

Controversy in technology innovation: Contrasting media and expert risk perceptions of the alleged leakage at the Weyburn carbon dioxide storage demonstration project

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ABSTRACT

On January 11, 2011 a local farm couple from Saskatchewan held a press conference claiming CO₂ had leaked from the Weyburn project onto their land. This first public reporting of potential leakage from a carbon capture and storage (CCS) project provides an opportunity to analyze media coverage and expert perspectives to advance understanding of risk perceptions and communication of emerging energy technologies. Risk perceptions of new and emerging technologies play an influential role in innovation processes. The Weyburn project has recently been the subject of controversy as local residents alleged that CO₂ leaked from the underground storage formation and affected their surface property. The public were presented with conflicting assessments of whether the CO₂ was or was not leaking, and communication about the alleged leakage and its risks reflected this uncertainty. We analyze media coverage of the controversy and interviews with CCS professionals to explore differences in media and expert risk perception and framing. This study considers the influence of public controversy on perceptions of emerging technologies and provides insights on responses and influences of both the media and technology experts.

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1. Introduction

Risk perceptions of new and emerging technologies play a critical role in the innovation process (Hekkert et al., 2007). Perceptions of risk vary among technology experts and the public (Barke and Jenkins-Smith, 1993), and communication of these risk perceptions often influences how, when, and where specific technologies will be adopted, deployed, or advanced (Dunwoody and Neuwirth, 1991). During the early phase of technology development, media reports of a negative incident can cause public concern by signalling an associated danger or risk (Kasperson et al., 1988).

Carbon dioxide capture and storage (CCS) is one potential strategy of reducing greenhouse gas (GHG) emissions to mitigate

climate change; CCS generally refers to the capture of CO₂ emissions from industrial sources and the long-term storage of their emissions in stable underground geologic reservoirs (Parson and Keith, 1998). Visions of “clean” coal-fired power plants that will not emit CO₂ into the atmosphere have motivated public and private investments in CCS technology (Meadowcroft and Langhelle, 2009). And the scale of CO₂ emission reductions deemed necessary for climate stabilization is so large that some consider CCS a necessary technology without which society will be unable to mitigate climate change. Others view CCS as an environmentally risky, expensive, end-of-pipe technology that is resource-intensive, technologically complex, promotes continued use of fossil fuels, and competes with investments in renewable energy (Stephens et al., 2011; Bielicki and Stephens, 2008). Despite growing technological development, research and investment in CCS during the past decade, large-scale CCS deployment has been slower than many had envisioned five or ten years ago (Bäckstrand et al., 2011).

New technology innovation generally includes some kind of “demonstration” before the technology can be widely adopted

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(Sagar and Gallagher, 2004; Shapin, 1984). Demonstration has been characterized as an interactive process, often focused on establishing consensus about the technology's properties and on building larger societal support to encourage the technology's deployment (Shapin, 1984). Different actors and audiences are likely to view the lessons learned from a demonstration project in different ways resulting in complex social processes surrounding knowledge production; demonstration projects include critical social learning as well as technical learning (Markusson et al., 2011). Although technology demonstration is often considered to be an opportunity to prove the success and potential of a new technology, demonstration activities may also highlight potential risks or problems with a technology, point to reasons why further development might be difficult or curtailed (Collins, 1988), and suggest a disconnect between hype and reality (Coninck et al., 2009).

One of the world's largest projects demonstrating the feasibility of underground storage of CO₂ in an enhanced oil recovery project is located near Weyburn, Saskatchewan, Canada (CCS101, 2012). Enhanced oil recovery (EOR) involves the injection of CO₂ to increase the amount of oil recovered while also storing CO₂ in the underground reservoirs (DOE, 2011). The CO₂ is transported 320 km (approximately 200 miles) by pipelines from a coal gasification plant in Beulah, North Dakota over the U.S.–Canadian border and injected approximately 1500 m underground in the Weyburn and Midale oil fields (PTRC, 2012). The project sparked early interest from the International Energy Agency Research and Development Programme as an opportunity to better understand subsurface CO₂ injection, migration and monitoring. Funding for this research initiative came from industry and both the US and Canadian governments and the provincial governments of Alberta and Saskatchewan. The EOR project is operated by Cenovus Energy and Apache Canada (Whittaker, 2005) and has been monitored by the Petroleum Technology Research Centre (PTRC).

This demonstration site has recently been the subject of controversy as a local couple alleged that CO₂ had leaked from the underground storage formation to the surface of their land. Initially different technical assessments were presented to the public in media accounts, suggested opposing views on whether or not CO₂ was leaking from the underground storage site (Energy, 2011; Petro-Find Geochem Ltd, 2010; Petroleum Technology Research Centre, 2011). Final reports concluded that the Weyburn project was not the source of the CO₂ found at the Kerr property and natural CO₂ levels were within a normal range (IPAC-CO₂, 2012; Cenovus, 2012). However, in the context of the initial conflicting technical assessments, the leak allegation provides a unique opportunity to examine media representations of emerging technologies. This study analyzes media coverage of the Weyburn controversy and contrasts it with interviews conducted with professionals who work on CCS, to explore how this controversial event has been framed in the news media and how that framing compares to CCS experts' perceptions of the controversy.

Given that this is the first public reporting of an alleged leak¹ that gained news media attention, both advocates and critics of CCS have closely watched developments. While technology experts within the CCS community may place considerable weight on the scientific evidence used to justify the conclusion that CO₂ has not been leaking from Weyburn, the competing and conflicting technological assessments of whether or not there has been leakage is confusing for non-experts. This study recognizes and explores these

differences by juxtaposing analysis of media coverage of the controversy with CCS professionals' perspectives of the controversy represented in a series of interviews. Analysis of news media is one approach to assessing public perception of an issue or controversy; news media play an important role in shaping public opinion (Feldpausch-Parker et al., in press; McCombs, 2004) and public discourse (Gamson and Modigliani, 1989), while interviews with CCS professionals represent experts reactions. Experts are aware of the potential for social amplification of risk (Kasperson and Kasperson, 2005; Kasperson et al., 1988; Pidgeon et al., 2003), and previous studies have explored the role of the media in amplifying risk perceptions (Lofstedt, 2008). While an event like the alleged leakage at Weyburn raises the public profile of the technology, it simultaneously focuses expert attention and encourages professionals to reassess and explicitly rearticulate their own expectations and beliefs. By interviewing the CCS experts after the public allegations had been made, we captured valuable temporally specific information.

This paper first provides background on the alleged leakage event at the Weyburn site and background on awareness and perceptions of CCS, followed by a review of public and expert risk perception literature. The methods are then described, and the paper concludes with study results and discussion of the findings.

2. Background

2.1. Alleged leakage at Weyburn as a focusing event

The alleged leakage at the Weyburn project can be considered a "focusing event" for CCS technology development. A "focusing event" has been described as "an event that is sudden, relatively rare, can be reasonably defined as harmful or revealing the possibility of potentially greater future harms, inflicts harms or suggests potential harms that are or could be concentrated on a definable geographic area or community of interest, and that is known to policymakers and the public virtually simultaneously" (Birkland, 1997). These events tend to be rare and consequently, are unpredictable and unplanned. They can be opportunities for some groups to elevate attention to a problem while other groups seek to prevent the issues from gaining prominence. Focusing events have the potential to shift a latent issue to greater attention, prominence, social contention, or policy change (Birkland, 1997; Kingdon, 2003). In this case, the allegations made in Weyburn may have generated some negative attention towards CCS. Prior to 2010 there was little discussion of the health and environmental risks of CCS in the Canadian media (Boyd and Paveglio, in press), so the media reports about the Weyburn alleged leak could contribute to focusing attention on risks of the technology.

On January 11, 2011 Cameron and Jane Kerr, landowners in Saskatchewan held a press conference (EcoJustice, 2011) claiming that CO₂ has been leaking from the Weyburn CCS project onto their land. The Kerr family had retained a consultant, Petro-Find Geochem, and their analyses found high CO₂ and methane levels in the soil on the Kerr family property (Petro-Find Geochem Ltd, 2010). Samples were analyzed by a University of Saskatchewan research laboratory which reported that "the leaking CO₂ is not naturally occurring and is similar in composition to the CO₂ injected in the Weyburn field" (EcoJustice, 2011). Initial news media stories described that the owners of a family farm near Weyburn, the Kerr family, had found animal carcasses and apparent CO₂ degassing on their property. While industry representatives moved quickly to reassure the public, through posting an initial response on January 11th on the Petroleum Technology Research Centre (PTRC) website and preparing scientific replies questioning the science and research methods of the Petro-Find study over the

¹ A CO₂ breakthrough occurred at the In Salah project located in Algeria (Wright, 2011); however, there was little media attention focusing on the leak. The leak (approximately 0.1 tonnes of CO₂ had escaped) was discovered from a suspended exploration well (Wright, 2011). The leakage occurred in an area where there was little vegetation, residents or wildlife (Government of California, 2011).

next week (Petroleum Technology Research Centre, 2011), the allegations raised public questions about the safety and environmental integrity and risks of CCS operations.

In response to the alleged CO₂ leakage, the International Performance Assessment Centre for Geologic Storage of CO₂ (IPAC-CO₂) announced on January 16, 2011 that it was assembling a team of international experts to conduct independent fieldwork to assess if CO₂ from Weyburn was leaking at the Kerr's farm. IPAC-CO₂ is a non-government organization whose mission includes performing risk assessments for CCS projects. The testing scheduled for June 2011 was delayed until August due to high rainfall and high groundwater levels. In late November, Cenovus, the energy company operating the Weyburn EOR site, issued its own report stating the leaking CO₂ was *not* from the Weyburn site (Energy, 2011). On December 12, 2011, eleven months after the initial media coverage of the alleged leakage, the independent study conducted by IPAC-CO₂ was released and concluded that the CO₂ injected by Cenovus as part of its enhanced oil recovery project is not the source of CO₂ found on the Kerr farm and that the levels of natural CO₂ on the property was within normal limits for the area (IPAC-CO₂, 2011).

2.2. Awareness and perceptions of CCS

Over the past decade, public awareness about CCS has increased (Reiner, 2008; Reiner et al., 2006), with a simultaneous increase in vocal public scepticism and concern about the technology (de Coninck, 2010). This increase in public awareness is apparent in Canada – the country where the allegation of a leak was made. A national survey administered in 2005 indicated that only 10.5% of Canadians had heard of CCS (Sharp, 2005). However, a second survey administered in 2007 demonstrated that 31% of respondents expressed some awareness of CCS (Ipsos-Reid, 2007). In 2010, results of a third national survey indicated that 39% of respondents were familiar with CCS (Boyd and Einsiedel, 2011).

Numerous other studies have examined public perceptions of CCS (see for example Ashworth et al., 2009; de Best-Waldhober et al., 2009; Fleishman et al., 2010; Reiner et al., 2010). These studies demonstrate that public concern and opposition to CCS technology can be divided into two categories: (1) general opposition to the technology as a resource-intensive, fossil-fuel promoting, renewables-competing, technologically complex climate change mitigation option and (2) project specific opposition from communities that are confronted with proposed projects (Bielicki and Stephens, 2008; Stephens et al., 2009). Project specific opposition is seen in recent CCS projects that have been postponed, cancelled or heavily criticized due primarily to non-technical challenges including public opposition, such as Vattenfall's cancelled or postponed storage projects in Denmark and Germany (NyTeknik, 2009), an ocean sequestration project in Hawaii (de Figueiredo et al., 2002), and the Barendrecht project in the Netherlands (Van Noorden, 2010). In contrast, the Weyburn CCS project had been operating for over a decade with no major controversies until the Kerr family made allegations that the CO₂ was leaking and causing damage to their property.

2.3. Risk perception and media framing

The challenges facing CCS and the alleged leakage at the Weyburn site highlight fundamental gaps in risk perception between expert and lay communities. The roles experts and the public play in shaping, weighing and communicating risk has been changing over time (McComas, 2006). While there remains a strong emphasis on one-way communication in classic risk management and communication, with experts providing technical information to the public (Breakwell, 2007; Fischhoff, 1995; Leiss, 1996), research has

repeatedly demonstrated that the public thinks and communicates about risks differently than experts (Leiss, 1996).

For example, while experts generally seek legitimate evidence from studies that adhere to the scientific method, the public generally uses more of an intuitive thought process about risks and may not make risk judgments based on direct evidence (Douglas and Wildavsky, 1983). The public is more likely to use the media and the Internet as sources of information (Breakwell, 2007). These differences are highlighted in this comparative analysis of how experts and the media approached the alleged Weyburn leak. Due to the fact that “scientists, policy makers and the lay people employ different, though equally legitimate, forms of rationality when evaluating evidence and generating knowledge about hazards” (Garvin, 2001) assessing risk perceptions and communications requires an understanding of how both experts and the public, through the window of the media, perceive a risk event or issue. This is particularly true with an emerging technology like CCS, which, while increasing in prominence as a climate change mitigation approach, still remains relatively unknown to the public. A review of CCS public opinion surveys by Malone et al. (2010) concluded that people typically ranked technologies that they are more familiar with (such as solar power and wind energy) over CCS. The fact that CCS is relatively ‘unknown’ and unfamiliar is a likely contributor to why the technology is perceived as risky (Singleton et al., 2009; Malone et al., 2010). Singleton and colleagues (2009) argue that field trials (such as the Weyburn-Midale CO₂ project) have the potential to improve public perception and acceptance of the technology by making it more familiar and therefore less risky. However, if a field trial results in a negative incident (such as an alleged or actual leak) the demonstration could enhance public perceptions of risks of the technology.

The media are important for communicating risks (Peterson and Thompson, 2009a) and for setting agendas (McCombs and Shaw, 1993). Media analysis of the alleged Weyburn leak allows the trajectory of risk communication to be traced over time. Traditional content analyses of media coverage of CCS had been previously carried out (Boyd and Pavaglio, in press; Feldpausch-Parker et al., in press; Bradbury and Dooley, 2004) and provide context to understand the evolving Weyburn leak storyline. The primary goal of this media analysis was to examine how Canadian and international media portrayed the reported CO₂ leak at the Weyburn CCS facility and to track the ensuing trajectory of this issue. Given the importance of media framing in agenda setting, this analysis reveals information about the influence of this event on the trajectory of CCS deployment.

Researchers have commonly used print media analysis to understand how the general public may comprehend a risk (Driedger, 2007; Dunwoody, 1992; Friedman and Dunwoody, 1999; Slovic, 2000). Studies have demonstrated the influence of the mass media on public attitudes and behaviours associated with risk (Raude et al., 2004). For example, Sharp (2005) requested research participants to read newspaper articles focused on either the benefits or negative impacts of CCS. Participants who read an article focused primarily on the negative impacts of CCS became slightly opposed to CCS (Sharp, 2005). It is helpful, therefore, to better understand media representations of CCS, particularly after a focusing event such as an alleged leak. While media analysis is not a substitute for focus groups or interviews, the “mass media can provide a unique window to infer public understanding of risks by virtue of stories on which they report” (Driedger et al., 2009). This is particularly relevant in instances where the public has little to no experience with or knowledge about a new technology. Research indicates that the news media play an important role in developing the public's perceptions of science and technology because media link technical assessments of experts to the psychological assessments of laypersons (Murray et al., 2001; Peterson and Thompson, 2009b;

Priest, 2009). People are more likely to learn about environmental and other science related risks through the media than through any other source (Corbett and Durfee, 2004; Peterson and Thompson, 2009b).

In addition to the content of media coverage, the timing of article publication can also affect risk perception. Past research demonstrates that the way in which a risk or focusing event is presented directly after the event can establish relevant traits of a risk story and that reduced coverage after the event can reinforce risk perceptions created during the initial coverage (Driedger et al., 2009). We used media analysis to examine what information the public received following the initial focusing event and to glean an understanding of how the public may view the alleged leak at the Weyburn project

3. Methods

We integrate two methods: (1) media analysis (Section 3.1) and (2) interviews with CCS experts (Section 3.2). A media analysis can provide insight into public communication activities by various stakeholders, including industry, landowners and government. These media representations are complemented by interviews with principal actors involved in implementing, developing and researching CCS. By using both of these methods we can derive important lessons and insights about risk management and communications regarding CCS and other emerging technologies.

3.1. Media analysis

We searched for newspaper articles published within a year of the initial public allegations of leakage, i.e. between January 10, 2011 to January 11, 2012 from English-speaking countries including Canada, the United States, Australia and the UK. These countries were chosen because they have existing CCS projects or plans for implementing CCS. We searched Factiva² databases for articles discussing the alleged leak at the Weyburn CCS project using the following search terms: Weyburn, Weyburn CCS, Weyburn CO₂, Weyburn leak, Weyburn CCS leak, Weyburn CO₂ leak, Weyburn CCS project, CCS leak, carbon leak and CO₂ leak. Articles that discussed CCS but not the alleged leak were not used in this study. There were a total of 110 articles found in the database, all of which were written for the general public (e.g. we did not include articles from trade journals and specialty publications with a narrow audience). Analysis consisted of both qualitative and quantitative attributes. We assessed *who* was communicating about the alleged Weyburn leakage by identifying sources, key actors and their affiliations and *what* was being communicated by analyzing the claims they made to provide a (partial) picture of evolving risk communication strategies. We also identified and analyzed emerging thematic categories from the stories as a whole, to show the ‘news frames’ used by different media. Framing refers to the ways in which an issue is presented or ‘packaged’ for audiences (Scheufele, 1999; Scheufele and Tewksbury, 2007).

To categorize and code for the overall tone of the articles each article was identified as either positive, negative, mixed or neutral with regard to its framing of CCS technology. The use of these predefined categories allows researchers to determine the content of the messages by translating “frequency of occurrence of certain symbols into summary judgements and comparisons of

² Factiva compiles articles from approximately 200 counties (Factiva, 2012). This database was used primarily because we examined articles from four different countries. However, it is acknowledged that Factiva may not find every article on a subject (Driedger et al., 2009).

Table 1
Explanation of claims made in the print media.

Claim	Explanation
1. CO ₂ is leaking	Any claim that anthropogenic CO ₂ is leaking
2. CO ₂ not leaking	Any claim that anthropogenic CO ₂ is not leaking
3. Link to Weyburn project	Directly links the CO ₂ to the Weyburn CCS project
4. No link to Weyburn project	States that the CO ₂ is not linked to the Weyburn CCS project
5. Impact of the leak	Describes what the Kerr's claim to have experienced or risks associated with CCS
6. Responses to problem	Describes how the problems or allegations will be responded to or what will be done to test for anthropogenic CO ₂ or other CCS related problems in the area
7. Implications to CCS	Refers to how CCS could be affected by these allegations or if there is a leak, how this will affect CCS development and implementation

content of the discourse. . . whatever ‘means’ will presumably take up space and/or time; hence the greater that space and/or time, the greater the meaning's significance” (Altheide, 1996, p.5, citing Starosta, 1984). Tone is therefore analyzed by examining the relative number of positive or negative statements about CCS in an article (Son and Weaver, 2005). An article was assessed “negative” if the general tone and content of the story criticized CCS, alleged that the CCS project was leaking and/or that CCS had negative effects on local residents. A story was classified as “positive” if the majority of the statements commented positively on CCS or rejected the claims of a leak. The story was classified as “mixed” if there were equal numbers of both positive and negative statements about the effects of CCS or the allegations about the leak. A story was classified as “neutral” if the author or spokesperson was objective in its portrayal of the incident, did not side with any stakeholder or assert any opinions on the issue. This classification of tonality is consistent with other CCS media analyses (i.e. Boyd and Paveglio, in press; Mander, 2009) and allows for a comparison with other studies examining media representations of CCS.

The media reports were divided into three major time periods: (1) initial reports (January 11–20, 2011); (2) period between initial reports and before final report (January 21–November 27, 2011); (3) response to final reports (November 28, 2011–January 12, 2012). The initial reporting period was divided into two sub periods to better understand how the media framed the allegations directly after the focusing event. These two sub periods included the preliminary reports (January 11–12, 2012) and the response to the preliminary reports (January 19–20, 2012). For the two sub periods, we identified all the claims and then determined what stakeholder had made each claim. Seven categories of claims were identified (Table 1). Claimants (stakeholder making the reported claims) were divided into five categories including: (1) *The Kerrs and Lawyer representing them* (i.e. Jane and Cameron Kerr or Barry Robinson, their lawyer from EcoJustice); (2) *Consultant for Kerrs* (included claims by Paul Lafleur from Geochem Petro-Find); (3) *The CCS industry* (i.e. anyone representing the CCS industry including consultants); (4) *Journalists* (i.e. journalists who made a claim); (5) *Government* (i.e. anyone from the public sector including federal, provincial and local government).

3.2. Interviews

To complement the media analysis, we also conducted semi-structured interviews with 39 professionals who work on CCS

Table 2
Demographics of the CCS professionals interviewed.

Conference ^a	Pittsburg (May 2–5, 2011)	Calgary (May 18–20, 2011)	Total
Gender			
Male	18	14	32
Female	5	2	7
Organization type			
Private	10	2	12
Non-profit	3	1	4
Research	10	12	22
Country of employment			
US	21	–	21
Canada	1	16	17
Other ^b	1	–	1

^a 39 interviews were conducted at the two CCS conferences. The Pittsburgh conference interviews included an equal number of representatives from research and private organizations. The interviews from the Calgary conference included individuals who worked for Canadian organizations primarily at research organizations. No public sector experts were interviewed at either conference.

^b One interviewee was employed in France.

and attended one of two CCS-focused conferences in May 2011, four months after the alleged leakage incident (Table 2). The same interview protocol was used to conduct interviews at the 10th Annual Carbon Capture and Sequestration Conference in Pittsburgh, Pennsylvania (May 2–5, 2011, 23 individuals), and the Carbon Management Canada Conference in Calgary, Alberta (May 18–20, 2011, 16 individuals).

We asked the interviewees:

- How and when had they first heard about the alleged CO₂ leakage near Weyburn?
- How was their organization responding?
- What kinds of challenges or opportunities does the controversy pose for their organization?
- What do they think of the media coverage of the situation? and
- How do they think the alleged leakage may impact the future of CCS?

In addition to the formal interview questions, some interviewees speculated on what they had learned from this controversy and whether or not they believed that the Weyburn project was actually leaking.

We categorized the CCS professionals interviewed as belonging to three types of organizations: private organizations (any

private company, including independent consultants), non-profit advocacy organizations, and research organizations (including academics, employees of national labs, and employees of state geologic surveys).

4. Results

4.1. Media analysis

The results of the media analysis are separated into: (1) frequency and temporal distribution of articles published within a year of the public allegations; (2) quantitative media analysis of preliminary reports of the allegations (January 11–12, 2011) and the response to the preliminary reports (January 19–20, 2011); (3) analysis of claims made by the various stakeholders.

4.1.1. Frequency and temporal distribution of news stories

Of the 110 articles from the Factiva database covering the alleged Weyburn leakage in Canada, USA, UK and Australia, seventy-nine of the stories (72%) occurred during the initial time-period directly following the media release by the Kerr's and the non-profit advocacy organization, Ecojustice, and the initial response by CCS stakeholders (January 11, 2011 to January 20, 2011) (Table 3 and Fig. 1). Most of the articles appeared in Canadian newspapers ($n=106$, 96%), only three articles were published in US newspapers, one in the UK, and no coverage of the controversy was found in Australian newspapers. On January 11th and 12th the majority of the media coverage involved reporting on the press conference held by the Kerr's and Ecojustice in Regina (Fig. 1). A week later, on January 19th and 20th the reporting included more detailed responses (by CCS stakeholders such as industry, the PTRC, International Energy Agency Greenhouse Gas R&D Programme and IPAC-CO₂ to the allegations made by the Kerr's). After this period, the frequency of new stories about the alleged leak decreased. There were only 19 stories (17%) about the alleged leak after the initial reports and before the release of the Cenovus report on November 28, 2011. The majority of these stories reported on updates about what was being done on the Kerr property to test for anthropogenic CO₂. After the Cenovus report was released to the public, 5 additional articles were found in the Factiva database, and after the release of the IPAC-CO₂ report

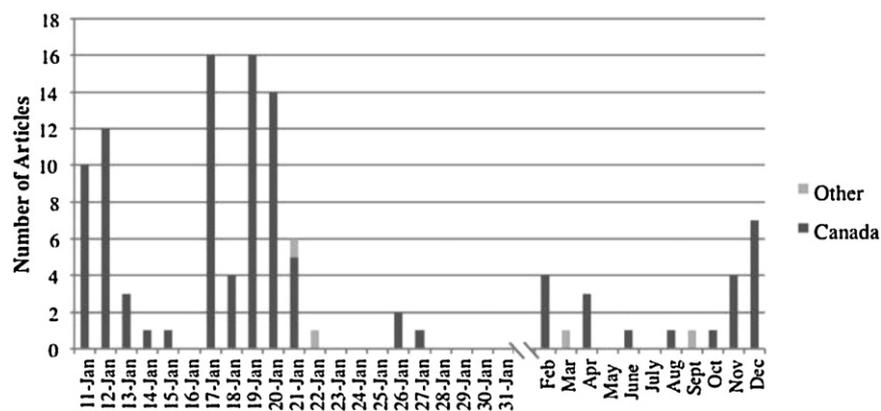


Fig. 1. Frequency and temporal distribution of newspaper articles about the alleged Weyburn leak. Newspaper coverage was concentrated in Canada and 72% of coverage occurred within the first two weeks of the public allegations. Coverage of the two reports released 11 months after the initial media coverage was only in Canada and only made up 11% of the total coverage within the year of the public allegations. No articles about the alleged leak were published before the January 11, 2011 press release, and no articles were found in January 2012.

Table 3
Number of stories in reporting periods across different English-speaking countries.

Country ^a	Initial reports (January 11–20, 2011)	Period between initial reports and before final report (January 21–November 27, 2011)	Response to final report (November 28, 2011–January 12, 2012)
Canada	77	18	11
Australia	0	0	0
United Kingdom	0	1	0
United States	2	0	1
Percent of total	72%	17%	11%

^a 96% of articles were published in Canada, 1% in the UK and 3% in the U.S.

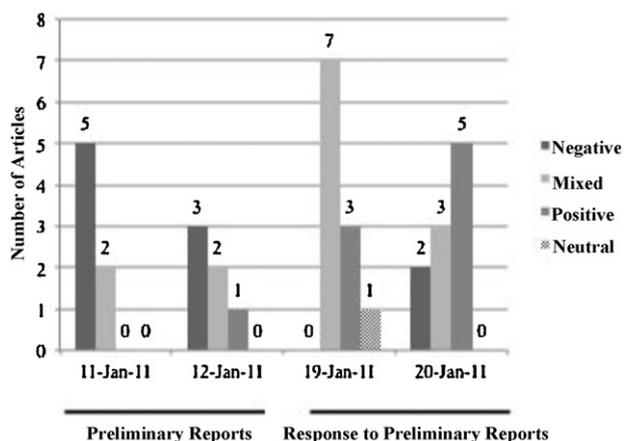


Fig. 2. Tone of articles during the initial two sub periods. Media coverage within the first two days focused on statements from the Kerr family, their lawyer and their technical consultant and was qualitatively different from the coverage a week later, which incorporated additional perspectives from CCS professionals and Canadian government representatives.

in December 2011 an additional 7 articles³ were found on the conclusion that CO₂ was not leaking from the Weyburn CCS project.

4.1.2. Characteristics of Canadian news stories: initial response

Analysis of the Canadian stories published during the initial 2-week period after the public allegations were made allows for an understanding of the geographic distribution of the media coverage. The majority of the stories emerge from cities within the Prairie Provinces including Alberta and Saskatchewan, two provinces that host many of the planned or current Canadian CCS projects. The remaining articles appeared largely in two of the largest population centers in Canada – Vancouver, British Columbia and Toronto, Ontario.

In the articles analyzed for tone (Fig. 2), the stories published during the first sub period of the initial reporting (preliminary reports; January 11–12, 2011) the alleged leakage reflected mostly negative or mixed tones. Examples of negative statements during this time period include: “such high concentrations of CO₂ would have serious health effects if the exposure was over a long period of time;” or articles that describe the Kerr’s experiences “explosions have blown a hole in the side of their gravel pit and the water came out of the ground carbonated.” During the sub period following the preliminary reports (response to preliminary reports; January 19–20, 2011), the stories developed more of a mixed to positive tone. An example of a positive statement includes: “CCS seems to be an extremely low-risk strategy for dealing with greenhouse gas

³ It is likely that there was additional news coverage about the Cenovus and IPAC-CO₂ reports than that found on the Factiva database. IPAC-CO₂ located approximately 300 websites, trade journals, and other media that discussed their report on the alleged leak.

(GHG) emissions”. During these two sub periods there was only one story that was neutral, the rest had either a positive and/or negative spin (positive, $n = 9$; negative, $n = 11$; mixed, $n = 14$).

4.1.3. General patterns of claims about alleged CCS leak

The claims made by stakeholders during the initial sub period are illustrated in Table 4. The Kerr family and Petro-Find made the majority of the negative claims. These two parties alleged there was a leak from the Weyburn CCS project and their claims are clustered in the three claims categories: *CO₂ is Leaking*, *Link to Weyburn Project* and *Impact of Leak*. They also made some claims regarding *Responses to Problem*. Examples of claims in these categories include:

- *CO₂ is leaking*: the Kerr’s stated “greenhouse gases that were supposed to be stored permanently underground are leaking out” on their farm.
- *Link to Weyburn project*: Cameron Kerr stated “a consultant found high concentrations of carbon dioxide in the soil that matches the carbon dioxide that Cenovus has been injecting.”
- *Impact of leak*: Jane Kerr alleged she and her husband “found dead animals near the water pooled in the gravel pit. . .hear explosions. . .while the water looked carbonated.”
- *Responses to problem*: Jane Kerr stated “In 2007, officials with Saskatchewan’s energy ministry had suggested a year-long study of the quality of the water, air and soil. . .that study was never done.”

It was not surprising that they made no claims that denied the leaks. Jane and Cameron Kerr made more claims in sub period 1 (January 11–12) than in sub period 2 (January 19–20), while their consultant Petro-Find made slightly more claims in sub period 2 (January 19–20) than in sub period 1 (January 11–12).

The claims made by Petro-Find consist of *CO₂ leaking* and *Link to Weyburn project*. The nature of the Kerr and Petro-Find’s claims is the allegation of a leakage and charges against the Weyburn project and CCS in general. They also blamed the CCS industry and the government for their lack of action in response to their concerns. Examples of claims by Petro-Find in these categories include:

- *CO₂ is leaking*: “It certainly is not biogenic, the tremendous amount of CO₂ that is coming out of the soil. . .all reservoirs leak to begin with.”
- *Link to Weyburn project*: “CO₂ concentrations in the soil are abnormally high and are linked to the Weyburn reservoir.”

The claims made by the CCS industry and the government are very different from the claims made by Petro-Find and the Kerrs. Most of the claims made by the CCS industry included *CO₂ is Not Leaking* and there is *No Link to Weyburn Project*. The government defended the CCS industry and did not make any claims related to a leakage. The CCS industry made many more claims in sub period 2 than in sub period 1, likely because they were attempting to refute the claims made by the Kerr’s and Petro-Find. The government

Table 4
Number and classification of claims during sub periods in initial reporting period.

Source	CO ₂ leaking		Link to CCS project		Impact of leak		CO ₂ not leaking		No link to CCS project		Response to problem		Implication to CCS		Number of claims per source
	P	R	P	R	P	R	P	R	P	R	P	R	P	R	
The Kerrs & Lawyer	11	8	9	3	40	21					13	10			115
Consultant for Kerrs	9	14	11	14	4	1					1	1			55
CCS Industry							18	63	7	19	9	26	3	3	148
Journalist(s)					2		2				6	3	13	17	43
Government							6		1	3	10	5	3	1	29
Total	20	22	20	17	46	22	26	63	8	22	39	45	19	21	

^a Preliminary reports (January 11th and 12th = P) and response to preliminary reports (January 19th and 20th = R).

made the majority of their claims in sub period 1. Overall the government made the least amount of claims when compared to all other sources. The nature of the CCS industry's and the government's claims is to defend CCS and Cenovus, and to firmly deny any leakage or connection to the Weyburn project. Both sources also stressed their efforts in trying to help the Kerr's to resolve the problems. Examples of claims in these categories include:

- *CO₂ is not leaking*: An individual [with PTRC] stated “They examined every claim in the report. . . They found no data in the report that can support the assertions that CO₂ has migrated through the geological storage system to the surface.”
- *No link to Weyburn project*: A representative [with Cenovus] stated “several tests, including independent ones, have been conducted over the years. . . all of those tests have shown that there is absolutely no link between Cenovus' Weyburn operation and anything that may be happening on the Kerr property.”

Journalists made the fewest number of claims. Most of the journalist claims reside in the *Implications to CCS* category and some in the *Responses to problem* category as well. Journalists made slightly more claims in sub period 2 than in sub period 1. The nature of the journalist claims are mostly focused on the implications of the issue at large instead of taking sides or exerting their own opinions on whether there is a leak. Examples of claims by journalists include:

- *Implications to CCS*: “CCS has become a centrepiece of Canada's climate-change strategy and attracted huge amounts of public funding. . . if carbon capture is unsafe, the public-policy ramifications are substantial.”
- *Responses to problem*: “We need independent expertise – not hired by government, industry or environmental groups – to review what's happening on the Kerr family farm.”

4.2. Interview results

Analysis of the transcripts of the 39 interviews conducted with CCS professionals demonstrates diversity in framing and perceptions of the Weyburn controversy as well as diversity in communication mechanisms. Twenty-one of the interviewees said they learned of the alleged leakage within a week of the January press conference that initiated the media coverage, and one interviewee reported hearing about it before the press conference. The other 17 interviewees either did not hear the news within a week or they did not clearly state when they heard. Twenty-five interviewees said they first heard about the potential leakage from informal professional networks including colleague emails, phone calls, and electronic CCS-related professional list-serves and CCS publications including the Carbon Capture Journal and the Global Carbon Capture and Storage Institute. General public media including traditional newspaper articles, radio, and Internet news were mentioned by 14 individuals as the source of first learning about the controversy.

At the Pittsburgh conference, 19 of the 23 interviewees responded directly to the question of how their organization was responding to the alleged leakage. Seven said their organization had no official response, 4 stated that their organizations had some suspicion of the validity of the claim of Weyburn leakage, and 8 respondents said that their organization would not be making a response until the independent investigation determined whether or not leakage occurred. For the Canadian CCS stakeholders interviewed at the Calgary conference 13 of 16 interviewees did not directly answer the question of how their organization was responding to the alleged leakage, and 10 of the 16 respondents answered by mentioning the necessity for the “truth” to come out about whether or not there was leakage from Weyburn.

Table 5
Breakdown of stakeholder perspectives on three interview questions.

	Private sector (13)	Research organizations (22)	Non-profit organizations (4)
Opinions			
<i>Challenges or/and opportunities of the controversy for organizations</i>			
Challenges	4 (30.8%)	4 (18.2%)	1 (25.0%)
Opportunities	4 (30.8%)	6 (27.3%)	1 (25.0%)
Challenges and opportunities	2 (15.4%)	2 (9.1%)	1 (25.0%)
No challenges or opportunities	1 (7.7%)	4 (18.2%)	0
<i>Attitudes on the media coverage of the controversy</i>			
Biased	5 (38.5%)	7 (31.8%)	0
Balanced	3 (23.1%)	6 (27.3%)	2 (50.0%)
Typical	3 (23.1%)	6 (27.3%)	2 (50.0%)
<i>The controversy's impacts on the future of CCS</i>			
Potential impacts	4 (30.8%)	14 (63.6%)	1 (25.0%)
No long-term impacts	5 (38.5%)	5 (22.7%)	2 (50.0%)
Depends on further investigation	4 (30.8%)	3 (3.6%)	1 (25.0%)

When asked about what kinds of challenges or opportunities the Weyburn controversy posed for their organization, 30 interviewees responded directly including 9 who highlighted specific opportunities, including business opportunities (e.g. opportunities to develop site assessment or monitoring technologies) and opportunities to better communicate with the public about

the complexity of CCS projects. Eleven respondents mentioned specific challenges, including the sentiment that this incident would contribute and reinforce negative public perceptions of CCS technology. Among them, 2 interviewees acknowledged the long information 'trail' on the Internet that could sustain the alleged controversy even if scientific assessments determined that the site

Table 6
Examples of claims made by CCS professional interviewed.

Questions and categories	Claim examples
<i>Challenges or/and opportunities of the controversy for organizations:</i>	
Challenge	<ul style="list-style-type: none"> • "The main challenge was it did raise some concerns in the community that we're dealing with that these types of things might be common." • "Well the challenge is that these kind of articles can take on a life of their own... So, this becomes embedded in the base perception of the technology."
Opportunity	<ul style="list-style-type: none"> • "I thought it was an opportunity to actually educate people about what storage is and to provide accurate information." • "I think it's a good opportunity for the entire CCS community, regulatory, technical and industrial to think through the implications of an event like this, what communication strategy works well, what doesn't and to prepare as best we can and also to really understand the potential that disturbed stakeholders might have in the experience and in the success of the project."
Neither	<ul style="list-style-type: none"> • "Our organization has no particular interest one way or another. We are not regulators or we are not active stakeholders. We are mostly in the analysis business. So it to me was interesting curiosity and it was a way for us to understand actually more about how people would react to this. So we have no particular stake in this one way or another."
<i>Attitudes on the media coverage of the controversy:</i>	
Biased	<ul style="list-style-type: none"> • "Bad. The media it's looking for controversy and for what will sell the newspaper."
Balanced	<ul style="list-style-type: none"> • "So yeah, I think the initial media was what I would say I would expect from someone who would do a press conference with Eco-Justice. I think the later response, like the New York Times article and some of the other articles that said, 'Well let's wait. Let's wait and see.' I thought those were very balanced for the media."
Typical media	<ul style="list-style-type: none"> • "I think the media coverage is, as you would expect media coverage to be, which was it was certainly a story that would have interest because it was the kind of thing the media likes to do."
<i>The controversy's impacts on the future of CCS:</i>	
Has potential impacts	<ul style="list-style-type: none"> • "Once I think that stuff is out there, it's not necessarily gonna be retracted. So any time someone does a search it'll start coming up and the same thing with, Barendrecht, how do you say that? The Dutch CCS site. All that stuff is also out there. So I think you just have to realize that it is gonna have an impact." • "Anytime you hear real data or claims that leakage has occurred or that an accident has occurred somewhere, it causes a lot of uncertainty, a lot of panic among residents and if there are future sites likely to be located in their communities, they're going to remember that and assume that if it happened one time it will always happen again."
No long-term impacts	<ul style="list-style-type: none"> • "I think it won't have that much effect. I really don't see – and then this may be a really pessimistic viewpoint, but if we don't get a rule or a law or something to make us do CCS, it has no effect at all." • "I don't think in this case because I think the response was swift and very well done. So it really left no question about the errors that were made in the measurements and the analysis done by the people who claim that there was a leak."
Depends on further investigation	<ul style="list-style-type: none"> • "I think it depends on the outcome of any investigations, ahh, if they find there actually is a real leak they can directly attribute to the project then obviously there's, gonna be some, ahh, fairly, I won't say serious, but fairly, important ramifications around CCS project design. I wouldn't say it's ever going to kill CCS, but, obviously we have to design them better if they break." • "It depends on how the inquiries that I guess are currently underway are handled and how effective the assessment is."

was not leaking. Interviewees also mentioned that the controversy exposes the technical challenges for CCS projects in monitoring and identifying potential leakage. Five interviewees mentioned that the alleged CO₂ leakage would not have specific impacts on their organizations' actions, and another five said they saw the controversy as simultaneously an opportunity and a challenge. Table 5 demonstrates the diversity of expert perceptions.

Interviewees were asked explicitly about their perceptions of the media coverage of the controversy, and at the Pittsburgh conference 22 responded directly to the question. Eight made negative comments about the media coverage, 5 mentioned that they thought the media coverage was balanced, and 9 expressed neither explicitly negative or positive comments expressing that the media coverage was "typical" and/or "expected". Among the 16 interviews conducted at the Calgary conference, only 4 had negative comments about the media coverage, and the rest expressed that the coverage was either decent, typical, or did not address the question directly. One interviewee explicitly mentioned that the media was amplifying the controversy by hyping a story where there really was no controversy; this represents a specific acknowledgement of media amplification – a well recognized phenomenon in risk communication (Kasperson et al., 1988; Lofstedt, 2008).

While 12 interviewees said they did not think the controversy would have long-term negative impacts on CCS, 19 said that the alleged Weyburn leakage would have impact on future CCS technology development. Eight mentioned that the impact of the controversy would depend on the credibility, transparency, and outcome of the investigation. These stakeholders claimed that when the investigations were completed and results released this issue would be publicly clarified.

Among those that thought the controversy could negatively impact CCS development, several specific claims were made including recognition that incidents like this could increase the cost of future CCS projects by requiring more outreach and public communication work. It was also acknowledged that the controversy could weaken public confidence and emphasize uncertainties of CCS technology, and that the negative news could have lingering impacts due to the long storage lifetime of web-based communication. Interviewees also mentioned that the public would likely connect this incident with other CCS controversies, i.e. the Shell Barendrecht project in the Netherlands that involved strong public opposition.

Eight respondents speculated on how they believed this controversy could promote future learning for risk identification, management, and communication. Among these, the need for more background and surface monitoring for large-scale CCS projects was mentioned. The Weyburn project could have been technically ready to provide baseline statistics and pre-existing background levels; some interviewees believed that with more robust background information CO₂ levels before and after the alleged leakage could have been distinguished and the controversy more rapidly resolved. Also the importance of respecting community concerns and ensuring that all concerns are thoroughly addressed and investigated was also mentioned.

Among the different types of CCS professionals interviewed (private sector, research organizations, and non-profit organizations), distinct patterns did not emerge when interviewees were asked about challenges and opportunities associated with the alleged leakage or about the quality of the media coverage (Table 5). The private sector demonstrated less of a perception that the controversy might have a potential impact on the future of CCS than those representing research organizations.

Among the different types of CCS professionals, different framings of the controversy emerged. Some of the scientists and engineers downplayed the allegations of leakage, claimed that there was no verification of the alleged leakage, and expressed

confidence that the independent report would confirm that the allegations were unfounded. Some of these experts maintained that once the "truth" was revealed the issue would be resolved and the controversy would be over. However, the CCS experts who worked in science communication or in more politically relevant roles saw the potential long shadow of this controversy on the future of CCS. Some experts clearly recognized that regardless of the results of the independent assessment, the controversy could remain in the collective memory, as it is now a part of the history of CCS development with potential to influence future projects.

Examples of specific claims made by the CCS professionals interviewed are provided in Table 4. While many of those interviewed acknowledged some impact of this controversy on CCS development, most did not think that this controversy would be a "show-stopper" (Table 6).

5. Discussion and conclusions

Several important conclusions related to risk perceptions and framing of experts, the media and the public (as represented in the media) emerge from this research. This study demonstrates how the media and experts frame focusing events differently, and how CCS professionals and the media present very different interpretations of the alleged Weyburn leakage.

Technology demonstration projects are designed, at least in theory, to provide learning-by-doing experiences to reveal both success and failure of a new technology. The Weyburn project is one of the most important and influential CCS demonstration projects in the world. But this case highlights the vulnerability of emerging technologies and the subsequent inherent challenges of acknowledging potential or apparent deficiencies in demonstration projects.

With respect to what this case offers to other demonstration projects, the analysis of expert framing provides justification for the need for additional baseline and continuous monitoring and additional communication and engagement with the public and local communities. The potential for integrating more "social learning" as well as "technical learning" into demonstration projects of CCS technology and other technologies has been recently identified and explored (Markusson et al., 2011).

The print media presentation of this controversy highlights the uncertainties of the scientific assessments and the varying opinions of different stakeholders mentioned in the media. As a focusing event, the alleged leak enabled us to clarify differences between how risks of emerging technologies are communicated to the lay public through the news media and how technology experts communicate about it among themselves. Among the experts, this study highlights the range of perspectives and frames used to interpret the focusing event. As expected given the very different contexts for communication, the CCS experts interviewed demonstrated different interpretations of the alleged leakage than that which was presented in the media. CCS experts demonstrate a more nuanced understanding of the complexities of the alleged leakage than represented in the media. Those CCS experts who had a largely technical and scientific perspective saw limited significance of the controversy and believed that the independent technical assessment would resolve the controversy, while the CCS experts who were sensitive to the non-technical and social impacts of the Weyburn incident believed that it could be important regardless of whether or not the leakage was proven.

This study also demonstrates the limited lifecycle of media interest in any controversy. While the initial claims received a flurry of media attention in early 2011, when the independent scientific assessment reports were released almost a year later media

coverage was minimal. Due to the lack of follow-up media coverage after the Cenovus and IPAC-CO₂ reports were released the lay public, who may have read about the initial controversy in the early 2011 media coverage, had limited opportunities through mainstream media to learn of the outcome of the additional studies. The media's role in raising problems and bringing public attention to controversy, but not necessarily following-through with a follow-up perspective, is an acknowledged, common pattern in media studies and highlights an information reporting asymmetry. Further research in the area of reporting asymmetry could provide interesting insights on long-term framing and risk perception of focusing events.

Given the global nature of CCS technology development and the number of international collaborations and projects, the lack of international media coverage about this controversy is notable. Searches of the newspapers in the US, Australia and the UK revealed minimal coverage of this controversy. Coverage was concentrated in the local area and within Canada, but even the coverage within Canada was not extensive. The limited coverage may be related to where CCS is in the technology development cycle; it is an emerging technology that may not yet be considered interesting to the general public. One of the primary tenants influencing the selection and production of news stories is its salience and potential impact to the audience. Because the audience of the news outlet may not be aware of CCS, it is less likely that a journalist will write about the subject (Shoemaker and Reese, 1996). Industry representatives were quick to respond to the allegations made in the media coverage. This rapid response within a few days may have dampened the media coverage; if industry was slow to respond, the allegations made by the Kerrs could have stayed in the foreground of media reporting longer. The limited media coverage could also relate to the lack of additional substantive claims of leakage, i.e. no other community members came forward with similar claims, so the controversy dwindled.

Given the high-level of CCS activity and investment in the UK and Australia, the lack of reporting of the leak allegations in those countries was somewhat surprising. Although we did not conduct media analysis in non-English speaking countries, Dutch researchers conducting CCS media analysis informed us that the alleged leakage in Weyburn was mentioned in a handful of newspaper articles in the Netherlands throughout the past year and a half (Brunsting, 2012). German media also reported on the alleged leak in both newspaper and Internet blogs (Scheer, 2012), indicating that our analysis which was limited to English speaking countries does not capture how this focusing event may have influenced CCS development in other countries. Both Germany and the Netherlands have had substantial public opposition to CCS, so it could be valuable to assess how and why the Weyburn controversy surfaced in the media coverage in those countries but not in the US, Australia or the UK.

This incident, the negative framing of CCS in the associated media coverage, and the concern by CCS professionals about the implications of the event highlight the importance of public perceptions in demonstration projects. This controversy demonstrates how local community stakeholders can be actively engaged and influence a project not only in the initial development of potential projects, but also within the operational phase. This controversy reinforces the importance of developing a science-for-the-community communication strategy and continuing engagement with various local community groups throughout a project life-cycle to create trust and communication pathways between locals and the project engineers. For example, many industrial operations have a citizen advisory committee, or another form of local community liaison, to help build regular channels of communication that could offset some level of community anxiety in the event of any incidents. Past work on risk communication has

shown that immediate denial of any risks is not a good strategy; transparency, open discussion of the risks, providing evidence, and explaining what is going on are suggested as ways to enhance trust (Frewer, 2004).

The alleged leakage incident at the Weyburn project undoubtedly has had influence on CCS technology development beyond what has been captured and discussed in this study. The full impact of this controversy on the development of CCS technology has yet to be determined, will be difficult to assess and is likely to be intricately linked with other factors that will influence future development of CCS. Within the CCS community, multiple signs suggest that the Weyburn controversy has had a broader influence than might be publicly acknowledged and the discrete but careful attention that the Weyburn incident received from some CCS experts suggests that the potential for influence has been recognized.

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