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# Synthesis of CCS social research:

## Reflections and current state of play in 2013

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Prepared on behalf of the Global CCS Institute

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## Important disclaimer

# Foreword

Carbon capture and storage (CCS) has a critical role to play in mitigating climate change and providing energy security. The Global CCS Institute (the Institute) advocates for CCS as one of the many options required to reduce greenhouse gas emissions, both from power generation and industrial sources. Fundamental to that advocacy role is a commitment to sharing the best possible research and information about the technology to our members and the wider public.

Recognising the importance of the complex social factors impacting future deployment of CCS projects, the Institute is proud to have supported the CSIRO Science into Society group and a host of international social researchers to produce a world-leading body of research into the often misunderstood area of CCS development.

Now, four years into this comprehensive research program, we welcome the opportunity to pause, reflect and analyse the key findings emerging from the CSIRO-led research and a collection of other respected social research from across the globe.

This report has been designed to provide an accessible summary of an extremely comprehensive body of research. It is hoped that the review will provide a quick and helpful guide to emerging thinking and best practices for those working to improve public understanding and acceptance of CCS technology, with extended bibliographical references to assist with further research.

# Contents

# Figures



# Tables

# Acknowledgments

CSIRO acknowledges the financial and other support provided by the Global CCS Institute. CSIRO also acknowledges the critical role played by our research partners and their individual contributions to the research, including:

- Angela Colliver:  CSIRO Education, Australia
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# Executive summary

Public acceptance of carbon capture and storage (CCS) technology has been identified as a potential show-stopper for its development and deployment at commercial scale. Over time there has been a comprehensive body of international work to understand and investigate the social factors that influence CCS project deployment. This report aims to synthesize the key findings, recommendations and challenges evidenced throughout this substantial body of work. In particular, it focused on the 25 social research reports prepared by CSIRO and their research partners for the Global CCS Institute, as well as wider literature that has emerged from research groups across the world.

To identify relevant publications the reference lists of the 25 CSIRO reports were combined, resulting in some 900 plus references. Of those 900 publications, 14 articles were cited 3 or more times. These articles were systematically analysed along with the content of the 25 Global CCS Institute's reports. Overall analysis of the 39 research outputs resulted in 7 key themes:

1. **Framing CCS –** it has been acknowledged that advocating for CCS as a standalone technology is unlikely to be tolerated and finding different ways to frame CCS for various stakeholder groups is key to successful communication on the subject.
2. **Local context** – developing a deep understanding of the local communities in which projects will operate has been identified as fundamental for assisting the deployment of CCS projects.
3. **Trust** - trust is a concept that is always referred to as being critical to project success. The research covers trust on a variety of levels, from building trusting relationships through consistent, honest and interactive stakeholder engagement, to consideration of trusted messengers and sources of information.
4. **Communication and engagement processes -** this theme covers the extensive discussions around best practice communication and engagement processes - the how rather than the what – for engaging with stakeholders and the public – with key findings around the importance of early engagement and inclusion of experienced high level engagement/communication resources within CCS project development teams.
5. **Information -** the need to improve access to quality, relevant and factual information about CCS and its wider energy and climate change context, is acknowledged as a key learning, as well as the importance of multiple sources of information.
6. **Risk perception** - Risk perception and risk communication has been an underpinning theme influencing CCS research since its inception, with key lessons emerging on the factors that influence different stakeholders' perceptions of risks.
7. **Governance -** the need for well established regulatory guidelines for all processes of the CCS chain and transparent and fair processes are critical.

The various contexts that surround CCS are key determinants for acceptance, be it the economic context that affects how people perceive the use of public funds, the political context that can determine how CCS is framed in public discourse, or the socio-cultural context that informs ideas of what the 'right' way is to treat the environment. Similarly the research has found that trust is vital. Not just trust in the capability of operators to carry out CCS safely, but also trust in the motivations of those delivering the CCS message. The way in which trust is developed and information is communicated will influence the levels of risk an uninformed public perceives in relation to a project.

There are ongoing challenges over how to communicate CCS to the public and the associated need to think through complementary or alternative rationales for CCS, in particular acknowledging that some people may never accept anthropogenic climate change which is the default position to provide a fundamental

role for CCS. Lastly, there is a growing awareness of the role that governance concepts of fairness, justice and the influence values can play in shaping people's idea of whether or not CCS is a socially acceptable technology.

These key themes are represented in the following diagram which suggests how their interactions ultimately assist in the formation of more a positive disposition towards CCS projects.

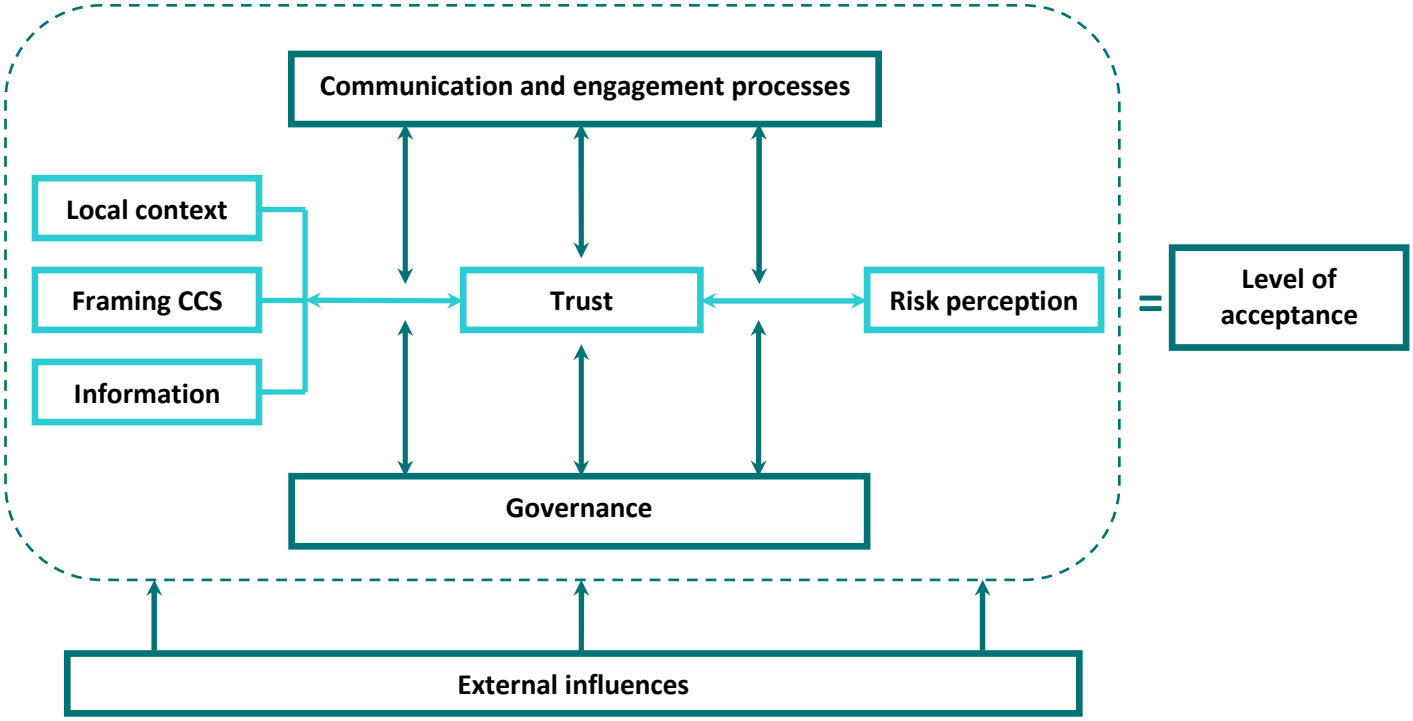


Figure 1 A framework of interactions for CCS projects

## Recommendations for CCS stakeholders

From the overall review of the key reports and literature there were a number of recommendations which were felt to be important to those involved in developing or funding CCS demonstration projects. These are adapted and collated below under the key themes to which they pertain.

- **Framing CCS**
  - Perceptions of climate change differ from belief in climate change to scepticism and denialism. Therefore, in contextualising CCS, consideration should be given to all perceptual positions and not focus on mitigation alone.
  - Discussions around CCS should include a clearly defined rational behind the technology's implementation and take into consideration relevant national and international policies that underpin CCS.
  - Comparison of energy options should be transparent and clearly communicated and include issues and explanations of the wider energy debate.
- **Local context**
  - CCS developments should take careful account of the local context of potentially impacted communities in terms of social, cultural, economic and political characteristics – the social site characterisation tool can be a useful aid to do this.
  - Establish a baseline of background knowledge and awareness across affected communities to better understand information needs, minimise misunderstanding and avoid false expectations.

- In order to pre-empt and prevent any unplanned issues, consideration should be given to local history and pre-existing concerns within a community, as well as the local, state and national overarching perspective.

- **Trust**
  - Identify trusted individuals, organisations and institutes within the community to ensure that those communicating messages on CCS are trusted.
  - It is important that advice and information provided to stakeholders is seen to be trusted, reliable, informative and is provided in such a way to provide sufficient time for assimilation.
  - To assist in smooth information transfer and feedback, consideration should be given to establishing a citizen's advisory committee or some form of community participation group.

- **Communication and engagement processes**
  - Communication and engagement processes should target gaps in local knowledge around CCS that have been identified through baseline understanding of local communities.
  - Project developers need to engage in meaningful dialogue with stakeholders and the public well in advance of project plans being finalised, making use of trusted advocates within different stakeholder groups.
  - Project communicators are encouraged to use a wide variety of engagement processes and tools that promote open and transparent dialogue and help to establish effective relationships.
  - Experienced, high level communication/engagement resources should be embedded in a CCS project development team.

- **Information**
  - Information provided to stakeholders needs to be wide ranging (i.e. formal, informal, technical, simple), and delivered by a variety of reliable sources in order to develop trust and ensure stability of opinion.
  - Information is to be balanced, of high quality, relevant, of minimal complexity, appropriately toned and readily accessible to a range of stakeholders.
  - Develop information delivery programs tailored to different audiences which could be delivered via educational institutions, and include curricula that addresses the wider context for CCS (climate change, energy options and potential mitigation solutions).

- **Risk perception**
  - To help minimise perceptions of risk, two-way communication processes that recognise individual risk perceptions and tailor responses are considered an essential component for allaying fears.
  - If risk perceptions are high, some flexibility in project plans which allow the public to influence the outcome can be helpful to minimise such risk perceptions.
  - Risk communication should include information that adequately addresses the multiple facets of risks associated with CCS including capture, transport, and storage
  - Risk communication personnel should be well trained to be aware of, recognise and be sensitive to the varying perspectives associated with risks surrounding CCS.

- **Governance**
  - Projects require clearly defined processes for communities and other key stakeholders to provide input into project decisions - helping to develop a partnership approach toward shared outcomes.
  - Legal and regulatory frameworks surrounding CCS need to be aligned across local, state and national contexts, to reduce conflict between different levels of government, and minimise the erosion of public confidence in the project.
  - A shared vision across project funders, development teams and within the teams themselves helps to create a unified vision for the need for the project.

The review has shown that a solid foundation of social research now exists that provides new insights and multiple frameworks for practical development of CCS projects. Future applied research that builds on this

foundational work is dependent on more projects being deployed, however, there is a body of research that continues around the world to refine and delve deeper into some of the more important social research concepts.

European researchers are still particularly active in this space, for example, investigation into host site compensation models for CCS as part of the CATO-2 project is likely to add significant insight for project developers, government and host communities alike. Both the *SiteChar* work, where public outreach activities have been conducted in potential CCS communities in Scotland and Poland, and the French based consultants' Acceptables Avenirs and Actys Bee research trials into the ULCOS Industrial CCS site, builds on the earlier Social Site Characterisation work by putting techniques into practice and suggesting practical adaptations. There may also be some interesting outputs from the *R&Dialogue project* for improving dialogue on transitioning to a low carbon society in Europe across ten countries, which includes CCS as one of the topics.

In North America, the US continue to focus on understanding best practices for communication, knowledge sharing, and risk mitigation and in Canada there is a body of work which includes understanding innovation in governance practices, analytical tools to assess the potential for CCS deployment as well as overall perceptions of CCS and barriers to investment within the oil and gas industry. The Petroleum Technology Research Centre that managed the $CO_2$ storage research behind the IEAGHG Weyburn Midale CCS Project is also working with the Institute to create and test simple communication material on $CO_2$ storage and enhanced oil recovery.

In Japan, the Japanese Knowledge Sharing Network has focused its activities on developing and testing a communication strategy and CCS argumentation map for Japanese stakeholders.

Finally, the South African Centre for Carbon Capture and Storage (SACCCS) has pulled together a consortium of practitioners and researchers to develop two separate stakeholder engagement plans, a national and a local plan.

It appears there are still ample opportunities to build and refine our knowledge of how best to engage on CCS. Whether it is near potential sites or conducting experimental designs to further test the effects of information sources, the results help to develop the body of knowledge on the impacts of communicating about this technology. One of the greatest opportunities for shared learning however, will be to ensure that alongside project communications and outreach activities, research institutions can be an independent observer to track the impacts of activities being implemented through case studies while comparing them to baseline research.

The key recommendations arising from this synthesis report are grouped for ease of reference into two categories - recommendations 'for future research' and 'for project developers':

**For future research**

1. Undertake a more systematic study of what has been done in developing countries in relation to CCS and, where possible, begin to test the findings from this body of work in those context specific locations.
2. Continue to investigate the psychological factors, values, and world views that may impact a project's acceptance through case studies of projects progressing through the project lifecycle.
3. Follow closely the work on host site compensation models and where appropriate, in conjunction with the researchers, test these in various cultural locations to assess if differences arise.
4. Conduct further investigations around perceptions in relation to transportation of CCS, in particular issues related to the siting of pipelines for the transportation of $CO_2$.

**For project developers**

1. Implement and test existing social site characterisation, risk assessment frameworks, and communication and engagement toolkits in host communities or potential host communities to provide further refinement to these tools as well as greater insights for CCS project developers.
2. Ensure researchers have access to projects from their inception to establish a baseline and observe the impacts of projects on host communities.
3. Develop regionally based communities of practice for project communication and engagement staff to ensure project experiences are openly shared.
4. Where possible continue to arrange formal knowledge sharing workshops between social researchers and projects to share findings and more openly elucidate where gaps in knowledge and challenges might still exist.

# Part I Synthesis of CCS social research

# 1 Introduction

## 1.1 Background

In 2009, the Global Carbon Capture and Storage Institute (the Institute) commissioned the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to undertake a comprehensive international social research program that built on prior international social research. The aim was to understand the social factors that may impact upon the successful deployment of CCS projects around the world. In total 13 projects were undertaken by 10 international research institutions (see Appendix A) which resulted in 25 final reports and a number of ongoing journal publications. The researchers employed a mix of qualitative and quantitative research methods including literature reviews and desktop studies, surveys, case studies, focus groups, large group processes, interviews and media analyses.

In order to provide as comprehensive a picture as possible of the current status of CCS social research the authors applied a broad approach, taking into account the reports and outputs from the CSIRO/Institute social research projects and the more extensive body of literature spanning past and present CCS research. This report summarises the common themes that have arisen from this body of work and provides valuable insights for all stakeholders with an interest in transitioning to a low carbon energy supply with CCS as part of the portfolio.

This first section describes the method of analysis, list of publications and the list of institutions involved in the work. Section Two provides more detail of the key themes that arose from the analysis and summarises the key findings and recommendations that relate to each of the individual themes. The third section discusses the implications arising from this body of research and makes some overall recommendations to be considered for both research and project developers alike. Finally, Appendix A presents a geographical depiction of major CCS social research projects to date; Appendix B shows a list of key references, Appendix C provides the extended abstracts of key references and Appendix D gives a complete reference list.

## 1.2 Method of analysis

To identify any relevant publications the reference lists of the 25 reports developed under the Institute's sponsored international research program were combined - resulting in some 900 plus references.. Of those 900 publications, 14 articles were cited 3 or more times. These articles were systematically analysed along with the content of the 25 Institute reports. Overall analysis of the 39 CSIRO referenced research outputs resulted in 7 key themes. Recognising that this analysis could be biased towards older work undertaken by CSIRO and their research partners, the scope of the literature reviewed for the report was extended to include recently emerged key publications from around the globe.

## 1.3 International institutions

In addition to the Science into Society Group at CSIRO, other contracted research institutions that contributed to the Institute's social research outputs included:

- Community and Culture, Faculty of Arts, University of Calgary, Canada
- Energy research Centre of the Netherlands (ECN)
- Illinois State Geological Survey - Advanced Energy Technology Initiative, University of Illinois, USA
- Judge Business School, University of Cambridge, England
- Mizuho Information and Research Institute, Japan
- Pacific Northwest National Laboratory, Battelle USA
- School of Geosciences, University of Edinburgh, Scotland

- Wade LLC, Washington, USA
- Energy and Resource Group, University of California, Berkeley, USA

The international mix of research organisations reflect a concentration of research focussing on CCS communication, outreach and engagement emanating from Europe, Australia and North America. With fewer numbers of publications in this review, Asia is nonetheless beginning to draw its focus toward these issues. See Appendix A for the geographic locations of the research organisations involved in social science regarding CCS and their most frequently used research methodologies.

## 1.4 Summary of the Global CCS Institute reports

Provided below in Table 1, are details on each of the 25 CSIRO/Global CCS Institute reports, including the institutions involved and the countries in which the research activities took place.

**Table 1 Summary of Global CCS Institute reports**

| REPORT TITLE | AUTHORS | DESCRIPTION | INSTITUTION | COUNTRY |
|---|---|---|---|---|
| Communication of carbon capture and storage: Outcomes from an international workshop to summarise the current global position (2010) | Ashworth, P. | An overview of the one day conference *"Communicating for CCS Projects – What have we learned in five years?"* | • CSIRO | • France |
| What happened in Barendrecht? Case study on the planned onshore carbon dioxide storage in Barendrecht, the Netherlands (2010) | Feenstra, C.F.J., Mikunda, T. and Brunsting, S. | Describes the Barendrecht project, focussing on stakeholder relationships and the characteristics of communication. | • ECN | • The Netherlands |
| Case Study of the Carson CCS Project (2010) | Bradbury, J. and Wade, S. | Reviews the communication activities undertaken for the proposed Carson Project. | • PNNL<br>• AJW | • United States of America (California) |
| FutureGen Case Study (2010) | Hund, G. and Greenberg, S | Details the community engagement for the FutureGen project and perceived effectiveness of this engagement. | • PNNL<br>• University of Illinois | • United States of America (Illinois) |
| Case Study of ZeroGen Project (2010) | Ashworth, P., Rodriguez, S. and Miller, A. | Provides details on stakeholder perceptions of the communication and engagement practices of the ZeroGen project. | • CSIRO | • Australia (Queensland) |
| Case Study of the CO2CRC Otway Project (2010) | Ashworth, P., Rodriguez, S. and Miller, A. | Examines the community consultation undertaken for the CO2CRC Otway Project. | • CSIRO | • Australia (Victoria) |
| CCS Media Analysis Report (2010) | Dowd, A-M., Rodriguez, S., Jeanneret, T., Miller, A. and Shaw, H. | A report on international media coverage of CCS technology. | • CSIRO | • Multi-national |

| REPORT TITLE | AUTHORS | DESCRIPTION | INSTITUTION | COUNTRY |
|---|---|---|---|---|
| Communication/Engagement Tool Kit for CCS Projects (2010) | Ashworth, P., Bradbury, J., Feenstra, C.F.J. (Ynke), Greenberg, S., Hund, G., Mikunda, T., Wade, S. and Shaw, H. | Provides practical and informative tools to assist in the design and management of communication and engagement activities for individual CCS projects. | • CSIRO<br>• ECN<br>• University of Illinois<br>• PNNL<br>• AJW | • N/A |
| Investigation carbon dioxide capture and storage (CCS) opinions via survey and focus groups methods: An experimental comparison in Australia, Japan and the United States of America (2010) | Carr, A., Wong-Parodi, G., Itaoka, K., Saito, A., Dowd, A-M., Rodriguez, S. and Ray, I | A research report investigating the formation of stable opinions through focus groups and online surveys. | • CSIRO<br>• Mizuho<br>• University of California, Berkeley | • Australia<br>• Japan<br>• United States of America |
| Communication, project planning and management for carbon capture and storage projects: An international comparison (2011) | Ashworth, P., Bradbury, J., Feenstra, C.F.J. (Ynke), Greenberg, S., Hund, G., Mikunda, T. and Wade, S. | Provides an overview of the findings from an international comparison of communication and engagement activities for five specific CCS project case studies. | • CSIRO<br>• ECN<br>• University of Illinois<br>• PNNL<br>• AJW | • Australia<br>• The Netherlands<br>• United States of America |
| Carbon Capture and Storage Technologies and the Environmental Movement (2011) | Corry, O. and Reiner, D. | A report summarising research into the environmental movement's understandings and evaluations of CCS. | • University of Cambridge | • United Kingdom (Scotland and Wales)<br>• Sweden<br>• Switzerland<br>• Germany |
| Report on Japan CCS Stakeholder Day (2011) | Ashworth, P., Rodriguez, S. and Shaw, H. | An overview of a one day CCS Stakeholder Day held in Tokyo, Japan, focussing on communication and public awareness of CCS projects. | • CSIRO | • Japan |
| Report on International Carbon Capture and Storage Education Materials (2011) | Colliver, A., Dowd, A-M. and Rodriguez, S. | This report presents research findings on the scope, characteristics and quality of currently available education material on CCS for the school sector around the world. | • CSIRO | • Multi-national |
| Evaluating global Carbon Capture and Storage (CCS) communication materials: A survey of global CCS Communications (2011) | Corry, O. and Reiner, D. | A review of the scope and characteristics of CCS communications. | • University of Cambridge | • Multi-national |
| Social Site Characterisation: From Concept to Application. A review of relevant social science literature and a toolkit for social site characterisation (2011) | Wade, S. and Greenberg, S. | An examination of why and how to conduct social site characterisation, including a social site characterisation toolkit. | • AJW<br>• University of Illinois | • Multi-national |
| Communicating the risks of CCS (2011) | Bradbury, J., Greenberg, S. and Wade, S | Discusses what we have learnt about the ways in which people view risk. | • Wade LLC | • United States of America<br>• Canada |
| Results from Collie CCS Hub workshop: What do the locals think? (2011) | Jeanneret, T., Ashworth, P., Hobman, L. and Boughen, | Presents results from a public workshop on energy technologies and CCS conducted in Harvey, Western Australia. | • CSIRO | • Australia (Western Australia) |

| REPORT TITLE | AUTHORS | DESCRIPTION | INSTITUTION | COUNTRY |
|---|---|---|---|---|
| | N. | | | |
| Publics and Energy – Results from Calgary, Alberta (Canada) workshop (2011) | Einsiedel , E., Boyd, A. and Medlock, J. | Describes the outcomes of a large group process conducted in Calgary, Canada on the topic of climate change and low emission energy technology. | • University of Calgary | • Canada |
| Public perceptions of low carbon energy technologies – Results from a Dutch large group workshop (2011) | Brunsting, S., van Bree, B., Feenstra, C.F.J. and Hekkenberg, M. | Describes the outcomes of a large group process conducted in Utrecht, the Netherlands on the topic of climate change and low emission energy technology. | • ECN | • The Netherlands |
| Public perceptions to low carbon energy technologies – Results from a Scottish Large Group Workshop (2012) | Howell, R., Shackley. S, and Mabon. L. | Describes the outcomes of a large group process conducted in Edinburgh, Scotland on the topic of climate change and low emission energy technology. | • University of Edinburgh | • United Kingdom (Scotland) |
| International comparison of the large group process. Results from Canada, Netherlands, Scotland and Australia (2012) | Ashworth, P., Jeanneret, T., Stenner, K. and Hobman, E.V. | A comparison of results from large group process workshops conducted across four different countries. | • CSIRO<br>• ECN<br>• University of Edinburgh<br>• University of Calgary | • Australia<br>• The Netherlands<br>• United Kingdom (Scotland)<br>• Canada |
| Understanding how individuals perceive carbon dioxide: Implications for acceptance of carbon dioxide capture and storage (2012) | Itaoka, K., Saito, A., Paukovic, M., de Best-Waldhober, M., Dowd, A-M., Jeanneret, T., Ashworth, P. and James, M. | An investigation and comparison of public perceptions, knowledge and understanding of $CO_2$. The research was conducted with the implementation of online surveys across three countries. | • ECN<br>• CSIRO<br>• Mizuho | • The Netherlands<br>• Australia<br>• Japan |
| How Australians value water: Results from a literature review (2012) | James, M., Dowd, A-M., Rodriguez, S. and Jeanneret, T. | A paper on the values and meanings relating to water in Australia, with examples of previous successes and failures in involving Australian communities in water-related decision making. | • CSIRO | • Australia |
| Understanding stakeholder attitudes to carbon capture and storage (CCS) in Victoria (2012) | Ashworth, P., Jeanneret, T., Romanach, L. and James, M. | A report on focus groups conducted to understand how Victorian residents perceive and accept potential CCS projects. | • CSIRO | • Australia (Victoria) |
| Deliberating emission reduction options: Identifying public perceptions to CCS using the Information Choice Questionnaire methodology (2012) | Dowd, A-M, de Best-Waldhober, M., Rodriguez, M., Straver, K., Jeanneret, T., Mastop, J. and Paukovic, M. | A report on the development of an online decision guide to aid public awareness, knowledge, deliberation and choice around CCS compared with other greenhouse gas mitigation options. Compares survey results from Australia and the Netherlands. | • ECN<br>• CSIRO | • The Netherlands<br>• Australia |

# 2 Key Themes Arising

## 2.1 Overview of themes

The overall analysis of the 39 research outputs revealed 7 key themes with some obvious overlaps between them. The most common themes were in relation to communication and engagement and the role that information plays in informing these processes. The key themes were arrived at by analysing the frequency of their occurrence (Figure 2) both in the body and the recommendations of all 39 identified research outputs. Further detail of each theme is documented below. It is worth highlighting that most themes reflect many basic principles for communication relating to new complex technologies with some uncertainty associated with them. However, it is the nuances in relation to CCS within the reports that provide insights for projects on how best to enable positive future deployment.

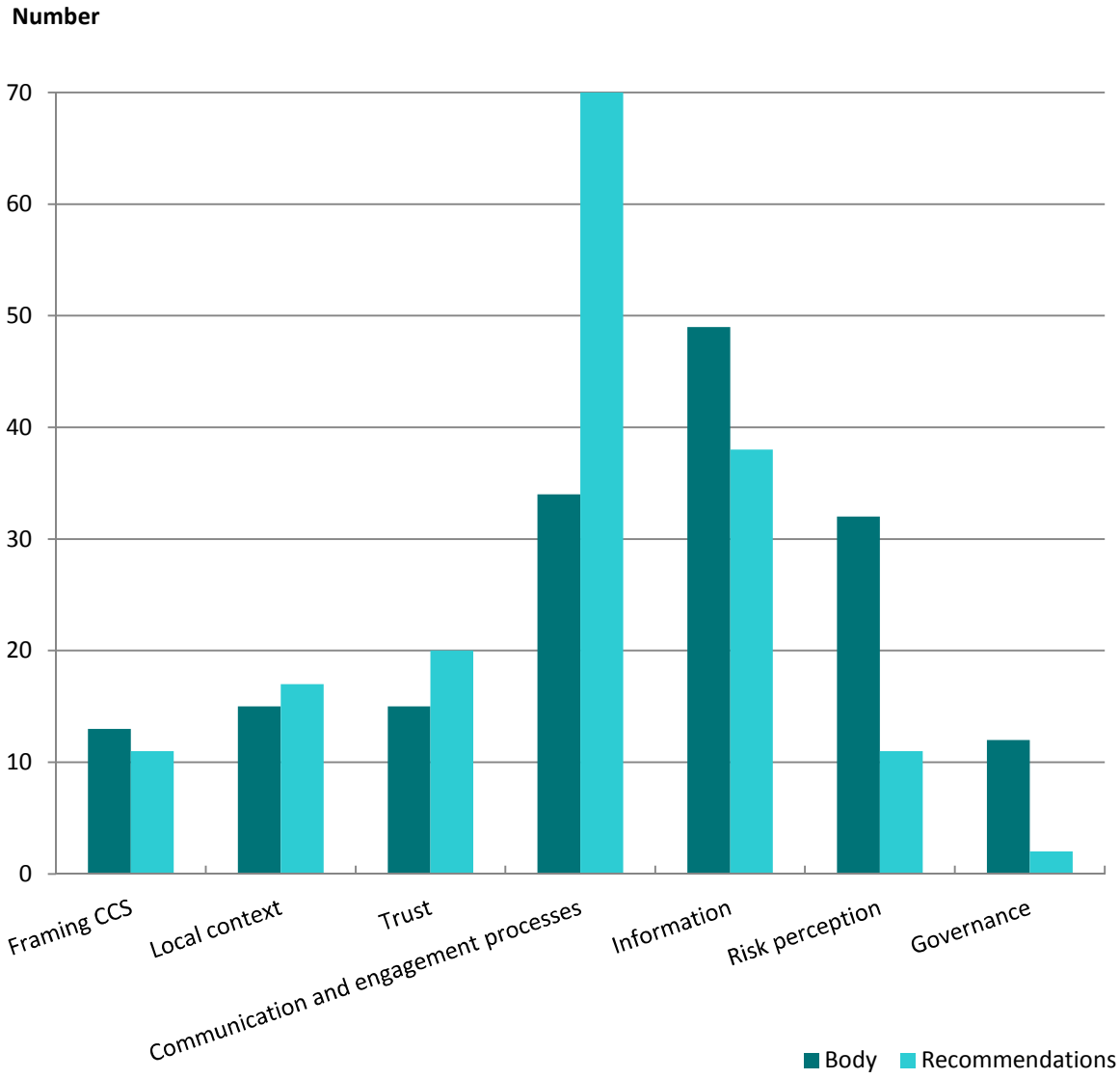


**Figure 2 Tally of frequently occurring themes from the 39 research outputs**

## 2.2 Framing CCS

### Key findings

- Research surrounding CCS technology suggests there are differing views on the way CCS should be framed. Traditionally, CCS is framed as a $CO_2$ mitigation option embedded in the climate change perspective. However, some researchers have suggested that contextualising CCS in this way may invalidate the technology's potential application amongst stakeholders who question the existence of climate change and the need for $CO_2$ mitigation.
- Views towards climate change mitigation will vary between individuals. CCS should therefore be acknowledged as one low-carbon option among many, rather than advocating for the technology as a standalone solution.
- In order to extend the context or framing for CCS beyond climate change, research emphasises positioning CCS within the wider energy debate, encompassing energy alternatives, markets and industries, as well as their associated cultural and political contexts.

From the earliest work into public perceptions of CCS (Ashworth et al., 2008; van Alphen et al., 2007; Shackley et al., 2005) it has been acknowledged that advocating for CCS as a single standalone technology is unlikely to lead to acceptance. Instead, the need to situate the technology around the topic of climate change and the potential portfolio of low carbon energy technologies has often been cited as creating the best opportunity for CCS to be understood (Ashworth et al., 2010; Feenstra et al., 2010; Howell et al., 2012; Malone et al., 2010). The earlier research also alludes to the fact that without the need to mitigate $CO_2$ emissions there is no role for CCS.

Further, it is emphasised that discussions about CCS should centre on energy supply and the associated trade-offs such as cost, and energy infrastructure demands, as well as the "why" of CCS as an appropriate technology that is fit for purpose (Corry and Reiner, 2011a; Feenstra et al., 2010; Malone et al., 2010;). It is also recommended for stakeholder discussions about CCS, that developers make reference to existing CCS projects (Ashworth et al., 2012a), as well as the relevant national and international policies that underpin them. Highlighting the scale of impact offered by CCS projects (very high volume reductions in $CO_2$) and what they contribute in the broader energy context, as well as the rationale behind the technology's implementation has also been suggested as being helpful.

More recent research, not subject to analysis for this report, has criticised the traditional narrative that is used for CCS (Markusson et al., 2012). This narrative starts with the existence of human-induced climate change and the need for deep cuts in anthropogenic carbon dioxide ($CO_2$) emissions in order to avert catastrophic climate change, then introduces CCS as the only way to achieve these cuts in the time frame available, whilst staying within existing social frameworks such as fossil fuel dependence (see Figure 3). Whilst not disagreeing with the climate science underpinning this narrative, Markusson et al. (2012) suggest that at each 'stage' of this narrative, there is the possibility that people may not make the next 'step' necessary for them to come to accept CCS. For example, some people may never accept that anthropogenic climate change is taking place, they may, like Anderson and Bows, (2011) see greater savings at the behavioural and 'demand' side rather than energy production, or they may choose to support investment in renewable energy as opposed to CCS.

Corry and Riesch's (2012) work with environmental NGOs and participants in British 'climate camps'[1] found that support for CCS among those with much stronger environmental views was generally lower. Reasons

[1] An event that has become popular in the UK in recent years. It is typically a week in length, where climate change activists gather for a mixture of talks, discussion and direct action aimed at facilitating the action needed to avert catastrophic climate change. See www.climatecamp.org.uk talks, discussion and direct action aimed at facilitating the action needed to avert catastrophic climate change.

for this included distrust in the kinds of companies involved in CCS (e.g. large energy companies) and deep-seated concerns about a continued reliance on fossil fuels.

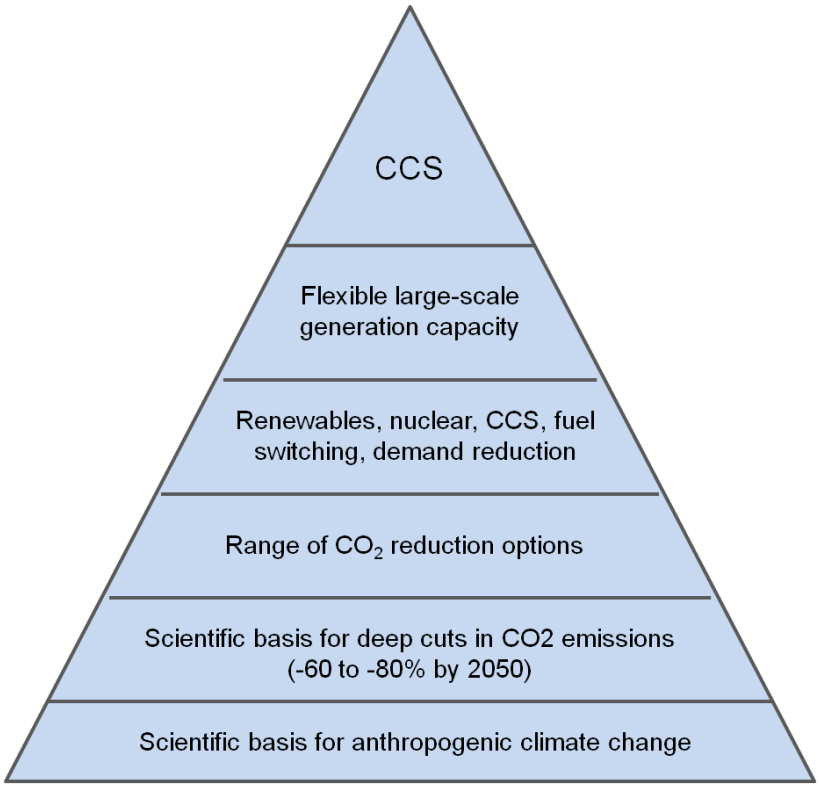


**Figure 3 The basis of acceptance of CCS adapted from Markusson et al. (2012)**

This raises the possibility that the narrative of 'CCS as a solution to anthropogenic climate change' may not be acceptable to all sections of society – even those who are well aware of the need for urgent and drastic action. In other words, some people's value systems and world views might lead them to follow options other than ones that lean towards CCS. It is interesting to note that in the case of the Decatur CCS project in Illinois, USA – which Ibarolla et al., (2012) view as a successful example of public engagement – the project developers made little mention of climate change and instead focused on much more general ideas of $CO_2$ as a pollutant that ought to be cleaned up.

There is a sense in some of the literature that it is perhaps important to acknowledge that CCS is just one low-carbon option among many, and that not everyone agrees on CCS as a solution. Summarising the findings of the New Participation and Communication Strategies for Neighbours of $CO_2$ Capture and Storage Operations (NEARCO$_2$) project carried out across a range of European countries, Brunsting et al. (2011a), believe that critical to the outcome of communication on CCS, is the extent to which this communication is an open and objective public discussion, one in which different views on the technology are acknowledged.

It is therefore worthwhile to try to tap into the wider cultural and political contexts within which CCS is considered – in particular conceptions of what an 'appropriate' solution to climate change is. For example, Buhr and Hansson (2011), make the link between generally low support for CCS in Sweden, to a much more general lack of support in the country for fossil fuels. Public perceptions of CCS are thus very much linked to constantly-shifting ideas about how society ought to respond to climate change, and what appropriate and 'right' technologies are – and as Brown (2011) states, as scientific understandings change, so to do perceptions of what is socially acceptable.

## Recommendations

- Perceptions of climate change differ from belief in climate change to scepticism and denialism. Therefore, in contextualising CCS, consideration should be given to all perceptual positions and not focus on mitigation alone.
- Discussions around CCS should include a clearly defined rational behind the technology's implementation and take into consideration relevant national and international policies that underpin CCS.
- Comparison of energy options should be transparent and clearly communicated and include issues and explanations of the wider energy debate.

## Further reading

**Note: Extended abstracts of key literature – references highlighted in blue – are available in Appendix C**.


Ashworth, P., Boughen, N., Mayhew, M., Millar, F. (2010). From research to action: Now we have to move on CCS communication. *International Journal of Greenhouse Gas* 4. 426-433

Brunsting, S., Upham, P., Dutschke, E., de Best-Waldhober, M., Oltra, C., Desbarats, J., Riesch. H., and Reiner. D. (2011a). Communicating CCS: Applying communications theory to public perceptions of carbon capture and storage, *International Journal of Greenhouse Gas Control*, 5(6), 1651-1662

Feenstra, C.F.J., Mikunda, T. and Brunsting, S. (2010). What happened in Barendrecht? Case study on the planned onshore carbon dioxide storage in Barendrecht, the Netherlands. ECN: Amsterdam

Howell, R., Shackley, S. and Mabon, L. (2012). Public perceptions to low carbon energy technologies – Results from a Scottish Large Group Workshop. University of Edinburgh: Scotland

Markusson, N., Shackley, S., and Evar, B. (2012). *The Social Dynamics of Carbon Capture and Storage*, Earthscan: London

van Alphen, K., van Voorst tot Voorst, Q., Hekkert, M.P., and Smits, R. E. H. M. (2007). Societal acceptance of carbon capture and storage technologies. *Energy Policy*, 35(8), 4368-4380

## 2.3 Local context

### Key findings

- Establishing an understanding of the local communities in which projects will operate has been identified as fundamental for assisting the deployment of CCS projects.
- Perceptions of CCS can be affected by local context which may include past history such as experiences with previous industry and infrastructure projects, as well as place and landscape values.
- Public opposition to new technologies may be established through an emotional investment in landscape that runs deeper than NIMBYism. Conversely, PIMBYism (Please in My Back Yard) would suggest acceptance of the technology where positive historical context exists.
- There is potential for conflict to arise where externally based decision making is imposed on local communities impacting the local context.

Developing a deep understanding of the local communities in which projects will operate has been identified as fundamental for assisting the deployment of CCS projects (Ashworth, 2011a). This may include gathering information about the social, cultural, ethical, political and economic landscape that exists within a potential host community (Wade and Greenberg, 2011) However, understanding the local context needs to include awareness of the wider regional and national perspectives that may influence the technology's overall implementation (Ashworth et al., 2012; Ashworth et al., 2010). In addition, case studies into the communication strategies of CCS and other energy infrastructure projects in Europe revealed the importance of determining and addressing historic and pre-existing issues (Desbarats et al., 2010; Feenstra et al., 2010).

Recent research by Bradbury (2012) suggests place history can affect local perception regardless of the strength or weakness of CCS communication. This is supported by Reiner et al. (2010), who observed lower support for CCS among communities who perceived they had been treated unfairly by other infrastructure developments in the past. Also of vital importance is the social context in which a CCS project is perceived – in particular the history and narrative of place. As highlighted by Wade and Greenberg (2011), it is important to explore local issues with stakeholders such as economic conditions, past decision-making experiences, underlying views towards energy industries, and previous occurrences of environmental or property damage.

Furthermore, Bradbury (2012) also strongly believes that context matters, suggesting that in order to fully understand public perceptions of CCS it is better to start with the context of the perceiver rather than the technological characteristics of CCS. There are multiple examples from other environmental sustainability initiatives to support this assertion, such as the work carried out by Devine-Wright (2009) on opposition to wind developments in south-east England. Devine-Wright suggests that publics' oppositions run much deeper than 'not in my back yard' (NIMBY) attitudes, being more closely connected with the values that people invest in the landscape around them and the emotions that are aroused when these places are threatened with change.

An alternative perspective, as noted by Reiner and Nuttall (2011) suggests that some of the first full-scale CCS projects might be met with PIMBY-ism (Please in My Back Yard), particularly in locations where the proposed storage is in a depleted oil or gas reservoir and there is a long history of oil and gas operations. Reiner and Nuttall (2011) give the Permian Basin in Texas and Lacq in France as two examples of where a history of oil and gas extraction has arguably provided employment for the local community and helped to build trust in the companies involved.

In addition, an in-depth study carried out over a period of several months on the Island of Barra in Scotland by Mackinnon and Brennan (2012), suggests that hostility to government measures to promote more sustainable development was rooted in the local culture's conceptualisation of belonging to and having

responsibility for that place. As such, there was hostility towards decisions that were perceived as being taken from 'outside' by people that did not have connections to the area. This would imply there is a need to understand where potential conflict may arise and to pre-empt it where possible (Brunsting et al., 2012).

## Recommendations

- CCS developments should take careful account of the local context of potentially impacted communities in terms of social, cultural, economic and political characteristics – the social site characterisation tool can be a useful aid to do this
- Establish a baseline of background knowledge and awareness across affected communities to better understand information needs, minimise misunderstanding and avoid false expectations.
- In order to pre-empt and prevent any unplanned issues, consideration should be given to local history and pre-existing concerns within a community, as well as the local, state and national overarching perspective.

## Further reading

**Note: Extended abstracts of key literature – references highlighted in blue – are available in Appendix C.**


Bradbury, J., (2012). Public understanding of and engagement with CCS, in N. Markusson, S. Shackley and B. Evar (Eds.) The Social Dynamics of Carbon Capture and Storage (pp. 172-188), Earthscan: London

Devine-Wright, P. (2009). Rethinking NIMBYism: the Role of Place Attachment and Place Identity in Explaining Place-protective Action, *Journal of Community and Applied Social Psychology*, 19(6), 426-441

Reiner, D. and Nuttall, W. J. (2011). Public acceptance of geological disposal of carbon dioxide and radioactive waste: similarities and differences, F. L. Toth (Ed.), *Geological Disposal of Carbon Dioxide and Radioactive Waste: A Comparative Assessment* (Vol. 44, pp. 295-315), Springer: Netherlands

Wade, S. and Greenberg, S. (2011). Social Site Characterisation: From Concept to Application. A review of relevant social science literature and a toolkit for social site characterisation. AJW Inc.: USA

## 2.4 Trust

### Key findings

- Research has found that perception of trustworthiness of specific organisations and groups as advisors on CCS corresponds to the levels of trust or distrust that recipients hold for CCS information and its sources.
- Quality and bias perceptions are seen to be influenced by context and sender, emphasis has been placed on the importance of ensuring messengers are perceived as trusted individuals, organisations and institutes from within the community.
- Building relationships has been identified as key to conditions of trust. A lack of relationship may result in an absence of trust in developers by the public, which may result in an inability by the developers to fully comprehend the publics' views.

There has been a large body of work – predominantly led by Terwel and colleagues at the University of Leiden – that has investigated how perceptions of the integrity of organisations involved in a project can facilitate or impede trust. This research concludes that building trust in project developers and other CCS advocates may also help to build trust in CCS technology (Terwel et al., 2011). Terwel et al. (2011) believe that trust does not come about because publics 'trust' organisations to carry out CCS competently and safely, rather it comes about because of publics' perceptions of organisational motives. For example, Terwel et al. (2011) explain environmental NGOs are trusted because they are perceived to be serving the public, whereas private companies can be seen to be motivated more by self-interest.

This second argument is backed up by a survey Terwel et al.(2012) carried out with residents of Barendrecht in the Netherlands, shortly before the decision was taken to cancel the CCS project there. The findings of their survey confirmed that trust – and not safety issues – was the key factor affecting people's perception of CCS, with the public's generally negative impression of the project a direct result of a lack of trust in the project developer and the regional government who were perceived as having too much influence over the project. As Reiner and Nuttall (2011:308) explain in much more general terms, "the primary advocates of CCS – national governments and the energy industry – are precisely those least trusted by the public, especially when compared to high levels of trust in NGOs and independent scientists[2]". Emphasis needs to be placed on the importance of ensuring messengers are perceived as trusted individuals, organisations and institutes from within the community (Carr et al., 2010).

To help engender trust in communities and provide an opportunity to validate messages and messengers of CCS information, some research has suggested establishing some form of citizens' advisory committee or community liaison for the purpose of ensuring trust in information transfer and feedback between the project proponents, its stakeholders and the local community (Wade and Greenberg, 2011).

Similarly, the opportunity to develop objective materials through the use of groups comprised of individuals with opposing views can help to build trust. For example, this may include industry, government and government agencies, researchers, scientist and non-government organisations (Ashworth et al., 2012a). Such diversity of opinion agreeing on the latest facts about the state of play of a technology may help to build trust in the information that is being presented (see for example Ter Mors et al., 2012).

Another key finding for the development of trust in a project, is the importance of providing sufficient time for stakeholders to assimilate information, get used to the concept of a CCS project and ask questions of project proponents (Ashworth, 2010).

An extension of time is the building of relationships, which was identified by Vercelli and Lombardi (2009), as key to the emergence of conditions of trust. They argue that opposition to low carbon developments can

[2] Reiner and Nuttall (2011) make these claims about high trust in scientists on the basis of the findings of the Eurobarometer (2008; 2011) surveys.

emerge because of a lack of a relationship between publics and developers, which means not only that the public might not trust developers, but also that developers may not have a chance to fully find out what the publics' views on the technology might be. This is borne out through Bradbury's (2012) study into a range of CCS demonstration projects in the USA, where projects that succeeded were at least partly able to do so because of existing positive relationships with the public.

It could be suggested therefore, that the perception of who is 'in charge' of a project – and whether this organisation or institution is trusted – can have a significant bearing on public perceptions of CCS projects. de Coninck and Backstrand (2011) express concerns that the public discourse on CCS has been dominated by the fossil fuel industry, and thus that the main voices conveying the CCS message are of questionable neutrality. Stephens et al., (2011) and Stephens and Liu (2012) argue that this is problematic should a disconnect with public concerns emerge.

## Recommendations

- Identify trusted individuals, organisations and institutes within the community to ensure that those communicating messages on CCS are trusted.
- It is important that advice and information provided to stakeholders is seen to be trusted, reliable, informative and is provided in such a way to provide sufficient time for assimilation.
- To assist in smooth information transfer and feedback, consideration should be given to establishing a citizen's advisory committee or some form of community participation group.

## Further reading

**Note: Extended abstracts of key literature – references highlighted in blue – are available in Appendix C.**


Ashworth, P., Jeanneret, T., Romanach, L., and James, M. (2012a). Understanding stakeholder attitudes to carbon capture and storage (CCS) in Victoria. EP125331. CSIRO: Pullenvale

ter Mors, E., Terwel, B.W. and Daamen, D.D.L. (2012). The potential of host community compensation in facility siting. *International Journal of Greenhouse Gas Control*, 11S, S130-S138

Terwel, B.W., Harinck, F., Ellemers, N. and Daamen, D.D.L. (2011). Going beyond the properties of CO2 capture and storage (CCS) technology: How trust in stakeholders affects public acceptance of CCS, International Journal of Greenhouse Gas Control, 5, 181-188

Terwel, B.W., ter Mors, E. and Daamen, D.D.L (2012). It's not only about safety: Beliefs and attitudes of 811 local residents regarding a CCS project in Barendrecht, *International Journal of Greenhouse Gas Control*, 9, 41–51

## 2.5 Communication and engagement processes

**Key findings**

- Awareness of CCS is limited across the general public, highlighting the importance of well developed communication, engagement and education plans, including early establishment of a baseline understanding of communities' perspectives and knowledge of CCS.
- Early engagement has also been identified as a key influencing factor in the development of meaningful and constructive stakeholder communication.
- To assist in developing meaningful relationships between a project and its various stakeholders, a range of methods and processes have been identified that are publically available.

There is a large volume of research evidence emphasising the critical role of communication and engagement in a CCS project, with multiple warnings to avoid the temptation of treating this area as an add-on to the overall project plan, by embedding experienced high level communication/ engagement resources into the core project management team (Ashworth et al., 2012). Frequently occurring topics in the research included the importance of stakeholder identification, developing a baseline understanding of local community needs and tailoring communication plans to meet the needs of the wide range of project stakeholders (Ashworth et al., 2010b; Hund and Greenberg, 2010). As de Groot and Steg (2011) explain, strong communication at the early stages of CCS is crucial, as new information shapes publics' attitudes toward a technology more when people know a little than it does when people know a lot.

Brunsting et al. (2011a) believe that critical to the outcome of communication on CCS is the extent to which communication is an open and objective public discussion, one in which different views on the technology are acknowledged. Hansson (2012) suggests that such an approach may not initially seem desirable to those who wish to see CCS deployed, but that an excessively positive stance on CCS communication runs the risk of creating expectations that cannot be managed later on. If expectations are built up and go unmet, Hansson (2012) argues this could be far more damaging for the prospects of CCS than some more cautious communication at an early stage. Indeed, both Ashworth et al. (2012) and Prangnell (2013) in their CCS case study comparisons of engagement practices, identify early engagement with the community as crucial to ensure meaningful participation and provide the community with a sense of empowerment. For example, where project plans have been announced prior to public engagement significant conflict resulted.

In addition to early engagement, the frequency (or lack thereof) of engagement activities has also been identified as an influencing factor toward the development of meaningful and constructive stakeholder communication. As part of a projects communication plan various methods for communicating and engaging are suggested. These include face-to-face meetings and group interviews with community leaders and influential stakeholders. In addition, different engagement processes can assist in capturing a wider audience. These may include the use of presentations at local meetings, shop front displays and drop in points in the local community, and various mediums for information dissemination such as newsletters, factsheets and websites (Ashworth et al., 2011a).

From a theoretical perspective, Ishii and Langhelle (2011) argue that greater public involvement in CCS decision making can produce more comprehensive outcomes. Building relationships and encouraging public involvement in the decision making process can result in outcomes that are more acceptable to all parties (Bradbury, 2012). For very complex technologies like CCS, it might even be the case that bringing a range of knowledge and understanding to the discussion table can lead to more technologically robust solutions.

In order to address these and other thematic issues identified in this report, Ashworth et al. (2011b) developed the Engagement and Communication Toolkit, designed to be a universal guide for CCS project developers, which provides practical and informative assistance for the design and management of

communication and engagement activities for CCS projects. The Toolkit contains best practice methods that may assist in addressing the many social components surrounding CCS deployment.

## Recommendations

- Communication and engagement processes should target gaps in local knowledge around CCS that have been identified through baseline understanding of local communities.
- Project developers need to engage in meaningful dialogue with stakeholders and the public well in advance of project plans being finalised, making use of trusted advocates within different stakeholder groups.
- Project communicators are encouraged to use a wide variety of engagement processes and tools that promote open and transparent dialogue and help to establish effective relationships.
- Experienced, high level communication/engagement resources should be embedded in a CCS project development team.

## Further Reading

**Note: Extended abstracts of key literature – references highlighted in blue – are available in Appendix C.**


Ashworth, P., Bradbury, J. Feenstra, C.J.F., Greenberg, S., Hund, G., Mikunda, T., Wade, S., and Shaw, H. (2011b). Communication/Engagement tool Kit for CCS Projects. CSIRO: Pullenvale

Ashworth, P., Bradbury, J., Wade, S., Feenstra, C.F.J., Greenberg, S., Hund, G. and Mikunda, T. (2012). What's in store: Lessons from implementing CCS. *International Journal of Greenhouse Gas Control, 9*(0), 402-409

Bradbury, J., Greenberg, S., and Wade, S. (2011). *Communicating the risks of CCS,* GCCSI: Canberra

Brunsting, S., Upham, P., Dutschke, E., de Best-Waldhober, M., Oltra, C., Desbarats, J., Riesch. H. and Reiner. D. (2011a). Communicating CCS: Applying communications theory to public perceptions of carbon capture and storage, International Journal of Greenhouse Gas Control, 5(6), 1651-1662

## 2.6 Information

### Key findings

- Research highlights a lack of knowledge and understanding of $CO_2$ and CCS which results in misconceptions that lead to unstable and uniformed opinions.
- Awareness raising programs and information dissemination are key considerations for increasing levels of understanding. Many different options may be utilised, such as informal information sessions, and dissemination through educational institutions.
- Evident within the literature is a common thread for the development of valid, credible, balanced and relevant information to be delivered to stakeholders and the public via trusted sources.

This theme acknowledged the importance of developing overall knowledge and understanding of CCS and stressed the factors that may be influential in forming opinions (Itaoka et al., 2012). There was an emphasis on the need for developing material tailored to different audiences (lay people, technical, and so on), to provide accurate information about CCS technology using easy to understand language that presents both the pros and cons of CCS (Ashworth, 2010). This information should be credibly sourced, of high quality, relevant and factual, be of minimal complexity, appropriate in tone, and be readily accessible (Desbarats et al., 2010; Hund and Greenberg, 2010).

Past research indicates that the general public on the whole know very little about CCS and that individuals readily provide opinions about a technology with little or no knowledge on the subject. Such opinions, being uninformed, tend to be unstable and change easily with time (Ashworth, 2010; de Best-Waldhober et al., 2012). This is supported by research conducted by Torvanger and Meadowcroft (2011), who note that people's perceptions of CCS are not fixed, that the public learns experientially, and through relationships. Therefore, it could be suggested that consideration should be given to tapping into pre-existing relationships as a means for information dissemination, such as local community groups (Ashworth et al., 2006). In addition, when considering how information should be made available, it is important to recognise that individuals react to information differently (Bradbury et al., 2011), therefore information is most effective when it is targeted to specific stakeholder needs.

Although communication of the processes involved in storing $CO_2$ are often cited as the most complex to communicate, recognition should be given to the wide range of information that has already been developed to describe these processes. More recently, the lack of accessible information around transport of $CO_2$, and other components of CCS including describing the behaviour of $CO_2$ across the CCS process have been highlighted as key knowledge gaps by social researchers (Wallquist et al., 2012).

Itaoka et al. (2012) noted survey participants demonstrated fairly fundamental misconceptions about the nature of $CO_2$ and its behaviour in conjunction with CCS. For example, over half of the survey participants believed $CO_2$ caused harm to the ozone layer and almost one third believed $CO_2$ affected human health in the same way as air pollutants such as soot. Care should be taken when addressing the characteristics of $CO_2$ to ensure these are well defined in connection to CCS. The nature of information provided – and the person or organisation providing it – has the potential to affect public perceptions. It is important that material about CCS be open and transparent; include information pertaining to the behaviour of $CO_2$ in natural phenomenon as opposed to leakage; and try to make analogies to $CO_2$ use or substances with similar properties in everyday life. In addition, it is essential for the development of trust in the information that it be from credible and reliable sources (Itaoka et al., 2012).

In order to address this lack of awareness and limited understanding of $CO_2$ and CCS by the public, consideration should be given to developing awareness raising programs (Itaoka et al., 2012). Information dissemination can occur through a wide range of options including formal, informal, technical and other less complicated processes. For example, the use of informal information sessions where experts are available to respond to questions, that are designed to permit participants time to absorb and familiarise

themselves with information communicated (Hund and Greenberg, 2010). The processes should also include educating and disseminating materials to teachers and education institutions across all levels – primary, secondary and tertiary – to act as conduits for knowledge sharing and improved understanding of basic energy and sustainability concepts (Colliver et al., 2011; Corry and Reiner, 2011; Reiner, 2008). To assist knowledge uptake and increase the understanding of risks and rewards, information should provide a clear clarification of the role that CCS holds within the energy debate (Ashworth, 2010).

As indicated, the raising of knowledge and awareness resulting from information dissemination may assist in stakeholder opinion stability and bias minimisation. An understanding of the background knowledge and awareness within communities should be established in order to inform the different levels of information required, and to minimise misunderstanding (Feenstra et al., 2010).

## Recommendations

- Information provided to stakeholders needs to be wide ranging (i.e. formal, informal, technical, simple), and delivered by a variety of reliable sources in order to develop trust and ensure stability of opinion.
- Information is to be balanced, of high quality, relevant, of minimal complexity, appropriately toned and readily accessible to a range of stakeholders.
- Develop information delivery programs tailored to different audiences which could be delivered via educational institutions, and include curricula that addresses the wider context for CCS (climate change, energy options and potential mitigation solutions).

## Further Reading

**Note: Extended abstracts of key literature – references highlighted in blue – are available in Appendix C.**


de Best-Waldhober, M., Daamen, D., Ramirez, A.R., Faaij, A., Hendriks, C., and de Visser, E., (2012). Informed public opinion in the Netherlands: Evaluation of CO2 capture and storage technologies in comparison with other CO2 mitigation options. International Journal of Greenhouse Gas Control, 10, 169-180

Desbarats, J., Upham, P., Riesch, H., Reiner, D., Brunsting, S., de Best-Waldhober, M., Duetschke, E., Oltra, C., Sala, R. and McLachlan, C. (2010). *Review of the Public Participation Practices for CCS and Non-CCS Projects in Europe*. Institute for European Environmental Policy: Brussels

Itaoka, K., Saito, A., Paukovic, M., de Best-Waldhober, M., Dowd, A-M., Jeanneret, T., Ashworth, P. and James, M. (2012). *Understanding how individuals perceive carbon dioxide: Implications for acceptance of carbon dioxide capture and storage*. EP 118160, CSIRO: Australia

Wallquist, L., L'Orange Seigo, S., Visschers, V.H.M. and Siegrist, M. (2012). Public acceptance of CCS system elements: a conjoint measurement, *International Journal of Greenhouse Gas Control*, 6, 77-83

## 2.7 Risk perception

### Key findings

- Perceptions of risk differ across individuals and are often locally centred and will be influenced by multiple factors including an individual's feelings, personal experiences and what they may have read, heard or seen.
- There is recognition that for CCS risk communicators to adequately and effectively address the risk concerns of their stakeholders and the public it is essential they gain a better understanding of how communities view CCS projects and associated risks.
- Perceptions of risk are very closely linked to trust in information, in the information source and in its delivery mechanism.

Risk perception and risk communication has been an underpinning theme influencing CCS research since its inception. This draws on previous studies from well known researchers working in the risk communication space such as Slovic, Renn and Fischoff. Multiple stakeholder perspectives (i.e. individual, collective, corporate and governmental) often express concerns around the perceived safety of CCS to the environment, humans (both physical and psychological) (Howell et al., 2012) and the economy, and how these risks are monitored and managed (Bradbury et al., 2011).

In order to better address stakeholder risk concerns, it may help to permit the general public's perception to guide how risk is communicated (Tokushige et al., 2007). Indeed, it has been suggested that risk concerns may be used to justify actions carried out for other reasons or may be expressed as a substitute "for other social or ideological concerns" (Slovic, 1987:285). Therefore, it is essential to ensure that any hidden agendas are made transparent to enable underlying issues to be addressed (Slovic, 1987). Slovic (1987) noted that as a concept, "risk" is difficult to define and differs between people and experts and risk professionals perceive risk differently to the general public. Unlike the general public, experts and risk professionals use structured processes to assess risk, evaluate hazards, and form strategies to manage and mitigate risk (Tsohue et al., 2006).

Assessing risk involves modelling the probability and the impacts of incidents (James et al., 2012, p.6) which are considered from a perspective of harm and potential loss or damage (Slovic, 1987). Risk perceptions of individuals on the other hand, regularly rely on feelings based on intuition and are often reflexive in nature (Slovic and Peters, 2006). Some researchers have suggested that debates surrounding risk may in fact be linked to other sociological or ideological concerns (Slovic, 1987) which may be influenced by factors such as "social and cultural norms and values, past experience, knowledge or access to knowledge, and perception of trust in the source of such knowledge", as well as the extent of the complexity attached to the risk (James et al., 2012, p.8).

Bradbury et al. (2011) found that for project managers and risk communicators to build a cohesive view of CCS risk it was imperative that they gain an understanding of "how the community views the project and perceives project risks" (p.23). In doing so, it is possible to develop communication materials that appropriately address local risk concerns. Bradbury et al. (2011) further note that in order to ensure an understanding of the public and stakeholders' risk perceptions, there is a need for risk communication staff to be fully trained in recognising the varied and many perspectives that surround risk (Bradbury et al., 2011). In doing so, it is possible for sufficient information to be made available to the public for them to determine for themselves the costs and benefit, risks and opportunities associated with CCS (Howell et al., 2012), and to better understand the links between them (Ashworth et al., 2011a).

It has long been recognised that risk perception is closely aligned to trust. Trust in information, trust in source and trust in the delivery of the information (Ashworth, 2010). As such, trust is an important factor in understanding the risk choices of individuals. Stakeholder perceptions of risk surrounding an issue may be strongly influenced by their understanding of how the issue is resolved. For example, stakeholder

perceptions of risks surrounding a storage project may be reduced if they have confidence in the monitoring and verification program that is proposed. In addition, an individual's perceptions of control and the voluntary nature of the risk in question may impact their overall risk evaluation (Adler and Kranowitz, 2005). Ha-Duong and Loisel (2009) see trust in key actors and in the process of decision making as vital to determining social acceptability, arguing that what makes risks socially acceptable is ultimately determined by social preferences and parameters that go beyond economic considerations.

## Recommendations

- To help minimise perceptions of risk, two-way communication processes that recognise individual risk perceptions and tailor responses are considered an essential component for allaying fears.
- If risk perceptions are high, some flexibility in project plans which allow the public to influence the outcome can be helpful to minimise such risk perceptions.
- Risk communication should include information that adequately addresses the multiple facets of risks associated with CCS including capture, transport, and storage
- Risk communication personnel should be well trained to be aware of, recognise and be sensitive to the varying perspectives associated with risks surrounding CCS.

## Further Reading

**Note: Extended abstracts of key literature – references highlighted in blue – are available in Appendix C.**


Bradbury, J., Greenberg, S., and Wade, S. (2011). Communicating the risks of CCS, GCCSI: Canberra

Ha-Duong, M. and Loisel, R. (2009). Zero is the only acceptable leakage rate for geologically stored $CO_2$: an editorial comment, *Climatic Change*, 93(3), 311-317

Slovic, P. (1987). The perception of risk. Science, 236(4799), 280-285

Tsohou, A., Karyda, M., Kokolakis, S. and Kiountouzis, E. (2006). Formulating information systems risk management strategies through cultural theory. *Information Management and Computer Security* 14(3), 198-217

Tokushige, K., Akimoto, K. and Tomoda, T. (2007). Public perceptions on the acceptance of geological storage of carbon dioxide and information influencing the acceptance. *International Journal of Greenhouse Gas Control*, 1(1), 101-112

## 2.8 Governance

**Key findings**

- It is recognised that the ethical dimensions of a project, the infrastructure, legal systems and regulatory processes that support it, and how these impact the local community, have the potential to significantly impact a project's advancement and long term outcomes.
- The process of site selection, development of a CCS project, and the imposition of legal and regulatory processes may involve procedural and distributive justice issues for stakeholders and communities affected by the project.

Although a less frequently occurring theme, governance is an area that requires attention due to the multiplicity of its components, including issues related to procedural fairness, distributive justice, effectiveness of outcomes, and legal and regulatory frameworks.

For example, distributive justice issues identified within the analysis included the fair and just sharing of burdens, such as air pollution, across all of society as opposed to specific minority groups and/or disadvantaged communities. Concerns arising from procedural justice issues included a sense of disempowerment and exclusion from the decision making process (see Bradbury and Wade, 2010). Negative experiences of the community associated with procedural and distributive justice impacts upon perceptions of efficacy. For example, a community may expect their concerns to be listened to and taken seriously, but instead they are left with a sense not being heard (see Desbarats, et al., 2010).

Issues of justice and efficacy are further exacerbated by the perception of a lack of coherent governance and regulatory process. Governance and regulation was seen to be required to establish authorities that are clear and delineated in respect of local, state and national perspectives, addressing safeguards, project requirements and development processes. There was recognition of the need for well-established regulatory guidelines across all processes of the CCS chain, with clearly identified responsibilities for any liabilities that might arise either now or in the longer term (Bradbury and Wade, 2010). Similarly, it was found to be important to establish a shared vision across all layers of the project from developers through to governments and authorities responsible for regulating CCS to ensure greater public confidence in the overall project.

Research has identified two forms of 'justice' around CCS, distributive justice and procedural justice (de Groot and Steg, 2011). Distributional justice refers to the question of the potential benefits and risks associated with CCS being distributed fairly across society, whether spatial, financial or social. Procedural justice refers to the question of whether all sections of society are able to participate in the decision making processes through which CCS comes into being. McLaren (2012) notes procedural justice as a key component of the fair and ethical implementation of CCS, and calls for further consideration of how a just governance process for CCS could be developed.

Furthermore, Hansson (2012) and McLaren (2012) express concern that some engagement processes focus on communication and on building support for CCS, rather than allowing for a range of possible outcomes. Gross (2007) observes in practice – with reference to wind farm developments in Australia – that perception of fairness in process can be just as important as perceived fairness in outcome. If people feel they have been treated fairly during the consultation and deliberation process, they may be more likely to accept an outcome that is not what they would have wanted.

Similarly, early research of the US Department of Energy's Carbon Sequestration Regional Partnerships clearly established the need for elements of procedural fairness and distributive justice for developing effective project outcomes (Corry and Reiner, 2011a; Regional Carbon Sequestration Partnerships (RCSP), 2009). The researchers highlight that in the absence of transparent and fair processes, technological risks are more likely to dominate discussions which may result in more negative perceptions of projects being formed. Strategies that clearly identify avenues for communities to provide input as well as a clearly

identified project contact for locals to call if there are any problems, help to demonstrate a willingness to be flexible towards local needs and go a long way at reducing negative perceptions (Bradbury et al., 2009).

Research by Brown (2011) on public perceptions of CCS exploring the ethical dimensions of the technology, acknowledges that the term 'ethical' is open to contestation, and can mean different things to different people. Brown (2011) summarises that ethical deployment of CCS "requires those who are the proponents of a project to protect others from serious harm caused by the project, particularly those who have not consented to be put at risk, and especially in cases where the harm is potentially significant and irreversible" (Brown, 2011, p319.). From a nuclear waste disposal perspective, Shrader-Frechette (2002) argues that such 'harm' need not be direct physical harm, but also 'harm' in terms of being denied the chance to participate fairly in decision making.

While mapping the ethical landscape around CCS, Boucher and Gough (2013) examined the viewpoints of a range of institutions (government bodies, industrial developers, NGOs, etc.), and charted how these institutions spoke about the ethical dimensions of CCS in terms of justice, wellbeing, control/influence/power, and social values/human understanding. In the process they noted potential ethical conflicts between actors in several areas, namely: environmental justice, the prevention of harm, scientific competence, and regulatory competence. They also found that accountability (in the context of long-term storage) represented a key challenge in discussing the ethical dimensions of CCS, arguing that this highlights the immaturity of legal and regulatory frameworks (Boucher and Gough, 2013).

## Recommendations

- Projects require clearly defined processes for communities and other key stakeholders to provide input into project decisions - helping to develop a partnership approach toward shared outcomes.
- Legal and regulatory frameworks surrounding CCS need to be aligned across local, state and national contexts, to reduce conflict between different levels of government, and minimise the erosion of public confidence in the project.
- A shared vision across project funders, development teams and within the teams themselves helps to create a unified vision for the need for the project.

## Further Reading

**Note: Extended abstracts of key literature – references highlighted in blue – are available in Appendix C.**


Boucher, P. and Gough, C. (2012). Mapping the ethical landscape of carbon capture and storage, *Poiesis and Praxis*, 9(3-4), 249-270

Brown, D.A. (2011). Comparative ethical issues entailed in the geological disposal of radioactive waste and carbon dioxide in the light of climate change, in F. L. Toth (Ed.), *Geological Disposal of Carbon Dioxide and Radioactive Waste: A Comparative Assessment* (Vol. 44, pp. 317-337), Springer: Netherlands

de Groot, J.I.M. and Steg, L. (2011). Psychological perspectives on the geological disposal of radioactive waste and carbon dioxide, in F. L. Toth (Ed.*), Geological Disposal of Carbon Dioxide and Radioactive Waste: A Comparative Assessment* (Vol. 44, pp. 339-363), Springer: Netherlands

Hansson, A. (2012). Colonizing the future: the case of CCS in N. Markusson, S. Shackley and B. Evar (Eds.) *The Social Dynamics of Carbon Capture and Storage* (pp. 74-90), Earthscan: London

# 3 What does this mean for CCS

## 3.1 Wrapping it all together

Given the breadth of research that has taken place over the past few years, at first glance the key themes arising from this body of work may seem underwhelming, not 'rocket science' and basic common sense. However, summarising the full detail of the research program to a small digestible number of themes can be misleading, as each theme contains a wealth of detailed learning that you are encouraged to read more about. The challenge is to understand the implications of this research for CCS projects now and into the future. To identify gaps and opportunities for further research and assess how they fit within the current CCS research and development program.

For example, we know from the experiences of several projects that some projects fail, not only due to technical and financial risks, but also as a result of social and political issues. Clear guidelines for developing strategic communication activities for CCS projects and their delivery to a wide array of stakeholders in a timely fashion, can assist projects at the earliest stages of their inception. Such guidelines have been developed through the Communication/Engagement Toolkit and are currently being applied by some CCS projects in various countries.

Establishing a current and relevant context for CCS deployment has also been identified as an important consideration for the ongoing communication of the technology. Early work discussed the importance of linking anthropogenic climate change to the need for CCS as a mitigation technology. It was found that not advocating for CCS as a single solution, but setting it in the context of a portfolio of options had greater saliency for most stakeholders. More recently however, the work of Corry and Reiner (2011b) has begun to question this context, particularly after their research with environmental groups, who saw no reason for extending the fossil fuel industry today – therefore making the role for CCS as a mitigation technology redundant. Despite these concerns, the most persistent framing or context for CCS still appears to be CCS as a vital technology for achieving mandated carbon reductions without the possible economic and lifestyle burdens of drastic changes in energy use.

There are a number of externalities that can impact on the overall success of a CCS project. These include both what is happening now or has happened previously at the local level as well as the broader political context in which projects are expected to operate. For example, is there overall government support for the project? What levels of regulation are in place to ensure responsibility for project liabilities? What is the track record and legacy of this company been in previous communities? Has the company demonstrated they are prepared to go beyond compliance when engaging stakeholders to build relationships with them? These questions demonstrate just a few examples of externalities that need to be considered because of their significant influence on the perception of a project from the outset.

Similarly, we know that what has gone on before in the host community will impact on how the new project is perceived. In addition to cultural considerations, this can include many things such as past experiences with government, socio economic status of the area, history and the community's experience with wider industry. The Social Site Characterisation workbook helps to provide projects with practical ways to do this to gain a better baseline understanding of the social factors that might positively or negatively impact on a project including such externalities.

A key finding from the comparative case studies across Australia, the Netherlands and United States, is that integral to a project moving forward is "the extent to which key government and project development team members are aligned in terms of support for, and coordination of the project" (Ashworth e al., 2012:405). Without such alignment, examples suggest it is pointless trying to progress projects. Similarly, when discussing communication and engagement activities, findings from the social research and associated literature demonstrate that for CCS projects to have a chance at being successful, communication and engagement must be considered as a two-way dialogic process (Ashworth et al., 2012).

Two-way implies that projects will be flexible to accommodate any issues and concerns that may be raised by stakeholders as part of the engagement process and, where necessary, make adjustment to their overall project plan.

To enhance communication and engagement successes there are two major factors to consider - first 'what to communicate', and second 'how best to do it'. In this case the 'what' encompasses the key themes of information, framing CCS, and risk perception, all of which help to inform the knowledge and opinions of stakeholders. Over the years there have been many studies around what information should be provided in relation to CCS, while this is invariably highly project specific, there is general consensus on the need to ensure information is comprehensive, of a high quality and easy to understand. More in depth studies on the 'what' have found that sharing analogues around naturally occurring $CO_2$ may bring about mixed responses, but often have a positive overall impact (Itaoka et al., 2009; Tokushige et al., 2007). This was tested in more recent research by Itaoka and colleagues (2012). Their results showed that providing information on natural phenomena involving $CO_2$ and $CO_2$'s behaviour had a weak but significant negative effect on CCS perception, while information on the properties and chemistry of $CO_2$ had a positive effect. However, regardless of shifts in opinion, through interviews with a cross section of the general public, information on $CO_2$ was considered important foundational information for projects to include.

Finally the perception of risk and how it can dramatically influence your decisions is well documented. The work "Communicating the risks of CCS" led by Judith Bradbury - well versed in the communication of risk from her earlier research roles into radioactive waste management in the USA - outlined processes to involve local communities in project risk assessment. This is a novel way of raising transparency of the process and generating greater understanding of project risks. It shows how to demonstrate to a range of local stakeholders how experts assess the overall risks of a project, and is a way of allowing local concerns to be considered as part of the overall project risk assessment process.

The 'how' of projects relates to the processes that project developers elect to use to engage the range of stakeholders who are affected by, or have an interest in their project. There is no doubt that communities, non-government organisations, and governments themselves, carry an expectation for processes to be used that are seen to be fair and equitable. With a focus on open exchange and dialogue, there is an opportunity for projects to build the trust of local communities, and other stakeholders, by carefully selecting the processes for engagement that attend to issues like representativeness, transparency and timeliness. At the same time demonstrating they can be flexible to attend to needs of stakeholders, as appropriate, within the development timeframes of a project. Hence, why there is a continual call for early engagement to ensure opportunities are structured in a timely fashion to enable input from all who might have an interest in participating.

It is useful to reflect on how each of these key themes interact overall in a way that may help to facilitate more positive project outcomes. Figure 4 on the following page attempts to set this out in a way that highlights the important considerations discussed above.

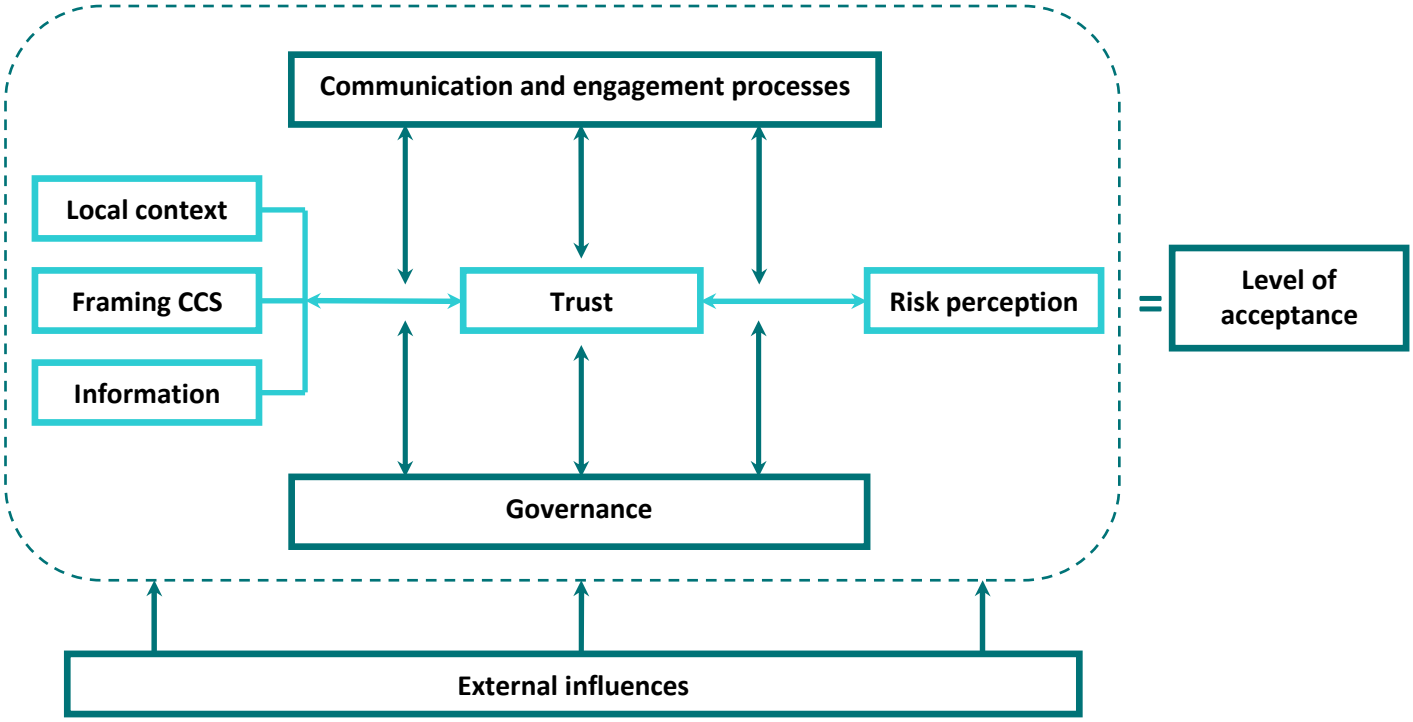


Figure 4 A framework of interactions for CCS projects

## 3.2 Implications and ongoing social research on CCS

Although a vast amount of practical knowledge has been amassed to inform and assist CCS projects' communication and outreach. It is worth noting that most of the work that has taken place has focused heavily in the developed world – which is not unexpected since that is where the early demonstration projects tend to be located. However, there is an emerging body of research from developing countries where CCS projects are also being considered. Although these are not analysed in this report, it is worth noting that all of the themes are likely to be just as applicable in the developing world and therefore should be considered by projects working in this area. It may be appropriate to now bring together the body of work that is emerging from the developing world and analyse this separately to compare and contrast with the findings of this research.

In addition to individual project communications and outreach activities which is not a focus of this research, internationally, social science researchers are continuing to focus research efforts on CCS. Below we present a snapshot of some of the activities currently taking place across the world; the list however, is by no means exhaustive.

### 3.2.1 Europe

In Europe there are several major projects being undertaken. Firstly, within the CATO-2 programme operating in the Netherlands, researchers from the University of Leiden continue to build upon research within the 'Public perception' theme (CATO-2, 2013). This includes new work on site host compensation models which is examining public and administrator preferences towards host community compensation. An earlier literature review has recently been published (ter Mors et al., 2012). The outcomes from this research are likely to provide far reaching insights into the expectations for compensation particularly when trying to establish the benefits of a project.

The lead researchers at Leiden, continue their investigations into whether expected and perceived information quality depends on the source of information (i.e. as single party versus a coalition) and other

researchers there are examining framing effects in communications and factors that may influence people's ability to achieve a state of cognitive closure

SiteChar is another major European project. Its focus is on extending the site characterisation process, by testing and implementing aspects from the social site characterisation and public engagement toolkits. Recently, as part of Work Package 8 – Advancing Public Awareness, public outreach activities have been conducted in communities in Scotland and Poland where CCS sites could potentially be located (Brunsting et al., 2012b). The aim of this work package is to provide trustworthy information to facilitate the formation of informed opinions regarding CCS and is being led by ECN (SiteChar, 2013) in conjunction with the Independent Institute for Environmental Issues, the University of Edinburgh, the Scottish Government, AGH University of Science and Technology, and Polish Oil and Gas company, PGN.

French-based consultant Acceptables Avenirs and Actys Bee are working with the Institute to develop the body of work and practical examples of social site characterisation and stakeholder analysis with their soon-to-be-published case studies detailing the processes, results and learning that emerged from applying current best practice processes to the Ultra-Low $CO_2$ Steelmaking (ULCOS) Industrial CCS project. Other work involving the Institute includes a recently published collection of case studies (Prangnell, 2013) that provide an opportunity to analyse recent project efforts to tackle communication and engagement challenges facing projects in Europe and also Canada.

Also in Europe, is the recently initiated R&Dialogue project involving 15 partner organisation/institutions and ten European countries. The objective is to improve dialogue on the transition to a low-carbon society and CCS is one of the topics that will be discussed. As part of the project, researchers will be conducting stakeholder interviews and discussion groups (R&Dialogue, 2013). CIRED who is leading the national dialogue process in France, is also conducting additional social research into CCS, with PhD candidates examining topics such as the politicisation and acceptability of CCS.

### 3.2.2 Canada and North America

Elsewhere, Carbon Management Canada has provided funding towards a range of projects currently being undertaken by academic and research institutions in Canada. The focus of these projects includes: the development of analytical tools to assess the potential for CCS deployment; innovation in governance practices; people's judgements about specific technologies, including CCS in Alberta; perceptions of CCS and barriers to investment within the oil and gas industry; the development of a risk assessment and management framework for CCS in Canada; and the media content and public communication stemming from the Weyburn incident. The study into the latter has recently been published by Boyd et al., (2013).

Other work in North America continues to focus on understanding best practices for communication, knowledge sharing, and risk mitigation. For example the United States Department of Energy Outreach Working Group has conducted studies on message mapping to facilitate effective communication (Daly and Wade, 2012), extensive public communication processes are being undertaken as part of the FutureGen 2.0 project (FutureGen Alliance, 2013) and the Petroleum Technology Research Partnership (PTRC) responsible for the $CO_2$ storage research behind the IEAGHG Weyburn-Midale CCS project is also working with the Institute to create and test simple communication material on $CO_2$ storage and enhanced oil recovery.

### 3.2.3 South Africa

The South African Centre for Carbon Capture and Storage (SACCCS) is focussing on the development of a Test Injection Project. Part of the project's delivery will be public engagement at the national and local level. A consortium of researchers was appointed in 2012 to develop two separate stakeholder engagement plans, a national and a local plan. These will be deployed by engagement staff on the SACCCS Test Injection Project. South Africa provides a unique opportunity to address the particular challenges of engaging diverse communities within a developing country. For example, communicating about CCS needs to occur within the context of other issues such as access to energy, poverty alleviation, job creation and education.

### 3.2.4 Asia Pacific

Across the Asian Pacific region, some interesting work is emerging from Institute-supported networks. For example the Japanese Knowledge Sharing Network - an initiative that involves over 40 individuals from 20 CCS-related Japanese organisations sharing knowledge on topics related to CCS communications and seismicity. It has focused its recent activity on developing and testing a communication strategy and CCS argumentation map for Japanese stakeholders.

## 3.3 Recommendations for future research

It appears that there are still ample opportunities to build and refine our knowledge of how best to engage on CCS. Whether it is near potential sites or conducting experimental designs to further test the effects of information sources, the results help to grow the body of knowledge on the impacts of communicating about this technology. One of the greatest opportunities for shared learning however, will be to ensure that alongside project communications and outreach activities, research institutions can be an independent observer and track the impacts of the activities being implemented. Understanding the impacts can only be done by first establishing baseline knowledge of how the project is perceived, so as to compare how perceptions are changing as a result of the communication and engagement activities.

Media analysis is one useful tool to assist in documenting and tracking emerging attitudes toward a project, and is demonstrated in the case study of FutureGen 1.0. By systematically documenting the changes and impacts of various outreach and communication activities it may be possible to build and enhance the overall package of support materials for projects and support more positive engagement outcomes for early projects.

The key recommendations for further research or opportunities arising from this synthesis are included below and grouped for ease of reference into 'for future research' and 'for project developers':

**For future research**

1. Undertake a more systematic study of what has been done in developing countries in relation to CCS and where possible begin to test the findings from this body of work in those context specific locations.
2. Continue to investigate the psychological factors, values, and world views that may impact a project's acceptance through case studies of projects progressing through the project lifecycle.
3. Follow closely the work on host site compensation models and where appropriate, in conjunction with the researchers, test these in various cultural locations to assess if differences arise.
4. Conduct further investigations around perceptions in relation to transportation of CCS, in particular issues related to the siting of pipelines for the transportation of CO2.

**For project developers**

1. Implement and test the social site characterisation, risk assessment frameworks, and communication and engagement toolkits in host communities or potential host communities to provide further refinement to these tools as well as greater insights for CCS project developers.
2. Ensure researchers have access to projects from their inception to establish a baseline and observe the impacts of projects on host communities.
3. Develop regionally based communities of practice for project communication and engagement staff to ensure project experiences are openly shared.
4. Where possible continue to arrange formal knowledge sharing workshops between social researchers and projects to share findings and more openly elucidate where gaps in knowledge and challenges might still exist.

# Part II Appendices

# Appendix A – Map

LEGEND:

- Qualitative
- Quantitative
- Global CCS Institute
- Combination: Qualitative/Quantitative

CCS Project Case Studies:

1. Barendrecht
2. Carson
3. FutureGen
4. CO2CRC Otway
5. ZeroGen

INSTITUTIONS:

- **National Institute of Advanced Industrial Science and Technology (AIST)** JAPAN
- **AJW Inc** UNITED STATES OF AMERICA
- **Carnegie Mellon University** UNITED STATES OF AMERICA
- **Centre for Low Emissions Technology (cLET)** AUSTRALIA
- **Centro de Investigaziones, Energeticas, Medioambientales, y Tachnologicas (CIEMAT)** SPAIN
- **Centre International de Recherche sur l'Environnement et le Developpement (CIRED)** FRANCE
- **Commonwealth Scientific and Industrial Research Organisation (CSIRO)** AUSTRALIA
- **Energy research Centre of the Netherlands (ECN)** NETHERLANDS
- **European Commission** BELGIUM
- **Fraunhofer Institute** GERMANY
- **Institute for European Environmental Policy (IEEP)** UNITED KINGDOM
- **Leiden University** NETHERLANDS
- **Massachusetts Institute of Technology (MIT)** UNITED STATES OF AMERICA
- **Mizuho Research Institute** JAPAN
- **Pacific Northwest National Laboratory (PNNL)** UNITED STATES OF AMERICA
- **Research Institute of Innovative Technology for the Earth (RITE)** JAPAN
- **Sallie Greenberg** UNITED STATES OF AMERICA
- **Tyndell Centre** UNITED KINGDOM
- **University of Calgary** CANADA
- **University of Cambridge** UNITED KINGDOM
- **University of Illinois** UNITED STATES OF AMERICA
- **University of Edinburgh** UNITED KINGDOM
- **University of Oregon** UNITED STATES OF AMERICA
- **University of Utrecht** NETHERLANDS

**Figure 5 Map showing institutions and corresponding research output methods. The diagram above illustrates where the social research of the 39 analysed reports was undertaken. The legend helps to identify which institutions have been involved and the type of research they have undertaken to date.**

# Appendix B – Summary of key references

### Apx Table B.1 Overview of key references from each theme

| TITLE | AUTHORS | INSTITUTIONS | COUNTRY |
|---|---|---|---|
| What happened in Barendrecht? Case study on the planned onshore carbon dioxide storage in Barendrecht, the Netherlands (2010). | Feenstra, C.F.J., Mikunda, T. and Brunsting, S. | • ECN | • The Netherlands |
| Public perceptions to low carbon energy technologies – Results from a Scottish Large Group Workshop (2012). | Howell, R., Shackley. S., and Mabon. L. | • University of Edinburgh | • Scotland |
| Public understanding of and engagement with CCS (2012). | Bradbury, J. | | NA |
| Site Characterisation: From Concept to Application (2011). | Wade, S. and Greenberg, S. | • AJW Inc | • United States of America |
| Understanding stakeholder attitudes to carbon capture and storage (CCS) in Victoria (2012). | Ashworth, P., Jeanneret, T., Romanach, L., and James, M. | • CSIRO | • Australia |
| Going beyond the properties of $CO_2$ capture and storage (CCS) technology: How trust in stakeholders affects public acceptance of CCS (2011). | Terwel, B.W., Harinck, F., Ellemers, N. and Daamen, D.D.L. | • Leiden University | • The Netherlands |
| Communication/Engagement tool Kit for CCS Projects (2011) | Ashworth, P., Bradbury, J. Feenstra, C.J.F., Greenberg, S., Hund, G., Mikunda, T., Wade, S., and Shaw, H. | • CSIRO<br>• ECN<br>• University of Illinios<br>• ALW Inc<br>• PNNL | NA |
| Communicating CCS: Applying communications theory to public perceptions of carbon capture and storage (2011). | Brunsting, S., Upham, P., Dutschke, E., de Best-Waldhober, M., Oltra, C., Desbarats, J., Riesch. H. and Reiner, D. | • ECN<br>• Finnish Environment Institute<br>• Manchester Institute of Innovation Research<br>• Tyndall Centre<br>• University of Leeds<br>• Fraunhofer Institute for Systems and Innovation Research<br>• CIEMAT<br>• IEEP<br>• Imperial College London<br>• University of Cambridge | NA |
| Informed public opinion in the Netherlands: Evaluation of $CO_2$ capture and storage technologies in comparison with other $CO_2$ mitigation options (2012). | de Best-Waldhober, M., Daamen, D., Ramirez, A.R., Faaij, A., Hendriks, C., and de Visser, E. | • ECN<br>• Leiden University<br>• Utrecht University<br>• Copernicus Institute<br>• Ecofys | • The Netherlands |

| | | | |
|---|---|---|---|
| Understanding how individuals perceive carbon dioxide: Implications for acceptance of carbon dioxide capture and storage (2012). | Itaoka, K., Saito, A., Paukovic, M., de Best-Waldhober, M., Dowd, A-M., Jeanneret, T., Ashworth, P. and James, M. | • Mizuho<br>• ECN<br>• CSIRO | • Japan<br>• The Netherlands<br>• Australia |
| The perception of risk (1987). | Slovic, P. | • University of Oregon | • United States of America |
| Communicating the risks of CCS (2011). | Bradbury, J., Greenberg, S. and Wade, S. | • Wade LLC | • United States of America |
| Psychological perspectives on the geological disposal of radioactive waste and carbon dioxide (2011). | de Groot, J.I.M. and Steg, L. | • Bournemouth University<br>• University of Groningen | NA |
| Colonizing the future: the case of CCS (2012) | Hansson, A. | • Linköping University | NA |

# Appendix C – Extended abstracts of key references

## Framing CCS

Feenstra, C.F.J., Mikunda, T. and Brunsting, S. (2010). *What happened in Barendrecht? Case study on the planned onshore carbon dioxide storage in Barendrecht, the Netherlands*. ECN: Amsterdam

This case study report details the events associated with the Netherlands' Barendrecht project from its initiation in 2007 to June in 2010. Outlining defining moments that influenced stakeholder relationships and opinions of the project, the report focuses on communication characteristics between stakeholders and the community. The report presents lessons learnt from the various communication shortcomings the study identified. In order to create mutual trust between stakeholders, importance is placed on ensuring stakeholders are brought into the project process early and communicated to at the outset. Throughout this process, stakeholder interests, needs, demands and values should be defined and integrated into the project design. This should include formal and informal communication around aspects of the project, process, procedures and context. The message source and sender to be well trusted in the community and such information to provide a level of detail pertaining to technical, economic and environmental aspects of the project. To better appreciate the local community, its relationships and history it is important to develop an understanding of the community, including any existing knowledge of $CO_2$, its characteristics, CCS policies and specific projects. By discussing the project as part of a wider range of alternatives for Climate Change mitigation it may be possible to capture existing local and national discussions that relate to the project.

Howell, R., Shackley, S. and Mabon, L. (2012). *Public perceptions to low carbon energy technologies – Results from a Scottish Large Group Workshop*. University of Edinburgh: Scotland.

This report discusses outcomes of a large group process workshop held in Edinburgh, Scotland, in September 2011. The workshop was designed to investigate Scottish citizens' perspectives on climate change and low carbon energy technologies, including carbon dioxide capture and storage (CCS). The workshop formed part of a wider comparative study, which placed regional findings into an international context. Key findings reflect a range of public opinions in regard to climate change, low carbon energy and CCS. Climate change was considered an important issue for Scotland by most participants, interspersed with anthropogenic influence and whether reducing carbon emissions would effectively mitigate climate change. Generally, support for renewable energy technologies was higher than non-renewables, while coal, oil, nuclear and CCS technologies received the least support. Unwillingness to pay more for electricity was persistent regardless of broad consensus that costs needed to rise to meet carbon reduction targets. Participants exhibited limited knowledge of energy use, technologies or climate change. While support for CCS diminished as the workshop progressed. When asked to rank trusted sources of information, participants expressed low levels of trust in the information sources provided. Rated most trustworthy were research institutes and universities, academic articles and family and friends; whereas, blog sites and industry were considered the least trusted sources. Research findings suggest that engaging people in facilitated discussion about climate change and energy technologies can shift perspectives.

## Local context

Bradbury, J., (2012). Public understanding of and engagement with CCS, in N. Markusson, S. Shackley and B. Evar (Eds.) *The Social Dynamics of Carbon Capture and Storage* (pp. 172-188), Earthscan: London

This book chapter focuses on public understanding and community engagement in deployment of a CCS project, where potential impacts are concrete in nature rather than abstract. The author limits her discussion to projects based in the United States (US). A theoretical background considers the current status quo of applied social science knowledge in relation to community perception and engagement perspectives. Six examples of CCS deployment are examined, mainly from within the US Midwest, in order to identify key factors that affect how communities understand and react, and how these impact effective engagement. Key findings can be found in the chapter summary. The author identifies issues and patterns of community response, noting that engagement does not necessarily guarantee success with multiple variables having the ability to impact deployment. Engagement is likely to be more effective if it draws upon foundations of trusted relationships and economic ties. Other implications include variances in cultural and social frameworks that influence what is and is not important to individuals and how they seek opinions from influential others. Opinions do not just appear but are instead based in broader policy views which may impact belief in climate change and result in potentially conservative views. Finally, concerns relating to risk and safety, such as leakages, draws upon issues of trust, responsibility and participation in how decisions are made. The author notes that for the technology to progress there will need to be more than a meeting of the technical and geological, suggesting that incorporating an understanding of social science into a site's selection, its operation and generally how the project is run, as well as budgeting might move some way to ensuring more successful project sitings in the future.

Wade, S. and Greenberg, S. (2011). *Social Site Characterisation: From Concept to Application. A review of relevant social science literature and a toolkit for social site characterisation*. AJW Inc.: Washington

Coined to describe the process of collecting and incorporating information about stakeholder views, the term *social site characterisation* was designed to resonate with technical experts involved in CCS and aware of the importance of site characterisation as a means for ensuring a CCS project's integrity. In addition to assessing the technical and physical characteristics of a site, this tool considers the social, human, characteristics as part of the selection and project design. Just as a technical site characterisation leads to a design process best suited to the site-specific physical conditions, information gained through social site characterisation can be developed with site specific needs of the community in mind. The report examines the why and how of conducting a social site characterisation for a CCS project. Further, it provides a review of a selection of social science literature in Part 1 that may help to provide insights to CCS project development. In Part 2 the report incorporates a Social Site Characterisation Toolkit the authors propose for inclusion as a module to the Communication/Engagement Toolkit for CCS Projects developed by CSIRO.

## Trust

Ashworth, P., Jeanneret, T., Romanach, L., and James, M. (2012a). *Understanding stakeholder attitudes to carbon capture and storage (CCS) in Victoria*. EP125331. CSIRO: Pullenvale

This report focuses on how stakeholders resident in Victoria, Australia, perceive and accept potential CCS projects. Focus groups showed that support for CCS improved significantly over the course of the day, while participants indicated increased knowledge on a range of climate and energy related issues. Participant's preferences were for CCS projects to be located over 10km away. Concerns and questions of participants were similar to commonly documented in CCS discussions that occur for the first time. Including themes demonstrating curiosity about basic technical aspects of CCS, such as: underground storage, long-term impacts of $CO_2$, the durability of CCS over time, and concerns regarding the effect of CCS on potential natural disasters. Other more broad perspectives identified included whether $CO_2$ had alternative uses, querying the comparisons and evaluations carried out to justify the decision to develop CCS over another climate mitigation technology. Also included in discussions were the economic status and prospects of CCS, the connection of CCS to a carbon price, the development of CCS internationally, and the interests and institutions supporting CCS. The results demonstrated a limited awareness of the technology and a need for information and education on CCS. A proportion of the respondents (around a third) had questions of a 'technical' nature, suggesting that participants sought additional information while considering their acceptance of CCS technology. These questions related to topics including procedures, $CO_2$ properties, $CO_2$ behaviour, impacts, potential for disasters, risks of leaks and aquifer damage, alternatives to CCS, and the ability to use existing infrastructure. The results are significant in that they call attention to the fact that members of the Victorian public are currently formulating an understanding of CCS that may also apply to other industries, such as coal and gas mining in Australia, and to other alternative technologies and policy solutions.

Terwel, B.W., Harinck, F., Ellemers, N. and Daamen, D.D.L. (2011). Going beyond the properties of $CO_2$ capture and storage (CCS) technology: How trust in stakeholders affects public acceptance of CCS, *International Journal of Greenhouse Gas Control*, 5, 181-188

Moving away from previous research seeking to address individuals' perceptions of the properties of CCS technology as a predictor of public acceptance of its use as a climate change mitigation option, Terwel et al consider another influencing factor; that of public trust in CCS project proponents and other stakeholders. By reviewing past experimental research they draw attention to how trust in stakeholders affects lay people's acceptance of CCS implementation. Their research confirmed that environmental NGOs are perceived to be trusted more than industrial stakeholders. They noted that trust in various CCS stakeholders was more likely to be engendered where arguments they presented resonated with the organizational motives stakeholders expect them to act on. For example, one would expect oil and gas companies to talk about the commercial advantages of using CCS while NGO's would be expected to discuss the environmental benefits of reduced $CO_2$ emissions. The findings from this report lead Terwel et al. to note that it is essential to consider CCS within a project's social context in order to gain a better understanding on the affects of trust on the public acceptance of CCS. However, in order to do this it is necessary to account for factors that go beyond the properties of the technology itself.

## Communication and engagement processes

Ashworth, P., Bradbury, J. Feenstra, C.J.F., Greenberg, S., Hund, G., Mikunda, T., Wade, S., and Shaw, H. (2011b). *Communication/Engagement tool Kit for CCS Projects*. CSIRO: Pullenvale

Designed as a universal guide for implementers and developers of CCS projects the *Communication/Engagement Toolkit for CCS Projects* is a practical and informative tool to assist the design and management of communication and engagement activities for individual CCS projects. As the aim of the gathering social data is to learn and understand about the consequences of a proposed CCS project on a population and community, the key to such an assessment is to identify both positive and negative impacts so as to best engage the community on the project. The Toolkit provides best practice methods for addressing the various social components that surround CCS deployment. The authors envisaged the Toolkit would be a resource to use at different stages and in various ways depending on the level of expertise of the project team and its knowledge of the local community. Each activity can be used in a standalone way or in conjunction with any other components within the Toolkit. Both quantitative and qualitative methods have been suggested for the early stakeholder identification and data collection processes, ideally resulting in a comprehensive bank of information to be utilised by the project team.

Brunsting, S., Upham, P., Dutschke, E., de Best-Waldhober, M., Oltra, C., Desbarats, J., Riesch. H. and Reiner. D. (2011a). Communicating CCS: Applying communications theory to public perceptions of carbon capture and storage, *International Journal of Greenhouse Gas Control*, 5(6), 1651-1662

This report provides an overview of different factors that influence communication outcomes associated with CCS. The authors provide a communications matrix drawing on experience with CCS projects and past studies. By applying the matrix to organize empirical data around four primary communication input factors (source, message, channel, receiver) on outputs such as, attention, interest, understanding, and attitudes, the authors were able to develop a 'map' of opinion shapers. The map may assist in the development of public communication, engagement, and participation in CCS projects. By understanding how input and output factors influence each other the authors believe it is possible to determine the features that are best to apply in order to achieve an intended communication outcome. Such knowledge requires early public engagement in order to explore the needs and concerns of the public. The authors stress the importance of ensuring multiple viewpoints regarding CCS are included in any communication about the technology, and that such communication should at all times remain an open and objective discussion, were considered critical to the communication outcome. Their approach to CCS communications using a communication–persuasion matrix emphasizes how effectively influencing the output of a communication imposes upon communicators a need to know the pertinent input factor characteristics, specifically pertaining to the receiver; the influencing nature such factors may have upon another in producing specific results; and, how these factor combinations influence specific outputs, including for example, message contact or the attitudes and behaviour a receiver towards CCS generally or more specifically CCS projects.

## Information

de Best-Waldhober, M., Daamen, D., Ramirez, A.R., Faaij, A., Hendriks, C., and de Visser, E., (2012). Informed public opinion in the Netherlands: Evaluation of $CO_2$ capture and storage technologies in comparison with other $CO_2$ mitigation options. *International Journal of Greenhouse Gas Control*, 10, 169-180.

This report discusses the findings of a study undertaken in the Netherlands with 995 participants as a representative sample of the Dutch general population. Participants were requested to take the part of policymakers faced with a policy decision based on the Dutch demand for energy in 2030 and carbon dioxide emission reductions of 50%. Using an Information Choice Questionnaire (ICQ) developed for this purposes, respondents evaluated information from experts on seven $CO_2$ emission reduction options and corresponding consequences. Analysis showed evaluation of information regarding consequences moderately influences how participants evaluate options overall. In addition, CCS options appeared to be evaluated less positively due to comparison with other options. From these results the authors point out several important findings. It is possible for experts of different specialisation to agree on what is relevant, valid and balanced information in regard to the consequences of $CO_2$ mitigation options. Participant option evaluations are based in part on this information. No particular CCS option consequences stood out as a main contributor to the evaluation or acceptance of CCS, however there is a hint of a potential negative effect of associating CCS to one technology or fuel source. Comparison with other $CO_2$ mitigation options in the survey also appeared to create a negative effect in relation to CCS options, with the exception of the nuclear energy option. The most significant find identified by the authors was that on the whole, after processing accurate, balanced and valid information about the consequences of CCS options, the majority of participants were not enthusiastic, but they had no intention to protest.

Itaoka, K., Saito, A., Paukovic, M., de Best-Waldhober, M., Dowd, A-M., Jeanneret, T., Ashworth, P. and James, M. (2012). Understanding how individuals perceive carbon dioxide: Implications for acceptance of carbon dioxide capture and storage. EP 118160, CSIRO: Australia.

This report describes an investigation of how citizens of three countries (Japan, Australia, and the Netherlands) perceive $CO_2$ and relates this to perceptions of CCS through both focus groups and an online survey. The report also determines how information provision about the underlying properties and characteristics of $CO_2$ influences individual attitudes towards low carbon energy options, specifically CCS. The authors primary goals were to explore public knowledge and understanding of the properties of $CO_2$, to examine the influence such knowledge has on perceptions of $CO_2$ and CCS; to investigate how information provision about the underlying properties and characteristics of $CO_2$ influences individual attitudes towards CCS; and, identify if any differences between countries exist in relation to values and beliefs, knowledge of $CO_2$'s properties, and CCS perceptions. Results revealed that respondents had limited knowledge of $CO_2$. Respondents from focus groups tended to perceive $CO_2$ negatively as toxic and harmful. Substantial uncertainty existed over whether $CO_2$ affects humans in the same way as carbon monoxide. Few respondents could describe uses for $CO_2$. Likewise, many research participants had misperceptions regarding the mechanism of climate change. Awareness of CCS was generally low, with greater awareness among residents of the Netherlands than of Japan or Australia. Perceptions of CCS also varied between each country. After the presentation of basic information on the technology during interviews and focus groups, Japanese respondents tended to regard CCS favourably, whereas the majority in Australia regarded CCS negatively, while perceptions were mixed in the Netherlands. Overall, respondents from the focus groups and interviews did not tend to support implementing CCS near their homes. Survey respondents were generally more favourable to offshore rather than onshore storage while the differences in extent of opposition between onshore and offshore vary among three countries. More broadly, participants from all three countries tended to agree that to a certain extent, society should accept some risks in relation to new technologies; and also tended to be averse to paying additional tax to address climate change. Information about $CO_2$ provided in the interviews, focus groups, and surveys promoted greater understanding and to a certain extent dispelled previous misperceptions held by some respondents, but it did not dramatically change perceptions and opinions on CCS.

## Risk Perception

Slovic, P. (1987). *The perception of risk*. Science, 236(4799), 280-285

The author presents a brief review of psychological research on risk perception with aims of providing a basis for understanding public responses, and improving risk communication amongst the public, experts and decision-makers. In reviewing past psychometric research the author notes that "perceived risk is quantifiable and predictable" (p. 282) and the concept of risk has a different meaning to different people. Therefore, there is a need for those who promote and regulate health and safety "to understand how people think about and respond to risk" (p. 280). The author explains that members of the general public may have other legitimate concerns, of a social and ideological nature, in their conceptualisation of risk. This will potentially differ to the technical risk assessment of experts; highlighting the importance of structuring risk communication as a two-way process, where differences can be identified and better understood.

Bradbury, J., Greenberg, S., and Wade, S. (2011). *Communicating the risks of CCS,* GCCSI: Canberra

This report provides the reader with insights into understanding the ways in which people evaluate risk, from experiences gained from interviews with early CCS projects. How people view risk is more expansive than technical and scientific assessment and therefore warrants additional attention. The report builds on previous work completed for the Global CCS Institute including the *Communication/Engagement Toolkit for CCS Projects* and the *Social Site Characterisation Toolkit*. The report is intended to assist the planning and implementation of CCS projects and to develop more effective and productive stakeholder engagement programs.

The report is structured in multiple parts. Part 1: provides an introduction to, and considers different potential understanding of, risk specifically from a CCS project perspective; Part 2: reviews the theoretical underpinnings for an approach to risk communication. Part 3: provides the authors findings from interviews with representatives from five CCS projects. From these interviews the authors reviewed project experience in risk communication and summarised lessons learned from those experiences. Based on these lessons, the authors take the reader to Part 4: where they suggest an iterative four-step strategy for establishing an understanding of how the community views the project and for the development of an effective risk communication program. Step 1: involves conducting a preliminary site assessment. Step 2: identifies local community and stakeholder perceptions surrounding project risks. Step 3: once an understanding of the community views and perceptions and potential risk of a project are ascertained relevant risk communication materials and topics for discussion can be developed and incorporated into the general stakeholder engagement program. Step 4: here the project team continually test its materials and monitors how the project is being perceived by its communities and stakeholders. This will enable the team to keep a running check of effectiveness and impact of the communications used and the information provided. The reader is also provided with a series of pointers and resources for application when developing risk communication programs.

Part 5, provides a summary of lessons learnt and provides suggestions for ongoing research highlighting that stakeholders and project developers may consider technical and non-technical aspects of risk differently. Particularly because stakeholder perspectives reflect multiple influencing factors such as values, experience, community, project and context. They suggest it is more likely that non-technical risks will prove more challenging to mitigate and communicate than technical risk.

## Governance

de Groot, J.I.M. and Steg, L. (2011). Psychological perspectives on the geological disposal of radioactive waste and carbon dioxide, in F. L. Toth (Ed.), *Geological Disposal of Carbon Dioxide and Radioactive Waste: A Comparative Assessment* (Vol. 44, pp. 339-363), Springer: Netherlands.

The authors of this book chapter investigate psychological factors, their relevance, and contributions to explaining acceptability of radioactive waste disposal and $CO_2$ disposal technologies. As acceptability of $CO_2$ disposal has historically received less attention in psychological studies than acceptability of radioactive waste disposal, the authors sought to determine the likely psychological determinants founded on research on acceptability of $CO_2$ disposal. They concluded that $CO_2$ disposal acceptability may be explained via factors similar to those which influence acceptability of radioactive waste disposal, for example, the risk characteristics of: dread and the unknown, affect, values, worldviews, fairness and trust. They also argue that such psychological factors relate both directly and indirectly to acceptability of $CO_2$ disposal. The authors considered group variances, such as differences between lay people and experts as well as cross-cultural diversities, in radioactive waste disposal acceptability and translated these result for possible consequences in psychological research in regard to geological disposal of $CO_2$ acceptance. From this information the authors develop a conceptual model integrating the psychological factors.

Hansson, A. (2012). Colonizing the future: the case of CCS in N. Markusson, S. Shackley and B. Evar (Eds.) *The Social Dynamics of Carbon Capture and Storage* (pp. 74-90), Earthscan: London

This book chapter describes and analyses the potential of CCS embedded in a variety of practices and how these practices are expressed and created. Being co-constructed, the boundaries between these practices are often indistinct. The author examines the construction of scientific scenarios, taking into account existing links such as research into public acceptance and policy-making to assist the analysis, though is somewhat tentative of scenarios that carry out actions towards co-creation. Such studies considered to make sense of the future by providing a link to the development of common objectives, and be part of the creation of expectations of emergent technologies and the organising of resources required for their execution. The author considers various lessons learnt as a result of the analysis and discussion implying that it is difficult to escape the fact that most scenarios have a limited 'shelf life' due to the boundaries of the methodologies used to inform the decision making process, and the fact that such concepts are often comprised of uncertain information. Hansson cites Brown and Michael's (2003) idea that it is better to create suitable, endurable and firm expectations when developing scenarios, however asks the question, how does one achieve this? The author then proceeds to take the reader through a series of suggested recommendations toward this end.

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