

GHGT-10

## A Comparative State-Level Analysis of Carbon Capture and Storage (CCS) Discourse among U.S. Energy Stakeholders and the Public

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### Abstract

Perceptions of the potential of emerging technologies like carbon capture and storage (CCS) are constructed not just through technical and economic processes but also through discourse, i.e. through compelling narratives about what a technology is, what a technology might become and why it is needed and preferable to competing technologies. The influence of discourse is particularly important in the innovation phases prior to commercialization when innovation activities are focused on research, development and demonstration, and when feasibility and costs of alternatives systems cannot yet be tested by market dynamics. This paper provides a state-level comparative analysis of CCS discourse in the U.S. to provide insights about the socio-political context in which CCS technology is advancing and being considered in four different states: Massachusetts, Minnesota, Montana, and Texas. This research combines analysis of interviews of state-level energy stakeholders and media analysis of state-level newspapers. In semi-structured interviews, state-level energy policy stakeholders were asked to explain their perceptions of the potential opportunities and risks of CCS technology within their unique state context. Interview texts were coded to assess the frequency and extent of various different frames of CCS opportunities and risks including technical, political, economic, environmental, aesthetic, and health/safety. A similar coding scheme was applied to analysis of state-level newspaper coverage of CCS technology. Here, the frequency of these different framings of CCS opportunities and risks in state-level print media was assessed. This analysis demonstrates wide variation in state-level CCS discourse and perceptions of the potential opportunities and risks associated with CCS technology. This mixed-methods approach to characterizing the socio-political context for CCS advancement in these four states contributes to improved understanding of state-level variation in energy technology innovation, provides valuable information about energy technology development in these specific states, and also offers insight into the very different sub-national discourses associated with emerging low-carbon energy technologies in the U.S.

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Keywords: carbon capture and storage; policy; media; discourse

## 1. Introduction

Over the course of the past decade, carbon capture and storage (CCS) has attracted growing attention as a potentially important climate change mitigation technology; considered one of the critical technologies for reaching climate-mitigation targets from 2020 to 2050 [3,4]. Not only does CCS have the potential for reducing CO<sub>2</sub> emissions, but it can also be integrated into the existing energy infrastructure [1,2]. As a new way of clustering existing technologies, CCS also carries with it scientific, technical and political implications.

In the deployment of energy technologies in the U.S., the sub-national context plays a critical role because decisions driving siting, finance, and public acceptance all occur largely at the sub-national level. Given the substantial U.S. contributions to global GHG emissions, sub-national U.S. activity is critical to climate mitigation efforts [5,6]. Variation of state-level energy policy in the U.S. results from great diversity in multiple sub-national factors including different levels of commitment to GHG reductions for climate mitigation and different energy systems resulting from geographic, resource, and cultural differences. Understanding these patterns of energy technology deployment and the multiple factors influencing this variation can contribute to more effective planning for energy-related GHG emissions reduction [5].

Perceptions of the potential of emerging technologies like CCS are constructed not just through technical and economic processes but also through discourse, i.e. through compelling narratives about what a technology is, what a technology might become and why it is needed and preferable to competing technologies. The influence of discourse is particularly important in the innovation phases prior to commercialization when innovation activities are focused on research, development and demonstration, and when feasibility and costs of alternatives systems cannot yet be tested by market dynamics. This paper provides a state-level comparative analysis of CCS discourse in the U.S. to provide insights about the socio-political context in which CCS technology is advancing and being considered in four different states: Massachusetts, Minnesota, Montana, and Texas.

Perceptions of state-level energy policy stakeholders contribute to and provide insights on the sub-national context for energy technology deployment. Policy stakeholders also have the ability to indirectly shape public opinion of a technology as their discourse and communication reflects to society their perceptions [7-9]. Understanding stakeholder perceptions of CCS technology's risks and benefits, therefore, provides insights with relevance to how further development of this emerging energy technology might proceed. News media, as a source of information and influence on risk perceptions [10], plays an important role in public awareness and opinions of CCS. Media coverage also provides insight into ongoing public discourse, which is especially important for new technologies [11].

In this study, we integrate analysis of CCS risks and benefits as represented in both semi-structured interviews with energy policy stakeholders and analysis of newspaper coverage from the four states mentioned above. These states were chosen due to their unique histories with energy and climate policy and infrastructure, allowing for a broader understanding of technology deployment in the U.S.

## 2. Methodology

To comparatively assess the state-level socio-political context of CCS advancement and energy technology development more broadly, this research combines analysis of interviews with state-level energy stakeholders and media analysis of state-level newspapers. By simultaneously assessing the discourse about CCS potential and risks among energy stakeholders and within the media, this research compares and contrasts perceptions of CCS at multiple levels. The interviews were designed to compare 1) the extent and framing of stakeholders' perceptions of CCS technology in the four states 2) patterns in stakeholder evaluations of risks and benefits within these frames and what that suggests about variation in state contexts for emerging energy technologies. Similarly the media analysis was designed to compare the extent and framing of CCS reporting in newspapers across the four states by identifying 1) frequency of CCS coverage and what frames were emphasized, 2) whether the technology was portrayed as a risk and/or benefit, and 3) differences between newspapers in relation to their proximity to energy production and/or political centers.

In semi-structured interviews, state-level energy policy stakeholders were asked to explain their perceptions of the potential opportunities and risks of CCS technology within their unique state context. Interview texts were coded to assess the frequency and extent of various different frames of CCS opportunities and risks including technical, political/legal, economic, environmental, aesthetic, and health/safety. A similar coding scheme was applied to analysis of state-level CCS discourse through content analysis of state-level newspaper coverage of CCS technology. Here, the frequency of these different framings of CCS opportunities and risks in state-level print media was assessed.

### 2.1 Interview Methodology

An interview protocol was designed to encourage policy stakeholders to 1) share their institutional and organizational perspective; 2) consider to what extent their state's renewable energy policies and technologies are motivated by climate change; 3) share their general perceptions of CCS development; 4) reflect on how the technology is promoted or discouraged within their state's policy setting; 5) share their opinion on media coverage of CCS; and 6) identify other influential stakeholders within their state. Selection of the energy policy stakeholders was then implemented in two steps. The first step was to search for state legislative committee testimony where energy bills were presented and discussed. Additional stakeholders were then identified via snowball sampling during the first round of interviews. This resulted in a total of 81 interviews from policy stakeholders in various positions within the policy process (industry, governmental, non-governmental organizations, and academic).

A codebook based on the socio-political evaluation of energy deployment (SPEED) framework and Luhmann's theory of social function systems was constructed for the purposes of documenting, categorizing, and analyzing frames used by interviewees as well as their perceptions of risks and benefits of CCS technology [5,11,12]. The codebook was developed as a matrix of coding categories that accounted for five social frames: technical, economic, environmental, health and safety, political/legal and aesthetic along with their respective risks and benefits to deployment [13]. A team of three researchers analyzed and coded each interview transcript using QSR International's NVivo™ 8 qualitative analysis software. The results were then analyzed quantitatively by comparing the number of sentences coded in each frame and also qualitatively by reviewing the specific details of the content within the coded text.

### 2.2 Media Analysis Methodology

Three newspapers were chosen from each of the four states, representing geographically and demographically different regions of the state (table 1). The LexisNexis™ Academic search guide and other smaller search guides that accessed less popular newspapers (i.e. Midland Reporter Telegram and Bozeman Daily Chronicle) were used to find articles highlighting CCS technology. The search criteria included all articles regardless of newspaper section or authorship (i.e. editorials) with the terms carbon sequestration, carbon capture and storage, clean coal and various renditions on the terms in the title and/or lead paragraph of an article. Articles were reviewed manually after retrieval to remove duplications and any articles not strictly adhering to the search criteria. This strategy ensured that article content was focused primarily on the technology. Search dates covered roughly a 20 year period (January 1, 1990 to June 15, 2009).

Table 1. Newspapers included in newspaper media analysis.

<b>Newspaper Type</b>	<b>Massachusetts</b>	<b>Minnesota</b>	<b>Montana</b>	<b>Texas</b>
Highest circulated	<i>Boston Globe</i>	<i>Minneapolis Star Tribune</i>	<i>Billings Gazette</i>	<i>Houston Chronicle</i>
State capital or different region	<i>Springfield Republican</i>	<i>St. Paul Pioneer Press</i>	<i>Missoulian</i>	<i>Austin American-Statesman</i>
Closest to energy technologies	<i>Cape Cod Times</i>	<i>Duluth News Tribune</i>	<i>Bozeman Daily Chronicle</i>	<i>Midland Reporter Telegram</i>

The same codebook developed for the interviews was adapted for the media analysis. QSR International's NVivo 8.0™ qualitative software was used for the purposes of coding with sentences serving as the coding unit. Coding protocol dictated that articles first be coded individually and then in teams of two coders to ensure coding consistency.

### 3. Results

#### 3.1 Interview Results

An analysis of policy stakeholders' use of frames showed a heavy emphasis on statements pertaining to the technical and political frames (figure 1). Though numbers were consistent across the four states in the importance placed on the technical frame, Minnesota stakeholders focused less of their discussions on the political frame than the other three states. Receiving a fair degree of attention, the economy was also a point of interest with stakeholders, especially in Minnesota, with the environmental and health and safety frames receiving the least amount of attention by all states surveyed.

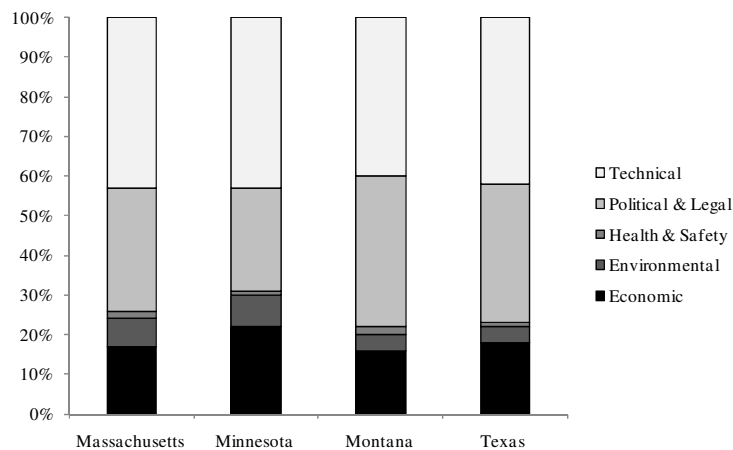


Figure 1. Comparison of frame use between state interviewees.

Interview results also showed that general discourse on CCS was predominantly negative in all four states. In reference to the technical frame, responses from all four states were frequently coded in the negative category. This frame included references to the technology's workability in a technical sense, its ability to make use of natural resources such as coal, its reliability in other uses such as in enhanced oil recovery and its potential for future research and development. Massachusetts in particular focused on the perceived risks of the technology (63% of all coded sentences). This discussion was often related to the uncertainty of CCS development in the state. However, Texas stakeholders saw more of the benefits to such technologies (46% of coded utterances), indicating that technical risks and benefits take a prominent position in the framing of CCS technology discourse.

Similar to the technical frame, use of the political frame by state policy stakeholders also generally portrayed the deployment of CCS in a more negative than positive light. The frequency of coding within the political frame indicated the importance of political processes in the deployment of CCS technology in these states.

The economic frame had equal percent of positive and negative references in all four states. In general the frame incorporates the financial aspects of CCS development, including costs related to future research and deployment at commercial scale, potential for revenue-generation and job creation, and continued use of abundant, cheap coal. Due to a lack of storage capacities in Massachusetts and Minnesota, stakeholders in those states frequently talked about the cost of sequestration operations and the resultant raise in the energy price, whereas in Montana and Texas, the

conversation was focused on the beneficial relationship between CCS and the states' energy resources (i.e. coal in Montana and oil in Texas).

Though the environment and health and safety frames were discussed less frequently by stakeholders, use of the environment frame was balanced between positive and negative responses whereas use of the health and safety frame remained predominantly negative. With regard to the environmental frame, Minnesota was the only state where interviewees discussed positive aspects within the environmental frame, making some weak but important connections between environmental issues and deployment of CCS technologies. The other states had only negative mentions of environmental impacts of the technologies. In all four states stakeholders questioned the general uncertainty associated with geologic storage of CO<sub>2</sub> including its affect on ecosystems and the atmosphere in the event of a leakage.

Some examples of policy stakeholder statements include the following:

If [CCS] becomes proven, if it's cost effective, and the pressure will mount for us to meet the goals of the Global Warming Act that just got passed, then certainly we'll be involved in it and how it's structured and so forth (MA15).

[CCS is] certainly not our preferred option, but when you are in as much trouble as we are in terms of global warming, you can't afford to get rid of anything that has the potential to be part of the solution(MN08).

What I've read in the Intergovernmental Panel on Climate Change report on carbon sequestration is...that worldwide, we would have about enough geological formations for about 60 years of sequestration. So sequestration is a finite resource as well (MT 04).

Texas is interested in fostering...captured anthropogenic CO<sub>2</sub> to grow the EOR business (TX08).

### 3.2 Media Analysis Results

Throughout the 19+ year period of analysis, a total of 216 articles in 9 of the 12 regional newspapers highlighted CCS technologies. All Montana and Texas newspapers included in the study showed some level of reporting, whereas the Springfield Republican and Cape Cod Times in Massachusetts and the Duluth News Tribune in Minnesota were removed due to a complete lack of reporting on the technology. Newspapers closest to CCS project/research sites (Midland Reporter Telegram and Bozeman Daily Chronicle) had the overall highest level of reporting compared to other newspapers within the states of Montana and Texas as well as the states of Massachusetts and Minnesota which generally lacked such projects (table 2).

Table 2. Number of articles reporting on CCS from January 1, 1990 to July 15, 2009 by newspaper.

State	Newspaper	Number of Articles
Massachusetts	<i>Boston Globe</i>	19
Minnesota	<i>Minneapolis Star Tribune</i>	4
Minnesota	<i>St. Paul Pioneer Press</i>	6
Montana	<i>Billings Gazette</i>	5
Montana	<i>Missoulian</i>	1
Montana	<i>Bozeman Daily Chronicle</i>	62
Texas	<i>Austin American-Statesman</i>	11
Texas	<i>Houston Chronicle</i>	17
Texas	<i>Midland Reporter Telegram</i>	91

Reporting on CCS technologies between 1990 and 2009 demonstrated a general lack of media interest until 2003 with a peak in 2007. Montana and Texas contributed the most articles during this time period due to a sharp increase in CCS research and other projects proposed in these states after 2005 (i.e. DOE Regional Carbon Sequestration Partnership phase II and III projects and the proposed FutureGen project).

Coding and analysis of the newspaper articles demonstrated a strong focus on 1) the political/legal frame with reporting on states' attempts to develop their own legislation, standards, or precedents for CCS deployment including how to navigate siting, permitting and liability; 2) the economic frame with a heavy focus on the creation of jobs and the possibility for monetary incentives as well as some of the economic pitfalls of technology adoption; and 3) the technical frame, debating the readiness of CCS technologies for commercial deployment (figure 2).

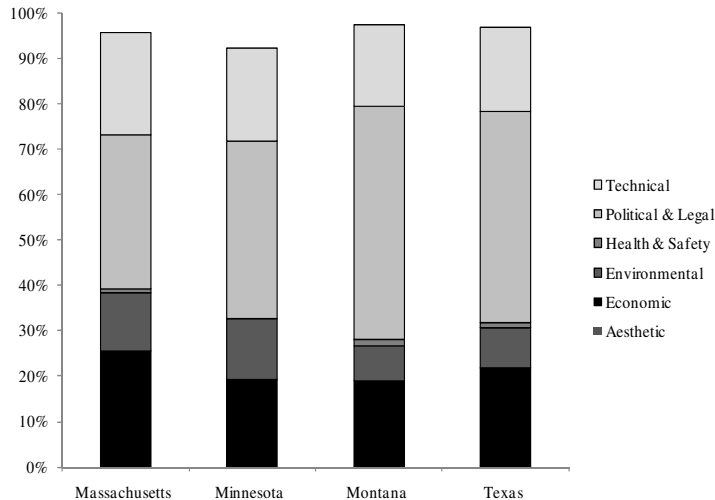


Figure 2. Comparison of frame use between state newspapers with the exclusion of the 'other' category not presented in this paper.

Although the states were generally similar in focus and framing of CCS, Texas and Montana put significantly more emphasis on the political/legal frame than Massachusetts and Minnesota. Some examples of these statements include the following:

After hearing Gov. Dave Freudenthal tell them Wyoming needs to be out front in regulating new ways of permanently storing greenhouse gas underground, a legislative committee last week endorsed two proposed measures dealing with carbon capture and sequestration in the state. The Legislature's Joint Judiciary Interim Committee endorsed proposals that would give the state Department of Environmental Quality regulatory oversight of CO<sub>2</sub> storage in the state and recognize that surface owners control the underground voids where the gas would be stored (*Bozeman Daily Chronicle*, region section, January 27, 2008).

The Somerset facility...is under strict orders by the state to cut down, by 2010, in the sulfur dioxide, nitrogen oxide, soot, mercury, and other toxic pollutants it emits. The plant's owner...proposes to meet the requirements by first gasifying the coal before burning it. This would greatly reduce those pollutants, but it would do nothing to curb carbon dioxide unless there is an affordable way to sequester it securely. Unfortunately, no one has done any studies whatsoever of potential sequestration sites in Massachusetts (*Boston Globe*, editorial, December 2, 2007).

There are two Texas sites on the shortlist for the FutureGen project, a joint government/private sector effort to build a clean-burning coal plant that captures all of its CO<sub>2</sub> output. Houston-based Tondou Corp. has proposed a 600-megawatt plant using coal gasification for the Corpus Christi area, and in Fort Bend County Hunton Energy...is planning a \$2.4 billion IGCC project fuelled by pet coke. (*Houston Chronicle*, business section, March 10, 2007).

Frames receiving substantially less attention included the environmental frame with minimal focus on the environmental benefits of CCS as a strategy for climate change mitigation; the health and safety frame with minimal attention given to the effects of CCS on public health and safety; and the aesthetic frame which received next to no attention from regional newspapers of all four states.

Unlike newspaper choices in framing on CCS, a breakdown of risks and benefits by state was less trend-worthy with all newspapers including both positive and negative statements in their portrayals of the technologies. However, Massachusetts newspapers generally focused on risks, highlighting a lack of technological readiness, whereas Montana and Texas were overly positive in their use of the technical frame. Montana and Texas were also more heavily positive in their use of the political/legal frame though all states exhibited a more positive trend in that particular category. Instead Massachusetts and Minnesota focused more on the negative aspects of CCS on the environment. All but Minnesota framed CCS deployment overall as a positive.

#### 4. Conclusions

The CCS discourse represented in the regional newspapers in the four states is overall more positive than the aggregate perceptions of CCS by the energy policy stakeholders interviewed. Risks associated with CCS technology were a more prominent feature in the interviews than in the media analysis. Within the interviews, technical risks emerged as dominant, whereas in the media analysis political and legal risks were most prominent.

Among the four states, Texas and Montana had more newspaper coverage of CCS which is associated with the salience of the technology in those states, as they have more specific CCS projects and initiatives than in Massachusetts or Minnesota (figure 3).

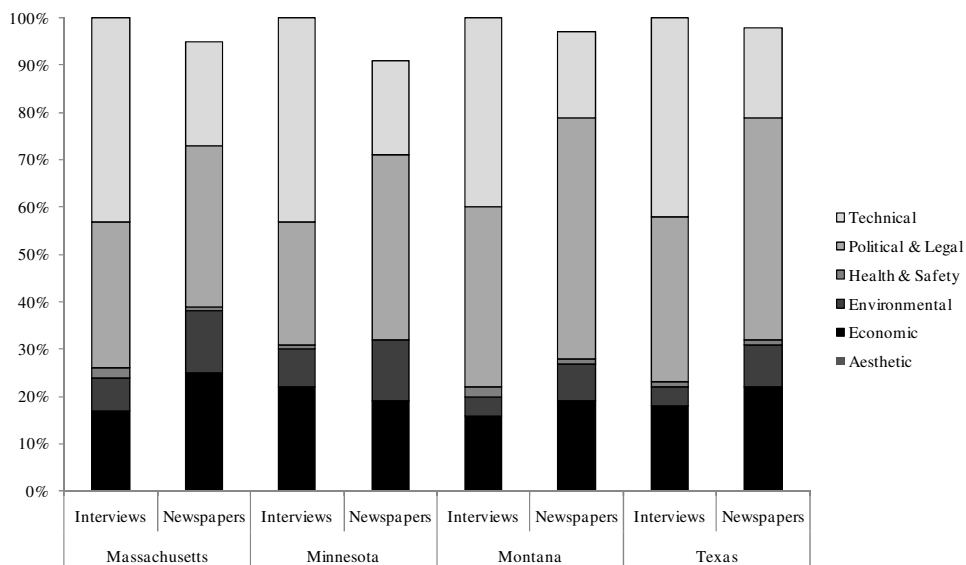


Figure 3. Comparison of frame use between interviews and newspapers with the exclusion of the 'other' category present only in newspaper results not presented in this paper.

Neither the media analysis nor the interviews had significant environmental/climate framing, i.e. explicit reference to the environmental and climate benefits of CCS technologies were infrequent. Two different explanations might account for this: 1) This could represent an unstated assumption that the environmental benefits of CCS technology

are generally understood; or 2) this could represent a disconnect between the environmental motivation for considering CCS and economic and political motivations for advancing this technology.

### Note

This paper is a general summary of two studies. Individual papers from these studies are in development:

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