Public outreach approaches for carbon capture and storage projects

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Preface

This report has been produced by IEA Clean Coal Centre and is based on a survey and analysis of published literature, and on information gathered in discussions with interested organisations and individuals. Their assistance is gratefully acknowledged. It should be understood that the views expressed in this report are our own, and are not necessarily shared by those who supplied the information, nor by our member countries.

IEA Clean Coal Centre is an organisation set up under the auspices of the International Energy Agency (IEA) which was itself founded in 1974 by member countries of the Organisation for Economic Co-operation and Development (OECD). The purpose of the IEA is to explore means by which countries interested in minimising their dependence on imported oil can co-operate. In the field of Research, Development and Demonstration over fifty individual projects have been established in partnership between member countries of the IEA.

IEA Clean Coal Centre began in 1975 and has contracting parties and sponsors from: Australia, China, the European Commission, Germany, India, Italy, Japan, Poland, Russia, South Africa, Thailand, the UAE, the UK and the USA. The Service provides information and assessments on all aspects of coal from supply and transport, through markets and end-use technologies, to environmental issues and waste utilisation.

Abstract

Following a few early failures of large-scale carbon capture and storage (CCS) demonstration projects due to public opposition to the technology, a considered public communication strategy is now regarded as an essential factor in the success of any prospective CCS project. Most active opposition to CCS has occurred in parts of Europe, where public fears over CO_2 leaks, water contamination, or 'industrialisation' of rural areas have combined with opposition by environmental groups and others to fossil fuels playing any role in a future energy mix. However, many other projects have since won acceptance or even widespread support, thanks either to improved public engagement or more favourable local context. Several key features of a successful communications strategy have been identified, including the need for engagement early in the process, encouraging and responding to community feedback, building and maintaining trust in the project developers, and use of a dedicated communications team with clear messages which are tailored to their intended audience. This report provides a comprehensive review of the public outreach strategy and results at most notable CCS demonstrations to date, and looks to future challenges for CCS communication. With the barrier of local acceptance appearing surmountable in most regions, the problem of making the wider case for CCS as a viable option for climate change mitigation largely remains. This could potentially be addressed through education initiatives and more effective use of mass media.

Acronyms and abbreviations

BUND	Friends of the Earth, Germany
CCS	carbon capture and storage
CFB	circulating fluidised bed
CLO	Community Liaison Officer
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
EEPR	European Energy Programme for Recovery
EIA	environmental impact assessment
ENGO	environmental non-governmental organisations
EOR	enhanced oil recovery
EU	European Union
FAQ	frequently asked questions
FEED	front end engineering design
GCCSI	Global Carbon Capture and Storage Institute
HECA	Hydrogen Energy California
IGCC	integrated gasification combined cycle
JPBU	Jamestown Board of Public Utilities (USA)
NGO	non-governmental organisation(s)
NRDC	Natural Resources Defense Council (USA)
PC	pulverised coal
PTRC	Petroleum Technology Research Centre (Canada)
RCSP	Regional Carbon Sequestration Partnership(s) (USA)
RWE	Rheinisch-Westfälisches Elektrizitätswerk AG
ROAD	Rotterdam capture and storage project
TCEP	Texas Clean Energy Project
US DOE	US Department of Energy
ZERO	Zero Emission Resource Organisation

Contents

List of Figures

1 Introduction

Since the early 2000s, the sequestration of CO_2 emissions in suitable geological formations, known as carbon capture and storage (CCS), has been internationally recognised as a key tool for achieving sufficiently rapid decarbonisation of the energy sector and fossil fuel-burning industries at the minimum cost to society (IPCC, 2005). National policy in many countries has therefore sought to encourage deployment of the technology, with an initial focus on promoting the construction of a first phase of demonstration projects at large-scale. As a result of these policies and other economic drivers, several such projects have been realised over the last decade, including the first at a coal-fired power plant in 2014, but the majority are so far confined to North America and much slower progress in most other regions highlights that CCS faces some significant barriers to its widespread deployment (GCCSI, 2016a). While foremost among these are economic and political factors such as regulatory and financial risks and the need for some form of technology-neutral CO_2 pricing mechanism, public acceptance of CCS has also been recognised as a key requirement, both in gaining a 'social licence' for the operation of demonstration projects, and in steering the wider political and societal debate over whether the technology should be pursued. To this end, there have been widespread efforts to develop new and more effective strategies for communicating concepts of CCS to the public, most commonly referred to as outreach and engagement activities.

As a new and unfamiliar technology, CCS has come under greater public scrutiny than more well-established subsurface industries, and has been perceived as presenting a number of unique risks and concerns. At the local level of communities directly affected by demonstration or research projects, visceral fears of health-endangering CO_2 leaks, drinking water contamination, or induced earthquakes in the vicinity of the storage site have played a key role in early instances of opposition to CCS developments. However, more fundamental concerns over the very value of the technology as a climate change mitigation option may be more important in influencing its acceptance, both at a local and national level. Often regarded as a clumsy solution to maintain business as usual for fossil fuels, CCS is framed as a poor substitute for more sustainable climate solutions such as renewable energy, and a perceived competition for investment with these alternatives has also made it a target of some influential environmental groups. On the other hand, it must be stressed that public awareness of the technology is generally low, and proposed demonstration projects in an area will usually represent people's first encounter with CCS.

While many CCS developers and research organisations have recognised early on the need to address such concerns with project stakeholders, the issue was given greater urgency by high-profile instances of strong opposition from the public and regional governments to a few early demonstration projects in Europe. Notorious among these is the Barendrecht project – Shell's proposal for the onshore storage of CO_2 emissions from an oil refinery in the Netherlands, which was cancelled in 2010 as a result of local government opposition, public activism, and negative coverage in the national media, largely driven by a perceived public health risk of CO_2 leakage (Feenstra and others, 2010). Around the same time, CCS faced similarly strong public opposition in several parts of Germany, culminating in the cancellation of

Vattenfall's proposed demonstration at its Jänschwalde coal power plant (EU CCS Network, 2012a). Taking place during a critical period for the implementation of national regulatory frameworks for CCS, the political fallout of these episodes had serious consequences for the future of the technology in both countries, effectively ending prospects for onshore storage. With instances of opposition also being encountered on a smaller scale for a few other projects in the USA and Poland, the idea that CO_2 storage (particularly onshore) is a highly unpopular practice rapidly became an accepted idea in the industry, despite several other small and larger-scale projects causing minimal local upset or even seeing good support during the same period.

Seeking to avoid repeats of the failures in the Netherlands and Germany and minimise the potential for costly project delays, commercial developers of CCS projects, governments, research institutes, and non-governmental organisations (NGO) have given even greater emphasis to developing more effective methods of communicating with the public about the technology and individual demonstration projects. Much of this work has employed established principles of good outreach strategy from other industries, such as building more trusting relationships with local communities and allowing the public as active a role as possible in project decisions. Unique challenges for CCS communication have included the need to improve the public's general understanding of climate change, the nature of CO_2, subsurface geology and storage mechanisms, with the dual goals of strengthening perceptions of the benefit the technology can bring and reducing perceptions of risk. Several more recent CCS projects have employed dedicated communication strategies for the public and other key stakeholders, generally achieving good results and local acceptance or even support for the project. However, the local context of any given project will also play a hugely important role in affecting public acceptance, with significant factors including the nature of the CO_2 storage, the CO_2 source, the project developer, and demographics of the local communities.

Alongside the obligation for individual CCS demonstration projects to gain local acceptance, there is a growing need for CCS communication to reach a wider audience and improve awareness of the technology at a national and international level. Currently, public understanding of CCS as a viable or necessary option for climate change mitigation is low relative to renewable energy sources or energy efficiency measures – often in stark contrast with national energy and climate policies. Given that government support for high-profile and costly infrastructure projects is ultimately subjected to high levels of public and media scrutiny, it is important that CCS establishes a more prominent place in the public debate over climate change mitigation as early as possible. National level outreach campaigns have most notably been conducted by state-sponsored organisations or NGO, but some commercial developers have also employed such strategies as support for specific projects. The introduction of elements of CCS into science education in various countries has also been assisted by several organisations.

This report outlines some of the key factors driving public attitudes to CCS, before reviewing the general principles which have been identified in improving public outreach and communication strategies for demonstration projects. A review of CO_2 storage case studies will then illustrate where these techniques have been successful and notable instances where less thorough methods have failed, as well as instances

where project context has played a more significant role. Finally, efforts towards wider communication of CCS beyond the level of individual projects are briefly examined.

2 Public attitudes to CCS

2.1 General attitudes

In most regions, awareness and understanding of CCS amongst the public is low, making it difficult to accurately assess general attitudes to the technology. As people with minimal knowledge of a subject tend to form 'pseudo-opinions' which are unstable and easily subject to change, many studies of attitudes to CCS have used methods in which participants are first supplied with some information on the technology (Daamen and others, 2006; de Best-Waldhober, 2009). Responses from before and after receiving the information can be compared to useful effect, or the relative influence of specific information can be investigated (Itaoka and others, 2009; Fleishman and others, 2010; Oltra and others, 2012a). Another approach is to investigate the existing knowledge and opinions which are likely to influence attitudes to CCS (Tokushige and others, 2007; Wallquist and others, 2010). Surveys of the general public, without reference to a specific project proposal, do not tend to reveal strong opposition to CCS, nor much enthusiastic support (Duan, 2010; de Best-Waldhober and others, 2012; L'Orange Seigo and others, 2014a; Li and Liu, 2015). As an option for reducing the carbon emissions of the power supply, it is usually ranked well below renewable energy sources and demand reduction measures. While nuclear power can be slightly preferred to CCS among some respondents, it also has a much stronger core of opposition than seen for CCS (Johnsson and others, 2010). A range of concerns are expressed about CCS, which can be broadly divided into those relating to health and safety and those finding fault with the fundamental principle of the technology (Shackley and others, 2005; Itaoka and others, 2009; Wallquist and others, 2010; Berg-Hansen, 2011; de Best-Waldhober and others, 2012; L'Orange Seigo and others, 2014a; Ashworth and others, 2015a):

The fundamental concerns are:

- CCS is an unsustainable solution which does not address the root cause of carbon emissions – the continued use of fossil fuels, but rather attempts to maintain 'business as usual';
- investment in CCS may divert investment from more effective renewable energy sources;
- any CO_2 leakage will negate the benefit of the technology;
- the high energy penalty of the process means even more fossil fuel needs to be extracted; and
- CCS is a costly, unproven technology.

Health and safety concerns are:

- a sudden CO_2 discharge could be dangerous to human health;
- pressurised CO_2 injection could cause earthquakes; and
- risk of water contamination (due to displaced brine, CO_2 promoting leaching of toxic elements, or unspecified reasons).

Social studies often discuss acceptance of new technologies as being governed by individual perceptions of benefits and risk, with the former needing to outweigh the latter to achieve good acceptance (Wallquist and

others, 2011a; Visschers, 2013; L'Orange Seigo and others, 2014b) (Figure 1). In the case of CCS, the benefit to the general public is mostly limited to climate change mitigation, although a desire to support a national fossil fuel industry or issues of national energy security may play a role in some regions. Climate change awareness and acceptance is obviously a prerequisite for perceiving a benefit to CCS, but is generally found to be very high (>90%) in most countries investigated, even in countries such as the USA where climate change denial is slightly more prevalent than elsewhere (L'Orange Seigo and others, 2014a). Perception of the urgency of climate change mitigation has not been shown to play a clear role in influencing support for CCS, as some strong proponents of climate change action may see CCS as delaying the necessary elimination of fossil fuel use. Such fundamental concerns about the value of CCS as a tool for climate change mitigation are indeed the primary driver of benefit perception, with many regarding the 'quick fix' or 'unsustainable' nature of the technology, as well as the possibility of the CO_2 eventually escaping anyway, as counting against its potential climate change benefit. Risk perception, on the other hand, is influenced to a greater extent by the health and safety concerns, with the possibility of leaks or even a sudden release of CO_2 often foremost among groups who have not been supplied with additional information (Palmgren and others, 2004; Tokushige and others, 2007; Wallquist and others, 2010).

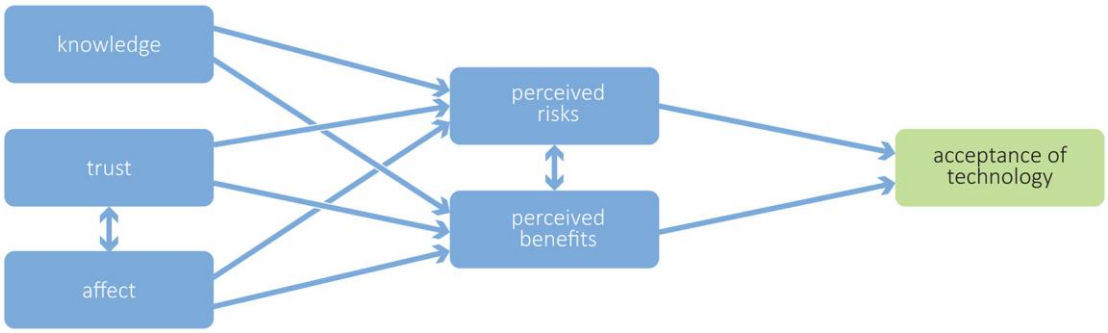

Figure 1 Factors influencing public acceptance of new technologies. When knowledge of a technology is low, emotional or instinctive responses (affect) and trust in expert opinions become more significant factors (Visschers, 2013)

Studies which have sought to further inform the surveyed group on aspects of CO_2 and CCS have often not shown large changes in levels of acceptance or risk and benefit perception, suggesting that people's instinctive reactions can be challenging to overturn (Itaoka and others, 2013; Bruine de Bruin and Wong-Parodi, 2014). Acceptance can decrease as well as increase depending on the nature of the information provided. As many people initially suppose CO_2 storage to take place in hollow underground spaces, better knowledge of actual storage mechanisms within porous rock and the liquid-like state of the CO_2 is correlated with reduced concerns over the risk of leaks (Wallquist and others, 2010; Wallquist and others, 2011b). On the other hand, awareness of the high pressures involved in injection and storage can actually raise concerns of a leak or explosive release, and information on real CCS demonstrations and monitoring procedures has also been shown to increase risk perception (Tokushige and others, 2007; Wallquist and others, 2010; L'Orange Seigo and others, 2011). A few studies have demonstrated that information on the existence of naturally occurring geological stores of CO_2 can lead to reductions in risk perception (Tokushige and others, 2007; Oltra and others, 2012a). Conversely, work by Itaoka and others in Japan found a negative response to some information on the behaviour of naturally occurring CO_2, but

details on properties of the gas such as its non-toxic, non-explosive nature were beneficial to acceptance (Itaoka and others, 2013).

Perhaps most interestingly, some studies have investigated the effect of presenting CCS in the context of a broader energy policy, as opposed to a standalone climate change solution. Members of the public were found to be much more receptive to the inclusion of CCS in realistic energy 'portfolios' including a mix of renewables and energy efficiency measures (Fleishman and others, 2010; Mayer and others, 2014; Ashworth and others, 2014a) (Figure 2). This kind of device can help alleviate concerns of CCS obstructing renewable energy deployment, and highlights the fact that the status of CCS as something of a 'last resort' climate change technology is contingent on people being able to properly assess alternative solutions. Presenting the role of CCS as a 'bridging technology' while fossil fuel use is reduced has also received a more positive response (Shackley and others, 2005; Wallquist and others, 2011b).

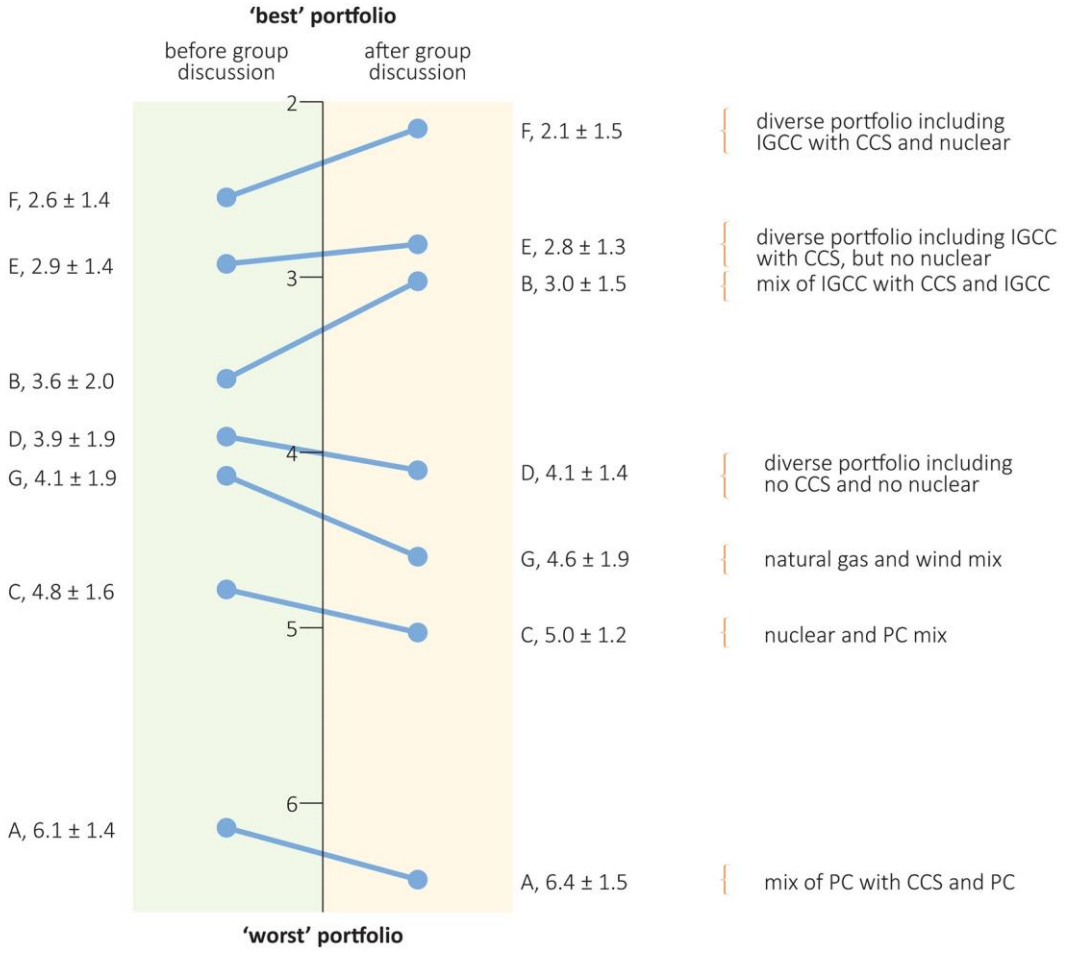

Figure 2 Ranking of mixed energy portfolios from best (=1) to worst (=10) by a US focus group (60 participants), having received information on each technology and before and after group discussions (PC, pulverised coal plant; IGCC, integrated gasification combined cycle). (Fleishman and others, 2010)

As early CCS demonstrations become more visible and receive more media attention, the high financial cost of power generation projects is often subject to scrutiny. Combined with equally well-publicised reductions in the cost of some renewable technologies (particularly photovoltaic cells), the cost issue is playing a

growing role in influencing public perceptions of the potential benefit of CCS. Cost has been highlighted by studies in the UK and Germany in particular, where the public were shown to be reluctant for state funds to go towards the technology, and were more willing to pay higher electricity bills to support renewables than CCS (Upham and Roberts, 2011; Kraeusel and Most, 2012).

2.2 Local concerns

When communities are faced with the real prospect of a CCS demonstration in their vicinity, public concerns shift away from fundamental issues with the technology itself towards more local issues – many of which are shared by other large infrastructure projects. Furthermore, the perceived health and safety risks listed above can be considerably heightened, with the threat of a sudden release of CO_2 playing a particularly significant role in opposition to some early projects. Some of the most-cited local concerns are:

- the health risk of a sudden CO_2 discharge;
- a potential decrease in property and land value;
- disturbances from increased traffic;
- general 'industrialisation' of the area, harming tourism and other investment;
- the risk of water contamination;
- increases in other pollutants from the power or capture plant (SOx, NOx, heavy metals, or chemicals associated with capture);
- increased energy bills; and
- preventing use of the subsurface for geothermal energy.

Initial opposition to a CCS project in an area is usually driven primarily by these local issues, but some of the more fundamental concerns about the principle of the technology can also play a role, and are frequently brought to the fore as more moral grounds for opposition.

While many of the perceived risks of CCS are heightened at a local level, there are also more potential benefits for a community, including increased investment in the area, increased employment, support or prolongation of a local coal, oil, or power generation industry, or a growth in international prestige for the area and a perception of making a local contribution to mitigate climate change. Economic benefit has been shown to play an important role in the acceptance of several projects, and this factor can become more significant in areas which are economically struggling (Prangnell, 2013; L'Orange Seigo and others, 2014a; Gough and others, 2016).

Previous experience with related industry in the area, such as oil and gas extraction, mining, or fossil fuel power generation, can have a positive or negative effect on local acceptance, depending on prior experiences. Communities which feel they have been unfairly treated or impacted on by related industries can be very hostile to further developments, whereas others may have built good, trusting relationships with companies and appreciate their role in the local economy (Wong-Parodi and Ray, 2009; Oltra and others, 2012b).

2.3 Effect of project type

The type of CCS project will also have an important effect on local acceptance. Projects using onshore storage in saline aquifers have presented some of the most challenging cases, particularly in more densely populated areas, due to the perceived risk of CO_2 leakage into homes or an effect on the water supply. Offshore storage on the other hand eliminates any health and safety concerns surrounding CO_2 leakage and is generally better accepted (Lofstedt, 2015), although a survey in Germany found little difference with attitudes to onshore storage (Schumann and others, 2014), and any issues relating to the capture plant itself will remain. Enhanced oil recovery (EOR) projects are often also more easily accepted, as local communities are familiar with the oil industry and subsurface activity, and may be in favour of prolonging the viability of a local industry (Bradbury and others, 2009). On the other hand, EOR is a less effective CO_2 mitigation strategy than dedicated storage without additional oil extraction, and therefore can attract more opposition from environmental groups.

On the capture plant side, retrofitting CO_2 capture to an existing emitter is generally a much less contentious proposal than projects which require construction of a new facility. The environmental case for capturing existing emissions can appear stronger (although this may not always be true in the case of old, inefficient power plants), and local communities may again see an economic advantage in supporting or prolonging a local industry. Dütschke and others looked at the influence of the type of CO_2 emission source on general public acceptance, finding that industrial processes or biomass-related emissions were perceived favourably over coal-fired power (Dütschke and others, 2014; Wallquist and others, 2012). This is unsurprising, given that non-power-related emitters are seen as harder to replace with alternatives such as renewable energy, and capture from biomass combustion offers the unique potential for negative CO_2 emissions.

The nature of the developer itself will also influence attitudes towards the project, with communities generally less trusting that large commercial enterprises such as power or fossil fuel companies are acting in their best interests. The visible involvement of government in project planning will usually help reassure the public that environmental and health concerns will be adequately addressed, but in some countries and regions trust in national government can also be relatively low (Breukers and others, 2011). Research projects led by academic organisations are normally met with better acceptance, as such institutes are usually more trusted and seen as less likely to disregard public issues when financial gain is not at stake (Ashworth and others, 2010; Oltra and others, 2012b). A study by Terwel and others (2009a,b) even concluded that the public did not respond well to corporate entities claiming they were acting in environmental interests, instead viewing them as dishonest and concealing profit-based motives.

2.4 Attitudes of environmental non-governmental organisations

Environmental non-governmental organisations (ENGO) such as think tanks or activist groups can be influential in determining the public acceptance or rejection of specific CCS projects and, perhaps more importantly, informing the wider public and political debate on CCS. The public often have a relatively high level of trust in these organisations, which perceived as independent, moral, and not driven by commercial

gain, and their stances on CCS consequently tend to be given more credence than those of private companies or government. The views of the ENGO on CCS are highly varied, ranging from firm opposition to muted or active support. Acceptance of CCS with various caveats is also common, such as reserving its application for industrial sources rather than power generation, opposition to its use for EOR, or opposition to public funding for CCS.

ENGO opposition to CCS is usually based on the fundamental objections listed in Section 2.1, framing it as an unnecessary continuation of fossil fuel use and a costly and counter-productive diversion of funds from renewable energy. The international group Greenpeace is one of the most notable opponents to all forms of CCS, and regional reports such as Greenpeace USA's Carbon Capture SCAM and Greenpeace Australia Pacific's 'Dead and Buried' are strong statements against the technology which have been used in opposition to specific projects (Greenpeace Australia Pacific, 2012; Greenpeace USA, 2015) (Figure 3). The NGO's website currently highlights relatively minor issues encountered at some storage demonstration sites as evidence for the probable impermanency of CO_2 storage, reflecting the high importance given to such concerns among the general public (Greenpeace, 2016). The increased oil production associated with EOR-based projects is also raised as a negative outcome of the technology. Greenpeace actively supported general public activism against CCS development in Germany, detailed in Chapter 7, providing literature and materials, and helping publicise the cause more widely (Gründinger, 2015). There are fewer instances of direct opposition to specific CCS projects, although the ENGO strongly opposed new coal units proposed for the UK's Kingsnorth power station which were potential candidates for a CCS demonstration (see Chapter 8).

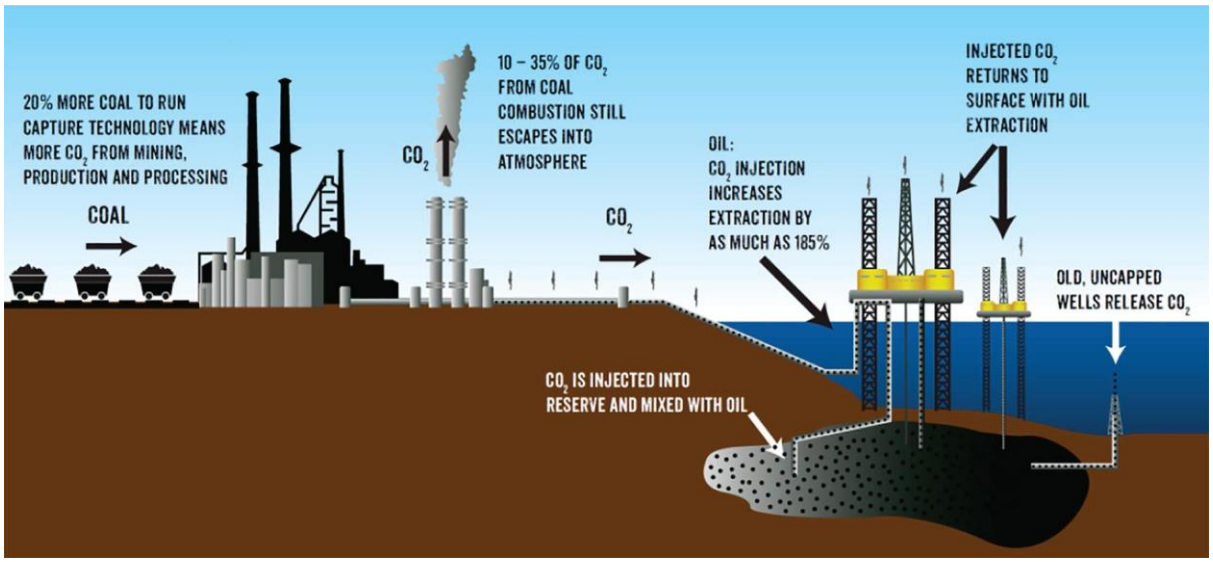

Figure 3 A sample figure from 'Carbon Capture Scam' (Greenpeace USA, 2015)

Another strong opponent is the anti-coal Sierra Club in the USA, which has simply encompassed coal plants with CCS within its general opposition to all new coal plants in the country (Sierra Club, 2011). The ENGO initially adopted a relatively neutral stance over the high-profile FutureGen project during the early stages of CCS development, framing it as a 'last chance' to prove clean coal could be a viable proposition. Since then, it has actively opposed coal-based demonstrations, even when involving existing power plants, such

as FutureGen 2.0, or new plants such as Kemper County integrated gasification combined cycle (IGCC) and the proposed Hydrogen Energy California (HECA) project.

Other regional ENGO which have been involved in opposing individual demonstrations are detailed in the corresponding case studies and include BUND (Friends of the Earth Germany), the Centre for Sustainable Development (CZR) in Poland, and various environmental justice groups in California.

Established in 2011, the ENGO network on CCS currently comprises eleven organisations which strongly support the implementation of CCS, including the Bellona Foundation, Clean Air Task Force, the Climate Institute, E3G, Environmental Defense Fund, Green Alliance, Natural Resources Defense Council (NRDC), The Pembina Institute, Sandbag, World Resources Institute, and the Zero Emission Resource Organisation (ZERO) (ENGO network on CCS, 2016). These organisations view CCS as a critical technology to complement renewable energy deployment and energy efficiency measures, and share the mission of helping develop national and international policy and regulations which can enable CCS to realise its decarbonisation potential. Some of these ENGO have been active in supporting individual CCS demonstrations, particularly in stakeholder engagement activities, including Pembina for Weyburn-Midale, Boundary Dam, and Quest, and NRDC for US projects such as Summit Power in Texas.

Some major global ENGO including WWF and Friends of the Earth have espoused more muted or mixed support for CCS, seeing an entirely renewable energy supply as the ultimate goal. WWF have produced some literature in opposition to CCS in power generation, while recognising its potential role in abating industrial CO_2 emissions. However, WWF in the UK came out strongly in support of accelerating a CCS demonstration in the country, giving particular backing to the planned Longannet coal-fired power plant project in Scotland (WWF, 2008; Prangnell, 2013).

3 Public outreach recommendations

Based on the experience of early CCS projects in the 2000s, and particularly the lessons learned from high-profile instances of public opposition such as Barendrecht in the Netherlands and Jänschwalde in Germany, several organisations have produced manuals or guidelines for more successful communication with the public and other stakeholders. These include the NETL's 'Best practices for public outreach and education for CCS projects' based on the experiences of the US Department of Energy's (US DOE) seven regional carbon sequestration partnerships between 2003 and 2009 (NETL, 2009), the World Resources Institute's 'CCS and community engagement' (WRI, 2010), several reports from the GCCSI and CSIRO in Australia (Ashworth and others, 2010, 2011, 2013a; Bradbury and others, 2011; Prangnell, 2013), and others (Hammond and Shackley, 2010; EU CCS Network, 2011; Hope, 2012). These publications mostly reach similar conclusions as to the essential features of an effective engagement strategy, which can be summarised as follows:

- Understand the social context of the project site by performing an initial survey of demographics and attitudes to CCS – 'social characterisation' or 'stakeholder analysis'.
- Establish a dedicated communications team which incorporates both technical and communication expertise and is fully integrated with other project operations.
- Develop a range of communication materials and clear key messages which are tailored to the various audiences targeted – discuss community benefits as well as risks.
- Start outreach as early as possible – before required by the regulatory process or any official announcements.
- Engage in a dialogue with stakeholders rather than a one-way flow of information – feedback should be actively sought and seen to be acted upon where possible.
- Gaining the trust of the public is essential – this can be assisted by partnering with more trusted organisations such as NGO and research institutes and maintaining a high degree of transparency.
- At each phase of the project (even following plant closure), changes in perceptions should be monitored and the communications strategy flexible in its response.

3.1 Social site characterisation

As discussed in Section 2.2, the nature of the affected communities will have an important effect on their perceptions of the project, and this factor should be well understood by the outreach team before any contact is made – ideally playing a role in the site selection itself. The term 'social site characterisation' was invented to draw an analogy with the essential geological site characterisation phase of CCS projects and suggest that a good understanding of the social landscape can be just as important in identifying and using a given site, but essentially refers to relatively established techniques of stakeholder analysis. These can incorporate identification of key stakeholders such as local authorities, NGO, or other people with a particular interest or influence on the project, as well as the gathering of information on the views of these groups and the general public. Figure 4 provides an example of the range of stakeholder groups affected by a typical project.

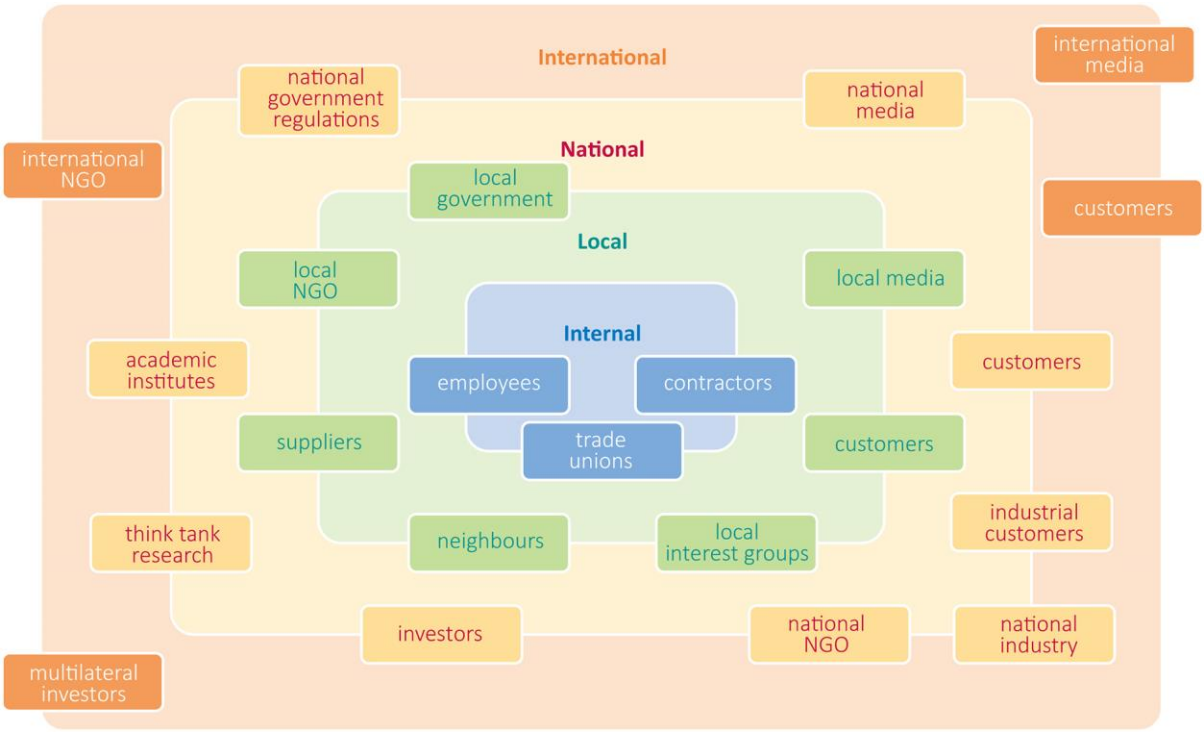

Figure 4 Types of stakeholder (Ashworth and others, 2011)

CSIRO and the GCCSI have produced a useful guide and toolkit for social site characterisation for CCS projects which suggests that an iterative approach will likely be taken to mapping stakeholder opinions, initially using readily available information from websites, media, and existing surveys, with the findings used to target subsequent, more in-depth phases of information collection (Ashworth and others, 2011; Anderson, 2013). Initial identification of stakeholder groups may begin with brainstorming and web-based research and can lead to the formation of 'cluster maps' showing connections between various groups. Tools for evaluating stakeholder opinions can range from one-to-one interviews with particularly key figures to focus groups, interactive project briefings, or surveys to gauge the views of the general public. These kinds of group sessions and surveys will closely resemble the more general opinion surveys summarised in Chapter 2, usually based on providing some information on CCS and assessing people's response. Many projects have employed external public relations companies to conduct these activities. Information obtained on stakeholders' relative influence and attitudes towards the project are often 'mapped' in diagrams such as that shown in Figure 5, which highlights groups which require particular attention from the outreach campaign (Kombrink and others, 2011).

Ideally, some form of stakeholder mapping will continue to be conducted at intervals throughout the project lifetime to assess changing attitudes and help the communication strategy adapt in response.

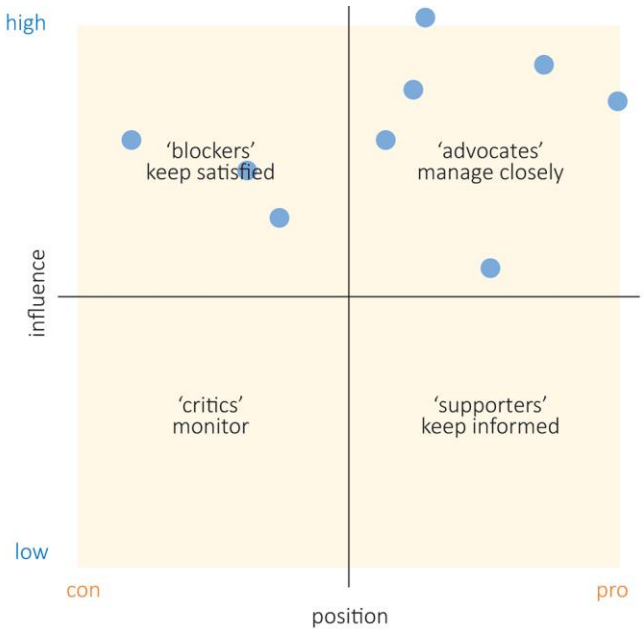

Figure 5 Stakeholder mapping (Kombrink and others, 2011)

3.2 Communications team

The most successful engagement strategies are usually carried out by a dedicated communications team made up of a diverse mix of technical and communication specialists. The importance of ensuring this team work closely with the rest of the project has been emphasised by projects such as ROAD (Section 6.2), as this ensures the team is kept well abreast of technical matters and that feedback from stakeholders is quickly fed back to other project teams (Kombrink and others, 2011). A useful approach is to include representatives from external organisations, such as research institutes or local authorities, as they can provide additional expert input and help gain trust through their more neutral status. Sometimes a member of the local community itself is employed to act as a liaison officer, further enhancing trust in the project developer and able to exploit existing connections to reach more people or act as a more approachable focal point for concerns and feedback (Ashworth and others, 2010; Shell, 2016).

All members of a communications team should be prepared to answer a broad range of questions accurately and consistently. A failure to adequately respond to technical questions has been highlighted at some projects (such as Barendrecht and Carson) as having contributed to a loss of trust in developers (Feenstra and others, 2010; Bradbury and Wade, 2010). On the other hand, it is preferable to admit when an answer is not known, and to be in a position to refer to an expert. It is generally recommended to keep an inventory of questions asked (WRI, 2010). Some projects have emphasised a need for a consistent message from all parts of the project team, including contractors, and may authorise who can communicate on behalf of the project (Shell, 2016).

3.3 Trust and transparency

If the project developer is not trusted by the public, any efforts to communicate can become ineffective and simply discounted as 'propaganda' for the project. Relative to other energy technologies, trust may play a

particularly important role for CCS, as the public is obliged to rely on expert assertions that the CO_2 is properly stored (L'Orange Seigo and others, 2014b). Developing and maintaining this trust therefore provides an essential platform for all other communications activity and, once lost, it can be very difficult to rebuild (Lofstedt, 2015). This loss of trust was a principal feature of the breakdown in relations at Barendrecht (Section 6.2), where the national government was perceived to be withdrawing democratic powers from the local community (Feenstra and others, 2010; Prangnell, 2013). As discussed in Section 2.3, the multinational fossil fuel companies or national utilities which frequently lead CCS projects tend to be seen as prioritising profit over environmental or public health considerations, and can find it particularly challenging to develop a level of trust. Research-based projects led by academic institutes generally encounter fewer problems in this respect (Dütschke, 2011). In addition to the inclusion of more representatives of more trusted organisations in the communications team, commercial developers can improve levels of trust by operating with a high degree of transparency. Openly discussing project risks and uncertainties, encouraging site visits, and publishing key data can all help contribute to public perceptions that a company is acting in a transparent manner (Shell, 2016). Community advisory panels are small, independently financed groups of community representatives which follow the progress of the (operating) plant and help build a trusting relationship between the community and the developer. They have been used in chemical industries since several accidents during the 1980s eroded public trust in the industry, and are now considered best practice. Typically, assembling a few times a year, as well as regularly meeting with the developer and visiting the operational site, these panels have recently been adopted or proposed for some CCS projects such as Quest and ROAD (Kombrink and others, 2011; Lamb, 2014). Ultimately, higher levels of trust can provide a developer with more leeway and better public acceptance of unforeseen problems.

3.4 Means of communication

A huge range of potential means of communication are available to the outreach team, and the choice of material will depend on both the target audience and timing. Early engagement is frequently cited as one of the most crucial factors in gaining support of the local community and authorities, normally beginning with relatively informal contact with key stakeholders, such as local authorities and landowners, through face-to-face meetings. Larger numbers of people in the area can be reached through distributing letters and flyers, emails, or phone calls, which is essential for notifying people of major events or distributing invitations to larger public meetings.

The formal regulatory process in most countries typically requires a public hearing which has often taken the form of presentations by developers to an audience in a town hall. However, many projects have highlighted the advantage of a more informal exhibition-style gathering for this purpose, where several stands covering various aspects of the project are manned by members of the project team, allowing for more one-to-one communication and preventing the whole audience from being swayed by a few vocal critics (Prangnell, 2013; Young and Sacuta, 2014) (Figure 6). Hands-on material such as core samples of the storage site geology are also better exploited at this kind of meeting. Exhibition materials can be further employed in permanent information points for the project, which are often set up in community centres or

other public spaces in the affected communities. Alternatively, such exhibits may be toured from town to town to reach several communities directly. A particularly recommended strategy for reaching a greater number of residents, employed by projects including Hontomin, Quest, and Peterhead, is to bring a stand to existing, well-attended local events such as fairs or festivals (GCCSI, 2013a; Lamb, 2014; Shell, 2016). This kind of informal outreach can also be done well in advance of the formal consultation process.

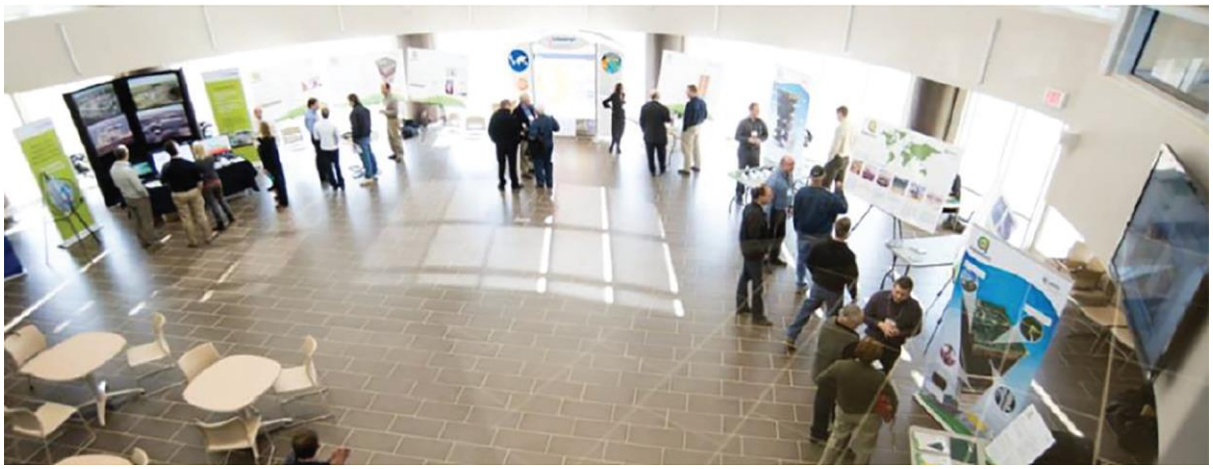

Figure 6 Exhibition-style community event used in outreach by the Boundary Dam project (Young, 2014)

Conveying information to as many people as possible is crucial, as initial lack of interest or poor attendance at public meetings does not necessarily translate to support for, or an absence of opposition later to the project. This should aim to include minority groups or other stakeholders who may otherwise be excluded from the process, and has been achieved in a number of innovative ways. Of note is the strategy used by the Quest project of visiting local cafes (both unannounced and advertised) to talk about the project and obtain feedback from residents (Wiwchar, 2016). The Tomakomai project in Japan invited various well-known celebrities to their information events to increase participation (Suzuki, 2016).

The project website is obviously another useful vehicle for information, with the advantages of being able to provide regular news updates and host unique material such as animations of the CCS process, or videos of interviews with experts, local authorities, and other stakeholders. Lists of 'frequently asked questions' (FAQ) and their responses are another common feature of project websites. As many people's first port of call when investigating a new project, the website should provide contact information for members of the communications team or other means of submitting feedback to the project.

One of the key conclusions from some of the early, failed outreach approaches is the importance of setting up a dialogue with stakeholders, in which concerns and grievances are responded to and may even influence aspects of the project design. With this in mind, the forms of communication used should also seek to maximise the opportunity for the public to provide feedback. Face-to-face meetings, house visits, and public exhibitions are obviously ideal in this respect, but online forms, email, and free phone numbers are also essential tools with wider reach. A community liaison officer (CLO) hired from the affected community can be a useful point of contact for residents, as demonstrated by the Otway pilot project in Australia (Ashworth and others, 2010).

Once projects have entered the construction or operational phase, the frequency of communication can usually be reduced, often focussing on a regular newsletter or announcements of important milestones. At this stage, site visits can be offered to interested residents, school children, and students, in order to ensure the project appears approachable and transparent. Many operating projects will feature a visitor centre with educational facilities for this purpose.

3.5 Content and language

Given the low public awareness of CCS, most members of the public will encounter the technology in detail for the first time through a local demonstration project. This has generally given most developers of CCS projects to date the responsibility of explaining and making the case for the technology itself, which often requires extensive background information on climate change and the nature of CO_2. As discussed in the previous chapter, how CCS is initially presented and placed in context can have a significant impact on its acceptance by the public. The most persuasive arguments for applications in the power sector usually seek to stress both the need for urgent action over climate change and the dependence of developed economies on non-intermittent sources of energy. As discussed in Section 2.1, it is particularly effective to emphasise that CCS will form only part of a future low carbon energy mix, acting as a complement to intermittent renewables rather than replacing them, or as a 'bridging solution' to a fossil fuel-free future (Fleishman and others, 2010; Wallquist and others, 2011b). This argument can be given much more weight by the participation of national government representatives in project communication, who are able to frame the need for the technology in the context of national policy and plans for a future energy mix. For CCS projects associated with industrial processes with fewer viable alternatives, the case for the technology is often more easily made.

Early experiences of communicating CCS to the public have quickly demonstrated that small details can have a significant effect on perception of risk, and that terminology and methods familiar within the research field can be wholly unsuitable for a non-technical audience. Perhaps the most well-known example of this is the mistake of using compressed depictions of geological strata which give the impression that the stored CO_2 is much closer to the surface than reality. More effective diagrams emphasise the depths (usually >1 km) at which most sequestration is performed by showing properly scaled buildings at the surface (Figure 7). Accurately conveying the extent of the storage area can also aid acceptance, as it tends to emphasise the relatively small scale of the injected CO_2 and the perception of a 'drop in the ocean' (Hund and Greenberg, 2010). Several technical terms widely used in the field of CCS have gained notoriety for their potentially detrimental effect in public communication. Most notably, there is a trend towards replacing the term 'saline aquifer' with 'saline formation' to avoid associations with contaminating drinking water. Other terms which have come under scrutiny are 'supercritical' in reference to the transported and stored CO_2 and the oil sector concept of 'abandoning' a well (Sacuta, 2015, 2016).

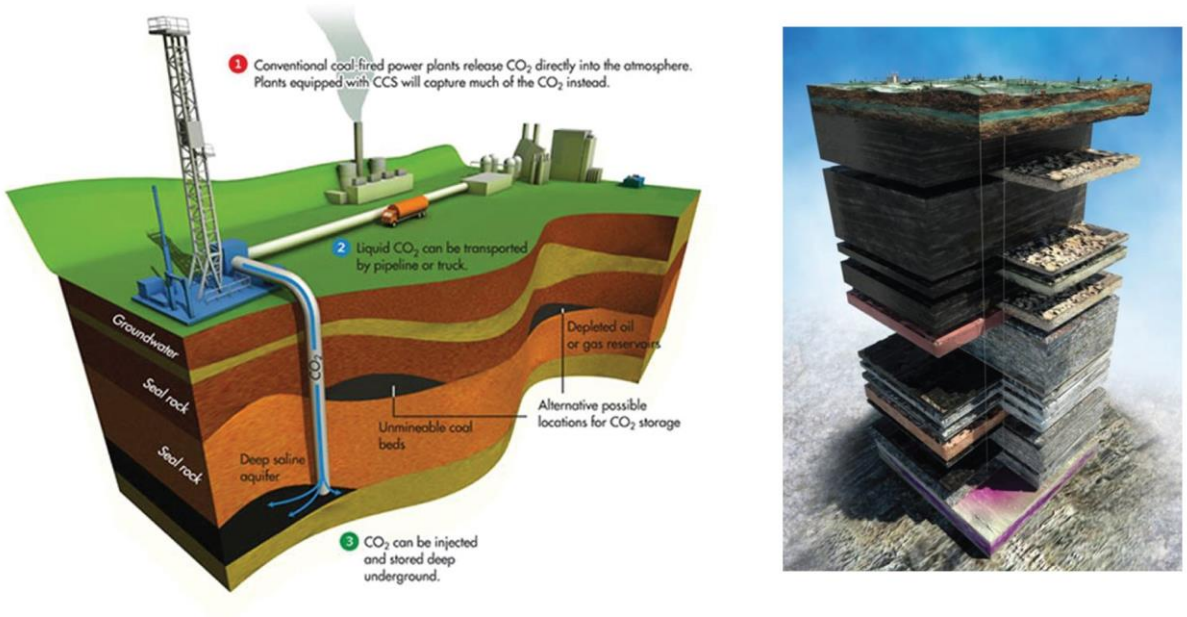

Figure 7 A common depiction of CCS with compressed vertical scale (left), and a correctly scaled representation of CO_2 storage used for the Aquistore (Boundary Dam) project (right), which also highlights various geological strata (Power Engineering International, 2015; Young, 2014)

The nature of CO_2 itself is usually addressed by communications teams in order to counter frequent misconceptions that the gas is toxic – often due to confusion with CO or some awareness of its potential to be harmful through asphyxiation (Wallquist and others, 2010; Itaoka and others, 2013). To help rationalise and place the asphyxiating property in context, some communicators have highlighted that it could be equally attributed to other fluids usually considered harmless, such as water or nitrogen (Greenberg, 2015).

Aside from concerns over health risks, the idea of any kind of CO_2 leak can be damaging for perceptions of the project on the basis that it will negate the fundamental aim of the technology. A key approach is to counter the popular notion that the CO_2 needs to be perfectly stored for eternity, as small leak rates over very long time scales will have a negligible effect on society's immediate need to mitigate climate change (van der Zwaan and Smekens, 2007; Wallquist and others, 2010). As discussed in Section 2.1, confidence in the permanency of CO_2 storage can be cultivated through countering people's intuitive ideas of gaseous CO_2 in hollow spaces with more accurate descriptions of liquid CO_2 contained in porous rock, as well as the mineralisation processes which serve to increase the stability of the store over time (Wallquist and others, 2011b). A number of projects have made use of core samples of rock from the proposed storage sites as highly effective props for visualising the storage process (Kombrink and others, 2011; Prangnell, 2013; Sacuta, 2015) (Figure 8). Making people aware of the existence of natural CO_2 stores has also been shown to reduce risk perceptions (Tokushige and others, 2007).

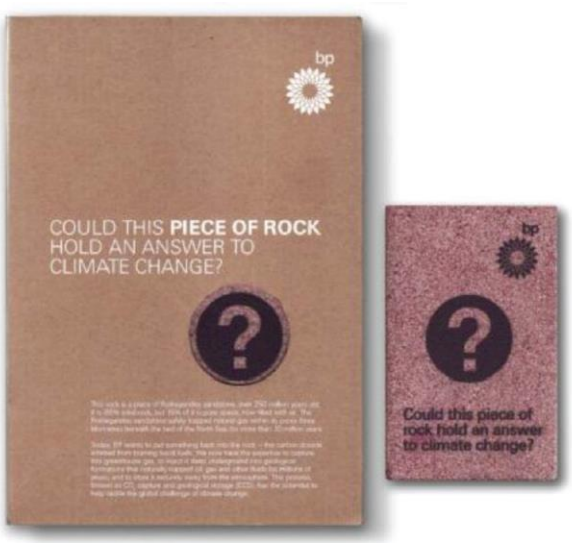

Figure 8 Images of rock samples used in CCS outreach (in addition to actual rock samples) by BP (Prangnell, 2013)

When discussing technical specifics of the project itself, it has already been noted that a policy of transparency over potential uncertainties and risk can help improve public trust (Lofstedt, 2015). For example, the small risk of hazardous accumulations of CO_2 from a leak in low-lying areas is nevertheless present and should be acknowledged and addressed. Discussion of CO_2 monitoring procedures specific to the local geology and contingency plans in the event of a leak is essential in helping mitigate the perception of such risks. It should be noted, however, that some project communicators have observed that explanations of standard 'belt and braces' safety precautions with high levels of contingency can actually worry people more, as they suggest a greater degree of risk than is actually present (Prangnell, 2013). In a similar way, a study of the general public has suggested that detailed descriptions of storage monitoring such as seismic tests or CO_2 detection may also exaggerate perceptions of the risk of induced seismicity or CO_2 leaks (L'Orange Seigo and others, 2011). Despite this finding, communities local to operating projects are generally reassured by the presence of site monitoring procedures, to the extent that this 'social role' is often cited as a primary motive for site monitoring (Feitz and others, 2014).

As highlighted in the previous chapter, it is essential that projects do not merely focus on reducing perceptions of risk, but also highlight potential benefits for their host communities. This argument will usually centre on supporting the local economy by creating jobs or providing work for local businesses. Having a policy of using local businesses can be valuable in this respect, and may extend to providing training schemes for local individuals or businesses to reach the standard required by the project developer (Shell, 2016). For regions with a history of coal mining or an oil industry which can be prolonged with EOR, there is an obvious case to be made for CCS helping to support local industry. For other sites, such as the host of the first FutureGen project, ideas of playing a role in a pioneering technology, enhancing the international reputation of the region, or 'doing their bit' for a global effort may play a more important role (Hund and Greenberg, 2010). The economic contribution of visiting scientists and researchers has also been seen as a minor benefit for projects such as the Ketzin pilot in Germany (Dütschke, 2011).

3.6 Use of the media

Mass media such as newspapers, television, and radio reach many more people than most project's own communication activities and have proved key in stirring opposition or raising support for many projects. A good relationship with press outlets can be formed by involving them in key events such as project announcements or milestones, and supplying regular press releases. When damaging editorials or letters appear, they should be rapidly countered with a measured rebuttal piece, as occurred in the case of the ROAD project (Section 6.2) (Kombrink and others, 2011). However, trust in the press as a neutral observer must be maintained, as the short-lived Jamestown project suffered from a local paper being perceived as a 'bought' mouthpiece for the developer (WRI, 2010). Some developers, such as Shell, have strict policies regarding which employees are able to communicate information to the press and require all contractors to have their public communications centrally approved (Shell, 2016). Many projects make further use of local papers to run announcements or invitations to meetings (Ashworth and others, 2010).

Whereas the Barendrecht and Belchatów projects were the subject of highly negative television or radio analysis, Shell worked with a BBC documentary to ensure a balanced portrayal of its Peterhead project (Shell, 2016).

Online social media such as Twitter can be useful for assessing or monitoring the attitude of a community towards CCS and responses to project developments (Wade and Greenberg, 2011). These platforms may also be used in project communications to help reach a larger audience and different demographics, or to engage vocal project critics (Sacuta, 2016).

4 USA case studies

The USA has been a pioneer of CCS demonstration projects, building on a long history of large-scale carbon capture for EOR projects, and was also one of the earliest countries to pursue research into dedicated CO_2 storage. In 2003, a network of seven regional carbon sequestration partnerships (RCSP) was created by the US DOE to oversee and develop CO_2 storage projects in different regions of the country, leading to a number of small pilots and a few larger projects, mostly in natural gas processing or gasification plants and using the resulting CO_2 for EOR. Public engagement and outreach has been a focus of the RCSP since their inception, and potential opposition to EOR-based projects may have been mitigated by the fact that the affected communities are usually either dependent on or at least familiar with both the oil industry and the CO_2-emitting industry (NETL, 2009). Other projects involving new power plants or storage in saline aquifers have the potential to be more contentious, but few of these have faced active opposition, with high-profile cancellations such as the FutureGen demonstration due largely to mounting costs and economic constraints. Operating since 2015, the Illinois Industrial CCS project at a bioethanol plant is an example of an effective communication campaign being implemented to help gain acceptance for saline aquifer storage (Greenberg, 2015). In the coal power sector, the Petra Nova project at the existing WA Parish coal power plant in Texas became the world's largest power generation CCS project when it was commissioned in January 2017, while the long-delayed Kemper County IGCC plant in Mississippi is also scheduled to commence full-chain operation in 2017. Both these plants use CO_2 for EOR and neither have faced significant public opposition to the storage aspect, but cost overruns and delays at Kemper County have attracted significant media and public criticism (Urbina, 2016). While communities in parts of the USA with a long connection to coal mining can often be supportive of projects which promote economic growth or support the industry, relatively low acceptance of climate change can also present a barrier in some areas. New coal power plants of any kind are strongly opposed by the Sierra Club NGO, but CCS is actively supported by some national ENGO such as the National Resource Defence Council and the Clean Air Task Force.

4.1 Greenville

The Greenville project was an early, short-lived CCS demonstration notable for the strong public opposition which was largely responsible for its cancellation. As part of the Midwest Regional Carbon Sequestration Partnership, project developers Batelle and Andersons Marathon planned to capture 1 Mt of CO_2 over four years from a new corn ethanol plant near the rural town of Greenville, Ohio, with storage in a saline aquifer. A public information event and several informal meetings were held with local residents, but a group called 'Citizens against CO_2 sequestration' was formed around six months after the first event (Figure 9). Sharing concerns about public health and a perception of the project as a dangerous and costly experiment, this group also gained the support of local politicians and media. Most public opinion in the region was to deny the existence of climate change, with one local paper labelling it 'sloppy pseudo-science'. Together with a strong distrust of federal government, large corporations, and scientists, and no history of oil or gas exploration in the area, this presented a very challenging social context for the project (Hammond and Shackley, 2010).

Figure 9 Protestors from the US-based 'Citizens Against Sequestration' activist group (Citizens against CO_2 sequestration, 2009)

Few details of the developers' outreach strategy are available, but the companies have stated that extensive, proactive engagement was undertaken, including prior research, formation of a dedicated outreach team, production of materials, and a mechanism for public feedback. Some of the materials produced may have been too technical and dense for a general audience. Also, given the project was first announced in May 2007, the first public meeting held in August 2008 was probably too late. However, it seems probable that a proper characterisation of public opinions in the region would have revealed that the site was unsuitable for a CCS demonstration, and was likely to be met with resistance no matter what outreach was conducted. The project was cancelled in 2009 before completion of the regulatory phase, and the 'Citizens against CO_2 sequestration' group went on to support CCS protests in neighbouring states and even other countries.

4.2 Jamestown

In 2004, plans to build a new 50 MW coal-fired circulating fluidised bed (CFB) plant were announced by the Jamestown Board of Public Utilities (JPBU) – a municipal utility. Originally planned without CCS, the plant was redefined as an oxyfuel combustion CFB plant with carbon capture in 2007 and incorporated an 'Oxycoal Alliance' of technology partners and backers. Despite also gaining the backing of the state governor, the project was strongly opposed by NGO and local activists, and failed to secure US DOE funding in the 2009 stimulus package, leading to its eventual cancellation around 2010 (WRI, 2010).

Early engagement by the developers included a series of informational community meetings staffed by the JPBU and its partners, occasionally with the participation of the governor's office. A series of workshops on CCS were also held by the New York State Department of Environmental Conservation. Some community members perceived these meetings to be largely promotional for the project and designed to minimise public criticism. JPBU were considered to be intent on building a new coal plant, regardless of any community concerns. A frequently-raised criticism was that neither JPBU nor the state had commissioned a study of alternative energy options, with many maintaining that the state's power requirements could be easily met by renewables and demand-side reductions. Critics also wanted a cost study for the new plant

to be released, for comparison with these other energy options. As test well drilling also took place without informing the community, opposition to the project quickly gathered as a core of local activists with support from a large coalition of 20 environmental groups from outside the area, known as Clean Energy for Jamestown. Even the NRDC, a usually pro-CCS ENGO, came out in opposition to the project as an unsuitable proposal for a CCS demonstration. The local media largely supported the project and was regarded by opponents as a mouthpiece for the JPBU.

The Jamestown project suffered primarily from a lack of transparency over the decision to choose CCS for the state, and the absence of any active dialogue with the community which could accept criticism and feedback from opponents. Indeed, the JBPU actively avoided meeting with Clean Energy for Jamestown, on the dubious legal basis that the coalition had threatened a lawsuit.

4.3 Carson and HECA

In February 2006, BP announced plans to build a petcoke gasification facility in Carson – an urban, industrialised area in Los Angeles County, California. Effectively a petcoke-fired IGCC with pre-combustion capture, a 500 MW combined cycle gas turbine would run on the resulting hydrogen gas, with the CO_2 sent to the nearby Wilmington oilfield for EOR. The plant was envisaged as a means of meeting power shortages in California (due partly to a moratorium on new nuclear and coal) while cleanly dealing with the petcoke from local oil refineries which was usually sent to China for combustion in unabated power plants. The CCS demonstration would also form part of geological sequestration research under the auspices of the Westcarb regional initiative. Although the project was ultimately cancelled in May 2009, mainly due to the unsuitability of the oilfield for EOR, it also met with considerable public opposition in the area despite an active stakeholder engagement approach (Bradbury and Wade, 2010).

For areas of the USA like Carson, where a largely ethnic, relatively poor community co-exists with heavy industry, the idea of 'environmental justice' is a key issue for environmental and community groups. This principle seeks to prevent such communities, which may have less of a voice in society, from having excessive industry and infrastructure projects unfairly imposed upon them. Anticipating these concerns, the community outreach team for the Carson CCS project included a special Spanish-language team for the Hispanic community, as well as making contact with Filipino organisations, churches, and sports clubs. Strong support was gained from key federal, state, and local officials, who saw benefits in bringing federal investment to the area, increased tax revenues, and the status of hosting a world-first 'clean' hydrogen power plant. While some of this groundwork was laid prior to the first, high-profile announcement of the project to a meeting of 200 key stakeholders and the media in February 2006, many groups felt that the public announcement was made too soon, when community support and details of the project (such as the storage site) were still uncertain. By 2007, nine local and state ENGO and environmental justice groups were raising concerns about the project, with a principal focus on the potential increase in 'criteria pollutants' (SOx, NOx and particulates) in an area already suffering from air quality issues.

A further barrier to the project was the lack of regulatory certainty for CCS encountered by many such early projects. In 2007, an active debate emerged in California over the passing of state legislation which would

direct the California EPA to develop a set of standards and regulations to govern CCS in a bill known as AB 705. Although it was uncertain whether such legislation should even be required for the EOR planned for Carson (a practice already widespread in the USA), the debate focused a spotlight on CO_2 storage in the state and the Carson project in particular, with strongly divided opinions. This began to shift the criticism of Carson from local groups towards issues relating to CO_2 storage, in addition to the early concerns over air quality. Many of the local and state ENGO opposed to the project felt that safety issues associated with CCS needed to be resolved before the bill could be passed, and that an Environmental Justice Advisory Committee should be involved in setting the new standards. On the other hand, some ENGO such as the NRDC strongly supported CCS as a clean energy solution for the state. An environmental justice spokesperson from the proposed storage site at Wilmington became a particularly strong opponent of the project, drawing up a list of 11 statements about the dangers of the project, including production of other waste and pollutants, and risks associated with CO_2 leaks including water contamination and ocean acidification. The risk of a leak was thought to be enhanced by the seismicity of the Southern California region.

While community outreach and stakeholder engagement had clearly been a priority for the Carson project, and were undertaken in a challenging social and regulatory environment, mistakes can still be identified. In particular, the high-profile public announcement was made before the concerns of environmental justice groups and air quality had been properly addressed. Although outreach efforts were made in the affected communities, the support of vocal environmental justice spokespeople does not seem to have been sought at an early stage. Some interviewees also raised concerns that the project team was not well prepared to answer standard questions, such as the risk of orphan oil wells compromising the storage site or increases in other air emissions.

HECA

As early as 2008, a new consortium led by BP was investigating an alternative site for a hydrogen power plant with EOR in Kern County to the north of Los Angeles, where the Elk Hills oilfield is situated. Although slightly smaller at 400 MW, this new 'Hydrogen Energy California (HECA)' project shared most of the features of the Carson plant. In 2011, the project was acquired by SCS Energy, who modified the plans to include urea production and increased the CO_2 capture rate. However, HECA also ran into problems with its CO_2 offtake agreement when Occidental Petroleum span off its California operations to a new entity which rejected the proposed EOR arrangement. Despite gaining the support of many local authorities and key businesses in the area, delays were also caused by opposition from residential and environmental groups. The project was effectively cancelled in March 2016 when SCS Energy withdrew its application for certification, although an alternative CO_2 storage option in a saline aquifer is officially still being considered a means to resurrect the project.

Little detailed information is available on the outreach work of the HECA project. Information was made available to residents through a community centre in Button Willow, direct mail campaigns, and on the project website, with all information also available in Spanish (Hydrogen Energy California, 2013, 2016). A number of community initiatives and events were sponsored. While local authorities supported the project

as a means to boost the economy of the area and prolong the lifetime of the oil industry, opposition came from the Sierra Club and residents and farmers groups such as 'Neighbours of HECA' and the 'Association of irritated residents'. Most concerns centred around emissions of non-CO_2 pollutants and waste, groundwater contamination, air quality, and the increased freight associated with shipping coal (from New Mexico), petcoke, fertiliser and waste, as well as the explosive danger of the fertiliser. The small amount of net energy produced by the plant when producing fertiliser and capturing CO_2 was highlighted as evidence of its poor value, seeing it as an unnecessary addition to an already-polluted area. These groups and some local media saw the project cancellation as a victory for its opponents, although it is unclear how significant these efforts were, as the project was still at an early stage of development (California Energy Commission, 2013; Sierra Club, 2016).

4.4 FutureGen

Originally announced by the US government in 2003, the original FutureGen project was to have been the first full-chain CCS demonstration on a coal power plant, and would have consisted of a new 275 MW IGCC plant with pre-combustion capture. The project was led by a partnership between the US DOE and the FutureGen Alliance – a non-profit consortium of coal mining companies and utilities created in 2005, whose membership would change frequently over the course of the project. Although this first incarnation of FutureGen was cancelled by the US DOE in 2010 due to mounting costs, the project is notable for gaining widespread support in its host town of Mattoon, Illinois, despite featuring the challenging context of a new coal plant and onshore storage in a saline aquifer formation (Hund and Greenberg, 2010; Folger, 2013).

A key factor in the local acceptance of FutureGen seems to have been the competition process used by the US DOE to identify the eventual host site for the project, which narrowed 12 possible states to four potential sites in Texas and Illinois before finally selecting Mattoon in December 2007. Although public support was not specifically considered in the selection, one site was ruled out based on nearby housing developments. More importantly, the competition process appears to have cultivated community pride and a desire to 'win' the high-profile research project for the town, along with the associated economic benefits to the area (*see* Figure 10). The bid for the project was led by the economic development office for the county, which would later play a leading role in communicating and engaging with the local community on behalf of the project. Mattoon is a rural town with a population of around 18000 and some concerns around economic stagnation and the departure of younger residents.

Stakeholder engagement in the area began as early as 2006, even before the final selection of the site, and interviews with residents agree that the FutureGen Alliance made public engagement a priority, using many different platforms. Some early public meetings were held by the local economic development office, prior to official meetings which were held at a later date as part of the regulatory requirements for permitting. As well as the economic development office's key role in communicating with the town, the Illinois State Geological Survey was also heavily involved as a trusted and independent source of information. Local media and newspaper coverage was largely positive and played a key role in distributing information about the project. The FutureGen Alliance's strong presence in the town, holding board

meetings there and attending community events, also appears to have been a key factor in gaining support and lessening the appearance of a multinational entity experimenting or profiting from the town.

Figure 10 A cinema (movie theater) in Mattoon celebrates the selection of the town to host the FutureGen project (Mercer, 2014)

Although some early support for the project was based on the prospects of jobs and economic growth, later support seems to have been based largely on community pride in hosting a pioneering research project – potentially a world first, and contributing to a global effort on climate change. Mattoon is not located in a coal mining area of the state, but many residents had links to the industry and there was also general support for helping a struggling industry seen as integral to the prosperity of the state. The whole community's general knowledge of CCS increased significantly, with better understanding clearly helping acceptance in some cases, for instance, through comprehension of the extent of cap rock, or the small scale of injected CO_2 relative to the storage formation. Some opposition was encountered, particularly from farmers concerned with the loss of good farm land, or dissatisfied with compensation for the value of the land alone. However, efforts by one resident to initiate an opposition group were unsuccessful, and specific meetings were held with opponents to allow them to air grievances. The Sierra Club NGO was initially against the project, but withdrew their opposition in 2008, stating that the development of the plant would decide once and for all whether coal could be made clean. There was general disappointment and even anger in the community when federal funding for the project was withdrawn in 2008 (WRI, 2010).

FutureGen 2.0

In 2010, the FutureGen Alliance revived the project using renewed funding from the federal government's 2009 stimulus package. This markedly different second version proposed the retrofit of an existing power plant in Meredosia, Illinois to a 166 MW (100 MW net) oxyfuel combustion capture plant which would also capture and store 1.1 $MtCO_2/y$. Although around 200 km from the new site, Mattoon was initially offered to retain the storage site, but the community found this diminished role and reduced economic benefits

scant reward for all the work it had put in on the project and refused the offer. A new site was selected in nearby Morgan County through another competitive selection process, but here residents were much more vocal than Mattoon and split between support and strong opposition. An initial location in the county had to be abandoned because of landowner opposition due to concerns over CO_2 leakage, or earthquake-induced release, contamination of the water supply, and damaging farmland. A petition of 200 signatures was drawn up and some landowners were prepared to take legal action. Eventually a storage site in the north-east of the county was selected in 2011 and was the focus of engagement efforts until the project's final cancellation in early 2015 (Humphreys, 2011).

The Alliance maintained a strong focus on outreach in the new communities affected by the transport and storage sites, including setting up a citizen's board, holding public hearings and one-on-one visits with landowners and community leaders. Local media was exploited by the use of educational inserts in local newspapers and broadcasts on local radio. The citizen's board comprised 14 members, including education leaders, county board members, neighbours to the storage site, and representatives from the farm bureau, the chamber of commerce, a local bank, and unions. This group was charged with helping disseminate project updates to their networks and the local public, as well as gathering feedback and concerns. The Alliance contributed to several community development projects, including providing municipal water to residents near the storage site, improving the local town square, and working with local labour unions to ensure local businesses and support services were employed. Had the project continued, the intention was to work with the citizen's board to create a number of support facilities to promote engagement with various stakeholder groups. A visitors facility would run tours and host educational programmes, exhibits, and films about the project; a training facility would provide vocational training and certification for local workers and businesses; and a research facility would be set up to study the storage site, disseminate data, and provide opportunities for researchers and students (Hund, 2012).

Despite these efforts winning general support for the project, the final storage site faced some opposition to the regulatory process from local landowners (Wells, 2011; Dettro, 2011). The Sierra Club took legal action on the grounds that a specific air permit should be required for the retrofit project, but ultimately lost the case (Marshall, 2014). The greater opposition than that encountered in Mattoon is notable, with residents affected by the new facility clearly feeling less connection with the project and the FutureGen Alliance. The lack of a competitive process to bring the project to the area, the absence of a local 'champion' in the regional economic development office, and not having the Alliance based in the local town may have all contributed to the opposition.

4.5 Texas Clean Energy Project (TCEP)

The Texas Clean Energy Project (TCEP) is a plan for a new 400 MW IGCC and polygeneration plant in Penwell, Texas, developed by Summit Power Group. The project has run into difficulties since US DOE funding was withdrawn in early 2016, but is nominally still active. A notable feature of Summit's outreach campaign for the plant is the close collaboration with ENGO including the CATF, the Environmental Defense Fund, and the NRDC. These groups were involved with the site selection, setting appropriate carbon

capture targets, and in obtaining air permits. Based on ENGO advice, the project deliberately avoided the use of drinking or agricultural water. Summit established an independently funded carbon management advisory board of scientists and ENGO to monitor the project's activity (GCCSI, 2013b).

5 Canada case studies

Canada ranks alongside the USA as one of the world's most successful developers of large-scale CCS, having brought two demonstration projects to fruition (not including the storage component of the cross-border Weyburn-Midale project), and with two more expected to come online in 2017. Similar to the USA, much of this activity has been driven by the high potential for EOR in the western provinces of Alberta and Saskatchewan, but capital grants from provincial and federal governments have also played a significant role, as well as Alberta's carbon offset emissions trading system for large CO_2 emitters.

Relative to other regions, awareness of CCS in Canada is high, with a 2011 survey finding 44% of participants had heard of the technology, and proportions as high as two thirds in the provinces of Alberta and Saskatchewan (IPAC CO2 Research Inc., 2011; L'Orange Seigo and others, 2014b). No significant opposition to CCS developments has been encountered in Canada, but several projects provide useful examples of stakeholder outreach.

5.1 Weyburn-Midale

Since 2000, CO_2 captured from a gasification plant in North Dakota, USA, has been piped across the border to Canada's Weyburn oil field, where roughly 3 Mt/y is injected for EOR. Originally a purely commercial venture by the oil field operator, the project was soon identified as a useful research platform by the IEA Greenhouse Gas programme and the nearby Petroleum Technology Research Centre (PTRC), and was joined by a second injection site at nearby Midale in 2004. Although public outreach was conducted by the PTRC during the early years of the project, the sparsely populated region, familiar with the oil industry, was mostly unconcerned by the injection of CO_2. Nevertheless, Weyburn-Midale is of considerable interest from a public engagement perspective due to a crisis in early 2011 when it was accused of having leaked CO_2, killing wildlife and farm animals (Prangnell, 2013).

This incident began with the discovery by farming landowners of dead animals in a gravel pit, accompanied by an oily sheen on water, foam, and bubbling noises. The farmers teamed up with the ENGO Ecojustice to bring in an independent geological engineer who produced a report identifying high levels of CO_2, methane, and ethane – all supposed to be leaking from the Weyburn site. This team quickly held a press conference attended by national journalists which PTRC chose not to attend, instead taking time to prepare a considered response to the allegations. Using crucial baseline measurements of soil CO_2 which had been performed prior to the project, as well as isotope analysis of the injected and 'leaked' CO_2, PTRC were quickly able to prove that the problem was an entirely natural phenomenon with no link to the sequestered CO_2. However, by this time other groups were conducting independent assessments of the area and it was some months before all parties confirmed the conclusions of PTRC. While the initial claims were scientifically refuted, and the media storm around the project quickly abated, a general perception that there was a crisis at Weyburn has remained, and the story probably continues to tarnish other CCS projects to some extent (Prangnell, 2013; Wildgust and Sacuta, 2013).

Nevertheless, PTRC's rapid and effective firefighting of the allegations against the Weyburn-Midale project can be considered a communication success due to several key factors. The baseline geological and soil data provided essential scientific evidence, while the presence of a scientific expert group and communications specialists in the project allowed the issue to be quickly addressed. In general, key stakeholders should be contacted and forewarned of planned actions during a crisis, and the roles of various project participants should be well defined. Key individuals and science writers in the media should be informed of scientific results used to rebut claims prior to their official release (Wildgust and Sacuta, 2013).

Partly in response to this experience at Weyburn-Midale, and backed by the 12 years of research data from the site, the PTRC and GCCSI produced a useful set of FAQ aimed at providing evidence-based answers for those communicating about CCS with the general public: 'What happens when CO_2 is stored underground' (PTRC, 2014) (Figure 11).

Figure 11 Map of natural geological accumulations of CO_2 around the world used in 'What happens when CO_2 is stored underground' (PTRC, 2014)

5.2 Boundary Dam

Since it commenced operations in October 2014, the Boundary Dam CCS project in Saskatchewan has become famous as the first full-scale demonstration of CCS on a power plant. Provincial utility Saskpower invested in upgrading Unit 3 of their existing coal plant to produce 160 MW gross power output and worked with Shell-Cansolv to retrofit an amine-based post-combustion capture system to the unit. At maximum output, 1 Mt/y of CO_2 should be captured and purchased by the oil company Cenovus for EOR, although capture rates in the first year of operation were much lower. Excess CO_2 not used for EOR is sent for storage in a saline aquifer site known as Aquistore, operated as a research project by the PTRC (GCCSI, 2015).

Based on an existing coal plant and oil industry familiar to the area, few elements of the project were likely to meet with opposition from local communities, but as a new dedicated CO_2 storage project, Aquistore was

given particular consideration in the outreach strategy. A communications steering committee was formed in June 2011, comprising representatives from PTRC, SaskPower, Enbridge, the Ministry of Environment, Schlumberger, and CCRL (a nearby oil refinery), and developed key messages and the communication activities which should accompany project milestones. The strategy aimed to engage key landowners, residents, authorities and schools in the closest town of Estevan and its rural municipality, regional media, ENGO, and the provincial and national governments. Outreach efforts employed social media such as Twitter, with a view to emphasising the novelty or 'cool factor' of the project. More traditional materials included fact sheets, pull up banners and posters for exhibits with to-scale images of the geology, and hands on display material such as core samples. Visits to all local landowners and affected residents ('kitchen table discussions') were held in 2012, ahead of any construction activity, building useful relationships for future engagement. In March 2012, the Aquistore project was presented to the authorities in Estevan, and in the following month an open house was held and staffed by project members and researchers. This event was widely advertised through newspapers, billboards, local radio and newsletters, in addition to invitations sent to every home in the community, and was well attended and received by the participants. The start of construction was marked with a formal ground-breaking event with tours and presentations, and local authorities and regional media in attendance. Tours for the pubic have continued throughout the project's construction and operational phases (Young and Sacuta, 2014; Sacuta, 2015, 2016).

Owing to the nearby Weyburn-Midale project and strong local links to the oil and gas industry, there was a relatively high public level of awareness and understanding of CCS in the area prior to outreach, and some technically detailed questions were posed to the outreach team during the open house event. The project has faced minimal local criticism, and any concerns appear to have been met early on in the engagement process.

During its first year of operation, Boundary Dam attracted some negative media and political attention due to early technical setbacks which reduced its capture rate and led to penalties for failing to meet CO_2 supply obligations. The falling price of natural gas also began to put the cost of the coal project in an unfavourable light relative to potential new gas power plants to meet the province's energy needs. Intended to further knowledge sharing with CCS developments elsewhere, the plant's policy of relatively complete transparency over the technical issues experienced may have contributed to some of this negative publicity.

5.3 Quest

In November 2015, Shell's Quest project began capturing 1.2 Mt/y of CO_2 from the steam methane reformer units of the Scotford upgrader – an existing facility which produces hydrogen and other chemicals from the Athabasca tar sands in Alberta. The CO_2 is sent by a 2-km pipeline for storage in a saline aquifer formation, with the possibility for additional EOR. Along with the Peterhead project in the UK, Quest is another example of Shell's thorough commitment to stakeholder engagement for its CCS projects following the opposition to Barendrecht. Much of the outreach work focused on communities affected by the pipeline, as well as the storage site (Pembina Institute, 2014a).

The engagement strategy aimed to establish new relationships and build upon existing ones with the local community, and identify opportunities to maximise benefits for all stakeholders. A public opinion survey across Alberta was initially conducted by an external market researcher, finding 64% of those surveyed had heard of CCS and 67% of those were in favour of the technology. An initial public announcement in October 2008 was made via a press release and open house. A stakeholder consultation programme then began in January 2010, targeting all landowners, local authorities, regulators, and aboriginal communities, with open houses continuing throughout 2011. This campaign included participation of the communications team in numerous local events and festivals, and events known as 'Quest Cafés' which brought together key stakeholders and community leaders to discuss the project with Shell and independent experts from the University of Alberta. A novel approach adopted to reach as broad a section of the public as possible was to attend local cafés, where the Shell team would provide drinks and discuss the project in an informal setting. As for the Shell project at Peterhead, key features of the outreach strategy were the active collection of public feedback and achieving consistent and aligned messages from all project staff (Spence, 2010, 2012; CCS101, 2010; Lamb, 2014; Wiwchar, 2016).

Similar to the wider campaign employed for Peterhead, Shell engaged an advertising agency to create material aimed at the media and general public in Alberta (Imagination, 2016). The media launch used a video depicting a journey from the Earth's atmosphere down into the storage rock formations, and tied into a billboard campaign using the tag line: 'Up here, too much CO_2 is a problem. Deep down there, we have a solution' (Figure 12). For some trade and publicity events this idea was used for an actual lift simulator called the Quest elevator, in which visitors would enter a lift and view the video (Lamb, 2014).

Figure 12 Poster used in Shell's public advertising campaign for Quest (Imagination, 2016)

6 Netherlands case studies

The Netherlands took an early interest in CCS development, including the technology in government climate policy as early as 1999, followed by the launch of the CRUST CO_2 storage pilot in 2004. A government research programme (CATO) was also set up in the same year. In 2007, the Dutch government issued a tender for CO_2 storage demonstrations which eventually awarded 30m euros each to two onshore storage proposals: Shell's oil refinery-based project at Barendrecht (discussed in the following section) and another plan to capture CO_2 from an ammonia plant in Geleen. Led by a consortium of DSM Agro, GTI, and VITO, the Geleen project was located in an already industrialised area and received little public protest, although an incident in which a leaked document referred to local residents as 'enemies' rapidly soured relations. This project was cancelled in 2010 primarily due to the moratorium on onshore storage following public opposition to the Barendrecht project. One of several proposals for large-scale demonstration of coal power-based CCS made in 2005 and 2006, Rotterdam's ROAD project was later selected as one of six European demonstrations to receive funding under the European Energy Programme for Recovery (EEPR), and remains the only active CCS demonstration project in Europe.

A Europe-wide survey of CCS attitudes conducted in 2011 found markedly higher levels of awareness of the technology in the Netherlands of 52%, which was ten times the average for the region. This is most likely due to the highly publicised public reaction to the Barendrecht project from 2009 to 2010 (European Commission, 2011; Pietzner and others, 2011). On the other hand, the proportion of people who would be very concerned by CO_2 storage near their home was among the lowest for European countries (19%). A 2013 study by Ashworth and others found CCS awareness as high as 84% among those surveyed, and with the most negative attitudes to the technology of a selection of countries (Canada, Australia, and Scotland).

6.1 Barendrecht

As an early CCS initiative, which was cancelled almost entirely due to local opposition and negative media coverage, the project at Barendrecht in the Netherlands has become a poster child for the consequences of a failed public outreach campaign, and has informed nearly all subsequent discussion of the potential pitfalls in gaining project acceptance. Indeed, it represents arguably the first moment at which the CCS industry realised that the then-new technology could be met by any significant opposition. In response to the government's 2007 CCS tender, Shell submitted the proposed project for its oil refinery at Pernis in the port area of Rotterdam, where a relatively pure stream of CO_2 is produced as a by-product of the hydrogen production process. Although part of the 1 Mt/y CO_2 emissions are sent to the drinks industry and local greenhouses, around 0.4 Mt/y remained for sequestration in nearby depleted gas fields under the towns of Barendrecht and Albrandswaard. The project was seen as so technically straightforward, that the main aims of Shell and the government were to test the legal and regulatory framework for CCS, such as the claiming of EU Emissions Trading System credits, as well as monitoring and verification procedures. However, Barendrecht had a much greater number of residential homes over the proposed storage site, and so became the centre of opposition to the plans, and thus synonymous with the project itself, while concern in Albrandswaard remained minimal. In addition to public opposition, the fatal blow for the project

was the concerted opposition of the municipal and regional authorities, who pitted themselves against Shell and the national government. The unpopularity of the project was such that it resulted in an effective moratorium on onshore storage in the Netherlands (Feenstra and others, 2010; Brunsting and others, 2011; Oltra and others, 2012b).

6.1.1 Key events

Shell first presented the CCS project to the Executive Board of Barendrecht in 2007, followed by a further presentation to the town council in early 2008, where it was not well received. At this stage, Shell had already begun the necessary environmental impact assessment (EIA), and the project appeared likely to proceed, leading the town to see itself as a helpless recipient of the plan. As part of the EIA, two public meetings were also held in 2008 which attracted large crowds and raised several concerns and technical questions which were not considered to be met with satisfactory responses. Concerns among the general public generally centred on the effect on property values and the perceived health risk posed to those living directly over the site, while local authorities also questioned the need for such a project to be imposed on a relatively densely populated area which had already been subjected to its fair share of industrial infrastructure. A statement in an early government report on CCS regarding the potential need to avoiding populated areas was used to back up this stance (and frequently cited by later opponents), although the document in question did not actually recommend such an approach. At this stage, the national government was not visible in the discussions, and the project was widely perceived to be a profitable venture for Shell, in which they were to be subsidised while further damaging the environment. The broader context of the place of CCS in the government's energy policy and its role in mitigating climate change was therefore somewhat lost. Potential economic benefits or enhanced status for the town were also not used as possible incentives. Even before completion of the EIA, a government grant was awarded as part of the tender process, fuelling the perception that the project was to proceed regardless of local feeling.

In response to the growing opposition to the project, Shell and the national government took a number of initiatives over the course of 2008 and early 2009, including the formation of a consultation group and opening an information centre near the storage site in Barendrecht. Known as BCO2, the consultation group was intended to set up direct communication between the local government and the developers, and it included representatives from the national government, the municipalities, and the regional environmental regulator, but did not include Shell. At this stage, developing a common stance was not possible, and the group served largely to avoid each party being surprised by announcements from the others. BCO2 was also tasked with setting up the information centre in Barendrecht, which used an external company to present all opinions on the project in an objective manner, including views of NGO, but still tended to be regarded purely as a Shell initiative by the public. Nevertheless, centre staff reported that only around a third of visitors were hostile to the project, with a third in favour and a third indifferent. The municipality was not involved in the information centre, preferring to use other means such as its own website and local media to communicate its stance. Other actions taken in 2009 included the launch of a website also intended to present a neutral view, large public meetings which attracted over 1000 people, and visits from

government ministers to the homes of concerned residents – these visits were well appreciated but did little to change public opinion (Feenstra and others, 2010).

On the publication of the EIA in early 2009, the municipal government called for further studies to be performed into the necessity of siting the project in Barendrecht, the potential psychological health effects on people living in fear of CO_2 leaks, and external safety issues, which were duly performed to the satisfaction of the national government, but with the municipal government critical it had been little involved in preparation of the reports. Although apparently not aimed at Barendrecht specifically, national legislation was passed in 2009 to remove local authorities from the permitting process for infrastructure projects, further adding to the sentiment that local views were being disregarded. Later in the same year, an organised activist group called 'No to CO_2' was set up by local citizens (Figure 13). Despite this, in November 2009 the project was finally approved by the national government to much local consternation. A 2010 survey of residents found 85% strongly against the project, with 82% believing CCS 'unsafe', and 72% considering a fall in property values very likely (Terwel and others, 2012).

Figure 13 Example CCS protest poster from Barendrecht (left) and an image used for the front cover of Dutch science magazine NWT, depicting an artistic impression of an explosive CO_2 release in the town (right) (Anderson, 2013)

Over the course of 2010, the government stalled over finalising project plans as the issue became a political tool taken up by some opposition parties at a national or provincial level in the run up to elections in June. A further legislation change prevented local governments from taking legal action against infrastructure projects, but negative media coverage also escalated, with a documentary entitled 'CO_2 bomb under Barendrecht' presenting a highly negative outlook on national television (Figure 13). The final decision was delayed until after the election, but the incoming government did not wait long before finally cancelling the project.

6.1.2 Analysis and recommendations

Given the initial poor reaction to the project locally and the rapid deterioration of relations, gaining acceptance for the project in Barendrecht was always going to be challenging, and may never have reached

a satisfactory result. However, had the developers taken better account of the need for local acceptance, several steps could have been taken to improve their outreach strategy.

Early engagement

Although the local authorities were engaged soon after the project was conceived, at this stage the project was already advancing rapidly and most of the details had been decided. Shell have highlighted that the nature of the government tender required a schedule-driven approach which was not compatible with the need for early debate. Ideally, the town would have been first approached as a potential candidate, allowing it at least a perceived role in the siting process. Many of the more public-oriented communication efforts taken as a reaction to opposition, such as the information centre, 'neutral' website, and visits to residents' homes, needed to be taken much earlier to be effective. Furthermore, the national government could have more widely publicised the decision to include CCS in its wider energy policy before any demonstration programme was launched, allowing for a more active public debate about the need for the technology.

Key messages

Although the goal of averting climate change certainly formed part of the developer's message, the arguments for CCS playing a role in CO_2 mitigation were not made sufficiently clear to the town. The project could have better highlighted the national and global effort to develop CCS as part of a range of solutions, and the related need for demonstration projects to advance the technology. This may have helped extend the debate beyond local issues and give the town a greater sense of contributing to a global effort. Instead, the knowledge to be gained from the project was perceived to be largely for the benefit of Shell. Perhaps more importantly, there was little attention paid to the potential benefits to the community, such as increased economic activity and international status associated with a pioneering project. The information provided by Shell and the government was instead largely technical and difficult to understand. For example, members of the public were frequently simply referred to the EIA to answer their questions, even though the document was difficult for a layperson to comprehend.

Active dialogue

Rather than simply relaying information to the town, the municipal authorities should have been encouraged to take a more active role in the project. Although the developers responded to their request for further studies in the EIA, they still did not feel sufficiently involved in this process. Feenstra and others (2010) have proposed that the municipality could have been involved in the EIA from the start, with a say on the content of the study and who should conduct it.

Trust and transparency

A loss of trust in Shell and the national government occurred early in the process and severely weakened any further efforts to improve communication, which was seen as pro-CCS propaganda. As a multinational company in the fossil fuel industry, it is challenging for Shell to gain a large degree of public trust, but several measures could have been taken to improve trust in a fair project process. More neutral and trusted proponents of the project, such as research institutes and NGO, were involved as a response to the opposition, but would have been better used proactively during the initial contact with the town. Shell may

also have gained trust through increased transparency in its motivation for pursuing the project, as claims that the company would not profit from it were seen as disingenuous. In reality, Shell's interest in CCS is largely a strategic investment in the future viability of fossil fuels, and this could have been made clear. The company also insisted that the project was entirely free of technical risk, but could have been more transparent about uncertainties relating to full-chain integration that were raised in the EIA. Trust in the national government was irrevocably damaged by the legislation withdrawing powers from the local authorities, which were seen as circumventing the democratic process.

6.1.3 Conclusions

The potential for local opposition to CCS at Barendrecht was obviously greatly underestimated by Shell and the national government, with serious long-term consequences for the future of CCS demonstrations in the Netherlands and elsewhere. As one of the earliest CCS projects in Europe, it is perhaps understandable that this problem was not expected, and the lessons learned regarding the importance of public outreach can be seen as one positive outcome of the project. It is not possible to know whether the project could have ever received sufficient local acceptance had outreach been improved, or whether the area was simply unsuitable due to the density and demographics of the local population. However, it seems likely that the highly emotional opposition and negative national media coverage could have been avoided through improved outreach, with less damaging long-term consequences for attitudes to CCS in the country and neighbouring countries.

6.2 ROAD

Named after the Dutch acronym for 'Rotterdam capture and storage project', ROAD involves the post-combustion capture of a 250 MW equivalent slipstream from a new 1100 MW coal-fired power plant and the storage of the resulting 1.1 Mt/y of CO_2 under the North Sea. Initiated by E.ON Benelux (now Uniper Benelux) and GDF Suez (now Engie Nederland) in 2009, the project was one of the six allocated EU funding as part of the EEPR and also received 150 million euros in Dutch government funding in 2010. Although the Maasvlakte Power Plant 3 was completed in 2015, the CCS element of the project has remained in limbo for several years while additional funding was sought, and was recently 'reactivated' in 2016 based on a revised business model. It remains the only nominally active CCS demonstration project in Europe.

Initiated at the height of local opposition to the Barendrecht project, ROAD could not fail to incorporate an extensive stakeholder engagement strategy in its plans, although the offshore storage element would certainly help reduce local concerns relative to the earlier project. With the experience at Barendrecht in mind, ROAD's strategy had a particular focus on gaining the support of local and regional authorities. The developers aimed to embed communications within every aspect of the project's organisation, and for it to inform every decision taken. A dedicated stakeholder management team was set up to handle everything relating to public engagement, permitting, and knowledge dissemination, and was closely involved with the work of other project groups, particularly in providing stakeholder-based risk assessments. The project's overall strategy aimed to move from an initial phase of informing stakeholders, towards a

consultation phase where local feedback could be incorporated, and finally to form a close working partnership with the community (Figure 14) (Kombrink and others, 2011; Prangnell, 2013).

To start with, the perceptions of CCS and potential influence of various stakeholder groups, such as local and national authorities, regional business platforms (the Port of Rotterdam), ENGO, research institutes, and media were mapped using a 'force field' analysis, based on survey data and focus groups (Figure 5). Based on this and prior experience at Barendrecht, the project aimed to emphasise the local value of the project and its crucial role in the economic development of Rotterdam port and the surrounding industrial area, while presenting clear statements of the project's vision and mission:

Vision: 'in transition to a sustainable energy supply we will have to rely on various transition technologies in order to secure a reliable, efficient and clean energy supply';

Mission: 'demonstrating that a large-scale, integrated CCS-chain (offshore) can be applied in a reliable and efficient way within 10 years and can make a substantial contribution to the climate change objectives and share knowledge and experiences with other industries and countries'.

The project used various tailored communication materials for its outreach work, including brochures, exhibition materials such as core samples, the project website (including FAQ), and videos, all of which were checked by technical experts and endorsed by independent research institutes where possible. One of the first activities undertaken was to present to key stakeholders individually, such as council members of local communities and representatives from regional authorities including the Port of Rotterdam and NGO. Presentations were also provided to existing community meetings, and to other key stakeholders referred by the first group. As part of the regulatory requirement for starting the EIA process, ROAD then organised two town hall meetings in the nearby communities, using an info-market style with stands on various topics, and core samples to help understand the geology of the storage site. This informal style allows more one-to-one dialogue and avoids a few critics stirring up a crowd. The technical experts presenting received communications training. In September 2010, a stakeholder roundtable meeting was held with representatives from government, local authorities, industry and academia, leading to the setting up of a regional advisory committee on CCS with the aim of closely co-ordinating CCS initiatives in the Rotterdam port area. In general, feedback from stakeholders was mostly positive, and appreciative of the efforts taken to engage.

Other activities included site visits to the power plant construction site, press releases, and one-on-one media briefings with journalists from local, regional, and national media. A noteworthy incident occurred in October 2010, when Greenpeace ran a negative piece about the project in a local paper. The project rapidly responded with an op-ed article refuting incorrect statements in the Greenpeace article, as well as distributing the response to all relevant stakeholders. This prompt action seemed to halt any further ENGO opposition and Greenpeace Netherlands soon lost interest in the project.

In the long term, as the project moves towards operation, the intention is to create a community advisory panel to provide a platform for ongoing dialogue with the local public.

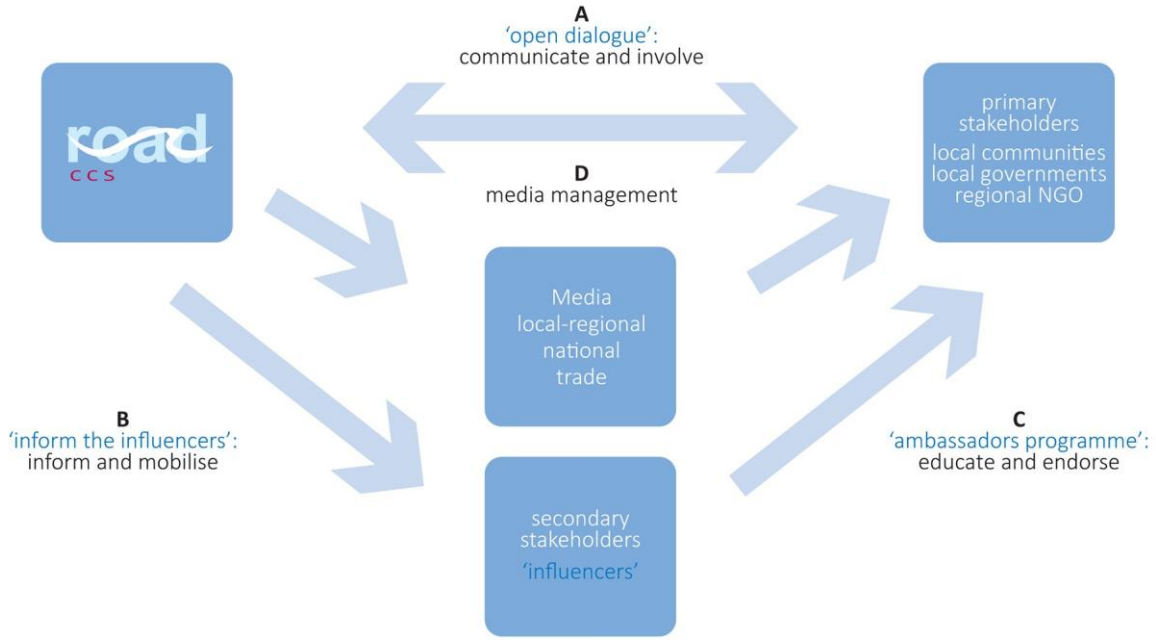

Figure 14 A representation of the stakeholder outreach strategy for ROAD (Kombrink and others, 2011)

7 Germany case studies

At around the same time as the declining fortunes of the Barendrecht plant, CCS was also facing growing political opposition in Germany, with similar long-term consequences for the future of onshore CO_2 storage in the country. While this outcome may initially appear to be evidence of an unavoidable, direct rejection of CCS by the German population, closer analysis reveals the significant roles played by public outreach failures, concerted NGO activism, regulatory uncertainty, and the complex interplay of politics at the state and national levels. The struggles of CCS implementation in Germany can be charted by the progress of the EU's so-called 'CCS Directive' – a 2009 ruling requiring member states to establish national legislation for CCS, but with the option of setting significant limits on the technology's deployment. This legislation was presented to parliament (the CCS Act) in increasingly weakened forms from 2009 onwards, eventually being passed into German law in 2012 with highly restrictive clauses limiting CO_2 storage to small volumes and allowing any state to independently forbid storage on its territory. However, the initial prospects for CCS in the country appeared highly favourable, with most political parties (including those in government) strongly supportive, together with strong backing from the energy industry and fossil fuel power plant manufacturers such as Alstom. Most national ENGO, as well as the Green Party, were also moderately in favour of the technology, although they called for a more cautious approach which would focus on demonstrating the technology to further its later use in Asia, and give priorities to renewables and energy storage options. The failure of the initial, highly supportive form of the directive to be passed in 2009 therefore came as a surprise, and represented a victory for a niche group of radical CCS opponents including Greenpeace and BUND, together with a loose coalition of public activists including landowners and farmers (Fischer, 2011; Gründinger, 2015).

7.1 RWE and early opposition

Much of the grass roots opposition to CCS which ultimately proved so politically influential can be traced to poor public outreach by the early CCS projects, under development well before the first proposal of the directive. In particular, the Hürth plant proposed by RWE in 2008 seems to have been a trigger for much opposition in the locality of its storage site, which rapidly spread to other regions. While this plant was to be located in the heavily industrialised state of North Rhine-Westphalia, suitable geology for CO_2 storage is found mostly in the state of Schleswig-Holstein, which would be accessed via a pipeline through the third state of Lower Saxony. Like Shell at Barendrecht, RWE did not see CCS as a particularly risky technology compared to other established infrastructure such as natural gas pipelines and storage, and paid little attention to informing the local populations prior to an official announcement in August 2008. Schleswig-Holstein is a rural state, also home to numerous community wind farm initiatives, and with little economic or social connection to the coal industry. The proposed arrangement could therefore easily be cast as one state having to act as a dumping ground for the waste of another, without gaining any of the potential economic benefits of the new plant. On top of this, RWE were initially secretive over the storage site locations, downplayed risks, communicated largely in technical terms, and neglected the key message of the role of CCS in averting climate change. The company belatedly tried to improve its communications strategy after it had lost public trust and was widely perceived to be acting in a confrontational and entitled

manner. Amidst unfounded concerns that exploratory drilling would forcibly take place on agricultural land, early opposition was first initiated by the farmers' association (Gründinger, 2015).

Broader opposition grew rapidly in Schleswig-Holstein as CCS became visible on the political agenda in 2009, and the first CCS law was proposed. A citizens activist group called 'Stoppt das CO_2-endlager' was formed in May 2009, expanded rapidly and began highly effective lobbying activities through interaction with the media, petitions, and mass demonstrations. They were soon backed by regional authorities such as town councils and opposition parties at the state level. Importantly, Greenpeace and BUND actively supported this local uprising and helped spread opposition to the states of Brandenburg, where Vattenfall had proposed its own CCS demonstration plant, and Lower Saxony, through which the Hürth pipeline was to pass. Common local concerns in all these areas included the risk of leaking CO_2 causing asphyxiation, contamination of drinking water, as well as lowering property values and damaging the reputation of the region for tourism. However, these issues soon broadened to a wholesale rejection of the concept of CCS as a tool for supporting the fossil fuel industry at the expense of renewable energy initiatives. Much of the public debate was conducted against a backdrop of poor knowledge of the technology itself, with a 2009 survey finding only 1% of respondents could describe the basics of CCS but 75% believing it to have large problems. This low awareness in itself can be seen as a fatal failure of public outreach by either the government or the companies involved. The anti-CCS ENGO also drew a highly effective analogy with the movement against nuclear waste disposal – still a highly emotive issue in Germany at the time, by using similar terminology and colouring in their materials (Figure 15) (Gründinger, 2015).

Figure 15 A protest against CCS in the Schleswig-Holstein region of Germany (Spiegel Online, 2010)

The effect of this negative public mood was amplified by upcoming state elections in Schleswig-Holstein which encouraged even politicians from the ruling parties to change their stance on CCS, including the prime minister whose own seat was a proposed storage site. The state government thus agreed to reject the recently tabled CCS Act when it came to the vote at the federal level. This position was quickly adopted by state governments in Lower Saxony and even Bavaria, where some potential storage sites were located

although no plants had been proposed. Only Brandenburg, a state strongly tied to the coal industry, maintained their support, while insisting other states also accept CCS for fear the state should become a 'dumping ground' for the nation's CO_2. Sharing a political party with many of the opponents at the state level, Chancellor Merkel was obliged to stall the CCS Act, and ultimately remove it from the political agenda for the near future. The Hürth project was cancelled by RWE in the same month.

7.2 Jänschwalde

As the highest profile victim of the rejection of onshore CCS in Germany, Vattenfall's proposed Jänschwalde plant has received much attention in various analyses of outreach failures in the country. However, Vattenfall were much more conscientious in their outreach approach than RWE, and may have suffered from the mounting national mood against CCS more than failings at the local level. Announced in May 2008, a new 250 MW oxyfuel combustion unit was to be added at the existing Jänschwalde power plant in Brandenburg, along with a post-combustion capture facility equivalent to 50 MW fitted to the existing plant. While these new additions did not meet with any opposition amongst a local, industrial community with strong ties to the coal plant, the proposed storage site under the more rural town of Beeskow (also in Brandenburg) was much more problematic. This picturesque, agricultural area is inhabited largely by older residents with a strong sense of community and conservative values, as well as newcomers from cities who want to live closer to nature (EU CCS Network, 2012a; Prangnell, 2013).

7.2.1 Strategy

While not necessarily expecting the eventual negative reaction to CCS, Vattenfall assumed a level of opposition in the area as would be encountered for any large infrastructure project, and carefully planned their engagement strategy with the community. A dedicated communications team of seven people was closely integrated with the rest of the project and frequently reported back on key developments. For example, in response to such information the announcement of the project was delayed so as not to coincide with an initiative against new opencast mines in the state. Early on, the energy company set up an information centre in Beeskow staffed by local people and launched a regional information campaign using public meetings, a touring exhibition, school visits, mailshots, and tours of their pilot capture plant at Schwarze Pumpe. A prior social characterisation of the area identified influential stakeholders and relevant authorities and invited them to take an active role in the process. For instance, the state ministry of economic affairs was involved in planning from the start, setting up a local advisory council that acted as a link between Vattenfall and the community. Continuous contact was maintained with these key stakeholders, and the regional authorities remained largely supportive. The overall approach of the communication plan was to set up a local dialogue on CCS at an early stage and allow people to address their fears by being present and approachable. Key messages focused on the importance of the CCS for climate protection and security of the energy supply, as well as the leading position of Vattenfall in developing the technology and its 'made in Germany' status. Adaptations to the company's strategy over the course of their campaign included using more trusted experts such as local academics to present to stakeholders instead of Vattenfall employees, as well replacing standard brochures with more easily understandable fact sheets.

7.2.2 Opposition and cancellation

Despite Vattenfall's best efforts, the town of Beeskow proved to be more receptive to the increasingly negative view of CCS then spreading throughout Germany. Concerns again centred on the risk of drinking water contamination and the potential loss of tourism and the industrialisation of an idyllic rural area. Offers of financial compensation to residents were met with further suspicion and regarded as evidence that the project was not safe. Eventually, formal complaints were filed with the regulators and consenting authorities. The ongoing political uncertainty surrounding the CCS Act in German law was to ultimately put an end to the project however, as even a revised and much weakened version of the Act was defeated by the upper house of the federal government in late 2011, despite the ongoing support of Brandenburg for the technology and its project. Jänschwalde was cancelled shortly afterwards and Vattenfall eventually ceased all CCS activities in 2014. The CCS Directive was finally passed into German law in 2012 (with the delay incurring a penalty from the EU), but became termed a 'non-CCS' Act as it limited the volume of onshore CO_2 stored at a given site to below that needed for a demonstration plant (Prangnell, 2013; EU CCS Network, 2012a; Oltra and others, 2012b).

7.2.3 Conclusions

The case of Jänschwalde appears to illustrate that even a well thought out engagement strategy can come to nothing if the context of the location is challenging and the national-level and political debate on CCS is highly unfavourable. There is little criticism of any aspect of Vattenfall's approach to be found in the literature on Jänschwalde, although Dütshcke (2011) has suggested that the developer was too positive and downplayed some of the project risks. Vattenfall maintains that it did everything it could, only to meet with an unchangeable, emotional reaction to the technology. However, in response to their experience at Jänschwalde, Vattenfall did develop a new stakeholder engagement model which seeks to better deal with affected stakeholders and resolve conflicts (Figure 16) (EU CCS Network, 2012a).

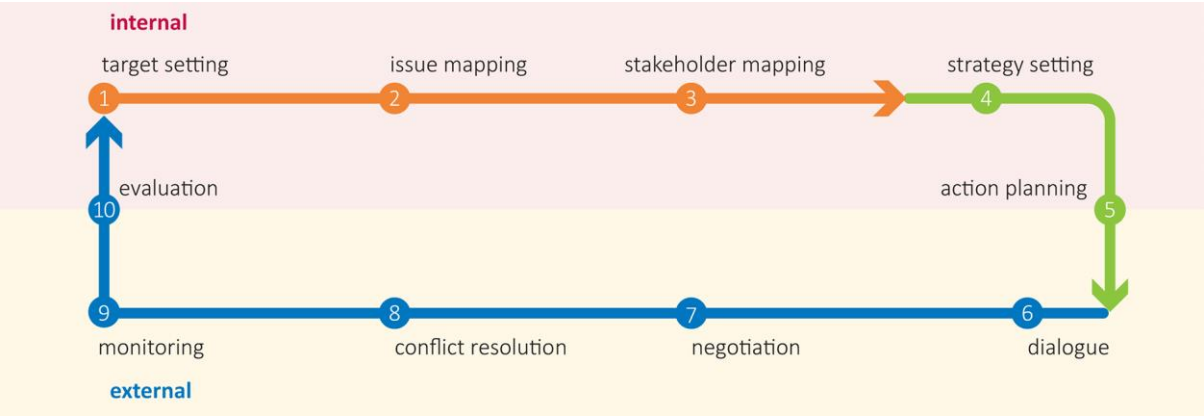

Figure 16 The new stakeholder engagement model developed by Vattenfall following the Jänschwalde project (EU CCS Network, 2012a)

7.3 The Ketzin project

As an onshore CO_2 storage project that met with good local acceptance, the CO2Sink research facility at Ketzin provides a useful counter-example to Germany's high-profile failed CCS demonstration projects.

This EU-funded research project sought to study the behaviour of geologically stored CO_2, and was undertaken by a consortium led by GFZ (the German Research Centre for Geosciences) and included industrial players such as Vattenfall, RWE, E.ON, and Shell. Limited to injecting a maximum of 100 kt of CO_2 over its operational period from 2008 to 2013 (the eventual amount was 67 kt), the much smaller scale, research-based nature, and limited timespan of this project clearly worked in its favour with local residents. Situated in an industrial location outside Berlin, the context of the local area is also likely to have been influential in the success of the project. The site was previously used as an underground reservoir for natural gas, and was even involved in an incident in 1964 when a small village had to be relocated due to a gas leak. This familiarity with gas storage, and even its potential risks, may have helped acceptance of the new storage pilot. Nevertheless, the relative success of the project during a period of passionate opposition to CCS in Germany remains striking, and the role of GFZ's thorough outreach approach should not be discounted (Liebscher, 2015).

The consortium first held meetings with the mayor and landowners as early as 2004, followed by local hearings in the town hall in 2006 – crucially, before the location of the project in Ketzin was finalised and contact with the national media. The start of drilling and injection activities were used as occasions to hold public events, and the project also participated in local events such as a harvest festival in 2009. From 2007, a visitor centre was used as the focal point for public outreach activities and site tours, with poster displays, brochures, films of the injection process, rock samples, and hands-on experiments for visualising concepts such as CO_2 solubility and rock permeability. Although most visitors to the centre are researchers and students, 25% were from the general public in a three-year period from 2010. A large annual open day event was also initiated in 2011, with participation from local businesses, musicians, and the fire brigade. From 2012, activities expanded to visit local schools, using short films, experiments, and presentations adapted to school pupils. Outside of Ketzin, the team participated in science outreach events at institutions in the nearby cities of Berlin and Potsdam. Other materials include the project website, with FAQ and details of all activities and information events, and a podcast produced in 2010 (Szizybalski and others, 2014).

As the EU-funded CO2Sink project ended in 2010, the Ketzin project operated under the German-funded CO2MAN project for the last three years of its injection period. This period seems to have coincided with an increase in public outreach activity, including an expansion of the visitor centre and improvement of the permanent exhibits, introduction of the annual open day and educational outreach, and improvement of the project website (Szizybalski and others, 2014). Some criticism of outreach efforts at Ketzin has therefore referred to the earlier phase of the project, pointing out that site visits were often booked up for weeks in advance by scientists or government officials, and that the CO2Sink website was only available in English and too technical for a general audience (Dütschke, 2011). However, the project gained good local acceptance even over this period, and was seen as a benefit in bringing international attention and greater visitor numbers to the town (Oltra and others, 2012b).

Several analyses have identified Ketzin's status as a research project as the most influential factor in its acceptance, with residents more trusting that scientists would shut down the project in the event of any leakage or other problem (Dütschke, 2011; Oltra and others, 2012b). The significance of the volume of CO_2

itself may have been overstated in analysis of the project (even by interviewed residents themselves), as few people will have a clear idea of the relative volumes involved in the pilot and demonstration cases or the change in risk (if any). Dütschke (2011) has also argued that the initial outreach efforts for the Ketzin project were less thorough than those employed by Vattenfall for Jänschwalde, but perhaps with the key difference of informing residents well before any definite plan was in place.

8 United Kingdom case studies

Helped by its access to the highly suitable storage geology of the North Sea, the UK has been a prime candidate for carbon capture development since the early days of the technology, but initially lagged slightly behind its continental neighbours in promoting large-scale demonstration projects. In 2005, an early proposal by BP for the Peterhead gas plant in Scotland had to be abandoned as government funds were not yet secured. However, the government launched its first competition for bidding demonstration projects in its 2007 budget, eventually awarding funds for front end engineering design (FEED) studies at Scottish Power's retrofit project at Longannet coal plant in Scotland and E.ON's proposal for Kingsnorth coal plant in Kent, although the latter would soon drop out. In 2010, the prize of £1 billion in investment was specified by the coalition government, but the Longannet project also had to stand down in 2011, as the developers and government were unable to agree on the required funding. In April 2012, a second competition known as the CCS commercialisation programme was launched with the same £1 billion in government capital at stake. The White Rose coal plant at Drax and a new retrofit proposal for Peterhead (this time led by Shell) were chosen as preferred bidders and completed FEED studies, only for the competition to be cancelled in late 2015 and both projects to cease all activities.

A few of the large-scale projects which were rejected in the two UK-funding competitions are still nominally active. Of these, the proposed Don Valley IGCC plant (formerly known as Hatfield) in Yorkshire is notable for being one of the six demonstration projects selected for EU funding as part of the European Energy Programme for Recovery, but further funding through the NER300 scheme was lost due to the UK government's lack of support. Two other plants were kept as reserve bidders in the final stages of the last commercialisation competition and have both received some government funding to conduct feasibility work. The Caledonia Clean Energy project plans to build a new IGCC plant at Grangemouth in Scotland, while the Teeside Collective project proposes linking the CO_2 from a number of industrial emitters in North East England, including fertiliser and hydrogen production plants, and has seen good local support due to its links to local jobs and economy (Gough and others, 2016).

As all UK CCS projects have proposed offshore storage in the North Sea, there have been no public concerns over the hazards of escaping CO_2, but some coal power projects in particular have faced general opposition to coal. In particular, several ENGO and other organisations including Greenpeace and the WWF, were strongly opposed to E.ON's 2006 proposal to build two new ultrasupercritical units at Kingsnorth, even following the company's plans to use the units in its bid for CCS funding in 2008. The power station experienced a number of break-ins and other action by protesters (largely from Greenpeace) between 2007 and 2009, but this could be attributed to general scepticism that the CCS plans would be realised (Adam, 2008; Greenpeace UK, 2008).

The 2011 Eurobarometer study of CCS awareness found 25% of people in the UK had heard of CCS, while a UK government study in the following year placed this figure at 36% (Eurobarometer, 2011; DECC, 2012). Despite the progress of the second CCS competition and particularly its cancellation receiving a moderate amount of media coverage, awareness had only grown to 41% at the time of the last government survey in

April 2016, with half of these not knowing anything more about the technology. Interestingly, over half of those aware of the technology supported it, with only 8% opposed (BEIS, 2016).

8.1 Peterhead

Located in the north-east of Scotland close to a terminal for gas arriving from offshore, SSE's Peterhead Power Station has operated various gas-fired units since the 1980s. In its current form, three combined cycle gas turbines can generate over 1 GW of power, but are usually limited to a maximum output of 400 MW. The two different CCS projects proposed for the Peterhead site have not faced any significant opposition, and have rather seen a considerable degree of support from authorities and local residents. The Scottish Government has strongly championed both incarnations, while criticising the UK Government for failing to support either of them sufficiently. These high levels of acceptance are perhaps not surprising given the familiarity and connection of the local population to both the existing power plant and the offshore oil and gas industry, as well as the offshore nature of the CO_2 storage. Nevertheless, it is instructive to look at the outreach campaigns conducted by the two sets of developers in the area.

BP's initial proposal planned to construct a new facility to steam reform natural gas to hydrogen and CO_2, using the hydrogen to fuel a gas turbine and sending the CO_2 for EOR in the almost-depleted Miller oil field. While physical extensions to the power plant site were required, these were considered minimal, and the prospect of extending the life of the oil field was thought economically beneficial to the area. The developers conducted consultations with local authorities, community councils and the general public, allowing for discussion and questioning. Positive backing from the local media and Scottish Government also helped lend the project credibility and assured the support of the local community (Hammond and Shackley, 2010).

Led by Shell, the second proposal at the Peterhead site came much closer to realisation than the first, having completed a detailed FEED study in late 2015, shortly before the government withdrew funding. This CCS demonstration would have used Shell's Cansolv amine technology to capture CO_2 from one of the three 385 MW gas turbine units at the site, sending the CO_2 via the existing gas pipeline for storage in the depleted 'Goldeneye' gas reservoir offshore. Despite the relatively uncontroversial nature of the project and support shown for its predecessor, Shell were determined to avoid a repeat of their mistakes at Barendrecht and embarked on an extensive public outreach campaign which sets a useful example for other, more challenging projects. As a requirement of the UK competition process, details of the project's outreach strategy are publicly available, as well as an extensive report on the obligatory public consultation prior to submitting the planning application. Lasting over a year from September 2013 onwards, this consultation went far beyond the legal requirement, and actively sought to gain support for the Peterhead project and CCS at a local and national level.

8.1.1 Outreach strategy and organisation

Shell made a distinction between stakeholder engagement, involving a consultation and dialogue with carefully identified key stakeholders, and communication, which sought to promote understanding and awareness of the Peterhead project and CCS generally at local, regional, and national levels, although it

recognised significant crossover between these concepts (Horan and Anderson, 2015; Shell, 2016). The objectives of the stakeholder engagement were identified as:

- to build relationships with key stakeholders in local communities and several opportunities for meaningful public consultation on proposals;
- to instil confidence in key stakeholders about Shell's global CCS expertise;
- to identify at an early stage any potential issues that might arise;
- to work with local communities and external agencies to identify and maximise opportunities to deliver local benefits;
- to build relationships with a variety of local, national, and international organisations;
- to contribute expertise, insights and learnings to think-tanks, industry groups, academia; and
- to provide a legacy of learnings.

The company identified 100 key stakeholder organisations or individuals across eight categories: local communities; regulatory/environmental; government/political; academics; media; NGO; industry, and internal (project employees). Individuals responsible for each sector were required to regularly report back in a discussion forum, in which feedback was used to help analyse and change behaviours or influence project decisions. Drivers of stakeholder attitudes were separated into local level issues such as environmental, health and safety impacts and potential benefits, and national and international discussions on the role of CCS and climate change. The engagement team sought to focus on developing face-to-face, collaborative relationships, while showing respect and accountability. This required early engagement to give stakeholders a chance to provide their input, communication of benefits and risks in a transparent manner to ensure trust, and educating stakeholders and the wider public about the role of CCS. To achieve these goals Shell planned to capitalise on the existing positive local relationships from the previous CCS project, and exploit ENGO and political support as much as possible.

Objectives of the broader communications campaign were:

- to become the trusted source of information on the project for all stakeholders;
- to manage communications to the media at all levels;
- to align internal and external communications, and coordinate them with project activities; and
- to quickly identify key non-technical risks, issues and opportunities.

8.1.2 Local engagement and communication

Engagement in the local area began in 2012, prior to a formal planning application, and continued in an informal way until the last quarter of 2013, when the pre-planning consultation began and a CLO from the local area was appointed and based at a community centre in Peterhead. The pre-planning consultation was divided into three phases over a 13-month period from November 2013, allowing subsequent phases to better respond to feedback from the earlier phases (Figure 17). Each phase included collective briefing sessions to all stakeholder groups, as well as individual briefings to each group, several public exhibitions, and site visits. The project gave consideration to reaching groups who would not normally participate in

such public events, using a diverse range of materials such as a regular newsletter circulated to local communities, the project website, more concise leaflets, advertising on local radio and in local papers, as well as updates from the CLO. Shell brought exhibition stands to several community events such as country fairs and firework displays. Face-to-face meetings and conversations were held with specific groups such as the county council and the Scottish Environment Protection Agency, as well as with key members of the public such as the landowner adjacent to the site.

Summary facts about Phase 1	Summary facts about Phase 2	Summary facts about Phase 3
• 1 collective Stakeholder Briefing • Briefings with Boddam and Peterhead Community Councils • Briefing with Buchan Local Community Planning Group • Briefing with Buchan Development Partnership • 6 public exhibitions, 5 Venues • 15000 homes mail dropped • Adverts in 5 local newspapers and 2 local radio stations • Communications materials: 12-page project brochure and 2-page CCS paper, plus wallet cards with contact details • 29 project team members involved in exhibitions • 505 members of the public attended exhibitions • 49 feedback forms received at exhibitions	• 49 feedback forms received at exhibitions • Collective Stakeholder Briefing • Briefings with Boddam and Peterhead Community Councils • Briefing with Buchan Development Partnerships • Newsletter (advertising public exhibitions and site tours) distributed directly to 5000 homes • Adverts in 5 local newspapers and 2 radio stations for proposed exhibitions • 2 Public Exhibitions, 2 venues • Stakeholder Feedback Brief from Phase 1 • Four community tours of Peterhead Power Station • 198 members of the public attended (stakeholder briefings, public exhibitions and site tours combined) • 12 Feedback forms received	• 1 collective Stakeholder Briefing • Briefings with Boddam and Peterhead Community Councils • Briefing with the Buchan Local Community Planning Group • 2 Public Exhibitions on Onshore component of Project, 2 venues • 1 Public Exhibition on Offshore component of Project, 1 venue • Adverts for exhibitions in 5 local newspapers and 2 local radio stations • Consultation take-aways for attendees • 34 Project team members involved • 152 members of the public attended (including the three public exhibitions and stakeholder briefing

Figure 17 A list of Shell activities during each phase of the stakeholder engagement campaign for Peterhead (Shell, 2016)

Feedback from the public was received at events and meetings, through online or paper feedback forms, or from the CLO. Public exhibitions were well attended (850 people in total), and stakeholders were generally highly appreciative of the level and breadth of engagement, and supportive of the consultation process continuing in the same manner. The communities expressed interest in what opportunities and benefits could be associated with the project, such as jobs, contracts for local businesses, and investment in the community by Shell. Concerns principally related to the impact of the plant on the environment, whether visually or from air or water emissions, especially with regard to a potential effect on local wildlife and fisheries. Problems from increased traffic and noise during construction were also highlighted, as well as potential health risks from material and chemical transport to the site.

In response to this feedback, Shell developed a Local Benefits Strategy to maximise potential benefits of the project to the community. A major part of this was in developing opportunities for procuring contracts with local businesses, which was assisted by skills development agencies, apprenticeships and training

opportunities. A database of local businesses was compiled and Shell worked to enhance SSE's existing Open4Business portal which the utility uses to engage local suppliers and contractors, introducing training programmes so local suppliers could achieve standards required for the current project as well as future ones. Other activities included a policy of housing construction workers with a range of local accommodation providers within one hour of the power station. Local investment included a provision to upgrade the coastal pathway to the back of the power station.

The company committed to minimising the impact of construction traffic and keeping it within acceptable limits defined by the government, and to upgrading the entrance to the power station from the main road by creating a filter lane. The new section of the plant would be integrated with the existing structure to minimise its visual impact, and a detailed environmental survey was carried out to determine what measures should be taken. In addition to best practice handling procedures, concerns about hazardous chemicals and materials would be met with total transparency with stakeholders around the chemicals to be used.

8.1.3 Education initiatives

Shell ran a number of initiatives with local schools and universities, covering elements of the project, CCS, and climate change in general. Using GCCSI's CO2degrees educational material, several workshops were run with local primary schools (GCCSI, 2016c), and an award-winning resource for secondary school education in Scotland and England was developed with GeoBus – an existing geology-based educational programme (CO2degrees, 2017). Through Shell's existing support of a 'Girls in Energy' programme in Aberdeen, a two-week course on the project and CCS was held with ten secondary school girls. Preliminary talks with the University of Aberdeen looked at ways CCS could be further incorporated into their teaching.

8.1.4 Wider public engagement

To help promote the wider acceptance and awareness of CCS, presumably with a view to strengthening the existing political case for the technology in the UK, Shell made concerted efforts to publicise the project and engage the media on a national level. Newspaper and television journalists were involved with key events such as the signing of the FEED, leading to coverage in all major national and Scottish newspapers as well as on BBC and Sky news. The team worked with a BBC documentary entitled 'Planet Oil' which partly focused on the Peterhead project and the potential for CCS in the industry. Most notably, the team produced an advertising campaign based on billboards and posters throughout the country. These featured images of large red balls representing a volume of CO_2 placed next to famous UK landmarks and accompanied by taglines such as 'imagine capturing this much CO_2 every hour' (Figure 18).

Figure 18 Poster used in Shell's public campaign for Peterhead (Artnet News, 2014)

Interactions with the media were carefully managed with a view to positioning the project positively in the public consciousness and to generate interest, while providing accurate information and regular progress reports. To ensure consistency of the project's message, only a limited number of people could act as official spokespersons, and material from contractors required prior approval from Shell.

Shell also held meetings with the local ENGO including E3G, WWF Scotland, Carbon Connect, and Forum for the Future.

8.2 Longannet

The CCS demonstration project planned at Longannet power plant in Scotland was to install a post-combustion capture plant on a slipstream equivalent to 330 MW of an existing 600 MW unit. Proposed in 2009 by a consortium formed of Scottish Power (the plant owners and project leader), Shell, and National Grid, the project was buoyed by initial government funding in 2010, only to be cancelled the next year due to disagreements between the developers and the government over costs.

The CCS funding competition was a complication for the project's outreach, as it imposed fairly strict rules on what developers were allowed to reveal publicly. As for many CCS projects, the uncertainty associated with government funding created a challenging environment for project communication, where the need for early engagement is balanced by a potential loss of reputation if proposed actions are not actually taken. However, the project had a small, dedicated communications team which worked hard to build good relationships with influential stakeholders at an early stage, identifying external CCS experts who could act as trusted sources of information. These included university professors, ENGO, trade union representatives, local politicians, and power station staff. Many of these individuals went on to become external experts who were frequently called on by the media for comment on the value of CCS and the Longannet project. The outreach programme also included school workshops and site visits, and the plant's visitor centre was refurbished to include information on the CCS project in addition to existing material on the history of the

coal mine and power station. The project used the installation of a small carbon capture pilot at the site as an opportunity to host a high-profile launch effort which received national media coverage and attracted political engagement. While early communication focused on the general case for CCS in the UK, this moved to formal community and consultation discussion of economic benefits to the area following the start of the FEED work. The team tried to demonstrate that all stakeholder input was being considered and acted on as much as possible (Prangnell, 2013; Anderson, 2017).

Good support was gained from local authorities and a variety of national ENGO; particularly WWF Scotland, who provided useful guidance for the outreach strategy and became a powerful public advocate for the project. The project's cancellation was met with vocal disappointment from many of these groups and was portrayed negatively in Scottish media (Devlin, 2015).

8.3 White Rose

Planned by a consortium of Alstom, BOC, Drax Power, and National Grid, the White Rose project centred on a new 426 MW ultrasupercritical coal unit with oxyfuel combustion capture technology to be constructed on the site of Drax Power's existing coal and biomass plant in Yorkshire. The CO_2 was to be transported by onshore and offshore pipeline for injection into a saline aquifer under the North Sea. The offshore storage and existing power plant make this project relatively uncontroversial for the affected communities, and little outreach was thought necessary by the developers. In a region with a long history of coal mining and power, the power plant forms an important part of the local economy and local residents were generally supportive of efforts to preserve the future viability of the industry and increase employment opportunities. Consequently, no objections were raised at the public meetings required by the permitting process.

However, the construction of a new coal unit with government investment is bound to attract the attention of ENGO opposed to any form of coal power. Drax power plant had already found an enemy in NGO Biofuelwatch UK, which opposed subsidies for the large-scale firing of biomass in some of the plant's boilers. This group extended their opposition to the CCS plans, leading several small-scale protests and presenting a petition signed by almost 114,000 people. The Coal Action Network were also involved in protests and petitions against the project (Biofuel Watch, 2015; Coal Action Network, 2016). There is a danger that this relatively small but concerted opposition, much of it from outside the area of the plant itself, could have eventually been problematic for White Rose, had the project continued. Although the public was fairly indifferent to the project during its planning phase, a positive final investment decision would have greatly increased its visibility and likely attracted further opposition from NGO and the wider public, potentially derailing the government support. Ensuring against this kind of reaction would require a much more thorough outreach process to raise awareness of the arguments for CCS generally, of the kind conducted to some extent in the UK by Shell. As a rather more controversial project than the Peterhead demonstration, the White Rose consortium or the government could perhaps have focused more on this aspect, rather than assuming acceptance based on the absence of early opposition in the area.

9 Other European case studies

9.1 Compostilla – Spain

Spain's Compostilla CCS project centred on the construction of a new 320 MW oxyfuel CFB unit at the existing Compostilla power plant in North-West Spain, with 1 Mt/y of captured CO_2 to be stored in an onshore saline aquifer. Led by Endesa, Foster Wheeler, and CIUDEN – a newly created government energy research institute with a coal focus, the project was one of the six EU demonstrations awarded funding in 2009 as part of the EEPR, but was ultimately cancelled in 2012 due to financing difficulties (Endesa and others, 2013). Within the scope of this project, Ciuden also conducted extensive pilot-scale research on each stage of the CCS chain, including ongoing CO_2 storage tests at a pilot site near Hontomin (~300 km east of the Compostilla site). Communication and education form a key part of Ciuden's remit, and extensive outreach and engagement activities were conducted by the institute – both as an essential step in gaining permission for the storage tests at Hontomin, and with a wider view to increasing awareness and support for CCS on a regional and national level. The pilot and demonstration projects are notable for gaining good local support, despite featuring the challenging context of onshore storage in Europe.

The developers put together a dedicated, trained outreach team with specialists from different fields, including engineers and journalists, who held regular meetings and worked to present a unified message to project stakeholders. Specialised spokespersons dealt with the media, and a small dedicated team was used to interact with the public in order to provide familiar faces. To begin with, a social characterisation was performed on the areas relevant to the project, as well as national polls on attitudes to CCS. Although knowledge of CCS and the nature of CO_2 was found to be very low in Spain relative to some other EU countries, awareness was better in the region of the project (Endesa, 2011; Lupion and others, 2013).

The communication strategy encompassed outreach at a local, regional, and national and international level, with specific messages targeted at each (Figure 19). Specialised information packs were developed for different audiences, including journalists, authorities, and the general public. Interaction with the media at all these levels was seen as a priority, as a means to reach as many people as possible, and the team organised early press conferences, regular press releases, and site tours for journalists. For local communities, the potential for economic benefits and job creation was emphasised. In all cases a proactive approach was sought, with rapid response to feedback and complete transparency.

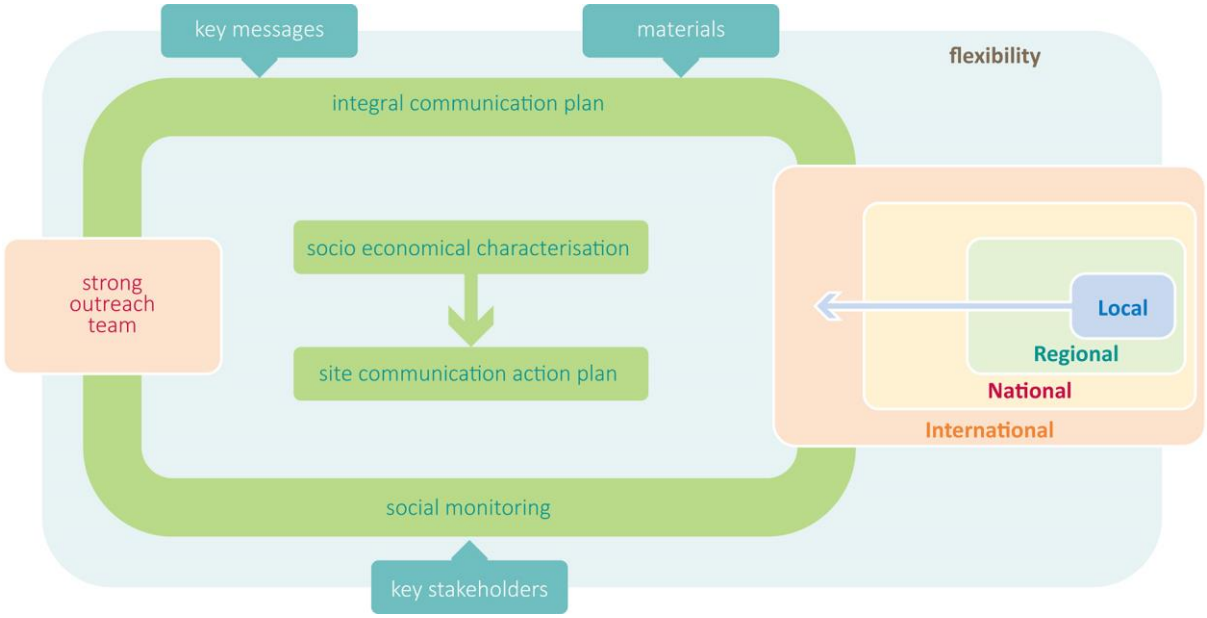

Figure 19 The public outreach process rationale used by Ciuden for the Hontomin and Compostilla projects (Lupion and others, 2013)

9.1.1 Hontomin pilot

Hontomin is a small rural community of only 86 inhabitants, largely consisting of relatively poor and elderly people, and with agriculture as its primary economy. The arrival of Ciuden researchers in the region was initially greeted with suspicion and scepticism, but the communication strategy rapidly won acceptance for the pilot storage site. As well as open days, face-to-face meetings with stakeholders, and presence in local media, the communications team attended a number of important local festivals to reach as many people as possible. From an initial position of ignorance regarding CCS, surveys of the population found majority support for the technology once the information packs had been distributed. The relatively poor community welcomed the prospect of an economic boost to the area, as well as the local pride associated with hosting a research project of international significance (Kovacs and others, 2013; Prangnell, 2013; de Dios, 2015).

Partly motivated by the low levels of awareness of climate change, energy, and CO_2 in the area, Ciuden formed a partnership with the regional authority to apply for government funding to work on education and communication of these issues to the population. Over this year-long project from September 2012, the team developed a broad range of activities and workshops for children and adults, including 'cooking with CO_2', 'wine and CO_2', and lectures for the elderly on sustainability and energy use. 'The magic rocks of Hontomin' was a CCS-themed summer school in the village of Hontomin. This successful set of educational and outreach tools were also used for communities of the Compostilla plant and capture pilot facility, and eventually led to a follow-up project in partnership with the council of the surrounding region (Cubillos del Sil). Much of this work has centred around an energy museum run by Ciuden in the nearby town of Ponferrada, as well as using visits to the pilot facility itself. With coal mining and power generation forming a significant part of the local economy, the benefits of CCS to the industry are more readily accepted in this region (GCCSI, 2013a; GCCSI, 2014).

9.1.2 Sahagun storage site

In addition to its strong focus on effective communication, Ciuden's status as a non-profit research organisation probably played an important role in gaining the trust of the community of Hontomin. For the storage site proposed for the eventual demonstration plant, outreach was initially led by the utility Endesa and met with much more mixed results. The injection site was located roughly halfway between the power plant and Hontomin, in a sparsely populated area of countryside north of the town of Sahagun. In the summer of 2011, before any meaningful engagement had begun, the developers began to encounter negative reactions to the early characterisation work being conducted, with the result that the next stage of 3D seismic tests were delayed. This reaction was partly attributed to the return of the educated younger generation from cities to their parents' homes during the summer, with more interest in preserving a rural idyll than regenerating the local economy. Several NGO also became involved in the opposition, and the timing of national and local elections turned the issue into a convenient political tool. With some landowners denying permit applications, the developers responded with an urgent action plan, and increased the role of Ciuden in the communication strategy for the region. More meetings were held with the general public, local and regional authorities and the media, and information packs and press releases were widely distributed. The team ran roadshows, participated in large local festivals, and arranged visits to Ciuden's energy museum and pilot facilities for residents in the Sahagun area. Key messages were designed to counter negative perceptions and preconceptions of the machinery employed in the characterisation work and, again, emphasise the economic benefit to the area. Eventually, politicians from all parties in the region supported the work, the NGO withdrew from the debate, and public acceptance improved (EU CCS Network, 2012b; Prangnell, 2013; Endesa and others, 2013).

The reaction of stakeholders at Sahagun makes for an informative contrast with the experience at Hontomin. It appears that the importance of outreach in this sparsely populated area, and at such an early stage in the project, was greatly underestimated and consequently neglected. However, the escalation of opposition was effectively prevented through quick response and the availability of the experienced and well-trained Ciuden outreach team.

9.2 Bełchatów – Poland

Polish utility PGE Elektrownia and Alstom proposed a CCS demonstration at the existing Bełchatów coal power plant, using Alstom's post-combustion capture technology on a flue gas slipstream from a new 858 MW unit and storing 1.8 Mt/y in an onshore saline aquifer. Having been awarded 180 million euros in 2009 as part of the EEPR, the project was cancelled in 2013 primarily due to lack of state support and failure to secure NER300 funding. However, poor public acceptance and opposition of local authorities to the CO_2 pipeline and storage was also cited by PGE as a reason for not proceeding. Since the failure of the Bełchatów project, full-scale demonstration of CCS has dropped from the political agenda in Poland, although some research has continued in academia and industry (PGE, 2015).

9.2.1 Opposition

PGE initially selected three potential storage sites for the demonstration, all located to the north of the power plant around the major regional city of Lodz. From late-2009 to 2011, geological characterisation studies were performed at two of these sites by the contractor Geofizyka Torun (data from the third site was already available and only required reprocessing), and faced considerable opposition at the site close to the town of Pabianice. A small communications team from PGE launched outreach efforts for the affected communities in September 2009, organising a meeting for various local councils which was quite poorly attended. With opposition to the geological work already mounting around Pabianice, PGE held a meeting in January 2010 with the local authorities, as well as the national geological institute as an external expert and the Centre for Sustainable Development (CZR) – a local NGO leading much of the opposition to CCS exploration in the area. This was followed by a series of workshops in Bełchatów to discuss the CCS project with stakeholders, as well as letters from PGE to authorities and residents admitting that many had not received the earlier outreach and explaining that only research activities were taking place. However, opposition continued to grow in the area, helped by highly critical assessments in a daily newspaper and a popular radio show. By April, a residents group called the 'Committee against CO_2 storage' was established, and many landowners refused access to Geofizyka Torun, stating that the earlier contracts they had signed were based on misinformation from the company. During this period, several local leaders petitioned the Minister of the Environment and residents' petitions were sent to the Ministry and the Prime Minister asking for exemption from the CCS exploration. One borough even took legal action against the decision, but lost on the basis that the issuing of the permits is the sole responsibility of the Ministry (PGE, 2011; Gargul 2013, 2015; Breukers and others, 2011; Oltra and others, 2012b; Glogowski, 2015).

Much of the concern about CCS in this area was related to fears that it would prevent any development of geothermal energy – a subject of particular interest to the CZR, who had invested time in promoting this technology in the region. The supposed conflict between the two technologies was further framed as an issue of 'foreign' EU investment in CCS against a potential local geothermal industry which would have more socio-economic benefits for the region. From this starting point, the opposition to CCS adopted many of the concerns seen in other countries, including fear of water contamination, explosions, or forced relocation. There was a general fear that by being used for CCS, the area would be designated an official mining zone, with a damaging effect on investment and growth.

As local protests mounted throughout the summer of 2010, PGE organised fairly successful meetings with local communities in July and September which were well attended by residents, provoked lively debate, and formed the basis of a FAQ publication later used by the developer. A CCS conference at the technical university of Lodz also helped rebut most of the arguments against CCS. Despite this, geological work in the area was soon abandoned, and legal action was not pursued against landowners who had breached their contracts (Breukers and others, 2011).

In early 2012, the alternative site to the north of Lodz was chosen as the final storage site for the Bełchatów demonstration, with purely technical and geological reasons given by PGE for this decision. Prior to this

decision, however, a social characterisation of the relevant regions was performed by an external PR company. Perhaps motivated on the negative experience at Pabianice, PGE appear to have conducted more thorough outreach work throughout 2012 for communities affected by the final storage site and the CO_2 pipeline. The furthest of the originally proposed sites, this 142-km pipeline would cross 16 communes and over 4000 landowner plots, posing a considerable engagement challenge. The developer conducted 25 briefing meetings in March 2012 with local authority representatives, as well as an information campaign concerning preparatory work for the pipeline from July, using a mobile exhibition and project literature. The response and interest in this campaign seems to have been relatively positive. However, the project was abandoned entirely in early 2013, before further permitting was required (PGE, 2015).

While it is unclear whether the difficulties encountered at Pabianice had any negative effect on public opinion at the new storage and pipeline locations, the experience seems to have helped contribute to PGE's increasingly negative view of the project's feasibility. The company have stated that public opposition to CO_2 storage and transportation was a barrier to the project, and maintain that the CO_2 pipeline should be qualified as a public purpose investment in order to simplify discussions with communes.

9.2.2 Conclusions

A number of factors seem to have contributed to the active opposition encountered by PGE in the Pabianice area. Primarily, the presence of a highly organised local NGO with a specific interest in developing a rival energy technology in the region presented a highly challenging context for any outreach strategy. Nevertheless, it is clear that the outreach campaign itself made several mistakes. The first contact with stakeholders, and local authorities in particular, needed to be made earlier and be more pro-active at reaching the necessary people. PGE wrongly assumed that all interested authorities would attend the 2009 meeting, and that those who did would inform their constituents, and failed to confirm whether people had indeed been adequately informed. Furthermore, there was a clear absence of any coordinated message between PGE and Geofyzika Turon, with the contractor apparently not having provided details of the purpose of their geological work to landowners. The national government were also conspicuously absent from the ensuing debate, depriving the developers of a clear case for CCS in the national energy context and creating a gap in information which the NGO like the CZR were happy to fill. Other criticisms of PGE's outreach were that the content was often too technical, and lacked attention to socio-economic issues such as the potential effect on investment in the region or the effect on other uses of the land (such as agriculture or geothermal energy). While PGE were quick to improve their outreach efforts in Pabianice and elsewhere, lost trust is extremely difficult to regain, and further work at the site became untenable.

10 Australia case studies

Australia has played a key role in CCS research and development from an early stage, supported by coal industry groups and the state and federal governments, although commitment has been variable in recent years. The cooperative research centre for CCS, CO2CRC, was set up in 2003 with government and industry funding, and has operated a large CO_2 storage pilot at Otway since 2009. Besides many large-scale CO_2 capture pilots operating in the country, a few full-chain demonstration projects based on coal power plants have been proposed and cancelled for financial reasons, such as Queensland's ZeroGen and Coolimba in Western Australia. In 2009, A CCS flagship programme was established by the government to help fund the construction of large-scale demonstration projects, and currently supports the South-West Hub project in Western Australia and the CarbonNet project in Victoria (Feitz, 2014; Ashworth, 2014). Both these projects are still in planning stages and propose capture and storage from a cluster of CO_2 emitters, including coal power plants (in the case of CarbonNet) and industrial sources. Meanwhile, the Gorgon offshore gas project in Western Australia is the country's first operating full-scale CCS project, although injection of the CO_2 it will extract from natural gas has not yet commenced. This project is developed by a consortium of oil and gas companies, and has also received some funding from the federal government through the Low Emissions Technology Demonstration Fund. With injection taking place on the uninhabited (apart from industry) Barrow island and in an isolated part of the country, local community opposition is not an issue, but the project has received some criticism from environmental groups due to the island's status as a conservation reserve (Toohey, 2015).

A number of studies on awareness and attitudes towards CCS in Australia have been conducted by Ashworth and others. A 2013 comparison with other countries found 77% awareness of CCS among the focus group, and relatively positive attitudes compared to the other countries studied (Canada, Scotland, and the Netherlands) (Ashworth and others, 2013b). A study of focus groups in different parts of Victoria found support for CCS as a means to prolong the local coal industry, although this was lessened in the urban centre of Melbourne. Principal concerns identified by these groups were CO_2 leakage and water contamination (especially its effect on farmland), as well as cost and the need to prioritise renewables over CCS (Ashworth and others, 2014b).

10.1 Otway

The Otway project in South-West Victoria is a pilot-scale demonstration of CO_2 storage in a depleted gas reservoir and saline formations, injecting highly CO_2-rich (80%) natural gas from a nearby well without further purification. Operated by the national CCS research institute CO2CRC since 2009, the project has continued to find funding from various sources to continue new research directions. A baseline survey of public perception of CCS in the area was carried out towards the end of 2005, with permitting activities taking place in 2007. The local community of Moyne Shire is agricultural with an economy based largely on dairy farming and some tourism. Residents tend to have kept the land within the same family for generations, so have a strong awareness of the land and local environmental issues, and have previous experience with proposals for wind farms and oil and gas exploration. The initial survey found that 33% of

people were comfortable with the project and 38% showed some degree of discomfort, with safety of the community the primary concern. CO2CRC organised a communication plan including meetings with local regulators, councils, and businesses, and individual visits to affected landowners. Three large public meetings were held a year with the project manager and CEO of CO2CRC often in attendance, along with technical specialists and research partners from universities. Information was provided in the form of fact sheets, brochures, the project website, and a regular newsletter sent to residents. In addition, a community liaison officer was hired from the local area to act as a trusted point of contact with good existing connections. This officer proved highly effective in convincing any remaining opponents (Ashworth and others, 2010).

Some problems were encountered by the project during seismic testing, when workers were seen to have left gates open, cut fences, and left depressions in the land, angering local residents. One landowner also refused to grant access and the state was obliged to use compulsory land acquisition as a last resort – this was also poorly regarded by the community. Some local ENGO such as the Australian Conservation Foundation were initially critical of 'dumping' CO_2 underground, but engagement with these groups helped reduce their concerns. In general, the project quickly achieved widespread support, helped by its status as a pioneering research initiative and the associated international exposure for the region.

10.2 ZeroGen

ZeroGen was a proposed 400 MW net IGCC plant with pre-combustion capture in Queensland, which was to store 2 Mt/y of CO_2 in an onshore location which was never precisely determined. The project was launched by the Queensland government in 2005, using Stanwell Corporation as a local utility and MHI as the technology provider. Although it was cancelled in 2010 due to lack of funds and political support, ZeroGen is informative from a public outreach perspective, as a relatively thorough communication strategy was employed (ZeroCO2, 2016).

The Central Highlands Region where the plant was to be situated is a rural district with several small towns, and an economy based mainly on agriculture and a mining sector then undergoing rapid growth. ZeroGen recruited a stakeholder manager with relevant experience from Stanwell Corporation, as well as a PR firm to identify the key stakeholders, local opinion leaders, influential community groups, and relevant local businesses. Early stage communication included individual presentations to decision makers and a series of community engagement workshops conducted by CSIRO in a role as independent experts. A community liaison group was set up consisting of nominated community representatives, technical experts, and representatives of ZeroGen. This group aimed to provide the community with a forum for raising questions and concerns, and held open public meetings with project exhibitions, rock samples, and speakers. Other means of contact included letters sent to residents and public notices in local papers (Ashworth and others, 2010).

Initial concerns in the area surrounded potential population growth and associated rent increases, damage to local infrastructure, and property acquisition without compensation, along with some usual fears of CO_2 leaks from the storage site or pipelines – based on a knowledge of natural gas leaks that had occurred

elsewhere in the country. On the other hand, many saw population growth, job creation, and infrastructure investment as welcome improvements to the region, and local government perceived the project as a means of supporting the local coal industry. With many local members of parliament sceptical about climate change, such economic benefits may have outweighed any sense of contributing to a global effort. However, as with many early CCS projects, the international attention associated with demonstration of a new technology was also a positive factor. While Stanwell Corporation were subject to some local suspicion due to cancellation of a previous project, the involvement of the state government was seen positively.

Zerogen's engagement team rapidly gained general support from local authorities, and support or at least indifference from the local population. One highlighted success involved working collaboratively with a landowner by encouraging him to participate in some of the work on the property that might otherwise have been done solely by contractors. Following damage to a local road by contractors, ZeroGen were seen to be quick to respond and return the road to its original state. A shift by many local conservation groups towards a more favourable stance on the project was also attributed to direct engagement with these groups by ZeroGen and its backers. However, the outreach strategy has received some criticism based on the apparently low levels of awareness of the project in the region and a lack of planning outreach around other local events.

11 Japan case study

Japan expressed a serious commitment to advancing CCS in 2008, and has been involved in a number of international pilot and demonstration projects involving Japanese companies, providing direct government funding or via export credit banks. Although a number of notable carbon capture projects are operating in Japan, there are no large-scale CCS demonstrations currently planned in the country itself. However, the Tomakomai project in Hokkaido is a smaller-scale full-chain project which represents an important first step in the country's plans to deploy commercial CCS in the 2020s. Under a contract from the Ministry of Economy, Trade, and Industry (METI), this project is overseen by Japan CCS – a consortium of 35 companies in CCS-related fields which formed in 2008 with the goal of developing full-scale CCS in the country. Among other projects, Japan CCS is also responsible for public outreach programmes associated with Tomakomai and across Japan (Sawada, 2015).

Itaoka and others have conducted several studies of Japanese attitudes to CCS, including a 2010 comparison with other countries which showed a relatively high proportion of respondents (56%) seeing a role for CCS in the national debate on climate change (Reiner and others, 2010). A 2014 study looked at the effect of the Tsunami disaster at Fukushima, finding a small decrease in support for CCS driven by an increased support for renewables over all alternatives (Itaoka and others, 2014).

11.1 Tomakomai

The full-chain CCS project at Tomakomai oil refinery in Hokkaido commenced in 2016, with CO_2-rich off-gas from the hydrogen production unit further purified using amine-based capture and the resulting 0.1 Mt/y CO_2 injected into a saline aquifer formation just offshore. Surveys of the site geology began as early as 2009, but the decision to go ahead with the demonstration project was only taken in late 2011. In 2010, a Tomakomai CCS Promotion Association was set up and chaired by the local mayor, both to attract the project to the area and to inform citizens about CCS (Figure 20). All major corporations and industrial associations in the city of Tomakomai also formed part of this group, including the fishery association – a key stakeholder for offshore storage (Sawada, 2015).

Figure 20 An information stand for the Tomakomai project in a local shopping centre (Sawada, 2015)

Public engagement has been a priority for the project from the outset, and extensive outreach activities have been conducted in the area, with a strong focus on interactivity and involving local businesses. Initial surveys found that people wanted more information about CCS and that some had concerns about the risk of CO_2 leakage and safety procedures, particularly in view of its close proximity to the city. In response, an effective information campaign was launched, with particularly effective use of films hosted on the Japan CCS website including descriptions of CCS and the project, footage of the offshore survey and geology, and a live camera showing the construction site once it had begun. The project set up panel exhibitions at several locations in the city such as a shopping centre, a community centre, and a local government office, and was featured regularly in the local media. Several lectures were given at the local university, science workshops were held for children, and presentations were given to senior citizens focussing on global warming and CCS. Held annually since 2011, a major 'CCS lecture' invites well-known celebrities as well as CCS scientists as speakers to help increase attendance, and has attracted over 1100 participants in total. This event also always includes a government spokesperson to emphasise the role of CCS in national policy (GCCSI, 2014; Sawada, 2015; Suzuki, 2016). With earthquakes a particular concern for CCS in Japan, a seismometer cable on the seabed continuously monitors seismicity in the area and data is released in real-time to help public acceptance (an earthquake actually occurred in the region in the summer of 2016 but had no influence on the status of the caprock strata).

12 China case study

As the world's largest emitter of CO_2 and consumer of coal, China is considered an essential region for the deployment of CCS technology. Although no large-scale (1 Mt/y CO_2 or greater) demonstration projects have yet commenced construction in the country, several have reached an advanced planning stage, and many notable smaller projects are operational. These include Shenhua Group's Ordos CCS demonstration, which captures 0.1 Mt/y from a coal liquefaction plant for injection into a saline aquifer, and Sinopec's Shengli project, capturing around 30,000 t/y of CO_2 from a power plant for use in EOR. One of the more advanced plans for a larger scale demonstration in China would expand the Shengli project to capture 1 Mt/y. Other proposed projects include the Yanchang CCS project in Shaanxi province, aiming to use CO_2 from a coal gasification plant in EOR, and Huaneng Corporation's GreenGen project to construct a new 400 MW IGCC plant with CCS (GCCSI, 2016b).

Most of these projects have involved minimal public engagement, partly because of their relatively early stage of development and partly due to China's relative inexperience with communication beyond a basic public consultation as part of regulatory requirements. While public opposition has not historically presented a barrier to many of China's large infrastructure and energy projects, public protests against potentially environmentally damaging projects has grown rapidly in recent years, particularly with respect to waste incinerators, chemical, and coal plants. Air and water quality issues are of primary concern for communities in China, so new CCS plant is unlikely to be seen as a major threat to communities, and may be more easily framed in a positive light. Nevertheless, plans to further develop CCS in the country should be careful not to disregard community engagement (CO2CRC Technologies, 2010).

A 2015 survey of attitudes to CCS in China found that 38.4% of people had heard of CCS, making it the most unfamiliar climate change mitigation technology, although the relatively high awareness can be partly attributed to most respondents being from an educated 'elite' (Chen and others, 2015). Only 5% of this group opposed CCS, but only nuclear power was a less favoured technology as a low carbon energy option. After being given more information on CCS, the group actually tended towards greater opposition or uncertainty.

12.1 China Resources Power CCUS project (Haifeng)

In 2013, the utility China Resources Power was selected to develop a CCS demonstration plant at its Haifeng coal power plant in Guangdong province, with the intention to capture 1 Mt/y for storage in a depleted gas field in the South China Sea. Currently undertaking feasibility studies, the project has heavily involved an international research collaboration known as the UK-China (Guangdong) CCUS Centre, also founded in 2013. As CCS communication forms a key part of this centre's activity, the specific needs for community outreach in the area have been assessed, and a number of engagement initiatives already undertaken. In 2015, the Centre published a report with the GCCSI detailing how the GCCSI's communication 'toolkit' could be adapted to the Chinese context. This work outlined a fairly broad plan of action based on standard practice of identifying key stakeholders and effective messages for the local audience. The use of print

media and social media were highlighted as useful tools, while implementation of a citizen task force was too big a step from the current, minor role played by communities in infrastructure development. Noting that school education forms a highly respected component of Chinese society, in 2014 the Centre also conducted trial workshops in two schools close to the power plant, using the GCCSI's CO2degrees education resource and international public engagement experts. Concerns over the potential effect of the plant on air and water quality were highlighted by the community mayor as the most pressing issues, with water quality of particular relevance to the region's important fishing industry. A survey of attitudes to CCS in the Guandong region found that around a third of respondents had heard of CCS, and 59% supported the proposed project at Haifeng when informed about it (GCCSI, 2014; Ashworth and others, 2015b).

13 General outreach and education initiatives

As experience with CCS demonstration projects has grown, developers have become increasingly adept at tailoring communication strategies to the needs of neighbouring communities, as well as recognising the limits of outreach campaigns in gaining local acceptance in some project contexts. However, with CCS still not considered or recognised as a viable climate change mitigation option by the general public in most regions, there is a growing realisation that the next frontier for CCS communication is to reach a wider audience at a national and international level. This presents a new challenge and calls for new strategies, as concerns of the general public will focus on fundamental justifications and value-for-money of the technology, in contrast to the local issues raised by individual demonstration projects. Indeed, key discussions relating as climate change and national energy policy, so far dealt with by project developers, may be more appropriately addressed by national level organisations – leaving project developers to focus on local environmental risks and economic benefits (Hammond and Shackley, 2010).

The growing number of operational large-scale projects and the media attention they attract are a mixed blessing for CCS communications. As first-of-a-kind projects, these plants are often inevitably faced with well-publicised high costs, construction delays, or cost overruns, which are usually portrayed as additional costs to the tax payer or energy consumer. The contrasting examples of the Kemper County and Petra Nova projects – the high cost overruns of the former attracting far more media attention than the latter keeping to budget, demonstrate the public preference for a negative story. On the other hand, the increased number of visible and successfully operating CCS plants is undoubtedly a positive message for CCS, raising familiarity with the technology and gradually diminishing the persistent idea, seen in public, media, and even political communications, that CCS remains an unproven or unscalable concept.

While a number of industry groups and NGO have worked to raise awareness and promote CCS in industry and political spheres, communication efforts directed at the general public have been more limited. Much of the work done in this area has focused on raising the presence of CCS in school-level education, either by developing teaching packages to sit alongside or within an existing curriculum, training teachers in CCS, or running workshops and educational events with school children (Colliver and others, 2011; Greenberg, 2016). Most notably, the Global CCS Institute (GCCSI) has developed the CO2degrees programme which provides free education resources on climate change, energy, and low carbon solutions with a focus on CCS (GCCSI, 2016c) (Figure 21). This includes material aimed at primary and secondary level students as well as resources for educators to either include in lessons or use to host a CO2degrees workshop, including experiments, educational games, and presentations. In Australia, the programme has received national exposure through incorporation in CSIRO's existing Sustainable Futures (previously Carbon Kids) educational programme, which supports the teaching of sustainability and environment in Australian schools. The CO2degrees material has frequently been deployed in workshop events held for schools neighbouring demonstration projects, including Boundary Dam, Peterhead, the Haifeng project in China, and in general outreach and training work with the governments of China and Mexico. The Institute has also held several workshops aimed at training educators in CCS in developing countries such as Mexico and

Malaysia. In Japan, the Research Institute of Innovative Technology for the Earth (RITE) has translated and adapted GCCSI resources to suit the Japanese educational system and held a series of pilot workshops as after-school programmes. As detailed in Section 9.1.1, Spanish research institute Ciuden has also developed a series of educational materials covering CO_2 and CCS, although this has largely been employed in the areas affected by CCS activity. In North America, CCS training and material for teachers has been provided by the Regional Sequestration partnerships such as the Plains CO_2 Reduction Partnership, covering much of the US Midwest and Canadian plains, which has worked with 700 teachers and given material to 112 school districts (Daly and others, 2016).

Figure 21 Infographic on CCS demonstration projects produced by the GCCSI for 'CO2degrees' programme (GCCSI, 2016c)

Examples of dedicated CCS outreach aimed at the general adult population are less common, and often aimed at supporting specific demonstration projects. In particular, Shell has employed national and provincial level advertising campaigns for its Peterhead and Quest projects respectively (Sections 5.3 and 8.1), involving posters and billboards in public spaces and newspaper advertisements (Shell, 2016; Lamb, 2014; Imagination, 2016). These campaigns are notable for promoting the concept of CCS rather than making explicit reference to Shell's demonstrations. In 2011, Alberta Energy (a provincial ministry) ran a province-wide promotional campaign for CCS in Alberta, including television advertisements covering climate change, EOR, and the basics of CCS, newspaper advertisements, and a six-page insert in the two largest regional newspapers (CCSTLM, 2011). Japan CCS have aimed to promote general public

acceptance and awareness of CCS in Japan, including educational work and also seminars aimed at the general public. In the UK, various government bodies have discussed a need to raise general levels of understanding of CCS, with the Scottish Government advocating a coalition of government, NGO, academia, and industry to address the issue. Industry group the Carbon Capture and Storage Association (CCSA) have also made some efforts in this direction (Hammond and Shackley, 2010).

Within the CCS community there has been a growing shift in emphasis from a focus on decarbonising coal power towards deploying CCS on industrial emitters such as cement, steel, and chemical manufacture, as well as its potential ability to achieve negative CO_2 emissions through capture from bio-energy. While the case for applying CCS to at least a proportion of the world's vast fleet of coal and gas power plants arguably remains equally strong, this new focus undoubtedly presents a clearer and more easily communicated value proposition for CCS, as these new applications offer unique benefits that are not perceived as competing with renewable energy sources. In contrast, arguments for deploying CCS with fossil fuel power rely on a more complex understanding of grid balancing and predictive models of least-cost scenarios. It is likely that this shift in emphasis will increasingly feature in public-oriented CCS communication, and the Norwegian government's recent commitment to support CCS demonstrations on three industrial sources provides a timely flagship for this movement (Bellona, 2016).

14 Conclusions

This collection of case studies highlights that most large-scale CCS projects have managed to avoid significant public opposition, leading to either their successful development or, more commonly, cancellation for other reasons. While many of these successes can be attributed to concerted efforts by the industry to improve its approach to stakeholder engagement, the absence of any major opposition since the failures of the Barendrecht and Jänschwalde projects must also partly stem from the industry's more cautious approach to new projects following these events. Developers have sought to minimise the potential for opposition by avoiding populated areas, using offshore storage sites, or focussing on retrofits to industrial emission sources rather than new power plant. Perhaps most significantly, development of CCS in Europe has halted with the exception of the offshore storage project at ROAD, resulting in a lack of further experience in the most challenging region from a public acceptance perspective.

Analysis of the few actively-opposed CCS projects in Europe and the USA reveals a number of common themes. These early days for the technology were associated with uncertain regulatory and political climates for CO_2 storage in both regions. The need to devise and implement CCS legislation (such as the EU CCS Directive or California's AB 700 Bill) during the development of these projects seems to have heightened public perceptions of a risky and uncertain technology, as well as enabling the issue to become rapidly politicised. This was particularly the case in Germany, where politicians at the local and state level were quick to use opposition to the new CCS legislation as an effective means of gaining popular support. In Europe, opposition to fossil fuels was also particularly active during this period, and was combined with analogies with nuclear waste disposal in Germany to create a particularly negative image for CCS. Lastly, it is clear that many project developers were not prepared for the scale of the public reaction to CCS, seeing the technology as unremarkable, analogous to existing gas storage technologies, and not requiring of any particularly exceptional engagement strategy. While the project type, the nature of the local community, and the political and regulatory environment are all hugely important project-specific factors in determining public acceptance, a considered communications strategy is nevertheless essential for minimising the potential for a negative public response in any project context.

Growing experience with public outreach for CCS projects and borrowing of proven techniques from more mature industries has established a number of key communication principles which most of the successful case studies have sought to implement to some extent. The need for early contact with stakeholders has been frequently highlighted as essential for establishing good relations in which communities and local authorities, representing a first step in giving stakeholders genuine influence in the project development. This principle of active, two-way engagement should be continued by actively seeking and responding to stakeholder feedback to the project, while aiming to be as inclusive as possible of all community and stakeholder groups. To aid this process, a thorough characterisation of local and regional stakeholders should be conducted at an early stage, and may even play a role in site selection. The other key principle is that of gaining and maintaining public trust in the project developer, which is a prerequisite for effective communication. While this is inevitably more challenging for private sector developers than for

government or research-led projects, adhering to principles of project transparency and cooperating with independent research institutes or NGO can help build sufficient levels of public trust. Prior community experience with individual developers or industry sectors can also play a significant role in this regard.

There is also an increased understanding of which media and messages are most effective for communicating with the public about CCS. Use of informal, exhibit-style gatherings which promote two-way communication have now become standard for most projects, and can be effectively integrated with existing community events to maximise attendance. Ideally, the engagement team should be trained in communications, or include a mix of technical and communications specialists, and employ a number of clear and consistent key messages which can be easily understood by the public. CCS communications face the challenge of needing to cover extensive background material to provide justification for the technology, such as information on climate change, the nature of CO_2, and requirements of the power grid. The principal challenge, however, remains that of convincing the public of the permanency and integrity of geological storage – both to meet safety concerns and in justifying the validity of the technology as a climate change solution. In this respect, the use of core rock samples and accurate, correctly scaled depictions of the storage area have proved effective. Going beyond the basic requirement of minimising public perceptions of project risk, developers should also aim to maximise perception of project benefits, including local economic growth, scientific importance, and a significant contribution to climate change mitigation.

Notable examples of projects which have prioritised these engagement principles with successful results (although not necessarily project completion) include Shell's projects at Peterhead and Quest, communications work by Ciuden research institute for the Compostilla and Hontomin projects in Spain, SaskPower's Boundary Dam and Aquistore projects, and the work of Japan CCS for Tomakomai. These projects have focused on reaching as much of the affected communities as possible, and have encouraged participation with local schools and businesses, as well as widespread publicity campaigns. The first FutureGen project in the USA is also noteworthy for achieving active local support from an early stage, thanks both to the nature of the competition process in site selection and promoting a sense of the project belonging to the host town.

Early experiences with local opposition to CCS projects in some regions may have led to an exaggerated perception of the scale of the public acceptance problem for CCS – particularly in Europe, where there is a risk of this perceived barrier being used as an excuse to halt further development of a much-needed technology. In reality, examples of successful CCS outreach around the world have demonstrated that this barrier is surmountable in a wide range of project contexts, and have even included examples of onshore storage work in Spain and Germany. The focus of early community opposition on the public health risk of CO_2 leaks may have also caused excessive emphasis on this aspect of the technology as a major cause for concern. More general opinion surveys have identified that the most significant factors influencing public acceptance are fundamental objections to CCS as a costly, unsustainable, and potentially ineffective climate change solution, serving only to extend the life of the fossil fuel industry. Tackling these perceptions pose a much more challenging task for CCS communicators than basic assurances of project safety, requiring more widespread public outreach beyond the project level and closer work with education. Ultimately,

making the case for CCS is inextricably linked to improving public understanding of the urgency for action on climate change, as the technology will inevitably be regarded as a last resort or radical solution in comparison to more widely supported measures such as renewable energy or demand reduction. In this respect, the current increase in media and political focus on climate change associated with the Paris Agreement should be effectively harnessed, and the necessary role of CCS in achieving ambitious climate targets better emphasised. The dramatic increase in public support for nuclear energy in some regions (such as the UK) provide a positive example of how a once-unpopular low carbon energy source can benefit from improved public understanding of climate change.

Ongoing deployment of the CCS demonstration projects worldwide is already helping to improve public familiarity with the technology, and these working examples should be fully exploited by outreach and education campaigns to dispel the lingering perception that CCS is an unproven technology. However, as for many other low carbon energy sources, the initially high investment costs and government subsidies required to develop early CCS projects present a public acceptance barrier as well as an economic one, and an effective publicity campaign must also highlight the potential for significant cost reduction. A path forward for CCS communication should aim to reach a wider audience, and would benefit from greater collaboration between government, industry, and researchers to formulate a consistent message which is aligned with policy and scientific consensus. Just as communication at a local level has often benefited from third-party advocates, wider-reaching communication strategies must also make greater use of the many high-profile and respected advocates of CCS, such as the IEA, the IPCC, and the Breakthrough Energy Coaltion led by Bill Gates.

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