COOLTRANS (Dense Phase Carbon Dioxide Pipeline Transportation)

WP5.2.1 Social impacts of the installation of pipeline networks

Interim Project Report

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Contents

Glossary

AGI	Above Ground Installation e.g. compressors, block valves, pig traps, pumping stations.
ALARP	"As Low As Reasonably Practicable" The ALARP principle is that the residual risk shall be "As Low As Reasonably Practicable". This relates to a cost-benefit analysis of the costs of taking measures to avoid the risk against an assessment of the risk, in UK law this should be weighted towards carrying out the safety measures.
Bar	Unit of pressure, equivalent to atmospheric pressure at sea level (1 bar is equivalent to 14.5psi)
CCS	Carbon Capture and Storage
CO_2	Carbon Dioxide
Crack arrestors	Prevent uncontained explosion occurring along the length of the pipe in the event of a puncture (Coleman 2009) (it is a reinforced section of pipe that can stop a rupture/ limit damage by absorbing its energy).
DECC	Department of Energy and Climate Change
DTL	Dangerous Toxic Load. Exposure conditions, in terms of airborne concentration and duration of exposure, which would produce a particular level of toxicity (Typically the SLOT (Specific level of toxicity for a substance) in the general population.
EOR	Enhanced Oil Recovery. A process by which CO_2 is injected into an oil field to increase oil production from that field. The CO_2 is separated and recycled for ultimate permanent storage in the depleted oil field.
Hazard	A hazard is something that can cause adverse effects
HSE	Health and Safety Executive
Kt/day	Kilo Tonnes a day
LOC	Loss of Containment
LPG	Liquefied petroleum gas

MAHP	Major Accident Hazard Pipelines
$MTCO_2$	Metric Tonne (ton) Carbon Dioxide Equivalent.
ppm	Parts per million
PRI	Pressure Reduction Installation
psi	Pounds per square inch
PSR	Pipeline Safety Regulations
QRA	Quantified Risk Assessment
Risk	Risk is a combination of the probability and consequence of a hazard causing detriment.
SFAIRP	So Far As Is Reasonably Practicable
SLOT	Specified Level of Toxicity

Note: Not all of the above terms have been used within the following report but are all terms commonly used in the discussion of pipelines management and risk.

1. Introduction

COOLTRANS (Dense Phase Carbon Dioxide Pipeline Transportation) is a large consortium project funded by National Grid. The overall aim of the COOLTRANS programme is to carry out research for the design and safe operation of pipelines for the transport of dense phase anthropogenic CO_2 as part of Carbon Capture and Storage (CCS) schemes. Since 2008 a number of CCS projects have encountered opposition from local communities and as a consequence have since been cancelled or gone ahead in a reduced form. Given the potential impact of pipelines on the understanding the opinions and concerns of lay citizens is an important component of the project planning process. The overall purpose of work package 5.2, undertaken by the team at the University of Manchester, is to understand the public perceptions of risk; this will be implemented across two strands of research. Firstly, this report explores the social impacts of the installation of pipeline networks and secondly the team will complete a series of focus groups exploring the public perceptions of CO_2 transport in pipelines. The overall aim of this report is to understand some of the social impacts and reactions to pipeline installations using examples in order to guide the framing of the focus groups to be conducted in WP5.2. The report does not attempt to set guidelines for the communication of risk, CCS or CO_2 transport - there already exists a body of literature that addresses these issues (for example (WRI 2008; Ashworth 2009; Hammond and Shackley 2010).

This report begins with an introduction to the context of CCS and the transport of CO_2 by pipeline as part of the CCS process, including a brief explanation of some of the key principles and concepts involved. In Section 2 five case study examples are presented, including a summary of each development, followed by a description of the nature of associated controversy. Section 3 introduces themes that emerge across the protests described during the case studies and which will inform the final stage of this research.

1.1. CO_2 transport for CCS

World energy demand is forecast to rise by 55% by 2030 and fossil fuels are predicted to meet 84% of this extra demand, potentially resulting in global CO_2 emissions being 57% higher in 2030 than in 2005 (OECD/IEA 2007). CCS is a technology designed to reduce CO_2 emissions associated with fossil fuels, offering the possibility of reducing CO_2 by up to 90% from fossil fuel powered stations (Vercelli and Lombardi 2009; World Coal Institute 2009). The CCS process involves the capture of CO_2 (e.g. at a power station) which is then transported to a permanent storage site (underground such as depleted oil or gas reservoirs, or saline aquifers). CO_2 can be transported in different ways by for example ship, road or rail; however in the case of CCS, pipeline is the most economic and efficient option. By ship, CO_2 is transported in a similar way to Liquefied petroleum gas (LPG) and is suitable for transporting CO_2 long distances or overseas, whereas road or rail transportation is only suitable on a very small scale. CO_2 has been successfully transported by pipeline, both over and underground, in the US since 1972 (Canyon Reef Carrier) and there are now over 2500km of pipelines transporting 50 $MTCO_2$ per annum, including the Bravo Dome, Cortez and sheep mountain pipeline (IPCC 2005). The UK, in comparison, has limited experience of transporting CO_2 by pipeline however has vast experience in transporting water, natural gas and oil using the same methods.

Conventional natural gas pipelines have been designed and operated based on industry knowledge and experience using the institution of gas engineers document IGEM/TD/1 and must comply with British normative standards and the British Standards PD series (HSE 2008; IGEM 2008). However, CO_2 has different properties to natural gas and requires additional standards beyond the prevailing legislation; IP6, BS EN 14161, BS PD 8010 and DNV OS-F101 standards also have to be met (HSE 2008). The re-use of existing pipelines originally constructed for transporting natural gas, for example, is not straightforward because of the properties of the CO_2 to be transported. Design considerations for CO_2 pipelines include: the effect of cooling from pressure changes, routeing topography, valve material and dispersion patterns.

CCS requires CO_2 to be transported between the source and the storage site (IPCC 2005). Under normal atmospheric conditions of temperature and pressure, CO_2 exists as a gas; however, to achieve sufficient flow rates and to minimise the pipeline diameter, CO_2 is transported in its dense phase – i.e. at sufficient pressure that it becomes supercritical (Eldevik 2008). At the supercritical phase (1070 psi / 74 bar and 31^oC), the CO_2 has the density of a liquid but expands to fill the space like a gas; the proposed CO_2 pipeline will operate at a pressure up to 150 bar. Prior to this stage the CO_2 may need treatment to remove any impurities (such as H_2S, N_2, CH_4, O_2, water vapour and hydrocarbons) which may alter impact the physical properties of CO_2 with consequences for the pipeline capacity and potential fractures, for example (Seevam, Race et al. 2007). Prior to transportation, the CO_2 is also dehydrated to levels of 50ppm of water to prevent pipeline corrosion (IPCC 2005; Forbes, Verma et al. 2008). Unlike natural gas, CO_2 is corrosive when dissolved in water therefore the materials used in the pipeline must be suitable; carbon steel is the preferred material for pipeline construction as it shows low or insignificant corrosion rates over a range of different temperatures and water contents (Heggum, Weydahl et al. 2005). The design of a pipeline must also take into consideration a number of different factors: the pressure it will be operated at, which will determine the thickness of the pipe, how to resist both internal and external degradation, how best to protect the pipeline from damage, how to incorporate appropriate monitoring facilities and the location in which the pipeline will be situated (IEAGHG 2002; Vandeginste and Piessens 2008; Serpa, Morbee et al. 2011).

1.2. Pipeline safety

CO_2 is not classified as a dangerous fluid under the "Pipeline Safety Regulations 1996" (PSR), however, DECC required companies involved in the first CCS competition to act as if it was. The EU CCS Directive[1] does not provide "technical standards for the design, construction, monitoring and maintenance of pipelines, [or] public participation procedures in the decision-making with respect to pipeline routeing", these are covered by the Environmental Impact Assessment (EIA) Directive or by national legislation in Member States (UCL 2012). Within the UK however, the Health and Safety Executive (HSE) are responsible for pipeline regulation and enforcing UK Health and Safety Law with respect to pipelines both on- and offshore. Part II of PSR requires that pipelines are designed, constructed, operated and maintained such that risks are as low as reasonably practicable (ALARP) and that they comply with relevant codes and standards. However, the current codes do not cover CO_2 pipelines and the COOLTRANS research programme is aiming to address this deficit. PSR applies to all pipelines in Great Britain and its territorial waters, including Major Accident Hazard Pipelines (MAHP) which transport anything defined as dangerous fluids (included in part III of PSR).

1.2 Transport infrastructure and Risk Assessment

Every effort is made to minimise the impact to both the community and the environment when planning a project. Onshore pipelines are built according to defined standards and are subject to regulatory approval to assure a high level of safety, particularly in densely populated areas. The Planning Act of 2008[2] is there to ensure the planning process for projects are both faster and fairer to both the communities and developers involved. There are a number of stages before any project can commence – pre-application, acceptance, pre-examination, planning inspectorate recommendation/secretary of state's decision and post decision (TPI 2012).

Land use planning zones around the pipeline and associated Above Ground Installations (AGIs) are used in conjunction with specified minimum distances from normally occupied buildings (separation distances) to ensure the safety of surrounding communities. These are based on a Quantitative Risk Assessment (QRA) according to the specification of the pipeline (i.e. pipeline diameter, wall thickness, maximum operating pressure, type of steel and its depth of burial) and the substance being transported. There are several zones defining different probabilities of exposure to a particular risk, for example the 'inner zone' (i.e. closest to the pipeline) typically describes an area in which there is a risk of 10 chances per million (cpm) per year of exposure to a 'dangerous dose' (which is the equivalent of a 1% chance of fatality in healthy person). If, as was the case for the Milford Haven natural gas

[1] Directive 2009/31/EC on the geological storage of carbon dioxide.

[2] Planning Act 2008 was later amended by the 2011 Localism Act.

pipeline, the risk at the pipeline is even lower than this, the inner zone is defined using the building proximity distance (HSE 2012). It is not always possible to satisfy proximity rules and in such cases there is a need to demonstrate that extra precautions have been taken, such as extra pipeline thickness. Pipelines in operation are closely monitored, externally through visual inspections for corrosion monitoring and leaks and internally by pipeline inspection gauges or 'pigs' (piston-like inspection devices that are driven through the pipeline by gas pressure) which detect potential leaks, damage, corrosion or failure of the pipe. In the case of a leak, transport of CO_2 is shut down automatically by closing off valves ensuring that any CO_2 released is limited. Although block valves are essential to allow certain sections of the pipeline to be isolated, more valves increase the cost of the project and may also increase the risk of leakage due to the number of joints along the pipeline route (Gale and Davison 2004).

1.3 Potential hazards

Unlike a natural gas pipeline, the risk of a fire or explosion is absent from a CO_2 pipeline, however CO_2 presents other risks. Pure CO_2 is colourless and odourless and despite CO_2 being present in the air we breathe (at a concentration of 370ppm), it is both toxic and an asphyxiate. There are a number of potential hazards associated with the pipe, which include corrosion, loss of containment (LOC) and its ability to arrest a fracture (HSE 2008). Relatively low concentrations of CO_2 can be hazardous to human health; inhaling CO_2 at concentrations above 7% (or 7×10^4 ppm) represents a significant toxicological hazard to humans (although a concentration of 50% is necessary to present immediate danger of death by asphyxiation) and from the toxicological effects from inhalation at 15%, (DNV 2008; Harper 2011). Although this suggests that CO_2 is only mildly toxic when compared with other commonly used compounds (such as Ammonia Hydrogen Sulphide (SLOT[3] 2×10^{12} ppm.min); carbon monoxide (4×10^4 ppm.min) and sulphur dioxide (4.7×10^6 ppm.min), the scale of carbon capture from a power station suggests that a release of potentially large volumes could present a major accident hazard (SLOT 1.5×10^{40} ppm.min) (Harper 2011; HSE 2012).

1.4 Commonly cited incidents involving CO_2

Accidents are rare in CO_2 pipelines, over 11 years (1990 - 2001) only 10 incidents were reported (Barrie, Brown et al. 2005). There were 5000 accidents in the same period relating to natural gas and hazardous liquid pipelines; this can however be explained by the sample size of CO_2 pipelines in comparison to that of natural gas and other hazardous liquid pipelines. More recently Edwards (2008) stated that between 1994 and 2008, the 3695

[3] SLOT - Specified Level of Toxicity involves the use of the most relevant toxicity data available that is then extrapolated for use on humans (Turner and Fairhurst 1993). Defined by HSE as: Severe distress to almost everyone in the area; substantial fraction of exposed population requiring medical attention; some people seriously injured, requiring prolonged treatment; highly susceptible people possibly being killed.

serious incidents reported from hazardous liquid pipelines only 36 involved CO_2 pipelines. Of these 36, only one person was injured (no fatalities) and the remaining were classified as serious as a result of the damage done to property or product. The most commonly-cited CO_2 incident occurred in 1986 as a a result of natural processes at Lake Nyos in the Cameroon (naturally saturated with CO_2 due to the existence of a magma chamber underneath which continually leaks CO_2), in which it has been estimated that 1.6 $MTCO_2$ was unexpectedly released killing in excess of 1700 people with many more injured. The quantity of CO_2 released at Lake Nyos is vastly greater than the volumes associated with CO_2 transport for CCS, which are more likely to be in the order of 10s of KT CO_2 at most (Harper 2011). Of more relevance as an analogue is an accidental release of about 15T of CO_2 from a fire extinguishing installation factory in Monchengladbach, Germany in 2008. Coincidental failure of door seals resulted in a CO_2 release outside, very still air conditions resulted in the intoxication of 107 people, of which 19 were hospitalised, all of these recovered and there were no fatalities in this example (HSE 2011).

2. Social impact: Examples from previous pipelines and CO_2 projects

The following section describes briefly the planning and development of five case study examples, focusing on how conflicts were manifested during the planning and development process, summarised in Table 1 (attached as a separate file). Each of the small sample of four pipeline developments and one CCS project has encountered significant challenges from parties opposing the development. Further case studies (in addition to those included here) have been considered elsewhere, with specific concerns for lessons to be learnt with respect to developing communication and engagement processes (Ashworth, Bradbury et al. 2011; Hammond and Shackley, 2010). Our purpose here is to focus more specifically on cases that are most relevant to the transport of CO_2 via pipeline and which help us to better understand how individuals and group accommodate and respond to the prospect of this type of infrastructure development.

Weyburn Monitoring and Storage Project

Overview

The Weyburn-Midale project is the biggest CCS project worldwide, transporting CO_2 via a 200 mile pipeline (320 km) running from Beulah, North Dakota in the US to the Weyburn oil field, Saskatchewan, Canada. The pipeline operates at a pressure of 152 bar and is routed with a one thousand foot buffer zone from the pipe centre to any occupied residence. Operation began in 2000, transporting captured CO_2 from a coal gasification plant for use in onshore Enhanced Oil Recovery (EOR); EOR uses CO_2 to make oil thinner and causes it to swell, making it easier for the oil to flow to producing wells. The CO_2 pumped out with the oil is then recycled. At the start of the project in 2000, CO_2 injection began at a rate of 5kt/day to the Weyburn field (owned by Cenovus Energy formerly EnCana operating on behalf of 23 other partners) and, from 2005, included the Midale field (owned by Apache) injecting at a rate of 1.3 kt/day. In the final phase, from 2006-2011 the injection rates were increased to 7kt/day at Weyburn and 1.8kt/day at Midale (Dakota_Gasification_Company 2012). Combined, this will result in storage totalling 40 million tonnes of CO_2 by the end of the project life. Operated by the Dakota Gas Company, and set up as a scientific monitoring study, the site has been subject to an extensive monitoring programme during the project duration, involving 30 international and independent research institutions led by the Petroleum Technology Research Centre (PTRC).

Conflicts

Unlike the other examples in this report, the controversy associated with the Weyburm project arose more than 10 years into the operation of the site and not at the planning phase. A well-publicised personal campaign was launched by Cameron and Jane Kerr who own a farm near Goodwater, Saskatchewan and have farmed in the area since 1975 (Ecojustice 2010). In 2011 the couple held a news conference claiming that the stored CO_2 was leaking into their local groundwater, they claimed that the gas could be seen bubbling up through ponds, which had since developed algal blooms[4] and that small animals had been found dead nearby, leading to headlines such as "*Farmer says land fizzing with CO_2*" and "*Sask. family claim carbon capture and storage site spewed dead animals*" (Johnstone 2011; Vanderklippe 2011).

The couple had initially raised their concerns in 2004 after seeing changes in water quality, depth and physical characteristics in and around their ponds and were promised, by the Saskatchewan government, a year-long investigation; the Kerrs claimed this study never materialised (although the government claim to have undertaken a study reporting in 2008 that there was no problem at the site)(Ecojustice 2010).

In 2007 the Kerrs teamed up with Ecojustice (a Canadian environmental law charity) and commissioned a consultant (Petro-Find Geochemical) to verify their claims that high CO_2 concentrations in their soil were derived from the Weyburn storage project (CBCNEWS 2011) and had moved off their land two years previously because of their concerns (Vanderklippe 2011). The Petro-Find Geochemical report claimed "the provenance source of the high concentrations of CO_2 in soils of the Kerr property is clearly the anthropogenic CO_2 injected into the Weyburn reservoir", it reported average CO_2 concentrations in the soil were 2.3% with peaks of 11% and concluded that "*CO_2 could enter the home in dangerous concentrations*" (Lafleur 2010). The report stated that raised levels of CO_2 were a result of horizontal flow of CO_2 from deep geological fractures or faults and that there was evidence of surface leakages of oil which could contaminate the local water table (Lafleur 2010). The research team overseeing the Weyburn study, the Petroleum Technology Research Centre

[4] Algal bloom – a rapid increase or accumulation in the population of algae in an aquatic system.

(PTRC), responded quickly to discredit the claims on the basis that the consultant's report did not provide adequate scientific evidence that the CO_2 contamination originated from Weyburn and that the consultant had not explored alternative explanations for the phenomena (CBCNEWS 2011). The PTRC reported CO_2 that at the property had been formed recently and attributed it to natural soil respiration processes. On 19 January 2011 PTRC produced a report responding to the Petro-Find report concluding that: "*The Petro-Find report reaches a conclusion that is unsubstantiated by the limited data in their study. The report contains technical errors, invokes undocumented data, and provides minimal to no information on their scientific methods or analytical techniques*" and that "*The phenomena observed at the Kerr property can be explained by near surface processes including microbial generation of soil CO_2 and methane*." A site investigation conducted on behalf of PTRC analysed the soil gases at Weyburn, at the farm and at a control site and concluded that the gas found adjacent to the Kerr's farm was of natural biogenic original – that it was typical of the soil gas chemistry for the region and not contaminated by hydrocarbons; a separate study found that the well and pipeline integrity were sound (PTRC 2011). The PTRC report responds to each of the conclusions presented in the Petro-Find report, rejecting either the methods or conclusions drawn, also stating that the soil concentrations measured at the farm by Petro-Find are not hazardous in ground samples, as they would be if measured in air samples (PTRC 2011).

A further assessment was also carried out in 2011 by IPAC-CO2[5]. IPAC convened a team of international experts (requiring that none had held any previous involvement with the Weyburn project) to conduct an independent peer-reviewed study into the Kerr farm allegations. The stated aim of the study was to "*reduce the uncertainty regarding the carbon dioxide anomaly reported to exist on the property owned by Cameron and Jane Kerr".* The enquiry applied a 9-step Incident Response Protocol (IRP) developed previously by IPAC and concluded that there was no evidence that the CO_2 found on the Kerr farm was from Weyburn and the groundwater met regional drinking water quality standards. In summary, IPAC concluded that all soil, soil gases and groundwater CO_2 found were produced by natural processes. While not explicitly investigating the causes of reported animal deaths or "explosions", the report concludes that these could not have been a result of leaked CO_2 from the Weyburn field since no leak was detected. Unsatisfied by the two reports from the IPAC and PTRC the Kerr's had not moved back into their property by December 2011 (Johnstone 2011). Despite this, Ecojustice claim the protest was successful as previous complaints by the Kerr's had not been heard.

[5] International Performance Assessment Centre for geologic storage of Carbon Dioxide - a not-for-profit environmental Non Government Organisation (NGO) set up to assess the risk and performance across the CCS chain

Milford Haven Pipeline

Overview

The Milford Haven Pipeline, completed by National Grid in 2007, is the UK's largest high pressure gas pipeline at 316km long and 1220mm in diameter. The pipeline links the two LNG terminals at Milford Haven, South Wales (operated by South Hook) to the National Gas network in Gloucestershire, passing through the Brecon Beacons National Park. The pipeline operates up to 94 bar to supply 20% of the UK's gas requirements and as such is identified as being of national strategic importance. More recently, permission has now been granted to upgrade the pipeline with a Pressure Reduction Installation (PRI) to increase the pipeline's throughput enabling it to operate at full capacity. The planning process for this installation was subject to significant delays in passing the planning process, including relocating the installation in response to local opposition; construction will be completed during 2012 (National Grid 2012).

Conflict

This is a complex case since it relates to opposition to three distinct components of a larger development: the LNG terminals at Milford Haven, the pipeline and the associated AGIs each of which attracted opposition from a variety of actors adopting a variety of approaches. AGIs can be the focus of much attention. The development of the pipeline and consequent opposition was closely tied to construction of the LNG terminals at Milford Haven. There were objections to the principle of building a large terminal through which supertankers would bring gas in liquid form from Qatar and North Africa (which is then transferred into LNG storage tanks and before being converted back into 'normal' gas (through the regasification process) and these objections may have carried over to the development of the pipeline. The development of both the LNG terminals at Milford Haven and the connecting pipeline were surrounded by high profile protest and opposition; a report on behalf of Pembrokeshire County Council suggests that, despite significant efforts by the developers through public meetings, information events and project literature to local residents, the local community and elected representatives, an atmosphere of suspicion, distrust and confrontation nevertheless ensued and developers were met with well organised opposition (PCC 2005; Yakovleva and Munday 2010).

Local opposition was primarily motivated by the impact to the local area and associated safety issues. Many of the communities along the pipeline route in South Wales do not have access to mains gas and therefore received little benefit from a development transporting gas supplies to into England. However alongside this, external groups were also mobilised, introducing protestors that, although deploying arguments related to the local impacts, were primarily driven by more generic objection to the project as a whole. Hence these direct action campaigns involving 3rd parties, for example the Brecon protest camp, introduced non-site specific concerns, such as climate change, to the protest (Yakovleva and

Munday 2010). Significant opposition also focused on the Above Ground Installations such as the Pressure Reduction Installation (PRI) at Cilfrew. Yakovleva and Munday (2010) described how concerns of various protest communities differed along the route of the development as did the level of 'official' support by local institutions. At the LNG terminals, concerns centred around local socio-economic impacts, safety and risk associated with the LNG cargoes; further along the pipeline concerns related to the risk of gas explosions, the AGIs, implementation of adequate construction standards and the impact on environmental assets (the National Park) (Yakovleva and Munday 2010). Brecon Beacons National Park opposed the pipeline, requesting a Strategic Environmental Assessment (SEA) into the "wider aspects of national gas supply" and whether the proposed scheme "represents the best option available." The Park authority felt the pipeline would have a negative impact on the environment of the National Park on the grounds of its recognised "outstanding geological heritage" and raised doubts that "no reasonable alternative" existed to route the pipe (BBNPA 2006).

In 2005, the Country Land and Business Association (CLBA) took a less opposing stance advising farmers, whose land the pipeline would cross, not to object to the development on the grounds that despite the disruption, they would ultimately be better off accepting the compensation, expressing the opinion that the pipeline would go ahead regardless of levels of opposition (Farmers Weekly 2005). Voluntary land agreements were made between National Grid and all except two of the 833 landowners along the pipeline route and also the Brecon Beacons National Park, all landowners were fully compensated and farmers were assured that all normal farming operations could continue over the pipeline (Davidson 2007). It is not clear what happened to the two landowners where no voluntary land agreements were made.

Despite the agreement by the land owners several protest groups were organised around the development: the Safe Haven Group, initially established against the terminal development in 2005, later extended to the Safe Haven Network; Cwmtawe Residents Action Group (CRAG); "Fight the Pipe"; Rising Tide; the Cilfrew Residents Association (against location of the Pressure Reduction Station); and the Campaign Against the Pressure Reduction Installation (CAPRI) established in 2006 (Yakovleva and Munday 2010). As with the Corrib project (see below), protestors have used direct action to disrupt construction and several arrests or protests have been made for trespassing despite this construction ran to schedule (BBCNews 2006; BBCNews 2007; BBCNews 2007).

Rising Tide is a grassroots network supporting campaigns (groups and individuals) linked to issues related to climate change. Rising Tide entered the scene at the invitation of CRAG who were trying to prevent 'ring blasting'[6] through rock found at Trebanos along the pipeline route in an area that had previously experienced subsidence close to houses and a primary school (Yakovleva and Munday 2010). The main issues raised by the Rising Tide protest, other than the claim that local protestors had been ignored, were: the potential for a serious incident at the terminal (accident or terrorist), the pipeline passes through unstable land, Middle East gas is more energy intensive than North Sea gas and the LNG terminals will cause a 30 year lock-in to more fossil fuels (Rising Tide 2007). Further along the Neath Valley, the Cilfrew Residents Association campaigned against a PRI station near their village. When planning permission was granted in 2006, the secretary of the Association (Linda Ware) successfully challenged the decision through a Judicial Review in the High Court, although subsequently lost an appeal against this decision by Neath Port Talbot Council in 2007 and was required to pay the council's costs. Ware's legal aid was withdrawn and in an out of court settlement she agreed to pay the costs at a rate of £10 per week for the next 14 years (This is SouthWales 2009). CAPRI was established in response to the proposed PRI in Herefordshire and adopted a different approach to some of the earlier unsuccessful protests. Although made up of 'ordinary' local residents they had the resources to employ the professional services of a lawyer, web designer and a botanist and adopted a more formal approach to their campaign, aiming to avoid the high profile direct action methods deployed at other protests along the pipeline (Yakovleva and Munday 2010). This approach proved successful in opposing the first planning application and securing changes to the design, locations and conditions for the final accepted proposal.

Corrib Gas Project

Overview

The Corrib Natural Gas field, was discovered in 1996 by Enterprise oil, 83 km offshore from County Mayo in the Republic of Ireland. The development of the Corrib Gas project started in 2001 as a joint venture between the Corrib Gas partners Shell, Statoil and Marathon (this share is now owned by Vermillion), with capacity to supply 60% of Ireland's natural gas. Final approval was granted to the onshore pipeline in 2011 with the final route selected to deliver "the best balance between community, environmental and technical issues (Shell E&P Ireland Limited 2012). The pipeline will operate at between 90-110 bar and pass no closer than 140m to any occupied dwellings.

Conflict

The consenting and approval process to operate the Gas Terminal began in 2001 but has been surrounded by controversy. In 2004, the Bellanaboy gas terminal was granted planning permission, however works on the 9km section of the onshore pipeline between the landfall

[6] Ring blasting – a type of long hole blasting system.

and processing plant were suspended in mid 2005 following intense local opposition. An independent safety review of the onshore section of the gas pipeline was conducted and recommended that the onshore pipeline pressure should be limited to a maximum of 144 bar. The pipeline monitoring and inspection regime was also upgraded and a formal mediation process was established. The Centre for Public Inquiry report recommended that the pipeline route around the village of Rossport should be modified in response to public concerns (Connolly and Lynch 2005) and in March 2008, SEPIL (the operators, Shell E&P Ireland ltd) applied for authorisation of a new route, developed following a public consultation process, which was revised in February 2009. This application was not approved and, however, a new application submitted in January 2011 was granted.

The scale of the local opposition in 2005 was centred on 5 residents of Rossport village ("the Rossport Five") who, although subject to a compulsory purchase order, refused to allow the developers access to their land and were jailed for contempt of court as a result. The imprisonment prompted widespread response across Ireland which included rallies, pickets at Shell garages and blockades at the refinery (Hederman 2005). The Rossport five were released after 3 months in jail when Shell lifted the injunction and have since sought High Court declarations that the Ministerial consent granted for the pipeline in 2002 did not comply with the conditions for the approval (Independent 2010; Siggins 2010). One of the Rossport five, Willie Corduff, a farmer whose land the original pipeline route passed through, was awarded the Goldman Environmental Prize in 2007 for his grassroots campaigning against the Corrib pipeline and received $150,000 to support the campaign (TheGoldmanEnvironmentalPrize 2007). However it has been reported since that Corduff was allegedly assaulted by Shell security guards during a protest at the Glengad compound and armed masked protestors attacked Shell security staff (Brady and Shiel 2009; Vidal 2009).

The controversy is as yet unresolved, with the perception of a lack of benefit of the project to the local community whilst Shell profits from the development. However protestors will deploy a wide range of arguments to support their case and both the Shell to Sea campaign against the pipeline and refinery and the Rossport Solidarity Camp remain highly active. A counter group to the protesters was formed called the Pro Gas Mayo – however, this appears to be a very small group (3 known members) with a low public profile (SourceWatch 2008). There have also been two films made about the project both released in 2010 at the Irish Film Festival "The Pipe" by Rising Tide and "Pipe Down". A book has also been published titled *Once Upon a Time in the West – The Corrib Gas Controversy (*Siggins *2010).*

Barendrecht

Overview

The only example to be presented here that does not relate to a pipeline development, the Barendrect project was a full chain CCS demonstration project operated by Shell and involved the transport and storage of pure CO_2 produced at the Shell Pernis gas refinery. It has been included here because it is a well-documented and well-studied case that delivers valuable insights (Desbarats, Upham et al. 2010; Feenstra, Mikunda et al. 2010; Brunsting, Best-Waldhober et al. 2011; Brunsting, Desbarats et al. 2011). Our purpose is not to re-iterate the analysis of how the consultation/communication process was conducted but to reflect on the form of the opposition, the issues raised and how the opposition manifested itself.

400 KT of CO_2 per annum was due to be transported at 40 bar through 20km of pipeline (16.5km new steel pipeline, the remainder using existing corridor), between the Shell hydrogen processing plant at Pernis and a storage location at near end of life gas fields below the Dutch town of Barendrecht. This is a densely populated town that has seen an increase in commuter population in the last 30 years. At the request of the Dutch government and with significant financial support from them (€30 million), Shell have been preparing for this project since 2007 when the Minister of Environment received budget for a National CCS tender however as a result of public opposition for this project and its delay for more than 3 years it has since been cancelled (VerHagen 2010; Kuijper 2011). Despite this set back the Netherlands is still expected to store up to 30 million tonnes by 2050 in other locations.

Conflict

The conflict in this case surrounds the storage of the CO_2 rather than the pipeline. This was a CCS pilot development which was eventually cancelled amidst a high level of public opposition.

Shell informed the municipal government in 2007 about the project and although the national government were supportive of the project, local councils were opposed and the town council refused planning permission. Shell published the EIA in January 2009 and was approved by the local authorities in April the same year, however the municipality disagreed with several points in it, which included that CCS was an established technology and stated that it should consider morbidity issues within the assessment (Brunsting, Best-Waldhober et al. 2011). Other issues raised included why the first onshore project should be in such a densely populated area, and that Shell would be benefiting from public money at the expense of the local citizens. The public communication process between Shell and residents of Barendrecht began in February 2008. Since then negative press stories have surrounded the project. Shell cited mistakes relating to the scale of diagrams caused concern, however residents felt that Shell did not listen to their concerns and that they were over confident (relying on a PowerPoint presentation to gain support from local residents); consequently, residents did not trust those involved in the setting up of the project (Feenstra, Mikunda et al. 2010). Residents had many questions relating to the project leading to an unexpected backlash in the area. Awareness of CCS technology is low among Dutch people (Brunsting, Best-Waldhober et al. 2011) and residents had many safety concerns alongside concerns that it may reduce house prices. The resulting problems at Barendrecht highlight the importance in publicly co-founded projects to work together in developing a public acceptance strategy from the start (Kuijper 2011). GroenLinks, the local Green party began to rally the Barendrecht community against the proposed pipeline collecting over 900 signatures and leading a 300 to 400 strong protest march against CCS and a local opposition group also formed "CO2isNee". There were many exaggerated and inaccurate statements during this time from both sides of the debate; for example "leak could kill 100,000 people" vs "CO_2 is completely harmless" neither of which are accurate (Brunsting, de Best-Waldhober et al. 2010). When the storage site is completely full it was expected to, using IPCC estimates, leak at a rate of 100 tonnes or 270kg a day – equivalent to the CO_2 generated by just 10 human beings.

There are a number of lessons that can be taken from Barendrecht to future CCS projects which includes the importance of support from local governments and engaging in key public opinion formers much earlier in the process. One of the key issues was residents felt that everything had already been decided, there was no consultation process and as such they felt they had little say in their local environment. Kuijper (2011) has suggested to understand the area in which the project is to be realised is important and although Shell has been operating close to Barendrecht in 1997 given the new technology, this was perhaps not conducted as thoroughly as it should have been.

Keystone XL Pipeline

Overview

The original Keystone pipeline was proposed by the TransCanada Corporation in February 2005 becoming operational in June 2010. The pipeline is 1,179 miles long (36 inches in diameter) and runs from the Athabasca oil sands in Hardisty, Alberta to Steel City, Nebraska transporting synthetic crude oil and diluted bitumen at a natural temperature range of 80-120 degrees Fahrenheit to a variety of destinations within the US. TransCanada judged there to be sufficient demand, need and commitment in the US marketplace to warrant an extension, Keystone XL, applied for in 2008 to the US department of state and forms the focus of our discussion. After installation, the Keystone XL pipeline would enter at Baker, Montana and Cushing, Oklahoma and become the longest pipeline outside Russia and China with the potential to carry more than half a million barrels of oil a day; enough capacity to carry over a third of current US petroleum imports (Parfomak 2012). The pipeline will be used solely to transport oil across the US and not for export. The construction of the extension involves building sections of pipeline underground and includes 26 pumping stations (TransCanada 2012). It has been suggested that the extension will offer a positive contribution to the US economy, generating over 15000 high wage manufacturing and construction jobs with additional benefits to affected states (TransCanada 2012). There has been a degree of support expressed for the pipeline; Secretary of State, Hilary Clinton, who is leading the evaluation of the project has stated she is "inclined" to approve the project; the Laborers International Union of North America are also in favour due to the amount of jobs that will be generated in the current financial climate.

Conflict

Keystone XL has faced a number of problems: lawsuits from small oil refineries and land owners suing TransCanada and opposition from environmentalists and certain members of US congress (Vanderklippe 2012). The Keystone XL project is associated with a high profile debate related to a controversial energy source. However, there are a number of concerns that have been expressed specifically relating to the pipeline; for example, opponents consider that the scale of the project makes it a target for terrorists, rendering it both an energy security and environmental risk. Gal Luft, the executive director for the Institute for the Analysis of Global Security has stated that "pipeline sabotage is becoming a weapon of choice for terrorists" given the size and predicted damage of the target (IAGS 2005). There are a number of pipelines in Middle Eastern countries that have been subject to terrorist attacks; the Ras Issa oil pipeline in Yemen by Al-Qaeda militants and tribesmen at a reported cost of $4 billion, the Kirkuk-Ceyhan oil pipeline in Turkey by Kurdish separatists, the Egyptian-Israeli natural gas pipeline by Bedouin terrorists and the oil pipeline in Homs province in Syria was also destroyed. Given the deep rooted political problems behind such attacks, or the strategic nature of a large scale energy pipeline, it is, however, important to consider the wider political or strategic context in evaluating the extent to which similar threats might pose a serious risk to a project.

The environmental and climate change concerns are widely voiced not only as the extraction of the oil uses huge amounts of water and heat, but when refined and used as oil would results in high atmospheric emissions of greenhouse gases. Oil sands are a mix of clay, sand, water and bitumen, extracting the bitumen and upgrading it to something suitable for pipeline transport produces emissions 5 to 15% higher than the production of crude oil (Farrell and Brandt 2006). Local and State politicians have also raised concerns about the water supply not only because of the amount of damage a spill could cause but that the pipeline route threatens a crucial aquifer; the sandy and permeable soil and high water table make the site vulnerable to an oil spill.

Protests in the summer and autumn months brought the issue to the White House; the proposal requires the President's approval as it crosses international borders. The main figure head leading those opposed to the pipeline is environmental and global warming activist Bill McKibben, supported by a number of other opposition groups: Sierra Club

(America's largest and most influential grass roots environmental organisation), Friends of the Earth and National Resources Defence Council (Friends Of The Earth 2012; NRDC 2012; SierraClub 2012). In August 2011, over 1000 non-violent arrests took place outside the White House and in November the 6th of the same year, several thousand protestors formed a chain around the White House to convince President Obama to reconsider the extension, with some shouldering a long black inflatable replica of the pipeline to illustrate their point. Four days after the protestors formed a ring around the White House, President Obama postponed the decision until 2013.

3. Controversy and protest

It is clearly in the interest of all parties, including local communities, if protest and opposition can be avoided. While there are no rules that can *guarantee* a development proceeds without protest (the opportunity for opposition and debate is an essential part of the democratic process, provides learning opportunities and ultimately a check on inappropriate developments), a healthy and well run engagement process can help to avoid unnecessary hostility and deliver a more positive outcome for all parties. When opposition does emerge however, it is important to understand why people are protesting and the type of protestors involved – members of the local community, political/environmental pressure groups or more extreme saboteurs intent on disruptive or obstructive action.

Allowing local voices to be heard at the beginning of the process could be critical in preventing larger scale protests; as campaigns grow and external parties (i.e. those not living in the local area) become involved, often driving a campaign and using the project to fight a bigger cause. As protest escalates (both in content, form and protaganists) the terms of the protest are amplified and charges become grander. When this happens, dialogue becomes a much more complex and intractable process, positions become entrenched and a long term legacy of hostility more likely to be established.

With reference to a variety of case studies, other authors have identified key steps to achieving public acceptance of CCS projects: why (understanding climate change and energy)? What (knowledge and understanding)? Who (trust)? Where (social fit)? How (details: benefits and risks)? (Hammond and Shackley, 2010). In addition, Ashworth et al (2011) present guidelines for engagement strategies from CCS and identify seven key principles: timing (engage early); know your community; identifying local benefits; information – what to communicate; information how to communicate; sources of information; competition (self selection) (Ashworth et al. 2011).

Through each of the case studies described in the present report, it is clear that public response can influence the successful implementation of a project; research suggests that support for CCS as a climate change mitigation strategy is likely to be a major factor in the way that specific projects are received (see for example Shackley et al. 2005; Sharp et al.

2009 and Terwell et al. 2011). Each controversy is unique – while much can be learned from individual cases, the evolution and scale of a controversy may not be predictable, since it is dependent on contingencies and individuals. However, certain themes and patterns can be identified as local communities respond to proposed developments in their environs and these are summarised below.

For a large proportion of people CCS is a relatively unknown subject; an increased awareness could be beneficial to both present and future CCS projects. Research has emphasised the importance of providing the public with information on CCS that they can compare with other energy technologies to determine for themselves the risks, benefits and costs of CCS (Howell, Shackley et al. 2012). Typically, concern for the development may first be voiced around direct local impacts (for example, in terms of health or environmental risk) but, as a debate heats up, broader and more abstract arguments may come into play. This may be a result in part of protesters deploying additional arguments to support their cause but also, as other parties join the debate they bring to it different perspectives, principles and concerns. Furthermore, once opposition to a development process becomes entrenched, every detail of developers response comes under hostile scrutiny.

History and local context

The importance of understanding the local context of a development has been described previously (for example, (Bradbury, Ray et al. 2009; Ashworth, Bradbury et al. 2010; Hammond and Shackley 2010) and key to the primary stages for developing a public engagement strategy is to understand the local area and to assess the impact the project will have on local residents Kuijper (2011).

The existence of previous established infrastructure developments in a region does not necessarily imply that there is a reduced likelihood of opposition to subsequent similar developments. In the case of Barendrecht, this has been associated with the notion of 'development fatigue' (Hammond and Shackley 2010) whereby communities feel they are bearing more than their fair share of the burden of industrial development. As communities evolve, population demographics change over time; new people moving into an area may be less accepting of developments. A history of unpopular developments in the region may unduly influence future developments, both in terms of relationships with developers and by association; opposition to the Milford Haven pipeline was linked to the opposition to the LNG terminal from which the gas was to be transported. This demonstrates how an unsuccessful and controversial proposal also can leave behind its own legacy in an area - the antipathy experienced during the Barendrecht case will cast a shadow over any future CCS plans in the area. Any such legacy following a controversial pipeline development, however, may be more complex; extending over a large range and not necessarily associated with a specific location, the controversy may flow along the pipeline route, as was observed in the Milford Haven pipeline case.

Physical risk

In many cases, a protest may begin small and local, supported by specific and 'local' arguments relating to physical risks or impacts; these may often be the first primary concern or residents may become more 'sensitised' to identifying potential impacts as a result of previous experiences (eg. previous developments, activities of the developer or governing authority). Concern may be about risk to health, environment and landscape impacts or, as in the case of the Weyburn pipeline, naturally occurring or potentially unrelated physical phenomena may be attributed to the development. Genuine engagement with local communities to supporting a mutual understanding of risks, impacts and concerns in relation to such physical impacts is clearly paramount from the outset and is rarely absent from debate when controversies do arise.

The role of scientific arguments

Key to any discussion of physical impacts is the way that scientific arguments are used and framed within the debate. This was critical in the Barendrecht example – both the presentation of technical material within the public meetings but also inaccurate media reporting as the controversy became established. McLachlan and Mander (2011) have described how different ways in which knowledge is framed and applied influences how it is used to support different arguments within a controversy. In the Weyburn example, the entire controversy was framed around conflicting scientific analyses; the NAME concept ("Not According to My Expert") (Hammond and Shackley 2010) reflects the increasing use of scientific expertise as a key element of protest. Local and larger protest groups increasingly have access to scientific and expert resources, whether through the resources to commission consultants (for example, as the CAPRI group did in the Milford Haven case study) or through the skills of individuals within the campaign. Despite this importance of scientific and technical evidence for all parties, the full picture is made up of a much broader set of factors; ignoring or dismissing concerns that fall outside the scientific or technical promotes distrust and hostility (for example arguments dismissed as 'emotional' created resentment in the Barendrecht case).

Trust

Genuine early engagement that is responsive and reflexive is a pivotal part of the process in establishing trust around a proposed development. A mutual trust requires that citizens have faith in the developers and authorities to act honestly and transparently and that their own opinions and concerns will be respected and taken seriously (Terwell et al 2011). Transparency of information is key in building public trust, with trust seen as a necessity in risk communication (Kasperson et al 1992, Jahansoozi 2006). The developers involved in each of the case studies were all keen to stress the safety of each of the pipelines, but this did not allay the fears of local residents. Trust, competence, care, fairness, commitment, satisfaction, control, mutuality and dialogue have all been described as essential characteristics in building relationships (Kent and Taylor 2002; Poortinga and Pidgeon 2003).

Public trust in the stakeholders and companies involved in a CCS project is crucial, Siegrist and Cvetkovich (2000) concluded that members of the public with little knowledge on a particular hazard are more likely to rely on the authorities involved, resulting in a more positive view of CCS if they trust the developer involved. This is particularly important for CCS projects, given it is a relatively unknown technology to the public and even with extensive engagement it is not always possible to reach every resident. If a project is run by a well respected company this may help to reassure the public that the project has been adequately planned and is safe, particularly if previous projects have been seen to be well-run.

Trust plays a key role in shaping perceptions. It has been reported that public trust in the stakeholders involved affects the acceptance of CCS projects and is important for the successful implementation of the technology in general (Terwel et al, 2009; Terwel et al 2012). Terwel et al 2012 found that citizens are more likely to accept environmental NGOs than industrial partners and it was suggested that this was down to the company motivations being driven by profit rather than by local interests, rather than perceived competence of the industrial partners *per se*. Establishing a reputation for a commitment to local communities is one way to build public trust (Terwel et al. 2012). It was suggested that developers need to think very carefully about how and when to engage with the broader public in order to ensure that sufficient trust been established to allow them to proceed.

Contingencies, external factors and linkages

In some instances controversy may arise in relation to concerns, events, individuals or organisations seemingly separate from, or as an indirect consequence of, the actual development. For example, while the purpose of the Keystone XL pipeline is to transport oil across the US objectors used arguments that it could compromise energy security by exposing the supply of oil to a risk of terrorist action or other forms of sabotage.

Discussions between developers and residents, local communities and stakeholders will exhibit a particular dynamic and dialogue can be established. The nature of the debate can change and in some case become amplified when other parties become involved – whether it is the media, professional experts (such as occurred at Weyburn), ‘crusading’ individuals (see for example Hammond and Shackley 2010) or larger non-local campaigning groups. This may contribute to a campaign against a specific proposal becoming linked to a broader issue. In the context of CCS projects, a pipeline is a very visible component of the CCS process and provides an “access point” for opponents of the broader context of CCS in association with coal fired power generation.

Justice

Issues relating to justice may become important when a community does not identify any local benefits from a project which is seen to deliver benefits elsewhere. For example when a local community does not perceive any immediate access to the resource being transported by the pipeline (as was the case in the Milford Haven pipeline); or identifies others profiting while the local community bears the burden (as was the case in the Corrib pipeline); or when there is a perceived conflict between the national and local interest (for example Barendrecht). The importance of delivering community benefits has been identified elsewhere as being important both for delivering justice and for promoting acceptance of the development in the context of wind farm developments (Cowell, Bristow et al. 2012). In the case of a CO_2 pipeline, constructed solely for its role in delivering climate change mitigation, it is not bringing clear tangible benefits to another community from which the host community is excluded (as was perceived in the case of the Milford Haven pipeline); the following stage of our research will enable us to explore such issues in further depth.

Explicit use of rights and justice based arguments may be seen to emerge as a protest escalates; this was seen for example in the case of the Corrib pipeline in which protesters claimed their democratic right to protest was being challenged and eventually charges of human rights abuses were levied.

4. Summary

This interim report has summarised 5 case studies in which either pipelines (4 cases) or a CCS project (1 case) has met with controversy. Based on the experience of these case studies we have identified themes which are exemplified in these cases. Although the wider context of the use of CCS technologies in climate change mitigation is relevant, the present study is specifically concerned with the transport of CO_2 in pipelines. Although much can be learnt from previous experience with both CO_2 storage projects and pipeline development in other applications, there has been minimal research and no experience (in the UK) of the potential response to a CO_2 pipeline. The next phase of this project will explore the specific issues and concerns raised by lay publics residing in the vicinity of a proposed CO_2 pipeline development. The themes identified through the case study analysis will be further considered in the planning and analysis of the focus groups to be conducted during the next phase of the research.

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