



**CARBON CAPTURE AND STORAGE**  
A Pembina Institute–ISEEE Thought Leader Forum  
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# Carbon Capture and Storage – Online Survey of Sector Experts

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# Carbon Capture and Storage – Online Survey of Sector Experts

## Contents

<b>1. Introduction.....</b>	<b>2</b>
<b>2. Results.....</b>	<b>3</b>
<b>2.1 Role of CCS in Reducing Canada’s GHG Emission.....</b>	<b>3</b>
<b>2.2 Concern about Various Aspects of CCS .....</b>	<b>4</b>
<b>2.3 Funding CCS.....</b>	<b>5</b>
<b>2.4 Evaluation Criteria .....</b>	<b>5</b>
<b>2.5 How to Put a Price Signal on GHG Emissions.....</b>	<b>7</b>
<b>2.6 Policy Options to Provide Public Support .....</b>	<b>8</b>
<b>2.7 Long-term Liability .....</b>	<b>9</b>
<b>3. Conclusions.....</b>	<b>12</b>

## List of Figures

Figure 1. Role of CCS in reducing Canada's GHG emissions .....	3
Figure 2. Funding CCS.....	5

## List of Tables

Table 1. Concern about various aspects of CCS.....	4
Table 2. Opinions about evaluation criteria for CCS policy options.....	6
Table 3. Opinions about policies that put a price on GHG emissions .....	7
Table 4. Opinions about policy options to provide public support for CCS.....	9
Table 5. Priorities for the development of long-term liability regulations.....	10

# 1. Introduction

This survey was designed to identify opinions about various aspects of CCS, particularly policy issues, in order to make the CCS Leaders Forum on November 10, 2008 more effective and efficient. It was administered online, and invitations were sent to CCS experts from various sectors who had been invited to the Forum. The survey received 87 responses from October 2 through October 17, and none after that time (respondents were given a deadline of October 15<sup>th</sup>). Respondents were anonymous and could be grouped generally into four sectors: industry (power, oil and gas, and consulting/service — 50 respondents), NGO (20 respondents), government (nine respondents) and academia (eight respondents). While several respondents selected the Other category, it was always to provide additional information (e.g. two respondents self-identified as landowners), with a primary category selected as well. The survey results reflect the opinions of the individual respondents, and are not necessarily representative of their organizations' official policies. The responses of government sector respondents in particular do not necessarily reflect government policy, or the direction of future policy. Geographically, there were 65 respondents from Alberta, seven from B.C., seven from Ontario, one each from Manitoba, Saskatchewan, Quebec, and Nova Scotia, as well as two from the USA, one from Australia, and one who did not identify their location. Respondents were 84% male and 16% female. Responses are discussed by theme below, and are analyzed by sector, with similarities and divergences in opinion identified throughout the report, and summarized in the conclusion.

# 2. Results

## 2.1 Role of CCS in Reducing Canada's GHG Emission

The vast majority of respondents believe that CCS will play a significant role in reducing Canada's GHG emissions, with 39.1% of respondents believing that CCS will be used to achieve 30% or more of total GHG emission reductions, and a further 36.8% believing that it will be used to achieve 15–29% of total reductions. Less than 5% believe that CCS will have virtually no impact.

The graph below shows how the results differed between respondents from different sectors. Upon closer examination, government representatives were extremely bullish on the role of CCS with nearly 90% believing that it will be used to achieve 30% or more of total GHG emission reductions. Industry respondents and academics were more optimistic than NGO representatives about the role of CCS, with 78% and 75% respectively believing that CCS would achieve 15% or more of Canada's GHG reductions, compared to 60% of NGO respondents. Only 5% and 4% of NGO and industry respondents respectively believe that CCS will have virtually no impact. Overall, government representatives are much more likely to believe that CCS will play a substantial role in reducing Canada's GHG emissions than those from other sectors. It would be worthwhile to bring this up at the Forum and discuss the reasons for the differences in opinion.

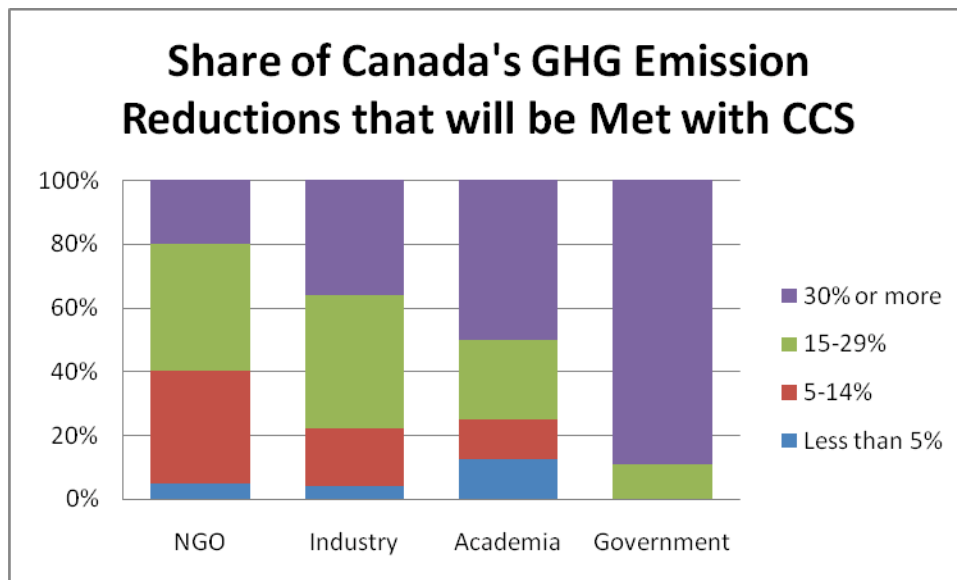


Figure 1. Role of CCS in reducing Canada's GHG emissions

## 2.2 Concern about Various Aspects of CCS

The four groups of respondents differ slightly in terms of what they view the most important issues concerning CCS to be. The most and least important issues to each of the groups are listed below. The results are based on a combination of rating and ranking questions, so the issues listed are not necessarily in order of importance.

Table 1. Concern about various aspects of CCS

	Industry	NGO	Government	Academia
<b>Most important issues</b>	Government policy certainty and stability (by <i>far</i> the top issue) Cost effectiveness	Cost effectiveness Security of storage Liability	Government policy certainty and stability Cost effectiveness	Government policy certainty and stability Cost effectiveness
<b>Least important issues</b>	Local environmental and health risks Security of storage	Availability of infrastructure State of the technology	Security of storage	Availability of infrastructure State of the technology
<b>Additional Issues that need to be addressed at the workshop</b> (Number in brackets represents the number of respondents who suggested this issue)	Public awareness (2) Willingness of industry to invest in CCS (1) Storage space ownership and tenureship (1) Storage capacity (1) Availability of public funding (1) Appropriateness of CCS (1)	Investment (availability/ appropriateness of government funding) (3) Emphasis on CCS compared to alternatives/ appropriateness of CCS/EOR (2) Landowner issues (1) Local community opposition (1) 'Who pays' (1) Storage capacity (1)		Public communication / acceptance (3) Linkage between capture-ready and storage-ready (1)

There is only one issue on which different sectors have completely opposite opinions. NGO respondents consider effectiveness concerns (security of storage) to be one of the issues of highest concern, while industry and government respondents consider it to be of low concern relative to the other issues. All sectors agree that cost effectiveness (compared to other means of reducing emissions) is one of the top concerns. Government policy certainty and stability is very important to industry, government, and academia, but is of more moderate concern to NGOs. Liability is very important to NGOs, but of moderate concern to other sectors. Availability of infrastructure is considered less important than the other issues by NGOs and academia, but

moderately important to industry and government. The most commonly suggested issues of concern that were not included in the survey were public awareness and the appropriateness of CCS.

## 2.3 Funding CCS

The different sectors have divergent views about the correct split between private and public funding to cover the financial gap associated with CCS, particularly in the early years. In the Pilot stage, industry respondents believe on average that the point source emitter should pay only 30% of the additional costs associated with CCS, while the public should fund 70% of the incremental costs. This contrasts sharply with the belief among NGO respondents that the point source emitter should be responsible for 65% of the additional costs associated with CCS, while the public should bear only 35%. The opinion difference narrows as CCS becomes more mature, until at full market penetration, respondents believe that the point source emitter should pay between 82% (Industry) and 93% (NGO) of the CCS financial gap.

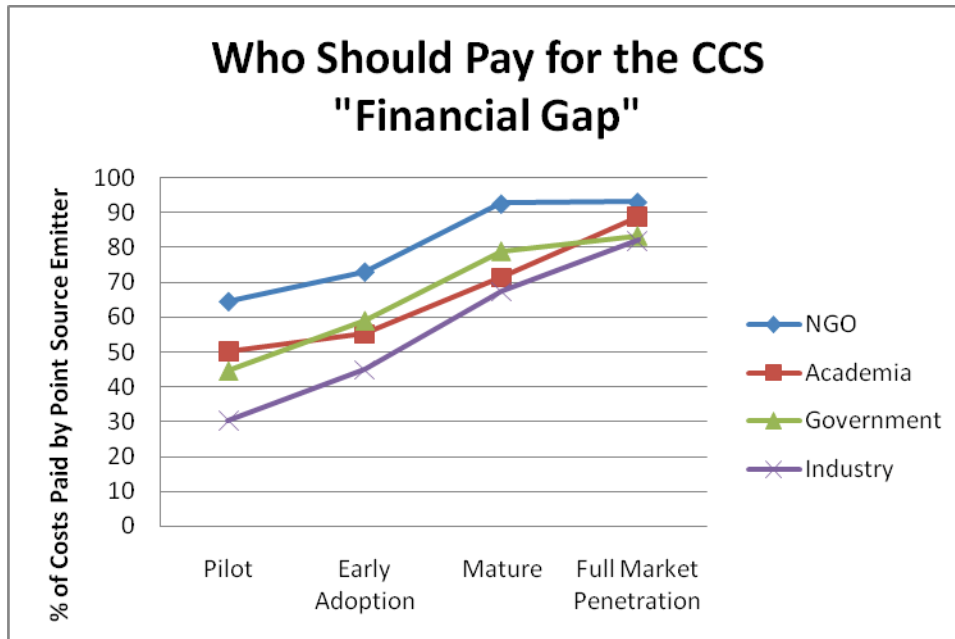


Figure 2. Funding CCS

## 2.4 Evaluation Criteria

Opinions about the most and least important evaluation criteria were extremely varied, both between and within the different sectors. Many criteria fell somewhere in the middle in terms of importance. The table below identifies only the criteria that trended strongly toward being of relatively high or low importance to respondents within each sector.



Table 2. Opinions about evaluation criteria for CCS policy options

	Industry	NGO	Government	Academia
<b>Most Important</b>	Ability to provide investment certainty for industry ( <i>by far</i> )  <i>Secondary:</i> Ability to stimulate innovation  Ability to stimulate rapid deployment of CCS	Ability to protect the environment and human health ( <i>by far</i> )  <i>Secondary:</i> Ability to stimulate rapid deployment of CCS  Ability to implement the policy quickly	Ability to stimulate rapid deployment of CCS ( <i>by far</i> )	Transparency and clarity  Ability to protect the environment and human health
<b>Least Important</b>	Ability to equitably distribute the costs associated with CCS  Flexibility and adaptability	Ability to provide investment certainty for industry  Flexibility and adaptability	Flexibility and adaptability  Transparency and clarity	Ability to equitably distribute the costs associated with CCS
<b>Additional Criteria Suggested</b>	Cost effectiveness/efficiency (1)  International competitiveness of technology (1)  Overall ability to achieve needed reductions in GHGs (1)  Avoid distortion of competitiveness (1)  Ability to prove technology with flue gas rather than natural gas capture (1)	Ability to facilitate coordinated infrastructure development (1)  Ability to protect the environment and human health — both <i>short term</i> and <i>long term</i> (1)  Ability to address long-term liability (1)  Level of emission reductions (1)	Streamlining and effectiveness of approval process (1)	Ability to mitigate GHGs in the short as well as long term (1)

As can be seen in the table, each sector chooses a different criterion as the most important to use when evaluating policy options, indicating substantial divergence on this topic. There are two points where significant differences of opinion were particularly observed between respondents. The first one is that Industry respondents consider the ‘ability to provide investment certainty for industry’ to be the most important criterion by far, while NGO respondents consider it to be one of the least important criteria. The other criterion with substantial divergence in opinion is ‘ability to protect the environment and human health’. This criterion received the most #1 votes overall, and is one of the most important criteria for NGOs and academics, but it splits respondents from other sectors: 26% of Industry respondents rated it as their most important

criterion, while 40% rated it as being one of their least important two criteria. Among government respondents, nearly half placed it in their top three criteria, while the remainder placed it in their bottom three criteria, indicating substantial polarization of opinions. In terms of similarities, all sectors except academia selected ‘ability to stimulate rapid deployment of CCS’ as one of their most important evaluation criteria.

## 2.5 How to Put a Price Signal on GHG Emissions

On this issue there is substantial agreement among industry, NGOs, and academia, but the opinions of government respondents were often completely opposite those of the other sectors. All sectors agree that one of the most preferred policy options for putting a price signal on GHG emissions is a carbon tax with reinvestment in emission reduction activities. However, intensity-based regulations (with the option of contributing to a technology fund instead of meeting GHG reduction requirements) were one of government’s most preferred options, while the other sectors universally considered it one of the least preferred options. Economy-wide revenue neutral carbon taxes were favoured by NGOs and academia, but government respondents placed them as one of the least preferred options. This is clearly an area in which further sharing of information and discussion needs to occur.

Table 3. Opinions about policies that put a price on GHG emissions

	Industry	NGO	Government	Academia
<b>Most Preferred Policy Options</b>	Carbon tax with reinvestment in emission reduction activities  Absolute cap and trade with full auctioning of permits	Carbon tax with reinvestment in emission reduction activities  Economy-wide revenue neutral carbon tax  Absolute cap and trade with full auctioning of permits	Intensity-based regulation  Carbon tax with reinvestment in emission reduction activities  Regulated requirement for CCS use where possible	Economy-wide revenue neutral carbon tax  Carbon tax with reinvestment in emission reduction activities
<b>Least Preferred Policy Options</b>	Regulated requirement for CCS use where possible  Intensity-based regulation	Intensity-based regulation  Absolute cap and trade with free allocation of permits	Absolute cap and trade with free allocation of permits  Economy-wide revenue-neutral carbon tax	Intensity-based regulation  Regulated requirement for CCS use where possible

	Industry	NGO	Government	Academia
<b>Additional Policy Suggestions</b>	Energy efficiency incentives (1) Voluntary public energy consumption reporting system with surcharges/ rebates for high/low energy users (1) Economy wide carbon tax that is NOT revenue neutral (1)	Combination of multiple incentives (1) Revenue-recycling approach like NOx reduction schemes (1) Cap and trade system with full auction and revenue recycling (1) CCS tax ( <i>perhaps they meant to write carbon tax?</i> ) on all companies, not just big ones (1) Economy-wide revenue neutral carbon tax with no corporate tax cuts Emissions tax on vehicle sales based on efficiency	Mixed regime that incorporates regulation, royalty, carbon tax, and emission reduction (1)	

## 2.6 Policy Options to Provide Public Support

There is also disagreement between the sectors about what policies should be used to provide public funding for CCS (and even *if* public funding should be offered to CCS — the most commonly suggested additional policy option was ‘none of the above/no government funding’).

While industry, government, and academics all favour direct public subsidies, NGO respondents believe that direct public subsidies are the worst policy option. The NGO sector’s most preferred policy option is public investment in, or ownership of CCS infrastructure, which is also favoured by government, but is one of industry’s and academia’s least favoured options. Government’s most favoured option is royalty reductions, but these are one of industry’s and NGOs’ least favoured options. One area of similarity in opinion between industry and NGOs is that putting a guaranteed future value on GHG reduction credits is a good option. If and how to provide public support for CCS is an area where substantial differences in opinion will have to be dealt with on the day of the Forum.

Table 4. Opinions about policy options to provide public support for CCS

	Industry	NGO	Government	Academia
<b>Most Preferred Policy Options</b>	Tax credits Direct public subsidy (gov't spending on CCS projects) Guaranteed future value of GHG reduction credits	Public investment/ownership in CCS infrastructure Guaranteed future value of GHG reduction credits	Royalty reductions Public investment/ownership in CCS infrastructure Direct public subsidy (gov't spending on CCS projects)	Government purchase of GHG reduction credits from operators Direct public subsidy (gov't spending on CCS projects) Tax credits
<b>Least Preferred Policy Options</b>	Public investment/ownership in CCS infrastructure Royalty reductions	Direct public subsidy (gov't spending on CCS projects) Royalty reductions	Government purchase of GHG reduction credits from operators	Public investment/ownership in CCS infrastructure Guaranteed future value of GHG reduction credits
<b>Additional Policy Suggestions</b>	None of the above — energy efficiency regulations, subsidies for train transportation instead Direct funding during initial stage driven by avoided emission cost in future (not credits) Application of multiple credits Tradable tax credits Multiple credits for early CCS	Public-private partnerships; trust fund for post-closure stewardship of sites None of the above/no government funding (4)	Government royalty and tax credits	None of the above

## 2.7 Long-term Liability

When it comes to long-term liability, yet again there is a substantial difference of opinion between respondents from different sectors. The first question about liability asked respondents to select from a list all of the responsibilities that they believed should be included in long-term liability. While NGO respondents were nearly unanimous that all responsibilities on the list should be included in long-term liability, approximately 40% of industry respondents believed that long-term liability should not include many of the responsibilities, including any liability for

damage to wells, mineral resources, soils, groundwater or the surface caused by leaks; environmental damage; remediation; or compensation to individuals who suffer damage from a leak. While most industry respondents are in favour of long-term liability including liability for measurement, monitoring, and verification (MMV) of the CO<sub>2</sub> plume's movement, or maintenance of records of injection sites, volumes, and plume movement for future generations, approximately 15–20% of industry respondents don't think these should be required. Only 46% of industry respondents believe that long-term liability should include liability for environmental damage, compared to 95% of NGO respondents, 67% of government respondents, and 100% of academics. Academics are closer in opinion to NGO respondents, with substantial agreement with almost all inclusions in liability (liability for remediation, which was selected by 75% of academics, was the least selected responsibility, with all others selected by between 88–100% of respondents. Government respondents were somewhere in the middle, with 89% agreeing that liability should include MMV, 67% agreeing that it should include liability for environmental damage or for compensation to individuals that suffer damage, and 78% agreeing that other forms of liability should be included.

The table below shows the relative importance that each group of respondents places on different aspects of developing long-term liability regulations. There is quite strong agreement that developing a clear definition of long-term liability is the top priority, and that allocating the costs associated with liability is a low priority relative to the other tasks.

**Table 5. Priorities for the development of long-term liability regulations**

	<b>Industry</b>	<b>NGO</b>	<b>Government</b>	<b>Academia</b>
A clear definition of long-term liability and what it includes	1	1	1	1
Identification of the party responsible for long-term liability	3	2	2	3
The point at which long-term liability is transferred from the company to government or another body (if such a transfer occurs)	2	4	3	2
The way in which the costs associated with liability are covered	4	3	4	4

Additional issues that respondents suggested need to be addressed by liability regulations include the following (the 'affiliation' of the respondents making the suggestions follow in brackets, each was suggested by only one person):

- The need to set standard costs (i.e. compensation) associated with various liability 'types' (academia)
- Regulations should focus on liability reduction through options like water scrubbing to inject CO<sub>2</sub> and other substances in a way that they are sequestered from Day 1. No CO<sub>2</sub> should be injected into an aquifer as a separate phase (industry — consulting and services)

- Accept modest risk now while studying implications and developing understanding. Define liabilities later (electric power industry)
- Pore space regulation. Technical requirements (electric power industry)
- Performance credits and long-term liability (government)
- Clear definition of financial security tools (government)
- Identification of what MMV is needed at sites over long term and who pays for it. Focus on stewardship and responsibility for sites rather than who is liable if something goes wrong (NGO)
- The legal costs and expert witness costs involved for determining damage must be applied to the company burying the carbon (NGO)
- Posting of 1000 year bonds to cover all liability by the company doing the CCS (NGO)
- Establishing an arm's length body and auditing branch to enforce regulations (NGO)

In terms of how long-term liability should be allocated between the CO<sub>2</sub> emitter (company) and the government, respondents from industry, NGOs, and government are in agreement on their preferred option — that the company should retain liability until a fixed time period has passed since project abandonment, with adjustments possible based on performance standards such as CO<sub>2</sub> plume stability. That was the second choice of academics, who preferred that the company should retain liability until a performance standard is met, without the fixed time period requirement. However, a high number of government and NGO respondents (22% and 30% respectively) believed that the company should retain permanent liability, while only 13% of academics and 2% of industry respondents shared this belief.

# 3. Conclusions

The responses to the survey can be considered informed, with nearly 50% of respondents indicating that they were very familiar with CCS, another 35% moderately familiar with CCS, and the remainder somewhat familiar with CCS. There are several areas of strong agreement between respondents from different sectors, including:

- All sectors agree that cost effectiveness compared to other means of reducing emissions is one of the top concerns about CCS
- Government policy certainty and stability is one of the most important concerns about CCS for industry, government, and academia, and is of moderate concern to NGOs
- In terms of evaluating policy options, all sectors except academia selected ‘ability to stimulate rapid deployment of CCS’ as one of their most important criteria
- All sectors agree that one of the most preferred policy options for putting a price signal on GHG emissions is a carbon tax with reinvestment in emission reduction activities
- The sectors agree on the priorities for developing long-term liability regulations: developing a clear definition of long-term liability is the top priority, and allocating the costs associated with liability is a low priority relative to the other tasks
- Industry, NGOs, and government all agree that the CO<sub>2</sub> emitter should retain liability for a fixed time period after project abandonment, with adjustments possible based on performance standards, while academics agree that the liability timeframe should be based on meeting performance standards but believe the fixed time period is not necessary

However, there are also many areas where respondents from different sectors have quite different, and even incompatible views, particularly when industry and NGO opinions are compared. These areas include:

- Government respondents believe that CCS will play a much larger role in reducing Canadian GHG emissions than respondents from other sectors
- NGO respondents consider effectiveness concerns (security of storage) to be one of the issues of highest concern surrounding CCS, while industry and government representatives consider it to be of relatively low concern
- Particularly in the early stages of development, industry believes that the public should fund most of the incremental cost of CCS, while NGOs believe that the emitter should pay the majority of the incremental costs
- In terms of evaluating policy options, industry respondents consider the ‘ability to provide investment certainty for industry’ to be the most important criterion by far, while NGO respondents consider it to be one of the least important criteria. There is also substantial divergence in opinion between and within sectors about the criterion ‘ability to protect the environment and human health’

- Intensity-based regulations are one of government's most preferred options for putting a price signal on GHG emissions, while the other sectors all consider it to be one of the least preferable options
- In terms of policies to provide public support to CCS, industry, government, and academics all favour direct public subsidies, but NGO respondents believe that direct public subsidies are the worst policy option. The NGO and government sectors favour public investment in CCS infrastructure, but this is one of industry and academia's least favoured options. Government's most preferred option is royalty reductions, but these are one of industry's and NGOs' least favoured options. Several respondents protested the question about policy options to provide public funding to support CCS, expressing a desire for *no* public CCS funding at all
- There is substantial disagreement about what long-term liability should include, with almost half of industry respondents preferring that no actual liability (beyond the responsibility for MMV and keeping records) is included, while NGO representatives want all types of liability included. Academia is closer to NGOs in opinion, while government is closer to industry
- A significant number of NGO and government respondents believe that the CO<sub>2</sub> emitter should retain permanent liability

It is important to keep in mind that each sector still includes respondents with a range of opinions, and the results discussed in this report are often averages of the responses for a sector. Additionally, the group of individuals who responded to the online survey is different than the group that will attend the Forum, and so the opinions expressed on November 10 may be quite different. Despite this, there are clearly areas where opinions are similar and areas of substantial divergence, and it would be wise to include both on the agenda for the Forum, so that respondents can come to agreement on some of the easier issues, as well as make progress on more difficult tasks.