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Public perceptions of carbon capture and storage in Canada: Results of a national survey

Amanda D. Boyd[a,*], Jay D. Hmielowski[a], Prabu David[b]

[a] The Edward R. Murrow College of Communication, Washington State University, Pullman, 99163, USA
[b] College of Communication Arts and Sciences, Michigan State University, East Lansing, 48823, USA

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ABSTRACT

Carbon dioxide capture and geological storage (CCS) is one strategy to reduce greenhouse gas emissions that has attracted interest from government and industry in Canada. A key factor that will determine if organizations implement CCS is whether the public support the development of the technology. Public views and understandings of key issues surrounding CCS were assessed via Internet and phone on a representative sample of 1479 Canadians. We examined descriptive statistics to understand public perceptions of CCS and applied regression models to assess how risk perceptions, perspectives of climate change and trust in government relate to the support for or opposition to CCS development and funding for the technology. Results indicate there is low support for CCS in Canada; however, findings varied when taking into account participants' proximity to projects. Furthermore, the publics' perceptions of the risk and benefits of CCS influenced support for or opposition to the technology. We discuss implications of public perceptions on the development and deployment of CCS and provide recommendations for communication strategies about the technology.

1. Introduction

There is a critical need to develop and deploy technology aimed at reducing greenhouse gas (GHG) emissions. Numerous countries, including Canada, have recognized the need to transition to a low carbon, climate resilient economy (Government of Canada, 2016a). The importance of transitioning to a low carbon economy has become more imperative as carbon emissions continue to increase. For example, there has been a 20% increase in GHG emissions in Canada since 1990 (Government of Canada, 2016b).

Carbon dioxide capture and geological storage (CCS) has emerged as a technology that could reduce GHG emissions in the atmosphere. CCS refers to the capture of carbon dioxide (CO_2) emissions from fuel combustion or industrial processes, the transportation of the CO_2, and its long-term storage in stable underground reservoirs (Parson and Keith, 1998). The sequestered carbon can also be used for enhanced oil recovery (EOR) processes, which involves injecting CO_2 into depleted oilfields to increase the amount of oil recovered (DOE, 2011).

Successful implementation of CCS technology will require overcoming many barriers. For instance, government and industry will need to continue making technological advances to make this a safe, cost effective technology (DOE, 2011). Another barrier to CCS implementation is public opposition to the technology. It is therefore imperative that policy makers, industry, and other stakeholders understand the public's perception of CCS and the factors that influence public support for or opposition to the technology. Policy decisions and public support has and will continue to play a crucial role in influencing the development and acceptance of technologies (Wüstenhagen et al., 2007). Without public support, CCS projects are unlikely to move forward in a democratic society (Ashworth et al., 2009).

Despite the potential benefits of CCS, few studies have examined the Canadian public's opinions of the technology and what factors will influence their perceptions of the risks and benefits relative to using this technology. To address this gap in the research, a nationally representative survey was administered to better assess the publics' perceptions of this technology and understand the factors that influence the Canadian publics' support for or opposition to CCS. The study had three main objectives. First, ascertain public perceptions of CCS and garner an understanding of the amount of support for or opposition to the technology. Second, examine the publics' perceptions of government or industry funding of CCS. Third, examine the relationships between several variables that could be important relative to shaping public perceptions of CCS and funding scenarios.

* Corresponding author at: The Edward R. Murrow College of Communication, Washington State University, 214 Goertzen Hall, Pullman, WA, 99163, USA.
E-mail address: amanda.boyd@wsu.edu (A.D. Boyd).

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2. Background

In the background section, we first provide an overview of our research questions (RQ) and several variables that will be assessed and presented in the results of the manuscript. These variables include: (1) support for or opposition to CCS developments; and (2) support for private or government funding. We then examine several factors that could influence the preceding variables including: (1) risk and benefit perceptions of CCS; (2) perceptions of climate change; (3) trust in government and industry; (4) demographic characteristics; and (5) proximity to CCS projects.

2.1. Background for outcome variables

2.1.1. Support for or opposition to CCS

A critical factor in the deployment of CCS is public support for the technology (Curry, 2004). This is emphasized in a report from Natural Resources Canada, which states, "success depends on creating the conditions that support the first and subsequent waves of CCS investment while gaining the publics' support for CCS as an acceptable way to meet the carbon challenge" Natural Resources Canada (2008, p.9). Numerous studies have examined reasons that the public may oppose CCS. These results indicate that people are often concerned about the risk of CO_2 leakage, contamination of groundwater, and risk of explosions or earthquakes (Ashworth et al., 2009; Oltra et al., 2010; Palmgren et al., 2004). The public may also be concerned about the unknown future effects of CCS (Sharp et al., 2009). Additional reasons for opposition may include the costs associated with CCS development and concerns that CCS technology will not effectively reduce CO_2 emissions (Ashworth et al., 2009). While there are numerous concerns about CCS, there are many reasons people support the technology, including the potential to reduce CO_2 emissions in the atmosphere, and potential jobs associated with developing, siting, and administering the technology (Ashworth et al., 2009).

To date, few studies have used surveys to examine the general public's support for or opposition to CCS in Canada. Therefore, it remains unclear whether Canadian public opinion will ultimately promote or hinder development of this technology. Notable exceptions to this dearth of research include two national surveys examining public perceptions of CCS – completed in 2005 by Sharp et al. (2009), and in 2007 by Ipsos-Reid Corporation (Sharp, 2008). More recently, a survey was administered in 2012 that focused on public perceptions of CCS in the western Canadian provinces of British Columbia, Alberta and Saskatchewan (Seigo et al., 2014). These Canadian studies and other international research (e.g. Ashworth et al., 2010, 2015) indicate the importance of examining the publics' support for or opposition to CCS. As a result, we first plan to examine the publics' level of support for CCS in Canada (RQ1).

2.1.2. Support for or opposition to government subsidies and industry funding

Numerous studies suggest that government support is required to encourage the development and deployment of low carbon emission technologies (Torvanger and Meadowcroft, 2011; Stern, 2007). Many countries have established subsidy frameworks that include research and development support, feed in tariffs, and infrastructure support to accelerate the emergence of low carbon energy technologies (Torvanger and Meadowcroft, 2011). Bäckstrand et al. (2011, p.279) discuss the problem as follows:

As long as climate policy remains half hearted, and the estimated cost of CCS exceeds the market price of carbon allowances and governments do not step forward with sufficient funding or regulatory constraints to overcome this difference, the longer CCS will languish with questions unanswered and problems unresolved.

Insights from international research on CCS demonstrates the importance of understanding the publics' perceptions of regulatory frameworks and subsidies. First, CCS implementation costs are significant (Intergovernmental Panel on Climate Change, 2005). However, the costs associated with CCS range significantly based on site-specific considerations such as characteristics of the facility, characteristics of the storage site, and required transportation distance of the CO_2 (Intergovernmental Panel on Climate Change, 2005). Second, there is concern from some individuals and stakeholders (e.g. NGOs) (see Bäckstrand et al., 2011) and the public (see Einsiedel et al., 2013) that CCS will divert financial investment and political effort from renewable energy development and deployment. Third, there is concern that subsidies will create a 'lock-in' situation where CCS is treated more favorable in terms of the regulatory system or direct government support (Torvanger and Meadowcroft, 2011). Granted, path dependency cannot necessarily be avoided when making decisions about energy systems and infrastructure (Torvanger and Meadowcroft, 2011). There are projects in development in Alberta and Saskatchewan that have support from both industry and government (discussed further in Section 2.2.5). It is therefore important to understand public perceptions of subsidies and industry funding as this could be an influential factor in the deployment of CCS technology. As a result, we plan to examine peoples' level of support for funding CCS through governmental (RQ2) and private industry means (RQ3).

2.2. Background for predictor variables

2.2.1. Risk and benefit perceptions of CCS

In addition to providing overviews of the variables highlighted previously, we also examine what variables might be associated with support for developing CCS and opinions of how CCS projects should be funded. We begin with a discussion of risk and benefit perceptions of CCS, as this is one factor that may affect the preceding variables. Social science research demonstrates that people often rely on intuitive risk judgements, referred to as "risk perceptions," when thinking about hazards (Slovic, 1987). Furthermore, perceptions of technological risks, such as CCS, can have a role in the development and deployment of technologies (Bradbury et al., 2009). During the past decade, there has been an increase in research and insight into the publics' perceptions of CCS (for overview see Ashworth et al., 2015). There are several CCS studies that have concluded that risk and benefit perceptions affect the support for or opposition to CCS (Wallquist et al., 2010; Tokushige et al., 2007). The risks and benefits of CCS can differ depending on the site and purpose of projects (Boyd, 2015), as discussed in the preceding section on support for or opposition to CCS (Section 2.1.1.). In this study, we examine if the perceived risks and benefits of the technology are associated with support for CCS and for private or government funding (RQ4).

2.2.2. Perceptions of climate change

Numerous studies have examined perceptions of CCS based on the framing of the technology. A study by Broeckset al. (2016) demonstrates that messages focusing on the benefits of CCS relative to climate change mitigation might not build favorable opinions towards this technology. In contrast, a study of CCS perceptions in the United States found that when information was provided about the role of CCS in reducing CO_2 emissions, opinion shifted slightly in support for the technology (Curry, 2004). The 2005 Canadian survey by Sharp et al. (2009) concluded that half of the respondents would like to see CCS used in climate change strategies, while just over a quarter of participants would likely *not* include it as a climate change strategy (Sharp et al., 2009). Due to these varying results, we further examine whether climate change beliefs are associated with perceived support for CCS in Canada and support for funding this technology (RQ5).

2.2.3. Trust in government and industry

Another factor that can influence attitudes towards technological developments is trust in risk managers. A lack of trust in risk managers