily desirable option, in addressing a commitment to climate change).

"It's got merit […] I think that as part of an overall energy mix […]. And when you look at some of the other potential threats to biodiversity, my particular interest, then you know wind power has threats, nuclear has threats too, continuing use of coal and gas have threats, we're hearing about shale gas

more. Where does it rank as a threat amongst all those? Well it's probably no worse than some of the others that we are going to end up using. So it probably has a place." Interview TS [YH?] 09

The use of different heuristics as short-cuts to addressing a complex issue indicates to us the different ways that cognition works for different stakeholders and reflects the accountability mechanisms that they are subject to (e.g. in terms of timescale, re-election in a year or so for a councillor, or long-term mitigation of climate change for an NGO), as well as personal values and context. All of these factors contribute to an overall perception developed by an individual. Understanding which factors play a role in formulating perceptions (i.e. when System 1/2 are used; which heuristics are used) helps us to determine the way in which individuals or groups with certain interests may respond to the issue of CCS, and how they may respond to various communication techniques.

Distancing

When people use System 1 thinking to form a judgement, they often divert the focus of the judgement from one topic with which they are unfamiliar, to another topic which is more familiar and accessible to them. In doing this, they distance themselves from the topic that does not engage them. There was extensive evidence of distancing from the issue of CCS, from a number of the research components of this project. This can be viewed according to two strands: i) 'self-distancing' of those asked to form judgements on CCS, and ii) distancing by those promoting CCS.

An aversion to discussing CCS was evident both in the Citizen Panel, and from some of the Tier 2 Stakeholders. In addition, some of the industrial experts who were interviewed about what they understood of public perceptions of CCS, noted that 'the general public' were unengaged by CCS. The Citizen Panel process identified an attitude from members of the public towards CCS which presented the questions: Why should we care about CCS? Why are we being asked to comment on CCS? How does it affect us? What impact do we really have on the process, if we do comment? Citizen Panel members and some Tier 2 Stakeholders dealt with CCS by directing the focus of the discussion towards other subjects – one of the most common being the role of renewable energy technologies for reducing carbon dioxide emissions and increasing security of energy supply. The Citizen Panel members made repeated efforts to revert to discussions on this topic, while CCS was being discussed. Therefore, starting with the life-world perspective allowed us to determine how the Citizen Panel members position CCS within their own contexts and the results showed that when given the opportunity to lead and shape discussions by themselves, CCS hardly features at all.

The media interviews and focus groups, and the CCS films reviews identified that the very efforts designed to communicate about CCS can cause a distancing between the general public and the technology. Much of the graphic material in use for CCS communication, was lacking in human perspective – i.e. images are often industrial, technical, large scale, and disconnected from the physical, geographical and social realities in which they actually exist. People, homes, cities, cars, etc. rarely feature in such imagery and therefore make it difficult for the viewer to connect the message portrayed by such images to the world which they experience.

The questions outlined above provide an indication to the reasons for this 'self-distancing' – members of the general public do not see their role in the CCS process because of a lack of *tangibility* and the absence of a sense of *agency*.

The consistent references to certain renewable energy technologies (as well as to policy and small-scale implementation of low carbon initiatives) within the Citizen Panel demonstrated the participants' need to discuss issues of relevance and familiarity to them. In other words, they

needed the topic of conversation to be something which was *tangible*. We all have 'mental models' of how a system, process or technology is working and within those mental models we try to identify and map cause and effect relations. With technologies such as wind, solar and tidal power, to some degree we can actually see, and experience how that form of energy is in existence and the technology which is used to 'harness' or transform it into power which we can use (electrical energy). With wind turbines, we are familiar with the structures of windmills, we can see when and how a turbine is working. Similarly, with hydro-power we are familiar with the basis of the technology used – water mills have been in existence for centuries. Conversely, with CCS, although power plants are visible, these are structures and processes at a distance from the public – they are literally fenced off and (often) located away from populations. Even if the sites were more accessible or present in our life-worlds, the processes occurring within them are abstract and complex. Providing information on how such processes operate would likely be insufficient (cf. the critique of the public deficit model, e.g. Wynne, 1995; Ziman, 1991). Compounding this is the fact that CO_2 capture, treatment and transport infrastructure is often retro-fitted to existing power plants, meaning complex and confusing change to existing infrastructure. Furthermore, the storage locations (geological formations) are environments with which no person interacts directly. All is mediated by highly complex and alien technologies, including horizontal drilling a kilometre or more below ground.

Another aspect which affects the tangibility of a technology is scale. While wind turbines, solar panels and hydro-electric turbines exist within our landscape and we can identify a singular piece of equipment (indeed, such technologies can be adopted and embraced by individuals or communities), we do not experience CCS in the same localised way. Power plants are often located away from communities/settlements, are closed to the public and operate on such large spatial scales (including the fuel supply chain) that they are physically inaccessible and difficult to envisage. Additionally, large infrastructure such as that used in power generation from fossil fuels and CCS, is designed to operate on timescales which are longer than an individual can identify with, while the lifespan of wind/water turbines or solar panels is limited to a few decades. In such a situation, some people re-direct responsibility away from themselves (e.g. towards governments, which operate at regional, national and global scales, and collectively, on much longer timescales).

When talking about CCS, Citizen Panel members asked 'what can I/we do about CCS?'. The dominance of this question for them suggests that they do not feel a sense of *agency* with the technology or process. Without some concept of how one can have a stake, responsibility or tangible role in the process, it is difficult to identify with and engage with an issue. Therefore, by believing they have no role or influence in the process, they believe there is no purpose in their involvement. When something operates at a spatial or temporal scale that we cannot envisage, or even if it is simply politically or culturally out of reach, we will not feel agency with that process, system or technology. Individuals and communities have many issues to deal with daily and many of them are more immediate, tangible and personal than CCS (or even than climate change). George Marshall (2014) outlines a number of characteristics that an issue must possess in order for a person to engage with it. The issue must be: personal, abrupt (rapidly changing), immoral and happening now (we have a limited ability to consider the future). CCS (as with climate change) does not meet any of these criteria strongly. It is something which feels distant and intangible to us, it has been discussed for over 20 years but there have been few significant developments (many are unaware of its existence), there is no single immoral party against which to rally, and it is not having a significant impact on people's lives right now. It is the perfect candidate for non-engagement.

Understanding of the role of psychological distancing is important for the present study because it allows us to establish the importance of tangibility and agency: people need to connect the abstract issue and relevance of CCS (i.e. appeal to their core values), with decision-making and problem solving which is based on concrete, specific, contextual details (i.e. to which they are psychologically close), in order to be able to act (or at least form an opinion on), CCS. This insight can inform communication and engagement strategies to allow them to be designed in such a way that the whole issue (rather than just the aspects which are spatially, personally or socially close) is opened up to participants for deliberation.

There are, of course, exceptions to the findings discussed above and these were identified within the QICS assessment, by the interviews with industrial experts, and by some of the Tier 2 Stakeholders. On the whole, the QICS study received support from the local public and stakeholders and this was attributed to the strong reputation that SAMS had for being a fair, reliable research organisation. Another important aspect in this positive relationship is the potential the project and the organisations involved offer for employment and investment in the area. This positive familiarity means that CCS research is something with which the local public and stakeholders can engage. It is possible for them to identify where CCS (or the test release research, at least) fits into their life-worlds: they can envisage how it impacts upon them, and how they may impact upon it. In addition, through the public meeting events, they were offered a 'way in', to the process – they were presented with the opportunity to comment and debate. And because of the positive reputation and previous experiences with the organisations involved, the public had the trust required in order to accept the project and utilise the engagement process. Such a relationship, and its impacts, were echoed in the experiences described by some of the technical experts, who suggested that people who were familiar with an industrial environment were more accepting of developments which showed potential to prolong or strengthen that environment. People may support CCS indirectly, by seeing it as an employment opportunity, an investment opportunity, or even the chance to showcase an industrial heritage in their area, of which they are very proud.

People think about and form judgements on CCS in different ways, but what this study has shown is that perceptions are dependent on a number of factors including values, context, prior experience/knowledge, tangibility, agency, familiarity amongst others. CCS needs to be relevant to peoples life-world in order for them to engage with it. The QICs project demonstrated that it is not necessarily CCS itself which causes distancing, but the social situation matters as much as the technological issue. Therefore, CCS does not necessarily need to be distant and intangible for people, but investment of time and resources to build trust and develop relationships could help it to become embedded in the fabric of a society. This will, inevitably, be more difficult for general populations outwith the local reaches of specific CCS projects. However, more general awareness and user-oriented promotion of the technology will give individuals and communities the opportunity to develop their own, informed, perceptions on the matter.

Recommendations

Based on the above findings, a number of recommendations can be made regarding CCS communication and/or engagement with the public and stakeholders. The recommendations fall into two categories: i) broader recommendations about understanding public perceptions, how they are influenced, and how people deal with the topic of CCS; ii) specific recommendations for communication and engagement design:

How people form perceptions and deal with the topic of CCS:

1. Understanding which factors play a role in formulating perceptions (i.e. when System 1 and System 2 are used or which heuristics are used) helps us to determine the way in which individuals or groups with certain interests may respond to the issue of CCS, and how they may respond to various communication techniques, based on their values and context.
2. The way in which people feel agency can be affected by the nature of the dialogue or engagement processes. If a person's opinion/comments count, then they have agency within a process. So a process which uses peoples comments e.g. to influence policy or decision-making (or which claims to do so), makes the participants agents of that process. A sense of agency is likely to make the participant think more deeply about the problems and solutions, because they are likely to be acting on behalf of a group/community/society, etc., and thus feel responsibility and ownership for decisions to which they contribute. Conversely, those who feel they are representing only themselves will have a 'weaker sense of agency': a weaker sense of their value within a process, and therefore may invest less in the process.
3. Psychological distance from an issue can cause members of the public or stakeholders to resist engagement with that issue. By mapping out the connection between the abstract ideas and problems around CCS, and how they specifically link with a person's values and personal context (psychologically close context: spatially, temporally and socially), participants can be facilitated in making personal judgements about the issue. Attention to the dynamic between psychologically distant and close aspects of an issue can help participants to make judgements in which they have confidence. Enhancing or highlighting the tangibility for CCS can help to reduce the apparent psychological distance of the problem.

Recommendations for CCS communication and engagement design:

4. Be aware of the sources people might draw on to help them form a judgement about CCS – they are likely to affect their perception, and are also likely to change between individuals and between groups.
5. Pay careful attention to the way people are engaged or asked to provide their judgements on CCS. This could affect the cognitive processes which come into play in decision-making (e.g. a survey may only capture System 1 response; a long interview or opportunity to formulate thoughts in own time and privately may get much more in-depth evaluation).
6. Materials prepared for communication should be designed with the user, not the communicator, in mind. Images should be appeal to personal/human aspects and be more user-facing. Considering the life-world starting points of a target audience can help to make the link between CCS and peoples' lives more explicit.
7. Be prepared to target communication strategies at different audiences, e.g. those familiar with CCS/industry, those who are unaware of it; and be prepared to accept criticism constructively and address the issue rather than be defensive. This may require the preparation of a number of different forms of communication/engagement methods or tools for engaging with different groups on the same issue.
8. Be clear and transparent about what people can (and, just as importantly, cannot) contribute to a process and demonstrate to them how they fit into that process.

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