Managing Low Emissions Coal Technologies project risk: The role of public awareness

Final Report

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**Executive Summary**

This report presents findings on public engagement with low emissions coal technologies, a two year study funded by the Coal Innovation Board of the NSW Department of Trade and Investment. Effectively managing and minimising the emissions from the coal sector remains a key challenge for governments across the globe. However, the fear of public opposition to low emissions technologies can be a crippling fear for innovators, industrialists and governments in the energy sector. The most important and notable of these technologies is Carbon Capture and Storage (CCS), a term covering a variety of techniques to separate Carbon Dioxide from industrial processes and sequester it, usually in deep geological formations.

The purpose of this research was to address the organizational dynamics within the Carbon Capture and Storage (CCS) and Coal Seam Gas (CSG) industries and the question of how and why publics form around issues related to them. Instead of seeing the industry organisations and the public as static, single entities, the project employed theoretical frameworks and staged research processes to understand the ‘how’ of these industries and their communities.

This is why social science was employed. Innovative theories and research practices, specifically Actor-Network Theory, can describe and measure the relations between people (industry executives, farmers, ‘activists’) and objects (drill rigs, measurement equipment), seeing them in new ways that suggest positive interventions. And that is what happened in this research project.

Four stages of research were used:

(i) interviews with key technical and policy experts in Australia, involved in the development and implementation of Carbon Capture and Storage;
(ii) a large Internet based survey of the NSW population;
(iii) online social media network analysis of Carbon Capture and Coal Seam Gas issues;
(iv) ethnographic research of public engagement with two energy issues.

These methods were compared – ‘triangulated’ – to enrich the understanding of participation processes related to CCS and their influence on local controversies. The idea of ‘actors’ engaged in ‘networks’ of relationships was mirrored in the concepts and measures of online conversations and in site demonstrations and meetings. Putting all of this together in one project pushed some boundaries of social science methodology and produced clear findings and recommendations.
Overarching findings were as follows:

CSG is a far livelier issue than CCS in Australia; a 'liveliness' that has generated some controversy around induced seismicity and other geological issues. The risk of current CSG protest activity transferring across to prospective geo-sequestration projects in NSW is low, but this depends on which project partners are involved and the geographical area selected.

Technology decisions around Carbon Capture and Storage (CCS) are shaped by social factors that are overlooked in major economic modelling studies of energy costs. The key finding from survey research was that those who support and understand the benefits of CCS also support renewable energy. In other ways, people in New South Wales view Carbon Capture and Storage as potentially viable, but await more detail to decide whether the technology is effective and safe.

Social media have great significance for public engagement and policy-making, as many contemporary issues relating to geological technologies are raised and contested online. It will be necessary to consider communities, and industries’ engagement with them, as both located on the ground and called into being online, around particular issues. The work of communicating with communities or publics requires active, strategic online professional communication.

The ‘Network Solutions Model’ developed from this project emphasises the importance of managing expectations; the pros and cons of ‘closing off’ the technology of CCS or keeping it as a loosely related set of research programmes; and practical suggestions for communicating low emissions coal technologies to different publics.
Recommendations

Recommendations to government

1. **Communication about CCS should make the bridge to a low emissions economy clear.**

The survey results show that the capacity of CCS to sequester biomass combusted CO$_2$ is crucial for support from some public groups. Incorporating this strategic vision into long-term research and development will be critical to maintaining public support.

2. **Government involvement in renewables and CCS should be displayed to interested publics for example at festivals and markets.**

The successful CCS pilot and demonstration projects engaged in dialogue with the local community early, and did not simply deliver technical data and quantitative risk assessments. A public architecture for people to witness the working of CCS technology is very desirable. The government’s involvement in a range of energy innovations from renewables to CCS and unconventional gas should be established at agricultural shows, music and other festival events and street fairs.

Recommendations to project proponents

3. **Industries should monitor social media in real time to understand publics’ concerns and emerging issues.**

Digital communication devices have considerable potential to shift the points of intersection of the global and the local, the rural and urban, and the public and private. As a result of this fluidity there is a need to monitor in real time where and how online publics are reacting to issues and emerging controversies.

4. **Project benefits should be communicated at local and state levels.**

Using PCC as a ‘good news’ story depends on how it is integrated into a wider narrative of sustainability and low-emissions economic development\(^1\). Expert interviews stressed

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the importance of managing expectations, maintaining trusting relationships and organisational accountability.

5. **Get involvement from interested publics early in the project, to create community ownership.**

The research demonstrates that many project proponents had simplistic views of ‘the public’ and ‘the community’. It is vital to consider the social and historical embeddedness of ‘the local’ – towns and communities tend to be composed of several complex waves of migration. Find ways to connect with both established and more recently arrived ‘locals’.

**Recommendations for strengthening local community acceptance**

6. **Communication of technical details through everyday metaphors is important for successful demonstrations.**

Ensure projects include someone adept at using ‘lay’ or common sense terms to describe technical details. Communication efforts cannot simply involve the one-way delivery or presentation of technical data. The importance of bridging scientific and lay terminology is also applicable online where knowledge experts can explain to concerned publics how processes function.

At the appropriate stage in the project, create detailed factsheets (such as those provided by the WA Dept. of Mines) to respond to public interests. These should demonstrate that community concerns have been listened to and taken seriously.

7. **In any mass media campaign, tell a big story of energy production; don’t simply promote ‘the science’.**

8. **Create consistency between the messages of government, science and environmental protection.**

The research found that conflicting information coming from NGOs and government reduce trust in both sources.
About this report

Science is a social and collaborative, rather than individualised, activity. The research presented in this report was no different – many contributors from Centre for Social Research in Energy and Resources staff, colleagues and affiliates made the results presented in this report possible. Indispensable administrative support was provided by Camilla Fisher and Kristy Rocavert. The depth and breadth of research, as described below in and in Part 1 and Part 2. Methods: How we studied Low-emissions Coal Technologies and its publics), was made possible through the following contributions:

Prof. Stephen Webb was the Chief Investigator of this project.


Ms. Diana Kennedy facilitated the focus groups on the Central Coast of the NSW, Canberra, and Newcastle and provided key administrative and survey support.

Dr. Declan Kuch, together with Prof. Webb and Ms. Titus conducted the interviews and fieldwork presented throughout the report. Dr. Kuch is also the lead author of this report, and sole author of the Network Solutions Model section. Proofreading and editing support has been provided by Dr. Benjamin Matthews and Emeritus Professor Patricia Gillard respectively.
1. Introduction: What is the purpose of this research and the thinking behind it?

With the introduction of carbon pricing in many jurisdictions, industries now have incentives to find efficiency gains and begin introducing lower carbon technologies. Energy markets have responded to these incentives over recent years, producing a ‘dash for gas’ and a significant export industry for Australia.

Whilst Carbon Capture and Storage (CCS) projects have largely ‘flown under the radar’, unconventional gas exploration issues have been a major domestic focal point in New South Wales and Queensland, and have become a global concern that garners attention in many countries. Public engagement with CCS is thus entangled with these industries and their practices. As leading researchers Markusson and Shackley (2012 p.5) put it, “the key promise of CCS, to square our need of continued reliance on fossil fuels with climate change mitigation ... appeals to a range of actors throughout society.”

This report presents the findings of a recently completed investigation of public engagement with Low Emissions Coal Technologies. These technologies are designed to increase energy efficiency and to improve the environmental performance of processes associated with the burning of coal to produce electricity. The purpose of this two-year study was to understand the network of relations between industry, community and government that impact on public awareness of Low Emissions Coal Technologies. Such an understanding could be used to raise public awareness about the issues and to build support.

The two-year study was supported by the Coal Innovation NSW (CINSW) Fund managed by NSW Trade and Investment. The Coal Innovation Fund supports Research and Development for low emissions coal technologies, and this project was commissioned following calls for expressions of interest from the then NSW Minister for Mineral and Forest Resources. The Minister announced the successful projects at the NSW Low Emissions Coal Technology Summit in Sydney in May 2010 and out of nine commissioned projects, the current investigation was the only social science based project selected. The research used a combination of social scientific methods, applied to the case of Carbon Capture and Storage (CCS) in New South Wales, and more widely in Australia.

The theoretical framework that guided the research design and fieldwork is Actor-Network Theory (ANT). ANT arose during the 1980s in Britain and France as a method for observing and describing how meanings are produced, contested and negotiated in the routine practices of science. In this study, ANT was used to examine how increased public awareness and positive social attitudes towards Low Emissions Coal Technologies might be achieved.

Landmark studies in Actor-Network Theory studied the political, social and engineering work of technology diffusion using case studies such as electric cars (Callon, M. & Latour, B. 1981); the ‘discovery’ of DNA (Latour, 1987); Pasteurization (Latour, 1988); and colonial naval networks (Law, 1992). The main approach taken across these studies has been to
fundamentally question the claims of Western science to provide absolute and definitive knowledge (Latour, 1993) while still respecting, indeed highlighting the inventiveness of modern science (Stengers, 2000).

The current report draws on Actor-Network Theory to simultaneously consider the power and processes of science as well as those of public democracy, defined as the exchange of information and influence between governing actors in formal and informal political processes. This makes it possible to analyse how actions in both fields of science and politics are mobilised and to treat the knowledge claims of proponents and opponents carefully while avoiding any judgements about who is ‘right’. Actor-Network Theory builds on the broader theory of the Social Construction of Technology (SCOT) to examine how and why particular visions for a technology allow it to succeed over time, or conversely, prevent its uptake and growth.

Publics are capable of understanding technology – such as a bike or a carbon capture pilot plant – in a variety of ways. ANT draws attention to this, and reminds us that the manner in which the introduction of new technologies into a community is conducted can create new groups, or re-ignite the controversies of earlier group concerns. A key challenge in the social construction of low emissions coal technologies, therefore, is to forge social support in a way that will attract enough interest from various actors, but not alienate anyone with enough ‘clout’ to halt its uptake altogether (Markusson and Shackley, 2012, p.6).

In this approach, ‘society’ is not seen as simply the result of all actions and social interactions up until now. Instead, ‘society’ is an idea we construct from what we have been able to know. To understand ‘society’ better, this approach contends, we must turn to the objects that are created and the contexts in which they are produced.

This perspective has also been applied to understand the complex problems of public involvement in politics. Marres proposes we see publics as a kind of ‘trouble’ with modern technology and science. When scientific expertise and existing institutions are not enough to settle disagreements on science and technology, a public in all its ‘unfitness’ is called on to adjudicate. (Marres, 2005)

Definitions

In this report of Public Awareness of Low Emissions Coal Technologies, we need to define each of the terms because they are used in a great variety of ways in scientific literature.

a) Public Awareness

The concept, ‘Public’ is pivotal to this research report. While it commonly refers to groups of people, as in ‘the public’, social science research has recently focussed on the many ways publics form and reform around particular problems or issues. ‘Publics’ is plural and as one
csrER: Public Awareness of Low Emissions Coal Technologies

social scientist puts it, ‘no issue, no public’. Publics form and disband again as issues are resolved or become less important.

‘Public awareness’ describes the knowledge that publics have at any one time but it is not synonymous with acceptance. Promoting awareness may not necessarily promote support. One illustration of this is the broad spectrum of NGO positions on CCS that range from demonstrated support for CCS (by the WWF) to scepticism (by the Australia Conservation Foundation) to opposition. (See Appendix 4: Australian NGO Public Positions on CCS).

b) Low Emissions Coal Technologies

Low Emissions Coal Technologies refers to capture of carbon dioxide emissions from an industrial source, its transportation via pipeline or ship and storage in either geological formations or mineralisation. As the International Energy Agency states,

\[ CCS \text{ is more than a strategy for ‘clean coal.’ CCS technology must also be adopted by biomass and gas power plants; in the fuel transformation and gas processing sectors; and in emissions intensive industrial sectors like cement, iron and steel, chemicals, and pulp and paper.}\]

The findings of this report relate primarily to CCS technologies associated with electricity production as well as public engagement with Coal Seam Gas.

c) Issue Network

In this report, the term ‘issue network’ is used to capture the ways a public can form, change and disperse around an issue over time. Current scientific paradigms emphasise the multiple actors involved in making and governing technology. In a similar fashion, the concept of an ‘issue network’ considers the processes and the actors engaged with a particular issue.

Actor Network Theory was used for this study because this framework made it possible to consider together the relations between; micro-decisions that govern material aspects of the technology, the parameters of the site where the technology is implemented, the nature of the participation process and the network of social relations in which they are embedded.

This report draws attention to the many complex social dimensions and side-effects of policies and practices associated with Low Emissions Coal Technologies.

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3 IEA Technology Roadmap for CCS

2. Methods: How we studied Low-emissions Coal Technologies and its publics

The use of multiple and complementary methods in research design is called ‘triangulation’. Four specific methods were used here, to understand the role of public awareness in Low Emissions Coal Technologies from a number of perspectives.

1. Forty interviews and three focus group discussions were conducted with key technical and policy experts involved in the development and implementation of Carbon Capture and Storage. Interviewees were approached through a variety of channels, including conferences and recommendations from project participants. Selection of interviewees and focus group participants used a ‘snowball’ approach where an interviewee/participant would suggest further people to contact. This is an established technique to locate relevant people that are difficult to access through other direct approaches.

Interviews are an appropriate method for gaining information about complex phenomena from an identified population where it is necessary to understand the variety of meanings and interpretations of what is being studied, for example by competing groups within that population.

2. An online survey of the NSW population to measure awareness of climate change science and energy policy. Surveys are an important tool for assessing differences across a sample, which can then be extrapolated to an entire population. Surveys are commonly used alongside other kinds of research such as interviews, focus groups and other qualitative techniques to provide different kinds of evidence. The strength of surveys is their ability to quantify concepts that are well understood across the sampled group.

3. Network analysis of Carbon Capture and Coal Seam Gas issues online. Network analysis of emerging issues is a novel methodology that combines both descriptive and numeric information. It utilises insights from network science about how information is brokered between groups (see also the Networks review paper), in order to monitor how public concerns about certain topics shift over time. The network analysis of online issues presented here involved development of a custom-built social media database and hyperlink analysis of relevant techno-scientific issues. Social media and hyperlink analysis were used together because social media is primarily used to exchange complex information, especially through embedded hyperlinks.

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4. Ethnographic research of public engagement with energy issues. This approach involved immersing social researchers at the site of an issue in order to understand how publics engage with issues in that site or context. Ethnography is a powerful supplement to other research methods precisely because researchers surrender control over sampling, timing and other factors in order to understand the nature of a site or context from the perspective of those who ‘live’ there. Ethnography is very useful for understanding how place and community are intertwined. Network ethnography refers to the combination of data between offline sources (e.g. surveys) and online sources (e.g new social media) to understand how relations that appear online gain momentum.

Through the stages of this research, our team of five researchers became active participants in major research projects in Capture and Sequestration in NSW, as well as building relationships with policy-makers, scientists and engineers nationally to gain knowledge of projects locally, nationally and internationally.

This project has involved four research streams that, taken together, explore how the social and technical elements of Low Emissions Coal Technology are understood by different publics.

(i) In Chapter 3 we present interviews with technical and policy experts in CCS. This includes findings on community engagement, project structure, and industrial risk. Reconciling these elements is necessary for maintaining appropriate expectations with local and wider publics, as well as maintaining the reputations of stakeholders.

(ii) In Chapter 4 we present an online survey of the NSW population. Correlations between survey components covering climate change knowledge, support for or concern about CCS, engagement with civil society and other issues have been examined.

(iii) In Chapter 5 we present the network analysis of online issues. This approach has required customised software to be developed to capture relevant social media data. (presented in Appendix 1: Online Issue Network Analysis Methodology).

(iv) In Chapter 6 we present the ethnographic study of local community engagement with energy issues. The data in this section lead to the important finding that there is a low probability of Coal Seam Gas opposition translating into blockades of potential geo-sequestration sites.

(v) Chapter 7 of the report draws the four stages, methodologies and results together. It ‘triangulates’ the different kinds of research findings to understand differences in public responses to Low Emissions Coal Technologies. The ‘Network Solutions Model’ is created as a framework for CCS project owners and policy-makers to use when working with publics in relation to CCS projects.
3. Community and Expert Perspectives on CCS

3.1 Introduction
This chapter presents findings from interview and focus group participants (‘insiders’), with direct experience of projects about social engagement with low emissions coal technologies. Forty people from a wide range of professional, work and community backgrounds were interviewed (for example, carbon capture plant engineers, Federal bureaucrats, coal industry policy analysts and geologists). Three focus groups were conducted, with a total of nineteen participants. The groups were held in Newcastle, Canberra and the Central Coast of NSW.

The findings draw attention to the important social and organizational dimensions of low emissions coal technologies. These encompass industrial cultures and risk management approaches, as well as the work called ‘public engagement.’ The interviews and group discussions focussed on the connection between expectations for specific projects and how these were worked through, from the perspectives of different experts and community members.

A wide-ranging review of research and reports about Carbon Capture Innovation were analysed (RISIW’s Rapid Evidence Review, 2011) as a basis for the detailed interviews and discussions. In these, economic perspectives on energy dominated the policy landscape. Social dimensions were discussed in marginal ways. However, concern for social dimensions and involvement by experts to monitor or change the perspectives of publics, were called upon when reactions to technology implementation by publics were unexpected or needed to be ‘managed’. From the review it was clear that organisational integration and community acceptance are important dimensions in establishing successful projects.

3.2 Communicating Information to local communities

*Power station staff emphasised the importance of developing easily relatable metaphors for the local community. Careful management, deliberation, and inclusion is much more likely to create a successful project.*

One interviewee spoke about inviting members of the community into the power station and creating a narrative for the project:

*I wanted the visitor centre to have a real focus … “This is a coal power station and as coal power station owners we need to be responsible for the complete chain of everything that we do”. So it was telling the coal story from how coal is formed, what it is, what we do at Longannet to produce energy… and then what we do at the back-end to actually deal with things like emissions that come off burning the energy…*

*A second interviewee created a metaphor to explain the complexities to 10 year olds:*
One of the things at the launch event for the test unit, I had done this whole thing to try and explain...the capture process. It had things like "You've got your CO2 molecules and they go into the big tower and they go through shower in the tower ..." There is this whole story line really simple for 10-year-old children... And because they were using that kind of language it made the BBC so it was great stuff for the journalist. [Scottish CCS Project Liaison officer]

Public support was garnered by moving from local contacts through power station employees out into the wider community:

I basically used ... power station [employees who were also locals] to help me understand the local community and help identify people within the community who would be influential ... when the power station was first set up ... all of this ash was covering houses and cars and it started off initially not as a protest group but as citizens group about making sure citizens rights were protected and because the power station has been there for like 40 years, that group is more of a... They keep the power station in check but they are very much a supporting group but they're very influential... What they're very against is when a head office project happens and they don't know about it first. [Scottish CCS Project Liaison officer]

Several participants emphasised the importance of an informed public for the success of communication. Understanding of science was a major aspect in this conversation:

Interviewee 2: It is difficult because you can’t win an emotional argument with science and that’s the conflict. Some people will never accept the science because they are emotionally opposed to it and just could not believe the science. Whether the project sinks or floats depends on the proportion of your community that have that perspective.

Interviewee 1: A lot of it is... if we can isolate that group, that’s not the right word to use because it’s more making sure that group doesn’t contaminate the rest of the pool in terms of public opinion so that we can have the discussion with those who are prepared to listen because it is two way. You need to understand their concerns and get back to them. You can’t walk in there and just assume that you know everything because we don't understand their concerns. We might think that we know based on what has happened in other projects but we don’t always know. When people come up with good questions for their local situation, you know, there are people who might be worried about earthquakes, and we have technical answers for that. They won’t always be comforted by those technical answers but you can’t give them absolute guarantees.
3.3 Demonstration projects as a social process

Demonstration projects are widely regarded as a means of ‘learning by doing’. During such demonstration the emphasis is usually on the scientific knowledge that informs the deployment of CCS technologies, while non-technical sources of knowledge and social learning so vital to the success of these endeavours are neglected. Recent evaluative studies of global CCS communication materials have highlighted the fact that most communication effort goes into explaining technical and engineering issues associated with the process of CCS. It is becoming very clear, however, that the biggest challenge for CCS projects is the promotion of knowledge sharing and coordination between different industrial sectors that are not used to working with each other. CCS projects are joint ventures that require involvement from the coal to electricity system; from miners to power generators, transportation providers and oil and gas industries. As a result, communication effort needs to encompass collaboration between different organisations and the joint understanding or even melding of practices from disparate industrial cultures. Moreover, the stationary power generation sector, which is the single largest source of greenhouse gas emissions in Australia, now needs to be closely integrated into the host power plant environment, to see large scale reductions.

To investigate this, we conducted interviews with scientists involved in research and development, and staff at different levels in the organisational hierarchy of the power station involved with the trialling of a PCC pilot. This is a small project that aims to test key technical parameters of the capture process with a view to scaling up to demonstration and eventual commercial size. Post-Combustion Capture (PCC) involves chemical and physical reactions that are largely new to the power industry. Familiarity with technologies plays a large role in the investment choice and deployment trajectory of retrofittable capture technologies.

Several research participants stressed the challenges of incorporating chemical engineering processes into the work culture, practices, and requirements of the power generation sector. Interviewees spoke of how the decision to go with ammonia (even though it is a challenging and corrosive solvent to use for CO$_2$ capture) was made on the basis of on-site familiarity with it:

... high confidence and high historical familiarity and systems with aqueous ammonia and anhydrous ammonia did sway us to an extent... it wasn’t just a

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**small factor in the decision, it was a dominant factor for both our staff (Station Manager)**

A research scientist reiterated these concerns:

**[power station staff and management] know about handling coal... and they’re very much inclined to choose something that they are familiar with. Now post combustion capture is out of the ordinary because it’s a leading technology... this amine process, so there’s liquid which absorbs CO2 and there goes a reaction, that’s chemistry. It’s chemical engineering. They had no idea what it is, to start off with at least. They do now. Certainly Delta has. (CSIRO scientist)**

CCS projects in Australia are at an added disadvantage. Low emissions projects run against the grain of many decades of power station development that sees electricity as the product and CO2 as a by-product. These challenges emerge especially when transferring a pilot from a research facility to the operational environment of a power plant. Some of the key deployment challenges relate to the bringing of new chemicals on site and their use with existing Occupational Health and Safety (OHS) culture.

**Interviewee: Power stations are not familiar with chemical plants on site so bringing in new solvents and new processors and just fitting into their safety culture is a huge learning for us and also for them... they are almost scared of going forward because it’s new territory.**

**CSRER: Can you give an example?**

**Interviewee: What we have found is that some of these solvents are fairly toxic and that is quite concerning for a power station, having these toxic chemicals on site that they are not familiar with... They don’t really have the safety procedures set up in their normal day-to-day operation to deal with these. (CSIRO scientist)**

Our findings show that organisational practices and work routines need to be taken seriously rather than assumed in order to achieve an effective transition from lab to field trial stage. The field trial requires training about maintenance and upgrade as well as general educational material and information about new hazards and risk assessment procedures.

In the case of Delta Electricity, the entire pilot required the heavy involvement of all of their electrical and environmental staff. One spillover benefit has been the technological development accrued to Delta as a unique set of skills for its operators:

**The way that Delta did it was quite unique in that they employed an operator, who worked alongside a CSIRO operator and there were direct learnings. [This operator] is now an expert in PCC basically so we can now grow out to Europe, to the US, to Japan. Talk to the vendors and ask the right questions. And that’s a learning which I think is invaluable ... It cost [Delta] several million dollars or**
so for the pilot plant project or half of that. No other power plant in Australia has hired an operator to run a pilot: The other two pilot plants are operated by CSIRO personnel so with power companies there, they sit more on the side line (CSIRO Scientist).

Trialling CCS has produced considerable benefits in the area of staff morale. Several power station interviewees noted the benefit of apprentices participating in building the pilot plant, with many expressing keen interest in being able to participate – not just in a new, technologically sophisticated piece of engineering – but in a ‘green technology’.

3.4 Different industrial ‘risk rationalities’
Perceptions of project risk vary according to disciplinary backgrounds and these different ‘risk rationalities’ are a major obstacle to success.

Several interviewees noted the conservative character of coal mining, where risk-taking about finding suitable storage was concerned. Safety is an over-riding concern for the industry and open-cut operations require the safe execution of very, very large-scale bulk handling of earth.

Oil and gas in some ways is very similar. It’s a very large industry but they have a completely different risk cap type because they look at drilling for a resource and they know that they might spend $1 billion on it and have to walk away without anything. The other industries like the power stations could not even comprehend spending a couple hundred thousand and having to walk away from it so the risk profiles are pretty different. That’s something that’s a very big challenge to overcome. (Coal Industry Representative)

The coal industry representative (a chemical engineer) also noted the differences in the approach between the coal sector, the oil sector and the power station sector: remarking that “they are three different cultural beasts.”

Power generation is very conservative... they have a very small margin and a very large volume of everything. Everything is large. There are large amounts of gas, large amounts of flu gas, and large amounts of water... when you walk in there it’s like “wow”. But they really just want to run the thing as hard as they can for as long as they can and produce a little bit of money and when there’s a spike in electricity prices they will run it even harder. But it’s very much focused on their plant. Putting in a PCC plant or an IGCC plant is also a different changing culture because that’s a chemical plant and that requires chemical engineers, Most electrical power stations are run by mechanical and electrical engineers so that is a change in mindset already just to get the capture site happening in there. (Coal Industry Representative)

Whilst chemical engineers tended to be more concerned about leakage; some geologists were concerned about surface engineering failures. For example:

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I don’t think the idea of having catastrophic leaks [of CO2] has any merit but I think there’s more chance of having catastrophic leaks from pipes than from storage. That’s where you have more concentrated carbon dioxide in locations where it could affect the public so I think there’s a lot of risk involved with compression and storage and transport…. (Geologist)

3.5 Insights from the oil & gas profession into CCS project arrangements

We found the strongest opinions about the structure of geo-sequestration project management amongst oil and gas professionals. Cost is in surface engineering (capture), but risk is in the geology (storage).

At Stanwell there was a group of electrical engineers who had to go through in their mind set to understand what they were doing for storage and one of the issues was that two and half years into the project, one of the senior executives at Stanwell finally said, ‘Look I’ve just realised all the cost is in the capture but all of the risk is in the geology.’ I said ‘Hallelujah!’ They finally realised this is not a simple thing and so we’ve said… ‘Compete on your capture, join together on the storage. Share the risk.’ Say, ‘We’re going to find a site and it’s got to be within five hundred kilometres of here. Let’s pool our resources and work through the basin trying to proof one up and if we can prove one up it’s going to have to be at this scale because this is what our joint emissions are going to be.’ (Senior geologist)

Oil and Gas geologists put risk values on every technical element of the petroleum system both in terms of the data quality and interpretation and the actual rock characteristics. One Interviewee argued that “It fundamentally comes down to risk … Oil and gas companies will come along and characterise every element of [the] petroleum system.” This is a highly skilled process based on experience in searching for appropriate reservoirs. Furthermore, there is tacit industry knowledge of acceptable risks that are vital in interpreting data. This is evident in the following exchange:

...Every element of that process technically both in terms of the data quality and the interpretation and the actual rock characteristics, we actually put risk values on. So we come in and look at the soil swipe and say ‘Is it high quality or low quality and what is the chance over there where we haven’t really explored that we’re still going to have that characteristic? So we’ll give it out of one, no, is it a 50% chance of a 0.5 or is it 20 and we multiply all those risks through technically. We come along and we may have a 20% likelihood of success exploring in that neighbouring permit to find oil and gas. Now for you guys, what would you say a 20% chance is? A good risk or a bad risk?

CSRER: Fairly bad.

Interviewee: It’s good. On gas it’s good. One in five.. Oil and gas is never a certainty and more often than not you find oil and gas for the wrong reasons. So
serendipity plays a big part. So you may have one which is high risk but low volume. It’s not going to make you a lot of money and so you’ve got to somehow mentally and economically and technically relate that to high risk but huge upside potential if we get it all wrong and it’s actually working really well. So that’s oil and gas industry mind set of oil executives and geologist and exploration managers. Come to the power industry or the coal industry, they’re not subsurface people and they don’t understand geology. They don’t understand how variable geology can be.

Oil industry expertise has driven most projects to date. Oil industry expertise with seismic monitoring, drilling and other techniques required to understand the subsurface has been essential for all geo-sequestration projects to date. Several interviewees expressed a desire for greater involvement by oil and gas professionals:

*We actually need the oil and gas industry more involved and there needs to be more cooperation between getting them more involved as a CCS industry with the power generation industry. That is at present very difficult. Most oil and gas companies know how to do storage. ... They know how to do it. They have the subsurface skills. ... With carbon capture and storage you need to prove up the whole resource so you need to invest a lot of money initially to say ‘This is big enough for us to put CO2 into’ because it requires large infrastructure and the costs are huge. ... In some ways your initial upfront costs don’t have to be as large as some of the oil and gas projects have been... with CCS there are no commercial returns. It’s just a loss at the moment.* (Senior Geologist)

Joint venture structures help pool risk among multiple stakeholders. A number of experienced oil and gas professionals argued that storage projects need to adopt a joint venture like the oil industry to pool rights to most prospective rocks and maximise the chance of successful storage.

*... a big issue with the way that the oil and gas industry works is that we will always have joint ventures so we will have four, five, six partners in a permit that we are exploring. ... the reason companies joint venture it to say: ‘Well look, we can share the financial and technical risk and if one of our five joint ventures, different parts of the world, different basins comes in, that’s the one we’ll make the money on and so that’s why we share that risk.’ You think about what’s happening with storage around the world. Can you give me an example of where companies who are serious about this are acting in a joint venture arrangement to do serious exploration industrially? There’s none.... You won’t find four power companies and a coal mine working together to migrate through a basin looking for areas that they could do storage so that they are sharing the risk.* (Senior Geology Consultant)
ZeroGen was created from a state-owned corporation as a special-purpose vehicle because of the risks of the project. The legal entity of ZeroGen was established to allow risky decisions to be made that could not otherwise be made on the (publicly owned) Stanwell board.

...there’s lots of companies who are engaged and personally really engaged within companies and to [start a CCS project], once you get to the board they just don’t understand a lot of those things and the board is actually responsible to the shareholders to make a profit. Otherwise they can be jailed. So why would you go into entity, into an operation like I’ve described with all this risk, technical risk which then coverts to financial risk, to do something that’s going to cost me even more money?

3.5 Investment Choice and Market Integration
Several interviewees noted the difficulties of making investment decisions in the current climate:

...it’s market failure at the moment. Essentially it is with lots of environmental things but with CO2 storage it’s just a fundamental failure of that system to provide an incentive for industry to actually do it. There’s lots of people worried. Lots of people who are saying, ‘Well what’s it going to be like in twenty years’ time? Is it going to be $100 a ton? Do I need to move now?’ Or, ‘Clive Palmer’s taking it to the high court. Tony Abbott will get in and get rid of it all. Do I need to do anything at all?’ and so both the market failure in terms of lack of value on a commodity with political overtones just makes it impossible for a company to make decisive decisions. (Senior CCS expert)

Power station engineers echoed these concerns:

Interviewee: The other important point is that... we’re not a technology developer but we want to be an informed buyer of technologies so we like to be involved in the development of technologies but not necessarily be the brains behind it but help the technology along and learning it as you go. Being on that learning curve. ...A power station is a fifty year commitment ... What would a change of government do to the regulations that they put out this year? That’s quite an interesting argument. At the moment we were planning towards a fixed priced carbon up to 2015 and then we start floating the price. Again there’s no certainty what that price will be in 2015 considering what else is going on so it’s very difficult to make long term capital investment at this stage. That’s a tricky question about 2050. (Power station engineer)

A common view of CCS was that it is ‘part of the mix’. The following quote articulates the view of dozens of interviewees:

Carbon capture, I think, has to be part of the mix. It’s certainly not the only answer. I think in the future it’s going to be horses for courses in that if you’ve
got a power station close to a storage location then why wouldn’t you try it? If you’ve got an excellent wind resource then wind turbines would be an obvious answer or if there’s a solar resource or wave or tidal or geothermal, they’re going to be region specific and so I think that’s how it will develop. It won’t be that every coal fired power station in Australia has to have post combustion capture on it.

However, this view was not uniform. In the rollout of the pilot plant, we observed how a range of internal stakeholders, from employees to sub-contractors, had a variety of perspectives. Dissenters questioned the viability of the technology and took the view that the money spent on the pilot would have been better utilised fixing core assets:

I don’t think anyone ruffled any feathers or anything... this is long before they were saying that they were going to hit us with a carbon tax or anything. It was, ‘CSIRO is doing something’ and they've been here before so it is not unusual and I’m pretty sure it would have been mentioned at team leader meetings and other staff communication... I don’t think it bothered anyone much other than perhaps the money they spent on it because people were saying ‘Hey, I would rather that money went into fixing these switches back in this core.’ It probably passed unnoticed. (Power station employee)

3.6 Integrating Carbon Capture with the National Electricity Market

Much has been made of the potential for partial capture and the flexibility to be turned off during periods of peak demand. A relatively minor issue concerns time lags, which are typically in the order of minutes rather than seconds. This conflicts with spot market timing. When the grid frequency drops and the dispatch goes out for support, the power station ramps up and its amines need to respond. Unfortunately, chemical processes are driven by mass transfer and chemical reactions which are in turn driven by concentration differences that are severely affected by liquid and gas flow rates. Response to change is relatively slow. These complexities are largely not seen in combustion reactions and steam generation.

This has implications for the commercial viability of CCS retrofits using post-combustion capture because, in the spot market, dispatch price is determined every five minutes\(^9\). In addition, this places a number of chemical processes in series such as desulphurization, absorption and desorption or liquefaction and separation, some of which may involve multiple steps from which overall time lags of 15 to 30 minutes can result. Dynamic response in a facility with CCS is therefore not only far more complex but also makes being anything other than a base load producer much more challenging.

The National Electricity Market was designed as a competitive dispatch system for electricity generation at the lowest price. Therefore, as producers of a low priced commodity, competitiveness comes from driving down operating costs, maximising uptime and managing assets more effectively than your competitor. So throwing in cumbersome, complex,

\(^9\) Six five minute dispatch prices are averaged every half-hour to determine the spot price for each trading interval for each of the regions of the NEM.
operator-hungry, chemical processes that need to be shut down every year or so for inspections and turnarounds makes the integration of PCC pilot into the power station quite difficult.

CSRER: As the mining investment boom peters off it’s a luxury being able to have modular technology that you can turn on and off as the electricity market conditions change. What are your perspectives on the importance of that as a feature of post-combustion capture technology going forth?

Interviewee 1: It depends why you’re doing PCC. So if you’re doing it to avoid a carbon cost and then you have another market volatility in your electricity market that says, ‘I want those megawatts so instead of using the megawatts to capture the carbon I’m going to use them to generate electricity for a short period of time and then switch back later.’... If you’re looking at the environmental compliance, ‘So I have to capture my carbon, I was told I have to.’ then that is less important but if you want to be as efficient as you can be in carbon capture then as you integrate PCC into a power plant it’s harder to then switch it on and off. So it all depends on the regulatory environment.

[Demonstration manager]

3.7 Conclusions
This chapter has presented findings from diverse individuals and groups who have been directly involved with CCS projects. It has highlighted the importance of communicating well, to change existing work practices on power station sites.

For the local community, a feeling of empowerment and belonging to the project must be created early. Community expectations about a project are tempered by existing experience, local history, and patterns of migration into the area. European experience suggests that previous struggles over pollution can have lasting impacts. (see also Brian Wynne’s work on sheep farming and radiation in Irwin and Wynne, 2004). The Longannet case study is exemplary here, where engaging with an earlier group was productive for the project proponents. It is important that project proponents’ understandings of risks and benefits of CCS are canvassed with the community. Approaches to risk vary markedly according to industrial practices and routines, where oil and gas professionals face very different practical challenges to coal mining and power station workers in their everyday operations.

Actor-Network Theory and the Social Construction of Technology emphasise the need to be attentive to the ways social groups both influence and are influenced by technologies in different ways. Understanding how these differences in approach to risk manifest themselves in project design is crucial, as mismatches in project expectations with those of the community may be a source of public disquiet. For these reasons, we recommend including social scientists early in project planning to reconcile the diverse ‘internal’ project proponent and ‘external’ community risk rationalities at work in CCS projects.
Finally, it is important to temper expectations about CCS research and development through the insights of social science. This means taking seriously the ways organizational and other constraints affect technology trials, pilots and demonstrations. Economic modelling is a powerful decision-making tool; however by its very nature it excludes the practical and social dimensions of power station management. Social scientific insights about how organizations receive new technologies should therefore be considered alongside the alluring linearity and precision offered by economic models.

**Key Findings:**

- Economic assessments dominate the scientific policy terrain, overshadowing key social elements of innovation such as how and why knowledge is shared across these sectors.
- Social experts are often called upon when publics react unexpectedly to technology implementation.
- Early initiation of the local community around the risks and benefits of the CCS Project is more likely to lead to success.
- Informal and formal negotiation with established locals should be commenced as early as is possible.
- Informing locals of events before media releases are distributed builds trust.
- A unique challenge for CCS projects, as compared with other low carbon energy options, is the requirement for knowledge sharing and coordination. Projects require involvement miners, power generators, transportation providers and oil and gas professionals. Integrating surface-based with subsurface/petrochemical storage expertise has presented difficulties for some projects.
- Technology demonstrations are social processes through which proponent organizations negotiate (internally and externally) which technologies are selected and on what scale they are adopted.
- Trialling new Carbon Capture technologies can boost the morale of power station workers by showing a willingness to be responsible for the complete chain of processes onsite.
- Some key workers and managers in the stationary energy sector still view CO₂ as a distraction from core operations and as a by-product, rather than a central issue of concern for the industry’s future. These workers would prefer that resources be directed to the maintenance of core assets.
- Many industries must collaborate to make CCS projects a reality; however they all have different conceptions of risk and uncertainty (‘risk rationalities’) based on their practices and market profiles.
- Joint venture structures can help to pool risk between many project proponents however they increase the need to account for divergences in ‘risk rationalities.’
There are trade-offs between technical efficiency of pollution capture on one hand and flexibility in operation on the other that should be considered when modelling post-combustion capture retrofits.
4. Online Survey of opinions, knowledge and support for Carbon Capture and Storage (CCS)

4.1 Introduction
This chapter details the findings of a survey of the NSW population about their knowledge and support for CCS. Most participants had no direct experience with energy production.

Surveys are an established social science tool for establishing how a population understands problems and solutions. Most studies of environmental action, opinion on climate change and carbon capture and storage technologies (eg. Miller, Bell & Buys 2007) use socio-demographic information such as gender, age, level of education, and occupational status as explanatory variables. A limitation of surveys is their separation of individuals from their complex web of relationships. At worst, this can simply impose the categories determined by the analyst (Callon 2006), rather than revealing the thinking of individuals, and can gloss over the ways in which issues arise and knowledge is taken on board by concerned publics.

This chapter also makes use of results of the Focus Group research (Chapter 3). It is used here to add descriptive evidence and examples to the quantitative results.

4.2 Research Questions
Five research questions were developed from international research:

1) Do age, location and other demographic variables affect opinions toward CCS?
2) Are energy company project proponents trustworthy information providers?
3) Do pre-existing opinions of renewable energy determine concern about or support for CCS?
4) Do media consumptions habits determine support for CCS, including trust in sources of information and preferred media?
5) Are socially and politically responsive individuals more likely to support CCS than their non-involved counterparts?

4.3 Survey sample and demographic variables
The survey sample was drawn from individuals who are listed with a leading online research organisation called MyOpinions. Members earn credits with MyOpinions to participate in and fill out surveys. The survey sample was drawn from a selection of residents over 18 years, resident in the Sydney, Central Coast and Hunter Regions of New South Wales. No other selection criteria were used.

The demographic profile of the MyOpinions participants corresponds with Census data; however being administered online it requires a level of computer literacy to fill out the surveys, that may not be completely representative of the wider population. To compensate for this, the company actively recruits lower socio-economic status participants to maintain correspondence with the Census
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demographic profile. The survey results were not weighted because the sample corresponds to the Australian Census profile.

The survey was made available to respondents in the selected postcodes for one week: the time taken to receive 800 responses. The number 800 was selected to be scientifically rigorous in testing the hypotheses formulated in the research design. The survey had a total of 20 questions (including self-reporting of postcode). Survey questions and results in graphic form are provided in a separate report, obtainable from the Centre for Social Research in Energy and Resources website.

The survey took about 15 minutes to complete and the response rate was 13.9%. This rate argues for some caution in interpreting results as being representative of the NSW population. Repetition of these questions in later surveys would provide trend data and evidence for their reliability. The relationships within the data are of more interest in this project and for these analyses, new variables were created from the original data.

Method for analysing demographic predictors

Survey respondents were asked whether they were concerned about potential risks with CCS, such as leakage, transport safety and responsibility for accidents. We tested for regional and demographic differences in support or concern about CCS. ‘Support’ refers to support for projects anywhere – locally or internationally. New variables were developed from the survey as follows:

a. ‘Overall level of concern’ about CCS was constructed as an index from Question 7, which measured concerns about multiple issues related to storage such as causing air pollution, leaking into the environment etc.

b. A measure of support was created, based on support for siting a CCS project either in the local community, in NSW or further afield.

c. The ‘Climate change knowledge score’ was an aggregate of correct answers to Question 2 on the effect of variables such as deforestation and wind farms on increasing atmospheric concentrations of greenhouse gases.

d. The measure of self-reported ‘knowledge of CCS’ was drawn from Question 5 which asked about technical aspects of CCs such as pre-combustion capture, transportation by pipeline etc.

e. ‘CCS seen as beneficial’ was measured as a composite index computed from agreement with Question 9 concerning the economic circumstances of CCS.

Demographic variables are not significant predictors of CCS knowledge and opinions

Support for and concerns about the risks associated with CCS are not dependent on socio-economic status, region or level of education. Furthermore, knowledge of climate change science (both self-reported and measured) does not correlate with support for CCS.
Survey results (presented in Table 1) show no statistically significant correlations between demographic variables and:

- knowledge of climate change
- perceptions of CCS as being beneficial
- prior knowledge of different components of the CCS chain, or
- overall level of concern about the technology.

### Table 1: Correlations for Hypothesis 1: Predictors of Knowledge and Support

<table>
<thead>
<tr>
<th></th>
<th>Level of concern re CCS</th>
<th>Climate Change Knowledge</th>
<th>Self reported knowledge of CCS - low is ‘most informed’</th>
<th>CCS beneficial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio-economic Status</td>
<td>-.078</td>
<td>.046</td>
<td>.009**</td>
<td>-.015</td>
</tr>
<tr>
<td>Age</td>
<td>.093*</td>
<td>.008</td>
<td>.062**</td>
<td>-.084*</td>
</tr>
<tr>
<td>Highest level of education</td>
<td>-.086**</td>
<td>.183**</td>
<td>-.198</td>
<td>.099**</td>
</tr>
<tr>
<td>Level of concern re: CCS</td>
<td>1</td>
<td>.111</td>
<td>.120**</td>
<td>-.057*</td>
</tr>
<tr>
<td>Climate change knowledge</td>
<td>.111</td>
<td>1</td>
<td>-.222**</td>
<td>.259</td>
</tr>
<tr>
<td>Self-reported knowledge of CCS - low is ‘most informed’</td>
<td>.120</td>
<td>-.222</td>
<td>1</td>
<td>-.162</td>
</tr>
<tr>
<td>CCS beneficial</td>
<td>-.057</td>
<td>.259*</td>
<td>-.162**</td>
<td>1</td>
</tr>
<tr>
<td>In favour of renewables</td>
<td>.095</td>
<td>.350</td>
<td>-.009**</td>
<td>.294</td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

The negative values suggest confusion around the facts of CCS.

Self-reported knowledge of CCS is a poor basis for decision-making. It is likely to correspond with poor knowledge of climate science and a negative view of the technology.

The greater values show positive relationships between knowledge of climate science, favour toward renewables and viewing CCS as beneficial.

The lack of significant correlation between level of education, age, and socio-economic decile ranking\(^{10}\) of the postcode in which respondents live and support for CCS project siting or concerns

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\(^{10}\) In our statistical analysis, we used Australian Bureau of Statistics (ABS) postal area indexes of relative socio-economic advantage and disadvantage. These widely used measures are drawn from the Census of Population and Housing.
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about CCS risks means there is no consistent association between them. Instead, support for CCS project siting is influenced by knowledge of climate change.

There is confusion about the facts surrounding CCS: those with high self-reported knowledge of CCS had a poor knowledge of the climate science, a negative view of renewable energy and a somewhat lower level of education (Table 1).

Neither age nor level of education predicts the view of CCS as beneficial. Furthermore, there were no significant regional differences between Inner Sydney, Western Sydney and Central Coast on these indexes.

4.4 Trust
Surveys in Europe and the United States have used items relating to trust in a range of professional and stakeholder roles, to measure how CCS communication should be targeted. These items answer questions such as, ‘Will communicating about CCS to the public be more effective if stakeholders from a variety of backgrounds are involved collaboratively, rather than separately?’ (Mors et al 2009, Upham et al 2010).

Figure 1: CSIRO (2011) Survey Results

A recent Australian national survey by the CRIRO (Leviston & Walker 2011) demonstrated that information coming from ‘university scientists’, ‘industry scientists’ and ‘oil companies’ was received very differently by publics based on perceived trustworthiness of their organisational backgrounds. Figure 1 shows results from this survey carried out in 2011. University scientists were much more trusted than oil companies!
A question in our survey asked respondents the extent to which they would trust governments, gas and energy corporations, scientists, journalists, political parties, environmental protection organisations and consumer associations ‘for impartial information on energy related issues’. Results showed that trust in scientists and environmental protection agencies are dependent on a base level of trust in energy companies and government institutions. The first step in the analysis revealed that scientists and environmental protection organisations accounted for more of the results about trustworthiness than any others. Further investigation was then made into the relationships between trust in science and other institutions.

**Finding: Where information provision about energy is concerned, trust in science requires trust in government**

The analyses revealed that trust in both science and environmental protection organisations rely on a base level of trust in government and energy corporations. Figure 2 summarises the pattern of relationships between trust in science and trust in government, around vertical and horizontal axes of the average (mean) for each measure.

**Figure 2: Survey results - Predictors of Trust**

The fact that this quadrant is empty shows that trust in scientists and environmental protection organisations are strongly inter-related with trust in institutions of government and energy corporations.

The fact that this quadrant has more responses than the opposing quadrant shows that some people trust governments and corporations while trusting scientists and environmental protection organisations less, to provide impartial information.

These findings have implications for how CCS communications campaigns are designed. It points to a need for active support and collaboration between Environmental NGOs and government. Without this co-operation there are likely to be much lower levels of trust in either groups.

4.5 CCS siting, relationship to local issues and opinions about Renewable Energy

International findings have suggested CCS is associated with the fossil fuel industry (See Rapid Evidence Review\(^\text{11}\)). However, this is not always a positive association. For example, negative associations between the fossil fuel industry and CCS were made in the case of Barendrecht, whereby local and national groups mobilized in opposition to a number of timing, planning and

logistical elements of the project\textsuperscript{12}. As Spence (2012) states, the “influence of local stakeholders was underestimated.”

Contextual factors and local contingencies complicate the stated policy positions found in wider opinion polls. This is the crux of the argument that there is ‘no issue, no public’. Thus, the robust international finding, NGOs held CCS to be a far more attractive option than nuclear (fission) power but much less than renewable technology should be viewed cautiously. These preferences depend as much on the detail of project rollout as the local communities in which they are embedded.

To provide baseline data for future project rollouts, two separate measures of support for CCS were constructed. Firstly, those who support the siting of CCS anywhere (Question 8) and a composite index to measure perceptions of benefit (Question 9).

**Finding: Those who support renewable energy are more likely to support CCS**

When applied to the question of siting of CCS technologies (anywhere) those who support renewable energy were more likely to support CCS siting. This raises questions of whether support for CCS is built on a foundation of favourability towards energy generation technologies other than coal.

As would be expected, the probability of support for siting of CCS projects increases with higher levels of seeing CCS as beneficial.

**Finding: Local history and context shapes how ‘the science’ is received**

International studies have emphasised the importance of both local and national context in the receptivity of projects. Results from our Newcastle focus group resonated broadly with this, whereby historical, technical, and political factors were seen to play a major role.

\begin{quote}
NFG3: I think CCS is so new that there’s just not a lot of discussion about it anyway. They have never heard about it. They wouldn’t understand what the processes are and if you talk about sequestering [sic] it underground, well particularly around the Hunter, well you could imagine these tunnels and tunnels from coal mining. With mine subsidence happening in nearly every suburb, and you know, you’ve got creeks disappearing downs holes ... Honestly, how would it work? The ground is so fractured from over 100 years of mining. We’re in an earthquake zone. (our emphasis)
\end{quote}

One Focus Group participant linked potential storage to wider local issues:

\begin{quote}
NFG1: ... I think the volatility of people’s opinions will be what they perceive as their immediate economic interest and so as soon as you say John Howard wanted to put a nuclear reactor in Port Stephens – that didn’t get out for a while – all of a sudden everyone from Port Stephens who had dismissed any nuclear activists as a bunch of hippies where the most strong opponents to nuclear. Likewise with carbon capture. If suddenly people
\end{quote}

say ‘That’s it. We’re now going to have electricity rationing so you’re going to have a blackout every second day unless you accept carbon capture’ suddenly you will find that people no longer think it’s propaganda but information about carbon capture.

**Finding: Risks of leakage are concerning**
The perceived risks of leakage are widely acknowledged as an important concern of the public, but, as Markusson et al (2012) point out, it is unclear how this will influence the development and deployment of CCS. There is no consensus within the literature on CCS about how the public perceives the risks of storage. One knowledgeable participant suggested that the public image of the technology is likely to be simplistic:

*NFG2:  ... maybe some people can say I understand the difference between a saline aquifer and depleted gas field or something like that... ... like the research they are doing here on minerals CCS. Not many people would know about deep ocean storage so there’s all those different techniques out there but I think most people just see it as pumping liquid into the ground and it’s just going to go wrong somehow.*

This suggestion resonated with an earlier comment from another participant who professed ignorance about the technology:

*Facilitator:  ... Where do you get your information on carbon capture and storage?*

*NFG2:  I have no idea, because I don’t know much about this technology whatsoever and going through my mind is exactly what you were talking about ... alarm bells starting going off in my head. I don’t know much about it at all.*

Risks of leakage were an overriding concern for some in the Newcastle Focus group.

*NFG5:  I think it doesn’t matter if you use coal CCS or biomass CCS, I think the problem is essentially is how to sequester it and people can’t understand that it is safe to do it... maybe they need to come far away from the living area or use it safely to generate or promote the oil production.*

*Facilitator: So you think it would be better that if there were a facility for it to be removed from areas of human habitation?*

*NFG1:  I don’t think it matters where it is because it will go straight into the atmosphere if it leaks.*

**4.6 Media Consumption and views of CCS**
Overall, media consumption patterns did not correspond with particular views on CCS. Because of this it will be most important for messages to be consistent across local, national and international contexts.
Finding: There are three main categories of media consumption about energy issues
Respondents were asked where they turn for reliable information about energy issues (Q14). There were three distinct but overlapping patterns which we have called Mainstream, Online and Environmental-Scientific.

The first group turned largely to mainstream media (television, radio and newspapers) as a trusted source of information. The second group turned to online and independent sources of information such as Wikipedia, blogs and forums. The third group turned to scientific and technical publications, newsletters and flyers from NGOs and local residents’ associations.

Finding: Consumers are nevertheless ‘media omnivores’
Seeking evidence of correlations between the groupings described above revealed that respondents were likely to turn to different sources of media for trusted information about energy issues. It is important to have consistent messaging about the details of CCS projects across media outlets because people may switch between mainstream, online, independent and other sources to sift through information and find contradictions.

This finding is consistent with the NEARCO2 project, where media consumption was found to cover many different media forms. Results presented in Working Paper 2 of their report13, found over half of the stakeholders consulted up to six different sources of information. University scientists/scientific publications were the next preferred source of information (18%), followed by national/international NGOs and national news media (14%). Word of mouth (6%), the developers (7%), and the EU were the least preferred sources.

4.7 Civic Involvement and support for CCS
The visibility of environmental movements in public life has been a central concern of international and national studies of public opinion about CCS14. These studies have examined role that environmental movements and anti-coal advocacy groups play in capturing wider public imagination at the regional and local level. Two interviewees mirrored these concerns:

Interviewee: Okay, you’ve got to approach it from our point of view... at a regional level like in the Hunter Valley, people like Rising Tide, they are opponents... to every new coal mine. So the Amble Hill mine which we now run as Mangoola, we went through four court cases over greenhouse gas emissions. They all got eventually turned down but people were able to have such a strong anti-coal movement, positioning with the environmental court over things like mainly greenhouse gas.

..., just about every coal mine that comes up for approval now is opposed by a group of people. It doesn't matter whether it is Amble Hill, Wongdall which is our

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13 Upahm et al (2011) Opinion shaping factors towards CCS and local CCS projects: Public and Stakeholder survey and focus groups. NEARCO2, Energy Research Centre of the Netherlands
The current survey included questions about civic involvement, such as whether respondents had signed petitions, participated in lawful marches or demonstrations or written to politicians to express their opinion on an issue (Q16 and Q17). Almost two thirds of respondents had never engaged in any kind of activism.

Three separate scales were created, to measure civic involvement; **Activism**, **Petition & Boycott** and **Civic Engagement**.

Modes of activism such as signing an email petition and boycotting an item because of objections about the conditions under which it is made were grouped together to form the **Petition and Boycott** scale.

More traditional forms of civic engagement like writing to public officials, being involved with broadcast media and print media to express opinion on an issue or seek advice were grouped to form the **Activism** scale.

A **Civic Engagement** index was formed out of the various items in Q17 that measure involvement in local community meetings, local consultation and planning meetings, voluntarism, links to environmental and charitable organisations and community groups.

The distinction between those engaged in these activities and those who were not was stark in each case, therefore they were analysed as a binary; those who had engaged and those who had not. Analysis of Variance (ANOVA) was used to investigate how socially engaged and disengaged segments of the population view CCS and renewable energy.

The survey results show that various forms of civic engagement and activism are less likely to be tied to a view of CCS as viable. Results from each level of analysis are detailed below.
Finding: Petition and boycotting activities relates to knowledge of climate change but not concern about CCS

Survey items that were correlated with petitioning and boycotting activities included ‘Greater knowledge of Climate Change’ (F = 21.713, df = 1, p < .01). Those who know more about climate change are more likely to engage in these forms of civic activity. Furthermore, greater climate change knowledge was more likely to correlate with favourability of renewable energy (F = 15.719, df = 1, p < .01) and trust in scientists and environmental protection organizations (F = 13.672, df = 1, p < .01).

However, petitioning and boycotting activities were not significantly tied to views on the viability of CCS, nor to concerns about it.

Finding: Activism correlates with concerns about CSS and scepticism of experts

Respondents who reported engagement with civic activities reported significant levels of concern with CCS (F = 4.553, df = 1, p < .05), trusted scientists and environment protection organization. This seems consistent with the concerns quoted above that opposition to coal mining is ‘symptomatic of a much broader public attitude’.

Conclusions and Recommendations

The pattern of results in this survey were very mixed and show that issues about CCS are not easily tied to conventional survey-type measures of demographics or opinions. This underlines the need to take a very different approach to understanding the dynamics of publics in relation to emerging issues about CCS. Rather than age and socio-economic status influencing support for CCS, it was associated with a few other measures. Support for CCS siting (that is, choosing a site for CCS locally or internationally) is likely to be dependent on a view of CCS as beneficial to the environment and the economy. Those who hold such a view are more likely to support renewable energy. However, support for siting CCS does not directly correlate with support for renewable energy. Therefore it is vital that the ‘bridge to a low carbon economy’ is made clear in project communication documents. This position emphasises the connections between CCS projects and a vision for an economic future that is reliant upon renewable energy.

Crucially, a strong level of trust in environment protection organisations and scientists was predicated on trust in government and energy companies to provide the public with impartial information.

Media consumption preferences for information about energy issues did not correlate with views on CCS, therefore any broadcast campaign should be carefully considered. What is more important than presenting ‘the facts’ about CCS is ensuring a consistent message, as publics get information from both online and broadcast sources.

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15 Bracketed figures are the crucial parameters of the ANOVA, denoting F-statistic (mean of variance within the group), degrees of freedom and strength of significance (p-value).

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Key findings
The survey shows a tentative public, who would like to see the details of any projects before making up their minds. We tested five different areas of contention for CCS:

1) **Concern or support for CCS.** The most significant finding from the survey is that there are no correlations at all between demographic factors of age, socio-economic status and level of education, and concern about or support for CCS. This goes against some key international survey findings.

2) **Trust.** When asked ‘whom would you trust to provide impartial information on energy related issues?’ it was found that a high level of trust in both scientists and environmental protection organisations relies upon a base level of trust in government and energy companies.

3) **CCS Siting and opinions about renewable energy.** Support for CCS siting (that is, choosing a site for a CCS locally or internationally) is likely to be dependent upon a view of CCS as beneficial to the environment and economy. Those who hold such a view are more likely to support renewable energy. However, support for siting CCS does not correlate with support for renewable energy.

4) **Media consumption and views on CCS.** Media consumption preferences for information about energy issues do not correlate to views on CCS. Furthermore, a consistent message is important for CCS projects as publics get information from both online and broadcast sources.

5) **Civic Participation, Social Capital and Views on CCS.** The survey shows that various forms of civic engagement and activism are more likely to be tied to a view of CCS as viable, as well as concerns about its risks.
5. Online Issue Network Analysis: Carbon Capture and Unconventional Gas

5.1 Introduction
Non-conventional gas extraction and geo-sequestration both utilise many common technologies for visualising and monitoring subsurface conditions. This chapter traces the formation and ‘heating up’ of issues about non-conventional gas and the manner in which various publics became engaged with issues that overlap the two sectors.

Involvement in scientific decision-making is profiled here, for both CCS and CSG. Its focus is on the ways information about CCS and non-conventional gas production are exchanged, brokered and discussed by diverse publics.

5.2 Background to social media technology use in Australia
The uptake of digital technologies has increased rapidly in recent years and Australia is one of the world’s leading nations in terms of Internet use as a proportion of the total population (90%). 81% of Australians aged 16 years and above, and 75% of Australians aged two years and above, can be classified as an active online user (i.e. has used the Internet in the past month\(^\text{16}\)). In addition to high Internet use, numerous national policies are directed towards harnessing information and communication technologies to become one of the world’s foremost digital economies by 2020\(^\text{17}\).

Internet development, described as Web 2.0,\(^\text{18}\) has engendered participative and user-created content production, which has in turn created the potential for new forms of democratising and social accountability. Social media facilitate faster, wider and cheaper information dissemination. The interactive and decentralised features foster new kinds of political participation. This has been described as a new ‘fifth estate’ where government, political actors and traditional media institutions may be held to account in new ways.

The (2012) Queensland University of Technology project ‘Mapping the Australian Twittersphere’ generated one of the first ‘crawls’ of the follower/followee networks on Twitter and they estimated this number of participants to be around 2 million, or 8% of the


\(^{17}\) The National Digital Economy Strategy expressly aims to increase Australian households’ online participation, increase business’ and not-for-profit organisations’ online engagement, expand online education, increase teleworking, improve online government service delivery and engagement and increase digital engagement in regional Australia. This includes strategic investment in the rollout of key digital economy infrastructure with Telstra launching the first commercial 4G service in September 2011 and NBN fibre network passing 38,914 premises in 2012 (Australian Communication and Media Authority Communications Report 2011–12: http://www.acma.gov.au/webwr/_assets/main/lib550049/comms_report_2011-12.pdf

\(^{18}\) Web 2.0 refers to social networking tools like Twitter and Facebook that places users at the center of content production. It refers to a decentralised mode of information dissemination that enables mass-collaboration.
country’s total population. Such diffusion of social media in the few years of its existence confirms the importance of making a detailed analysis of these media for the current project.

The findings in this chapter reveal the strategic use of interactive and broadcasting features of social media like Twitter, Facebook and YouTube by advocacy organisations, to make distinctive interventions in public debate.

The analysis reveals how scientific information is distributed online and then shared, brokered and contested by different social groups. Then in the following chapter a further method, ‘network ethnography’ compares ‘offline’ observations with the online findings here.

5.3 Methods of researching online networks

Issues call publics into being. It is necessary therefore to begin from the issue rather than assume a pre-existing ‘public’ to be communicated to, educated or informed. Issues and their trajectories over time can be mapped in detail to see variations in the composition of participants, themes, language for and against, and wider uptake of the issues.

Twitter employs ‘hashtags’ – user generated references that allow online discussions to be made visible for otherwise unconnected audiences. It is possible to monitor issues, such as those related to CSG and carbon capture by following hashtags and other embedded links. The interest for this research was how authoritative public documents on an issue form a network and how clusters of information are brokered by certain domains, such as Twitter.

Twitter’s public API or application programming interface was used to chart the evolving dynamics and composition of online advocacy networks and the ‘ad hoc’ online publics that co-ordinate around the issue of Coal Seam Gas (CSG). Specific hashtags19 were analysed, for example #fracking #CSG #lockthegate #gasland, #wewantCSG. This issue trajectory was traced and tracked online from Jan 2012 to May 2012 using a customised database of 54,479 tweets over the 4 months (see Figure 3). A custom-built scraping application was developed specifically for this project.

Detailed content analysis was carried out to examine the themes of these tweets, retweets and embedded links in order to understand the ‘liveliness’ and ‘heat’ of the topics. The number of ‘retweets’ about a topic is particularly significant in this respect. Users ‘retweet’ content they find interesting from other users, which suggests a lively network of interest or concern about a topic. This implies that lower retweets on a topic indicate less interaction and interest in that topic.

The archive of ‘carbon capture’ tweets did not have publics and alliances as diverse as the CSG related tags. Tweets containing the keyword ‘carbon capture’ were collected from April

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19 Users on Twitter started the phenomenon of adding tags to their messages sometime around February 2008. These tags aid in filtering and directing content so that it appears in certain streams. With over 50 million tweets per day, hashtags are central to organising information on Twitter and it functions as an online curation device. Clicking on a hashtagged word in any message shows you all other Tweets marked with that keyword.
2012 to Aug 2012. Surprisingly, the low number of tweets during this period coincided with several major events in the technological development of CCS, including the inauguration of the world's largest carbon capture facility dubbed as Norway’s 'Moon Landing' and the launch of *Greenpeace Australia’s* Pacific Report on CCS.

Figure 3: Number of tweets containing CSG-related hashtags and those containing the term ‘carbon capture’

5.4 ‘Carbon Capture’ Online Network Analysis

The analysis of *Twitter* data gathered under the search term ‘carbon capture’ shows that it is a specialised topic of discussion that hasn’t created publics nearly as large as those of CSG, in a similar time frame.

The main themes in *Twitter* discussions of carbon capture during April to August 2012 were:

- New project and technology announcements
- Criticisms of the viability of the technology
- Concerns about safety and technical risks of the technology
- Commentary on policy and legislation
- Tweets with hyperlinks discussing the above in greater detail

News and technical announcements, corporate investors and energy market professionals seemed to dominate the online debate space.
The first peak in the volume of tweets graphically depicted in Figure 4 around 12 May corresponds to the release of the *BBC Science and Environment* article titled, ‘Whatever happened to carbon capture?’ a day after Norway inaugurated the world’s largest and most advanced laboratory for testing carbon capture technologies. Several users retweeted the same news announcement by adding the comment: ‘Carbon capture battles money, politics and technology’ or ‘The IEA says we need 1,500 CCS plants by 2035 - right now there are eight’. Amid the general scepticism in twitter content on that day there were two comments that referred to how the conversation needed to focus more on how successful carbon capture has been. These thoughts did not gain wide circulation or currency. *The Economist* covered the event with the headline ‘Carbon capture and storage: a shiny new pipe dream’ and the *Guardian*, ‘Whatever happened to carbon capture in the fight against climate change?’

Following this surge in attention to CCS, close analysis of Australian content revealed few discussions of the *Greenpeace* report titled ‘Dead and Buried: the demise of carbon capture and storage’ that was released on 14 May. This was covered by *ABC News*, Gippsland as well as by a popular political blog. If the number of retweets is used as a measure of influence, then the @CSIROnews tweet during the same period linking to an article in the independent news website *The Conversation* was less influential. The following tweets give some indication of the range of discussion:
RT @CSIROnews: Coal provides 75% of Aus elec. Paul Feron explains why we need to build on carbon capture tech http://t.co/0DoKvPq @ConversationEDU ^CS

RT @ConversationEDU: How close is Australia to capturing emissions from its coal-fired power plants? Paul Feron @CSIRO on carbon capture. http://t.co/dRNRAhLi

RT @__: Australia is in deep with coal-fired electricity. CSIRO is looking for ways to clean it up http://t.co/UWCzrEUA @conversationEDU @CSIROnews

RT @greenpeaceaustp: @abcnews on our new report 'Dead and Buried: the demise of carbon capture and storage' http://t.co/WcWeywafc coal

RT @__: All those pollies & journos pushing carbon capture & storage a few years ago should read this: http://t.co/uusFfj0 #wastedtime #ccsfail

Analysis of the second peak in the volume of tweets on 19 June revealed references to the Financial Times news announcement that GE had made a breakthrough in the development of capture technology. The release of the Stanford study also occurred. It highlighted risks of CCS in terms of the possibility for underground earthquakes to release sequestered carbon. This led to discussions about induced seismicity and the viability of CCS from a safety perspective.

Social Media Analysis: Induced Seismicity

A few users linked CCS to reports of the Gippsland earthquake at the beginning of the year, referring to the potential threats of large-scale storage in what is currently seen as a world-class storage location in Victoria and the home of the flagship CCS project, CarbonNet.

Topical after an earthquake in Gippsland! RT @physorg_com 'Carbon capture' too risky, earthquake prone: study http://phys.org/news/2012-06-carbon-capture-risky-earthquake-prone.html

RT @__: @__ Whoops! There goes all the CO2 [sic] the Global Carbon Capture And Storage Institute geosequestrated so carefully.

Publics mobilising around CSG have used the participative features of Web 2.0 for the active politicisation and mainstreaming of their concerns. In contrast, the only time that Carbon Capture and Storage featured on a high volume hashtag like #auspol was as a provocative comment on Deputy Prime Minister Wayne Swan being asked about the government’s commitment to the technology. This is a high volume, user created, Australian topical hashtag where developments in politics are raised and discussed. The user who placed the

tag next to the tweet about carbon capture technologies is consciously pushing that message on to the high circulation hashtag. It is a means of flagging regional issues and throwing it into the global debate. Now anyone who clicks on #auspol from any part of the world has live access to posts that are coming from beyond the followee lists.

#qt Coal industry toys with post-combustion carbon capture. Pre-combustion capture works: http://blog.gerbilnow.com/2012/04/qanda-climate-debate-special.html#coalandindustrydelay #auspol @swannydpm

RT @____: Wayne Swan is delusional: "The govt doesn’t apologise for its commitment to carbon capture and storage one bit" #qt #environment #mining

Content analysis of the 12,999 tweets to identify overarching themes revealed that most of the fluctuations and variability of the term ‘carbon capture’ can be traced back to newsworthy events. Many tweets were about technology or project announcements and the shrinking of public funding for CCS. These included self-publicising of new technical developments such as carbon pre-filters, research announcements about carbon capture potential in soil and algae and the possibility to use Bio-Energy with CCS to get atmospheric concentrations back to 350ppm.

While the few users talking in positive terms about CCS are project proponents21 at an early stage of the project lifecycle, there is a general tone of scepticism about whether CCS has a foreseeable future. There were references to the lack of political will in the coal industry to actually use carbon capture except to ‘delay carbon caps’. Twitter handles such as those of the Global CCS Institute, the National CCS week and the IEA had links to educational resources introducing CCS.

Our database showed a few instances of British environmental organisations connecting fracking with CCS. Two main strategies were used. Firstly, the term ‘extreme greenwash’ was deployed, however it was not taken up in wide public discussion. A key argument of these organisations was that discussions around the viability of CCS technology missed the point. Rather, they argued that it is the entrenched fossil fuel dependency of modern economies that required systemic change. This was achieved by linking to an article of a direct action group provocatively titled ‘Using Carbon Capture and Storage: Having your cake and burning it.’22

@NoTarSands @RisingTide_UK Why CCS is an answer to nothing: http://frack-off.org.uk/carbon-capture-and-storage-having-your-cake-and-burning-it/

Secondly, induced seismicity emerged as a key issue of contention with a variety of users beyond the environmental organisations. A number of reports and scientific articles were linked, for example a write-up in the widely read scientific journal, The Proceedings of the

21 RT @BritBizClub: Steve Holiday, CEO, National Grid Plc: Carbon capture and storage is the real future and a huge opportunity for the UK #britbizembassy
22 http://frack-off.org.uk/carbon-capture-and-storage-having-your-cake-and-burning-it/
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*National Academy of Sciences.* This research showed that even small- to moderate-sized earthquakes can threaten the seal integrity of CO₂ repositories:

RT @newscientist: Move over #fracking: #CCS schemes are more likely to trigger #earthquakes http://www.newscientist.com/article/dn21954-earthquake-risk-for-carbon-capture-and-storage-schemes.html

The majority of discussions related to ‘downside’ risks from CCS, rather than the role of CCS in mitigating climate change or in the transition to a low emissions future. Excluding project developers and peak bodies such as the IEA and the GCCSI there were few non-expert discussions of the place of coal and fossil fuels in energy generation.

**Hyperlink analysis of Induced Seismicity issues**

Seismic events induced from the construction of large dams, mining and geothermal operations have been recorded in Australia. However, there is currently no Australian seismic risk data available for gas-related operations, such as hydraulic fracturing or large scale injection of fluids. Overseas evidence suggests that low magnitude induced seismicity can be generated during such operations as shale gas drilling when large volumes of water, produced from a large number of wells, is re-injected into the subsurface for disposal at or near a ‘critically stressed fault’.

A hyperlink analysis of the term ‘induced seismicity’ was conducted through the Web to find out where the authoritative websites on the topic were located in the online network and the extent to which the techno-scientific issue had gained traction with wider publics. Based upon preliminary analysis of *Google* searches we used an issue crawler to map the network between sites with a high rank in *Google* searches:

1) Popular articles reporting the induced seismicity issue


http://www.physicstoday.org/resource/1/phtoad/v65/i8/p22_s1

http://www.pnas.org/content/early/2012/06/13/1202473109.full.pdf


2) Official Government sites

http://www.energy.senate.gov/public

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3) A book chapter available online

http://www.nap.edu/openbook.php?record_id=13355&page=51

A co-link analysis of these URLs was conducted. This search retains the pages that receive at least two links from the seed url, thereby providing an exhaustive picture of interlinks between these seed sites. The results revealed that Twitter is the dominant intermediary between the science and the technical reports.

Significantly, no reports of actual seismic events were found in initial network analysis crawls. This means that, for the term ‘induced seismicity’, scientific analysis has achieved greater salience on the web than other related terms such as ‘man-made earthquake’.

Fugitive Methane Emissions Hyperlink Analysis: Guardian article Case Study

Representation of an issue network can be found in the following report on fugitive methane emissions from fracking. Guardian journalist Damian Carrington linked otherwise isolated websites: the Institute of Mechanical Engineers report on Shale Gas, a Greenpeace report on Shale gas, and an International Energy Agency report with energy predictions of energy demand:

http://www.guardian.co.uk/environment/damian-carrington-blog/2011/nov/03/shale-gas-game-changer-fracking

Sites linked in the news story were:

http://www.bseec.org/content/us-carbon-emissions-are-declining-thanks-natural-gas-and-free-market
http://www.cuadrillaresources.com
http://www.ft.com/cms/s/0/287378ee-0708-11e2-92ef-00144feabdc0.html#ixzz27fodtltj
http://www.iea.org/newsroomandevents/news/2012/may/name27216en.html

The author makes a clear attempt to link several different websites that are otherwise unlinked.
5.4 Coal Seam Gas Online Network Analysis

Initial assessments of networks revolved around the hyperlink structure of YouTube videos. In June 2011, we searched the term ‘fracking’ and mapped videos that link to them. A user-generated clip titled ‘Lock the Gate’ emerged as one of the most centrally connected\textsuperscript{24} and visibly prominent. It examined the coal seam gas situation in Queensland through a tour of Kingaroy, Dalby and Tara in the style of the US documentary \textit{Gasland} by Josh Fox.

‘Lock the Gate’ referred to the \textit{Lockthegate Alliance} which began as a heterogenous regional network of resident action, \textit{Landcare}, conservation and church-based groups together with traditional environmental advocacy groups and the rural and regional \textit{Greens}. It has since grown into an umbrella organisation conducting online campaigns through social media. Hashtags, such as #eatgas were developed to resonate with concerns about aquifer interference from fracking in the context of land-use debates in Queensland. ‘Eatgas’ was developed by users as a scathing reference to the rapacious growth of CSG over agricultural land, and policies directed at ‘balance’ and ‘co-existence’ in the Western Downs.

Counter-claims and refutations were provided by \textit{Australian Petroleum Production} and exploration industry Twitter handle @RWilkinsonAPPEA. The latter account has become less active since the hotly discussed media campaigns, ‘We want CSG’ translating to #wewangcsg on Twitter. Other than the industry peak body, supporters include @Unlockthegates and @Fracking4future who see CSG as a key to achieving future energy security.

The research shows that ‘retweets’ do not crystallise into more persistent direct action at regional and local levels. Rather, they function to manage content between multiple audiences.

The three figures 5, 6, and 7 below depict the trends from the analysis of hashtags and retweeting against major events.

\textsuperscript{24} This analysis of information about videos posted on Youtube was done using a network degree centrality measure which showed that among all videos at that point that linked to each other, this clip bridged the entire network by reducing the maximum path distance to around 2. That is, in a manner that mirrors the algorithm that generates Google search engine results, even the most peripheral videos on Youtube under the self-marked tag of ‘fracking’ linked to it at 2nd remove at the most. Implications of this finding is that high centrality media that has captured online debate space show up first in searches for information by someone relatively new to the field, be it a journalist or interested community member. This video is still online at: \url{http://www.youtube.com/watch?v=2w5KpKe0ys4&feature=youtube_gdata_player}
March was a particularly significant month, corresponding with the Queensland State elections where CSG was becoming an important matter of dispute and concern. This period also saw key peaks in the volume of CSG hashtags which for the first time exceeded #fracking, owing partly to the release of three key policy frameworks during 2012:

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25 The gap in data around 10 Feb occurred because of a technical failure with the online hosted database.
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- NSW Strategic Regional Land Use policy
- NSW Draft Aquifer interference policy
- NSW Draft Code of Practice for Coal Seam Gas Exploration.

The NSW Government 2012 Strategic Regional Land Use policy documents were widely discussed in regard to the implications for the state agricultural, vineyards and horse breeding sectors. Illawarra locals also mobilised around concerns about water contamination, as below:

*NSW Govt Plan fails to protect Illawarra & drinking water catchments of millions: http://stop-csg-illawarra.org/2012/nsw-govt-plan-fails-illawarra-catchments/ #CSG #lockthegate*

Furthermore, tweets referencing inadequate protections for wineries were launched through small community news Twitter accounts that would normally only involve residents and businesses broadcasting tourism related events in the region.

600 tweets referencing #CSG on the 6th of March also coincide with global events such as Unlockthegate refuting Josh Fox’s interview on *MSNBC* following his attempt to gain access to a US congressional hearing to provide an uninvited statement as well as an instance where the *Guardian* article discussed the fate of the cancelled Scottish Longannet project. ‘Carbon capture is part of our energy future’ was curated by a British anti-fracking campaign account under the hashtag #fracking (in spite of there being no reference to fracking in the article)

This again showed that hashtags are a device to broker content between multiple audiences, in this case between those concerned about fracking and wider climate policy and low emissions coal technologies.

*Figure 7: Volume of tweets denoting notable events in mobilisation around Coal Seam Gas*
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*Note: The first arrow in Figure 7 refers to a peak on 6 March 2012; the Second arrow corresponds to 15th March 2012 protests.*

Other main events in the period include the week-long campaign by GetUp! to gather 10,000 online signatures to present to the UNESCO representatives investigating the impacts of dredging in Gladstone for the CSG to LNG export facilities on the Great Barrier Reef World Heritage Area and the leaked Greenpeace strategy paper “Stopping the Australian Coal Export Boom” which called for $6 million a year to fund the campaign.

**Conversation Networks around Coal Seam Gas**

Figure 8 is a visualisation of the conversation networks around 15 March (#fracking: 805, #CSG: 543, #lockthegate: 173, #gasland: 19 mentions) when the Greens motion calling for a moratorium on all CSG projects in the state was voted down, 16 votes to 19 (Coalition, Shooters & Fishers and Christian Democrats against; Labor and Greens in favour). Widely discussed and retweeted was the Youtube clip of the afternoon session of NSW Parliament ([http://www.youtube.com/watch?v=fLQ5TrL7Xqs](http://www.youtube.com/watch?v=fLQ5TrL7Xqs)) where the 20,000 strong CSG People’s Petition calling for an ‘an immediate moratorium on all CSG projects; a Royal Commission into the full impacts of CSG; and an immediate ban on fracking’ was put to debate following the Premier’s election promise to debate in the Lower House any petition of over 10,000 signatures. 100 protestors had gathered outside the NSW Parliament building and 40 gained entry into the gallery. The speaker eventually ejected the 40 protesters and cleared the MPs out of the parliament before police took control. These proceedings were widely reported and ‘retweeted’:

*Government fails the people of NSW on coal seam gas with farcical parliament debate*
http://www.greenleft.org.au/node/50373 #lockthegate #csg #nswpol

*RT @____ NSW drilling moratorium bill has been voted down 19-16 in parliament #fracking #csg*

Figure 8: Conversation network snapshot around 15 March NSW Parliament protests on CSG
Figure 8 shows the importance of mainstream media commentators in Coal Seam Gas issues. The node sizes in the graph depend on a network measure for influence called ‘Betweenness centrality’ which is an indicator not of numbers of followers, but relational position within the network. More central actors broker information between two (or more) otherwise unconnected clusters. High ‘Betweenness centrality’ refers to access to diverse forms of information that goes beyond what circulates in one’s own subgroup.

The cross-cutting conversation network in Figure 8 shows the diversity of actors who are active in conversations around CSG policy. Rural action groups, Sydney-based bloggers, media advisors for State and Federal MPs, local councillors and MPs themselves made comments on the issue. Several others flagged time and venue of the protest event including intention to attend in person. On the top right of Figure 8 is a ‘gatewatcher’ who has created a #fracking hashtag to curate, forward and circulate relevant information about CSG to their followees.

A range of advocacy organisations across the spectrum of the environmental movement are involved in the conversation. These include conservation-based groups like the Wilderness Society, NGOs that have emerged around specific concerns such as water contamination and direct action groups that have been created with the explicit purpose of opposing CSG. We

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also see regional users like the Hunter Valley Winemakers Network mounting contestations through local chambers of commerce and local official tourism pages.

Our research clearly refutes popular misconceptions about the user base of Twitter as being limited to vocal, media-trained urban activists and large media conglomerates. Our analysis of the data on CSG mobilisation shows that Twitter users are utilising the fluidity and low costs of participation afforded by the platform for ongoing discussion and instant evaluation of newsworthy events relating to CSG.

The ‘newsworthiness’ of CSG cuts across forms of civic participations to include citizen journalism, local newspapers and national publications, as demonstrated by the following tweets:

“the people who attended the rally are accidental activists, elderly people, farmers...” said @NoCSGGurley. #polaw http://www.moreechampion.com.au/story/188703/protestors-hit-sydney/


The hashtag #agchatoz, appended to the latter tweet by one user, is a weekly discussion forum created by the social media advocacy group Agricultural Chat Australia which exists with the explicit purpose of using digital media to help farmers in remote locations overcome isolation and actively network. #polaw stands for ‘Protect Our Land and Water’, created by NSW Farmers Association as a focal point of their campaign after the consultation period on the land use frameworks ended.

Analysis of the content and link networks to #polaw shows a cross-section of political positions, from farmers and landholders to urban individuals. The use of such tools for online petitioning to create parliamentary debates and influence policy suggests that terms such as ‘armchair activism’ and ‘clicktivism’ mask a much more complex network of engagements between media forms and users. Advocacy organisations and others use social media to frame and reframe issues in ways that could not be achieved without these new means.

5.5 Conclusions

Online participation enables widespread public participation and raises fundamental questions about representation and the public sphere in the context of gas and CCS technologies. Research on the ways energy issues of Carbon Capture and Coal Seam Gas are mobilised online has shown that Twitter is an important site for brokering information about these issues. However, relative to unconventional gas, there is very limited discussion of Low Emissions Coal Technologies online. Discussions about carbon capture peak with the release of major reports from news organisations and large environmental organisations such as Greenpeace. Induced seismicity has been used by environmental organisations to connect risks of CCS to those of unconventional gas. A key role for policy-makers will be to develop and implement strategies to measure and manage such incidents. This efficacy of a website
presenting scientific information on energy issues can be monitored through hyperlink and social media network analysis because its place in the network can be monitored over time.

While town meetings and face-to-face discussions have an invaluable role to play in managing project risk, it is also vital that project proponents carefully monitor how online discussions around issues shift over time. An important competency for network analysts will be to track how scientific reports are linked (or not) to Internet searches, then build and promote through social media websites.

Actor-Network Theorists have cautioned about assuming ‘society’ and social activities are well described and represented through the traditional tools of social science, such as the survey within this project. In the context of CCS and CSG issues, this means how electronic public participation is used to contest policy issues should be understood and followed as a set of relations between people (farmers, ‘activists’ and others) and objects (drill rigs, measurement equipment). The central challenge for social science is not so much one of representation through social surveys, but rather understanding the dynamics of how and why publics form around objects and issues.

To adequately chart such movements and formations a fully committed online presence in social media is necessary. This will allow for dialogue and deliberations between experts and non-experts that enhance confidence in CCS technologies. Investment in research infrastructure and active cultivation of a ‘fifth estate’ are also vital for the coal innovation industries; to understand public concerns and emerging user practices (like #eatgas) and to interact well with different publics.
Key findings

- Diverse social groups and unusual coalitions are involved in Coal Seam Gas mobilizations and protests.
- Social media websites can operate as sites of brokerage between discrete bodies of information about a topic.
- Relative to unconventional gas, there is very limited discussion of Low Emissions Coal Technologies online.
- Most ‘tweets’ about energy issues contain embedded links with news articles or policy documents.
- Online discussions about carbon capture peak with the release of major reports from news organisations and large environmental organisations such as Greenpeace.
- Induced seismicity has been used by environmental organisations to connect risks with CCS to those of unconventional gas. A key role for policy-makers will be to develop and implement strategies to measure and manage such incidents.
- Online participation enhances entry for public participation, raising fundamental questions for policy-makers about representation and the public sphere. Our research suggests that concentrating just on the size of publics is misleading.
6. Public Engagement with Gas Exploration: Network Ethnography Results

6.1 Introduction: Network Ethnography

Ethnography is a methodology for studying social activity that places the researcher within the everyday complexity of what is being studied and seeks to gain a detailed account and understanding from the perspectives of ‘actors’ in that place. Ethnography favours ‘embedded’ methods of fieldwork such as participant observation and in-depth interviews.

‘Network ethnography’ refers to mixed research methods that are used to study organisational forms built around new media. With examples of protest in contemporary liberal democracies, recent social science writing has asserted that online and offline forms of protest must be analysed together, if they are to be fully contextualised and the knowledge made useful. Building on the idea of ‘no issue, no public’, this requires methods that make it possible to examine how much hyperlink patterns reflect organisational structures, including communicative behaviour, alliance building and information dissemination.

Twitter has become extensively intertwined with journalistic practice. Mirroring this, the uptake of mobile devices to share content has made possible new kinds of ‘Citizen Journalism’. Where journalism was typically assumed to be the practice of speaking to an already-defined public sphere the findings in this project raise questions about how we are to think of publics (plural) in the digital age. This research has consistently shown multiple spillovers between online and offline activity.

So ‘community’ in this project is redefined as ‘communities’; a series of interactions, exchanges and transactions between online and offline sites at different global, regional and local levels. A community is no longer defined just according to place or geographic proximity.

6.2 Case Study: A community blockade near Newcastle

A good example of how new media can be used to make local issues gain wider traction is the case study of a community blockade of a Coal Seam Gas drill site just outside of Newcastle. The blockade took place at Fullerton Cove on the edge of the Tomago Sand beds. International gas company Dart Energy sought to drill an exploration bore hole in order to demonstrate the potential production reserves of the underlying coal seams.

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29 Dart Energy Limited has its head office in Singapore, with operations in 8 countries.
Dart Energy hold Petroleum Exploration Licence 458. The license area covers the city of Newcastle and extends over an area of approximately two thousand square kilometers from Belmont in the south to Myall Lakes in the north, Raymond Terrace in the west to the coast in the east.\(^{30}\) Kate Ausburn, a journalist and participant in the protests, describes the community mobilisation as follows:

*The Fullerton Cove community is calling for a more rigorous environmental assessment of the coal seam gas drilling plans. The site Dart has chosen is on a rural residential street, home to many families and paddocks of animals. It is also around 500 metres from internationally recognised RAMSAR wetlands.*\(^{31}\)

Ausburn was one of many participants drawing attention to elements of the local area – such as its landscape, flora and fauna – that may be threatened by drilling. Another protest participant attended primarily to photograph the event as part of research into social media use, as well as to show solidarity. She demonstrated how she would scroll through the photos on her iPhone to select those with the most impact. One image, of women chained to the tractor blockading the drill site, expressed the loss of the agricultural way of life. The photographer immediately uploaded it to a Newcastle tourism and information page on Twitter giving it an instant, broad audience. When asked to reflect on whom she posted it for, she said there were those that followed her exclusively to hear news of the radical event of the day. She also had friends who now followed her on Twitter, whom she knew from a two-year resistance to the destruction of 14 mature fig trees in Newcastle.

Interviews with activists and representatives of advocacy groups revealed how unexpected and unlikely some of the groups of people are, who have embraced this platform. The findings show that several people from a regional upper Hunter locale, on the brink of unconventional gas exploration have joined Twitter expressly because they wanted to talk about coal seam gas. The Twitter medium has the potential for both shrinking and widening geographic coverage of individual tweets by interacting with emerging community alliances that are global. One research participant, for example, related how she was contacted by someone from the United States because of her postings about fracking. There were others who dubbed themselves ‘Accidental Activists’, who had joined Twitter primarily to tweet politicians/gas company representatives and to showcase activities on their farms.

Part of the reason such new media is gaining currency is that it has the potential to redefine what is considered public and private in ways that may enable new forms of accountability;

...*take the case of [a Queensland government department], I’ve had one question that I’ve been trying to get an answer on for a week and I’ve had four emails from them, none of which have answered my question. So it’s really hard to get these people to communicate in private forums like emails or telephone*...  

\(^{30}\) A map of the coal seam gas exploration licence area 458 can be found [here](http://www.kateausburn.com/2012/08/19/blockade-fullerton-cove-community-blockade-against-darts-csg/#.UdPs3PnVASM).

Social media has implications for defining the ‘community’ that is said to be impacted by low emissions technologies. Rather than already existing ‘out there’, a community may emerge as an effect of interactions between individuals in one place and ‘strangers’ who enter, perhaps to install a drill rig. New media have the potential to change the ways we think of what is global and local, rural and urban, public and private. This has implications for how ‘community’ engagement is carried out. Research results here suggest that merely labelling and quantifying publics in terms of their location and geographic proximity to an industrial site and then planning communication on that basis ignores the whole question of who the different interests are and the ‘actors’ who emerge and congregate around them. It is knowledge of the latter that will be most useful as the basis for communication that addresses particular issues and the publics most associated with them.

6.3 Case Study: ‘Black Soil’ farmers in northern NSW
Researchers observed a briefing from the Environment Defenders Office of NSW in Moree on 18 September, 2012, with the objective of understanding how landholders were engaging with the science of subsurface monitoring technologies in the gas industry. Farmers’ main concerns were related to practices in use and access arrangements for the gas industry as well as water and groundwater integrity. As Kerr suggests in her analysis of the conflict between gas and farmers:

There are fundamentally different business models in operation between farmers and CSG producers and this would appear to be a natural source of conflict unless managed appropriately. Farmers are strongly grounded in their region, and one family may own the same farm for generations. They generally undertake their daily lives and conduct their farming enterprises with little interference from others. These ‘new’ extractive industries are contesting farmers’ long held views that they are the sole or major custodians of the land.32

Farmers raised a number of concerns about the practicalities of ‘co-existence’ with gas companies. They were disappointed with changes to the government’s Strategic Regional Land Use Policy which lifts the ban in NSW on fracking and were confused as to why strategic agricultural land was being included when PELs are given to cover that land.

They especially wanted the review of licensing conditions.

Specific questions were asked about how Farmers should continue to manage their property, in proximity to the drilling. They asked;

- What if we want to spray when there are workers at the wells?
- Do I do a stubble burn: are we liable if something goes wrong around the wells?
- Will the fire department send out its people? The risk may be too great to them.
- Are the people coming onto our property licensed to work with children? It would be a perfect job for a paedophile to be out here and have access to our families.

Considerable resistance was made to the idea of accepting minimal compensatory payments; a feeling of injustice at the paltry sums offered when the reality is that lost productivity due to removal of land for gas infrastructure will result in net financial losses. There was also dismay at the realisation that the gas companies have seemingly unlimited power to access land – if not in the present, then later.

Frustration was intense regarding the lack of simplicity and clarity in the legal process. Terminology in legislature was not quantified. For example ‘substantial’ was not given a precise definition or measure, even though it referred to improvements a landowner could make to a property which may result in an exemption or a postponement of licence grants.

Landholders made the following specific complaints:

Gas company tactics: they get people we know to make initial contact. It’s verbal, not written. They’ll turn up on a Saturday morning and you don’t expect them to be doing work for the company.

It’s deceptive.

They catch people unawares, off-guard.

They try to push an access agreement on you.

[an access agreement presented for signature by a friend operating on behalf of a gas company] ...an A4 piece of paper, 2 paragraphs, no letterhead.

How can you trust a company that does that?

If they send someone around to try to get you to sign an agreement... they’re supposed to make the first contact with landowners a written one.

A few of us spread the word [after being initially contacted].

People started saying, ‘My husband’s not home,’ or hanging up the phone.
6.4 Conclusions
This chapter has presented further evidence that highly disparate groups with different values have united over opposition to CSG exploration activities. Furthermore, it has provided valuable insights into how and why users choose to join and use new social media such as Twitter to share information. ‘Accidental Activists’ are joining Twitter purposefully to raise concerns about unconventional gas. For these activists, initial contact with gas companies remains critical. Unease about potential effects of drilling, as well as concerns from farmers about land access tactics are of much greater concern than the probity of subsurface water modelling and associated technical issues. Issues of control, access and power cannot be diffused through science, no matter how robustly demonstrated.

Key Findings:
• If scientific facts are only as strong as the social and online networks they circulate in, government and industry positions on CCS and unconventional gas has much ‘catching up’ to do.
• Highly disparate groups with very different values have united over opposition to CSG.
• ‘Accidental Activists’ are joining Twitter explicitly to raise concerns about unconventional gas.
• Unease about potential effects of drilling, as well as concerns from farmers about land access tactics are of much greater concern than the probity of subsurface fluid migration modelling.
• Public mobilisations over CSG exploration are unlikely to be quelled through reference to ‘the facts’ alone.
7. Network Solutions Model

7.1 Introduction

This report has drawn attention to many groups who contest or oppose low emissions coal and CSG technologies: farmers concerned about CSG company access, residents near power stations, gas industry professionals, power station operators. Understandings from Actor-Network Theory and the Social Construction of Technology have been used, to draw attention to the ways ‘networks’ of relations emerge around particular issues. These networks use the capabilities afforded by recent developments in social media to communicate on site and through the Internet.

From the perspective of the CCS and CSG companies, there is an urgent need to successfully manage project risks to existing and further projects in New South Wales. In response, this chapter pulls together all the different stages of research to outline a Network Solutions Model that suggest methods to managing public risk by monitoring and responding to public concerns in the development of the technology. These responses can be incorporated into industry and project timelines as they are refined, revised or developed.

The model emphasises the importance of the social groups participating in CCS developments – including the different groups within CCS projects themselves – as well as the importance of taking public concerns seriously.

Active participation by CCS has hitherto proved challenging in two ways. Firstly, CCS projects are large, complex engineering exercises that require extensive state and private sector support to proceed within highly competitive energy markets. Secondly, uncertainties in the development of the technology often concern particular aspects which, in turn, ‘silo’ thinking. With few notable exceptions33, most policy makers, project proponents and science communicators deem ‘public acceptance’ as a discrete category to be analysed apart from technical risks. Instead, the ‘Network Solutions Model’ emphasises that technology governance does not begin from a set of ‘facts.’ Rather it is a continuous process of public engagement and pressure both online and offline, including technology selection, expert-lay dialogue and regulation. As Figure 9 graphically represents, this is a process.

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7.2 Pathways and speed of development: addressing selective opposition

The concept of ‘selective opposition’ draws on central precepts of the Social Construction of Technology framework; the meaning of technology does not lie within it, but in ways social groups contest its purpose and viability. Selective opposition refers to the ways groups will contest particular elements of a technology, such as bicycle users choosing particular tyres or handlebars to influence widespread manufacture.

In the context of CCS, choosing appropriate pathways for the development of capture and storage options for each jurisdiction’s geological and energy needs remains a central challenge. A SCOT perspective emphasizes that the array of diverse technologies for capture,
transport and storage should not be viewed as a weakness, let alone a failure. As Markusson and colleagues suggest, ‘competition among technology variants is normal and good for learning, but will most likely be reduced as we get nearer wide deployment. There is uncertainty as to what technologies will win out, and when that will happen.’

Meta-analyses of technology deployment provide useful points of reference for the issue of scaling up and speed of CCS. For example, Wilson examined both supply (e.g. coal, natural gas and nuclear power plants) and demand side technologies (e.g. passenger cars, jet aircrafts), and CCS and applied a diffusion of technology framework. The general pattern observed was growth first in terms of numbers of units (a ‘gestation period’ that is often several decades long), then unit scaling (two to four decades), and then growth in numbers again as mature technologies diffuse. Wilson observes scaling times (time from 10% to 90% of market penetration) of 20–65 years in the energy area, with nuclear energy on the low end (and cars on the high end). The pattern observed is especially true for large-scale supply technologies. Based on these findings, Wilson suggests that the current emphasis for CCS on rapid unit scaling may be premature.

‘CCS will have its greatest support if it can be convincingly tied to renewable energy development.’ However, this observation should be treated with some caution. Technology path developments and deployments are due in large part to otherwise ‘hidden’ organizational, social and policy elements this report has drawn attention to (see especially Chapter 3). The familiarity of amines in power stations is particularly important, for example. Such social nuances tend to be glossed over by broad-scale, ‘big’ histories of technology change (such as Wilson’s), which leave little room for opposition, negotiation and dialogue.

Opposition may signal a lack of confidence in regulation, as well as signalling the need to build new alliances and resist intransigence in current technology pathways. Public sentiments may shift for reasons beyond the control of any particular actor, as when Sweden sought to wind back its civil nuclear power programme in the 1980s following the Three Mile Island incident thousands of kilometres away. Though a greater variety of technologies are in play with CCS, it is no less susceptible to such shifts in sentiment, though opposition may be more ‘selective’.

The survey findings demonstrate that CCS will have its greatest support if it can be convincingly tied to renewable energy. If this is successfully accomplished, public tolerance for appropriately regulated geo-sequestration is likely to be much greater.

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7.3 Managing expectations by reconciling risks with publics

The assumption that publics are dynamic and plural is vital in considering community engagement strategies. One key to successfully implementing CCS projects will be ensuring expectations are successfully managed, and thus public awareness does not translate into public opposition. The importance of establishing an appropriate baseline of expectations was evident from interviews with international experts (see especially Chapter 3) Others emphasised the uncertainties around project timelines and stated plainly that they didn’t ‘know what the results [of the project] would be.’ Nevertheless, local and community champions were important supporters of the local pilot project we witnessed. These champions had pre-existing links with the power station that they were able to establish.

The flipside of this communication effort is the need for social scientists to become involved early to evaluate how stakeholders’ networks are formed and how they understand and communicate risks. The frustration of highly experienced geo-sequestration practitioners at being unable to communicate the ‘holism’ of risk to other partners is instructive here. (Several expert interviewees said this.) Risk assessments involve knowledge based on experience, as well as an array of scientific devices and techniques.

An important social scientific insight here is that ‘lay-persons’ understandings of scientific projects in their local areas rest on a nuanced understanding of ‘local’ knowledge alongside external expertise (see especially Irwin and Wynne, 2004, Ch.1). In Wynne’s famous example, the Chernobyl radiation cloud was an issue that entangled sheep farming with public health in unexpected ways. The government turned to science to establish when caesium levels would be reduced to acceptable levels. Wynne shows how local sheep farmers knew very well the importance of soil types to water flows and vegetation growth, whilst scientists glossed over these local contingencies by using radiation models developed in different conditions. These local contingencies, combined with several local historical incidents (especially radiation leaks at the Sellafield plant), turned out to be highly important, as state scientists revised their original assessments of safety when locals pointed out oversights.

Wynne’s broader lesson is that laypeople are capable of being reflective about their social relationships to scientific experts, and well understand their ‘local’ knowledge in relation to ‘outside’ knowledge. He suggests that public uptake of science might be improved if scientific institutions expressed an equivalent reflexivity about the limits of their own knowledge in relation to local knowledge.

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Many CCS project proponents already understand the locality of their knowledge. Power station operators, as noted in Chapter 3 have sophisticated community liaison processes that have meant interactions between locals and scientists on site provide the kind reflexivity Wynne views as desirable. Oil and gas expertise, on the other hand, has not been so reflexive with its knowledge in relation to local concerns. This is largely due to the nature of the expertise and structure of the industry itself noted in Chapter 3. For CCS projects to proceed, some integration of local community know-how with other diverse knowledge-making practices will be vital, and will require social scientists reveal how locals know their area.

‘Those jurisdictions with coordinated Federal oversight have made greater progress than those without.’

7.4 Policy support

In Australian policy, the relationship between renewable energy and CCS is much further apart than most other developed countries in the world. CCS is excluded from the Renewable Energy Target and Clean Energy Finance Corporation funding mechanism. International experience shows that successful project rollout not only requires appropriate legal frameworks, but also a commitment by all stakeholders to complete the mission. Online platforms allow for a new level of transparency and public engagement by governments that could help ensure such commitments are followed through. Providing an ‘extended level playing field between mature technologies and novel ones’ would establish trust and ensure appropriate path development, if stimuli and subsidies for established technologies are appropriately dealt with.

A further consideration is global policy co-ordination. Some experts have argued that only China and the United States have economies of sufficient size to progress CCS to sufficient scale. However, projects and associated regimes have developed outside these jurisdictions suggesting other factors, such as appropriate geology, and existing experience with oil and gas exploration must be considered.

Countries have developed CCS regulations based on existing oil and gas industries, historical relationships with the UNFCCC and climate regime and co-ordination with relevant neighbouring jurisdictions. These suggest a more comprehensive approach to socio-technical networks must be considered – not simply gross economic size.

‘Early mover’ jurisdictions continue to lead with the development of primary legislation and supporting regulations. Jurisdictions with co-ordinated Federal oversight, such as Norway, have made greater progress than those without. However, some large Canadian provinces with tar sand and oil resources, such as Alberta and Saskatchewan, have also made significant progress.

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38 http://www.abc.net.au/4corners/content/2009/s2678936.htm
National leadership to connect sources and storage of emissions has been a hallmark of leading jurisdictions. For example, Norway has adopted a logical process to developing their regulation regime for CCS to support their large-scale demonstration projects. In Australia, many jurisdictions have CCS regulations in place to allow pilot and demonstration programmes to proceed; however this is a highly uneven ‘patchwork’. We therefore recommend a harmonised approach across state borders that will enable Federal Government linkage of key sources (such as NSW) with key geological storage sites.

### 7.5 Online and offline communication

We recommend a fully committed online presence in social media, rather than its use for ‘broadcast’ only. In line with international scientific findings, a fully committed online presence allows for dialogic deliberations about technologies that may enhance confidence in CCS technologies among both experts and non-experts. Invest in research infrastructure and the active cultivation of a ‘fifth estate’ in order to understand public concerns, emerging user practices (like #eatgas) and to deal with publics interactively.

Publics use search devices like hashtags for coordinating information from various sources. There are clear advantages to entering this conversation space and proactively engaging with peoples’ concerns. As we have seen, users are already making the most of the medium and the possibility it affords for distributed content production.

A good example of this is the #eatgas hashtag that was created and put to work at the peak of the opposition against unconventional gas exploration. The key issue for government is less whether in-depth debate and discussion is possible within the 140 characters space that micro blogging platforms like Twitter make available; rather, it is how debates are initiated and questioned.

For example, a preliminary analysis of the Department of Primary Industries’ Twitter presence (@nswdpi) over the last year shows that there is very low interactivity between messages and its multiple intended audiences. NSW Trade & Investment currently only has a Twitter handle aimed at business development.

The NSW Government ICT Strategy 2012 aims to initiate ‘a fresh approach to engaging with the public and industry through online and social media technologies’ to enhance ‘transparency and accountability, and direct better and more targeted services to the community’. If these ideals of ‘Open Government’ are to be realised, further concerted efforts with social media are required. Choose between active participation and irrelevance.

The research results have consistently shown multiple spill-overs between online and offline activities, thereby bringing into question the notion of local community that has a fixed

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definition based on place. ‘Community’ is redefined as a series of interactions, exchanges, and transactions between online and offline at different global, regional and local levels. Therefore there needs to be a revision of the manner in which community engagement is carried out. This research suggests that concentrating on the size of publics in terms of geographical space is misleading.

The search functionality on Twitter can retrieve content from a maximum of one week. So there is a whole volume of rich digital data, cultural articulations and political discussions that don’t stay online. Over time, a more comprehensive approach will be needed, therefore, to grapple with the volume of tweets and the user concerns they represent.

7.6 Conclusions
This project has demonstrated that the governance of CCS is multi-faceted. It must involve dialogue between the many parties required to make projects work. This includes government, civil society groups, local community members and industrial project proponents themselves. This final chapter has presented a ‘network solutions model’ for NSW that emphasises the importance of dialogue and the revision of goals and ‘stakeholder’ lists. Recognizing the ways publics may shape technologies will be vital to the future success of CCS projects in Australia and internationally. A ‘network solution’ requires an acknowledgement that plans may need to be revisited and that governance is a process for all involved. Public awareness of positive processes of governance through dialogue will contribute positively to CCS project developments now and in the future.

Key Findings:
- This chapter presents a ‘Network Solutions Model’ for the governance of CCS projects. This model establishes key tasks for policy-makers, civil society and project proponents.
- There are many pathways for developing and implementing CCS. Opposition may be directed ‘selectively’ at different aspects of the process depending on how issues are raised and mobilised in related areas such as unconventional gas production.
- Successfully managing expectations for projects requires carefully checking and reconciling risk rationalities between different stakeholders and publics. In practice, this means understanding the limits of scientific knowledge, and developing a coherent narrative for how CCS bridges to a zero/negative carbon emissions economy in conjunction with civil society partners.
- Arguments that policy support for CCS should be based on economies of scale are not borne out by experience. CCS projects have progressed in countries where oil and gas regulations are well defined.
- Online and offline communication strategies should be tightly integrated in project planning. In practice, this means monitoring how online networks change, whilst also
attending important local community events with information that can be incorporated back into official communications.
References


CSRER: Public Awareness of Low Emissions Coal Technologies


Appendix 1: Online Issue Network Analysis Methodology

Gathering rapidly produced online data is not a simple task. Application Programming Interfaces (APIs) change within platforms, meaning coding invariably involves a lot of trial and error.

Initial trials were carried out using the Twitter Archiving Google Spreadsheet (TAGS) v3.1 that harvests and stores tweets into an online google spreadsheet. Given that this open source software is built to handle keyword searches to capture twitter output from conferences and other such small events, we experienced serious limitations in data gathering. This related to the number of tweets that could be archived, reliability of the online server and the inability of google spreadsheets to handle the volume of tweets initial keywords like coalseamgas pulled in (18000 unique tweets in the first month that included from and to user fields, tweet text, geolocation and time stamp)

To overcome these limitations and to archive tweets in a systematic manner we secured a dedicated server. We used a customised database software called yourtwapperkeeper (https://github.com/jobrieniii/yourTwapperKeeper) to scrape and archive the twitter dataset. Customization was necessary for a number of reasons. One of the major downfalls of this software was that it required to be manually started by a user if the server it was running on crashed. Therefore, our developer built a script that would be triggered on the reboot of the server that would start the script. During the outage, if longer than 5-10 minutes, a gap in data would occur as Twitter has a time-limit on how far you can search back through data. Once this script was implemented, the software ran without major interruption for a number of months. We gathered publically available data on:

- `text` - the actual tweet text
- `user_id_str` - unique id of the user that sent the tweet
- `in_reply_user_id` - if the tweet is reply to a user, id of user
- `created_at` - time of tweet
- `user_timezone` - timezone of user
- `user_location` - location of user, this is user defined
- `user_geo_enabled` - if user has enabled geo information
- Number of followers
- Number of people following
- Their chosen language

This information was available via the recently introduced feature called the Streaming API (https://dev.twitter.com/docs/streaming-apis). This method of data collection would provide higher quality data along with a reduced risk of a gap in data. The downside of this implementation was that it was built from scratch by the developer, and as result no Graphical User Interface was available due to time constraints. All requests to review/slice data were done through the
CSRER: Public Awareness of Low Emissions Coal Technologies

developer. The script was written in PHP and the data collected stored in a secure MySQL database. The requests to slice data included splitting by keyword and only providing data where users’ language was set to English. A number of the keywords, such as CCS, were common phrases in Spanish. As a result, there was a significant amount of data pollution. During high-traffic periods as many as 250 tweets were collected per minute. Another key challenge we grappled with was how to filter by geolocation in order to exclude non Australian tweets as only 1-2% of users actually add GPS-based location data to their tweets. This made it difficult to filter a Twitter stream for tweets from a specific area only. However, it underscored the global dynamism around the key terms and lent itself to more nuanced and fine-grained analysis.

Appendix 2: Survey Results

[Available on the CSRER website]

Appendix 3: Survey Analysis: Technical Elements

Table 2: Results of Principal Component Analysis.

<table>
<thead>
<tr>
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<th>Component</th>
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<tbody>
<tr>
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<td>1</td>
<td>2</td>
</tr>
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<td>Q15_1 National government</td>
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<td></td>
</tr>
<tr>
<td>Q15_2 Regional/local government</td>
<td>.868</td>
<td>-.177</td>
<td></td>
</tr>
<tr>
<td>Q15_3 Electricity, gas and other energy companies</td>
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</tr>
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<td>Q15_4 Scientists</td>
<td>.486</td>
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<td>Q15_5 Journalists</td>
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<td>Q15_7 Environmental protection organisations</td>
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<tr>
<td>Q15_8 City council</td>
<td>.863</td>
<td>-.107</td>
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</tr>
</tbody>
</table>

The Principal Component Analysis is a tool to explain variance in data. Here, the larger numbers in bold show that responses 4 and 7 are the main source of difference in people's responses to the question of trust.
The fact that this quadrant is mostly empty shows that there is almost nobody who sees CCS as beneficial who does not also support renewable energy.

There is only a slight upward trend in the data (shown by the line), however it is not statistically significant.

Table 3: ANOVA Results - Conditions of Support for CCS

<table>
<thead>
<tr>
<th>Correlations</th>
<th>Overall Support anywhere</th>
<th>Fav_Renew</th>
<th>CCS seen a beneficial</th>
</tr>
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<td>Pearson Correlation</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>800</td>
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<td>800</td>
</tr>
<tr>
<td>Pearson Correlation</td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.107</td>
<td>.291**</td>
<td>1</td>
</tr>
<tr>
<td>N</td>
<td>800</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>.451**</td>
<td>.291**</td>
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</tr>
<tr>
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<td>.000</td>
<td>.000</td>
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</tr>
<tr>
<td>N</td>
<td>800</td>
<td>800</td>
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Table 4: Conditions of Support for CCS

<table>
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<th>Self Perception Climate Knowledge Score (Inverse: low means most informed)</th>
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<tr>
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<td>Sig. (2-tailed)</td>
<td>0.000**</td>
<td>0.000</td>
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<tr>
<td>CCS seen a beneficial</td>
<td>N 800</td>
<td>N 800</td>
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The fact that these numbers are not significant shows that knowledge of climate change science (actual or self-reported) does not correlate with view of benefits of CCS.
### ANOVA Petition Table 2 (significant correlations highlighted)

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<th>Sig</th>
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<td></td>
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<tr>
<td>Score * PETITION Y/N</td>
<td>Between Groups (Combined)</td>
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<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Between Groups (Combined)</td>
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<tr>
<td><strong>Fav. Renew.</strong> * PETITION Y/N</td>
<td>Within Groups</td>
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<td></td>
<td>Total</td>
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<td>Within Groups</td>
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<td></td>
<td>Between Groups (Combined)</td>
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<td></td>
<td>Within Groups</td>
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### Table 5: ANOVA Activism Results with other survey findings

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<th>ACTIVISM Y/N</th>
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<th>MEAN GOV AND CORPORATE TRUST</th>
<th>MEAN SCIENCE AND ENVIRONMENTALISTS TRUST</th>
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<tbody>
<tr>
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<td>21.5679</td>
<td>17.2360</td>
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<td>Mean 6.0720</td>
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<td>21.6417</td>
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<td>4.64249</td>
<td>1.04000</td>
<td>.77288</td>
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<tr>
<td></td>
<td>Mean 5.8312</td>
<td>17.7938</td>
<td>21.5923</td>
<td>17.2788</td>
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<td>Total N</td>
<td>Std. Deviation 2.76357</td>
<td>4.26103</td>
<td>.94000</td>
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<table>
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<th>ACTIVISM Y/N</th>
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<th>Overall level of concern re ccs</th>
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<td>No N</td>
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<td>Mean 2.7159</td>
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<tr>
<td>Total N</td>
<td>Std. Deviation .91188</td>
<td>.75218</td>
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<tr>
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<td><strong>Climate Change Knowledge Score * ACTIVISM Y/N</strong></td>
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<tr>
<td>Within Groups</td>
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<td>Total</td>
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<td>Between Groups (Combined)</td>
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<tr>
<td>Within Groups</td>
<td>14497.255</td>
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<td>Within Groups</td>
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<td>Between Groups (Combined)</td>
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<td>Between Groups (Combined)</td>
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<tr>
<td></td>
<td>Within Groups</td>
<td>.555</td>
</tr>
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<td>Total</td>
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<tr>
<td>MEAN SCIENCE AND ENVIRONMENTALISTS TRUST * ACTIVISM Y/N</td>
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<td></td>
<td>Within Groups</td>
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Table 6: ANOVA Civic Engagement Results with other survey findings

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<th>MEAN SCIENCE AND ENVIRONMENTALISTS TRUST</th>
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<td>17.7938</td>
<td>21.5923</td>
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<td>Total</td>
<td>Std. Deviation</td>
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## ANOVA Table

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<td>Within Groups</td>
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<td>Overall Support anywhere * CIVIC ENGAGEMENT Y/N</td>
<td>Total</td>
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</tr>
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<td>Between Groups (Combined)</td>
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<td>Within Groups</td>
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### ANOVA Table

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<th>Total</th>
</tr>
</thead>
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<td>Fav_Renew * CIVIC ENGAGEMENT Y/N</td>
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<tr>
<td></td>
<td>F: 1.107</td>
<td>Sig.: .293</td>
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<td>.563</td>
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<tr>
<td></td>
<td>F: 4.553</td>
<td>Sig.: .033</td>
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## Appendix 4: Australian NGO Public Positions on CCS

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<tr>
<th>Organisation and mission statement</th>
<th>Representation</th>
<th>Current or Recent Issues Active</th>
<th>Position on CCS</th>
</tr>
</thead>
</table>
| Friends of the Earth Australia: “Friends of the Earth (FoE) is a federation of autonomous local groups who are working towards an environmentally sustainable and socially equitable future. FoE Australia functions both through the activities of its local groups, and on the national level through appointed spokespeople, campaigns and projects, the national magazine - Chain Reaction, and the work of the national liaison officers.” | Affiliated with 15 global groups representing 2 million people (FoE Annual report, 2012) | Murray Darling Basin Plan; Climate Campaigning; Anti-Nuclear; South Melbourne Commons; nanotechnology; Forests, Biodiversity and Habitat, Energy Policy | Friends of the Earth sees geo-sequestration as a high risk, limited, and short term band-aid solution for climate change. They maintain that there is no certainty the gas will be effectively trapped, thereby posing a serious risk to human lives.  
In a recent submission on the Energy White Paper they criticise its reliance on Carbon Capture and Storage which they refer to as an ‘undeveloped’ technology.  
Instead, they advocate a greater support for renewable energy. Their main objections stem from the fact that despite heavy public funding to assist the coal and gas industry to develop and commercialise CCS, this technology will not come into play until 2035. They see CCS as a legitimisation device for the continued use of coal and the EWP’s reliance on it as deliberately obfuscating IEA figures that state that by 2035 coal derived energy use will have decreased to just 16% of global energy.  
| Greenpeace Australia Pacific “an independent campaigning organisation that uses non-violent direct action to expose global environmental problems and to force solutions which are essential to a green and peaceful future... Greenpeace’s goal is to | 28,794 ‘likes’ on Facebook as at January 2013; around 70,000 financial supporters in Australia, who give regularly or on one-off occasions (website FAQ) | Numerous campaigns covering Climate, Forests, Oceans, Food, Arctic, Nuclear and Whales | Released widely discussed report titled ‘Dead and Buried: The demise of carbon capture and storage’ in May 2012. The report shows how attempts to demonstrate commercial-scale CCS have been marred by failure.  
They claim that CCS is an unrealistic option for future power generation as it would mean overcoming numerous challenges. These include prohibitive costs, pilot projects that have not got off the floor and grave concerns about whether the CCS Flagships program’s objective of having projects commissioned by 2015 will be met. |
<table>
<thead>
<tr>
<th><strong>CSRER: Public Awareness of Low Emissions Coal Technologies</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ensure the ability of the earth to nurture life in all its diversity.”</strong></td>
</tr>
<tr>
<td><strong>Lock the Gate: “formed in 2010 following community meetings in New South Wales and Queensland. All over the eastern states, people were raising concern about the rapid expansion of coal and coal seam gas development. A declaration was made: farmers would lock their gates to these rapacious industries.”</strong></td>
</tr>
<tr>
<td><strong>Australian Youth Climate Coalition “building a generation-wide movement to solve the climate crisis.”</strong></td>
</tr>
<tr>
<td><strong>Beyond Zero Emissions “a not-for-profit research and education organisation developing blueprints for the implementation of climate change solutions. Our goal is to transform Australia from a 19th century fossil fuel based economy to a 21st century renewable powered clean</strong></td>
</tr>
<tr>
<td>GetUp! “An independent movement to build a progressive Australia and bring participation back into our democracy.”</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>WWF Australia: “to stop the degradation of the planet’s natural environment and to build a future in which humans live in harmony with nature, by: conserving the world’s biological diversity; ensuring that the use of renewable natural resources is sustainable; promoting the reduction of pollution and wasteful consumption.”</td>
</tr>
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</table>
Appendix 5: Hyperlink Network Diagrams

Figure 11: Induced Seismicity Hyperlink Network
CSRER: Public Awareness of Low Emissions Coal Technologies

Figure 12: Guardian article as a Fracking Network Map