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Policy Option Paper – Closing the Implementation Gap

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Policy Option Paper – Closing the Implementation Gap

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1. Introduction

Given the state of carbon capture and storage (CCS) technology, the current state of public policy in which CCS is a core strategy of Alberta's GHG reduction plan and the potential for CCS to reduce GHG emissions in Canada (as demonstrated in "CCS Discussion Paper 1: Environmental and Economic Opportunities and Challenges"), this paper will provide a set of policy options to transition CCS from its infancy to a level at which we can make decisions about large-scale implementation, a scale at which it could make major reductions in economy-wide CO_2 emissions.

The Alberta government has committed $2 billion to CCS which as per the national task force recommendations will result in 3–5 projects and approximately 5 Mt in CO_2 reductions. It is expected the focus between now and roughly 2012 will be on the initial commercial-scale projects driven by the $2 billion. The focus of the policy options presented here are primarily for the "post $2 Billion world" of CCS.

We divide the steps **following the "$2 billion pilot phase"** of initial commercial-scale projects into three phases:

Early Adoption Phase

With the 3–5 commercial-scale projects underway, companies will be watching and looking for opportunities to apply CCS to their expansion projects or new projects. Leading companies will be proposing and including CCS with their projects.

Mature Technology / Rapid Market Transition Phase

Commercial-scale projects will be fully operational, additional early adopter projects will be in development. During this phase, adequate experience and confidence in the technology, economics and policy regime will have the vast majority of companies proposing new or expansion projects with CCS — we expect to also see an increased number of retrofit projects on mid-aged infrastructure.

Wide Market Penetration Phase

CCS will be fully applied to large CO_2 emissions sources where technically feasible. Existing infrastructure will either be retrofitted for CCS, repowered with other energy sources or shut down. All new large fossil energy projects will include CCS.

The pace at which CCS technology moves through these phases will depend both on the extent to which the technology meets expectations, and the Canadian (both federal and provincial) climate change public policy framework.

This paper will:

- Present the current best estimate available for the cost gap to implement CCS;
- Propose a set of evaluation criteria to be able to compare policy options;

- Present a list of "public coin" and "polluter coin" policy options;
- Propose a shortened list of policy options by eliminating options that clearly fail the evaluation criteria.

From this policy options paper, a "straw model" paper will be written and presented at the November 10, 2008 thought leaders forum to provide a starting point for discussion. This options paper draws on the results from the electronic survey of the invitees to the forum to help inform policy option priorities and gaps in opinion between stakeholders (see paper "CCS Discussion Paper 4: CCS Online Survey Results" by Jacqueline Sharp).

2. The Scale of the Economic Gap for CCS

The "economic gap" for CCS is, in simple terms, the difference between the cost of CCS and the cost of carbon. It is worth being a bit more careful with the definition, since differing views about the gap often arise as much from differing assumptions about what it includes as from assumptions about the cost of the hardware.

For the sake of this discussion we define the gap for a project as the difference between (1) the cost of reducing emissions by implementing a CCS project using economic assumptions on items such as the cost of capital and economic life used for regular investments made by the project developer; and (2) the expected cost of emitting CO_2 during the project's planed economic life due to all rules, regulations and market conditions in so far as they are known today.

Both costs are highly uncertain. We will look first at the cost of reducing emissions with CCS which in turn depend on the difference between the cost of CCS (and emissions) of the CCS facility and the cost (and emissions) of a non-CCS baseline.

Estimates of the cost of generating electricity with CCS — which depend on factors specific to the plant — are therefore much more robust than estimates of the cost of avoiding emissions in $/t-$CO_2$ — which depend on the alterative generation technology in the electric power market in which the power plant operates. The choice of reference case can easily have a larger impact on the per-ton cost than uncertainty about the cost of the CCS hardware. For example, the per-ton cost of CCS for hydrogen production will be 30–60% lower if the base plant gasifies a heavy fuel such as pet-coke than for a gas SMR plant. Industries' choice of base plant depends in turn on the factors such as the estimated future cost of natural gas. If the cost of gas is high, the per-ton cost of CCS looks lower, not because of any change in CCS technology but because of a change in the baseline plant.

The cost of implementing CCS at a specific facility may, for simplicity, be divided into three factors:

- The costs for large energy-sector construction projects at the time and place at which the facility is constructed.
- The cost of "generic CCS" which we will take as the cost for a new coal fired electricity plant with CCS. While "generic CCS" is a vague concept given the range of technologies to be employed, the idea is to capture something about the expected cost of the leading CCS technologies in typical applications worldwide.
- Situation specific costs that depend on site and integration with a particular process.

The last half decade has seen a spectacular run-up in the cost of constructing heavy energy infrastructure driven by increases in the costs such as specialty steels, concrete, EPC services, and the labor rates for various trades. During the half decade from 2002 to 2007 North American

costs have risen by 30 to 70% (CERA), and costs in Alberta have risen considerably faster. These increases have, of course, caused sharp increases in estimates of the cost of CCS facilities. Taking the capital cost of a large coal fired power plant with CCS, for example, the estimated cost per kW have risen from ~$2000 in the IPCC-SRCCS report (based on data from early in the decade) to $4000 according to recent EPRI data.

Will costs keep increasing? This kind of construction has historically seen boom and bust business cycles that exceed those of the economy as a whole. We think that it's likely that costs will now decline from a 2008 peak, as the economic slowdown slows demand for the specialized products and services that drive these prices, causing them to fall. This is a guess, however, and no one knows for sure. What is certain is that these variations in cost are not CCS specific; they affect other technologies for cutting emissions such as wind, hydro and nuclear power as well along with oil, gas and electric infrastructure.

Estimates of the per-ton cost of reducing emissions with CCS in Canada range from about 40 to 150 $/t-$CO_2$ where the low end of the cost estimates would apply to the cost of CCS applied at construction of a new large coal-fired power plant using capital cost indexes halfway between the early 2000's values and the 2008 peak, and the high end would apply to costs for retrofitting hydrogen SMR facilities or other relatively small oil sands related facilities.

Note that recent estimates for the cost of CCS in Alberta may be somewhat high for the following three reasons:

- They assume that CCS would be applied as retrofit (e.g., to SMR) and that base plants would not change, this is a wise estimate for projects that will move forward in the next couple of years driven by the $2 billion, but this will likely be a upward cost bias for estimates for projects started beyond 2018.
- Many of the estimates were performed during a time of rapidly increasing capital costs and may have been biased upwards by expectation of continued capital cost increases.
- The costs do not include the possibility of new technologies such as the PowerSpan or Alstom post combustion technologies that will likely see industrial scale projects within the next five years.

Finally, we expect that despite much talk of "learning curves" for CCS, traditional technological learning-by-doing will play at relatively small role in driving CCS costs over the next two decades compared to factors such as capex indexes, base plants, and CCS technology choice.

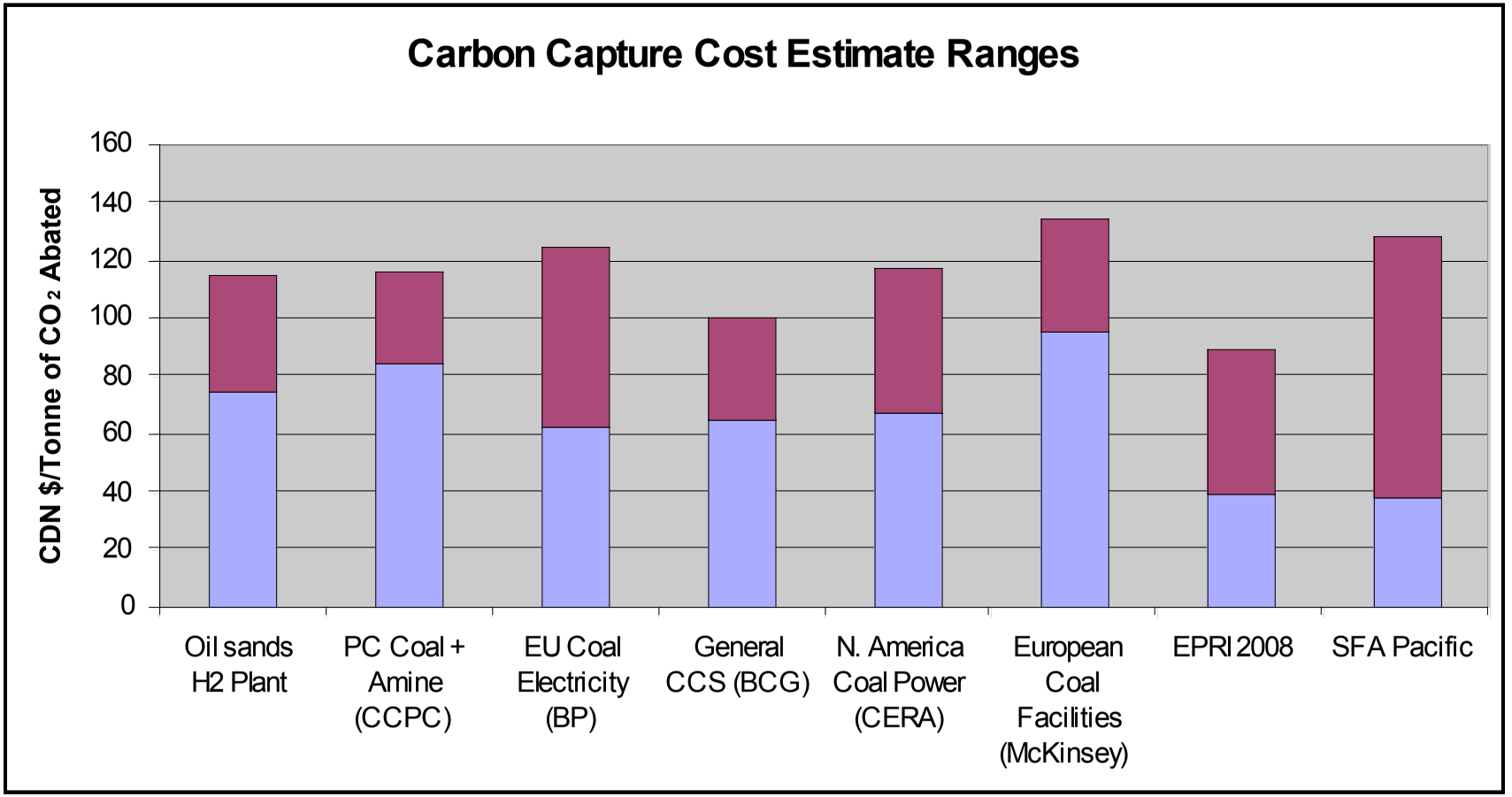
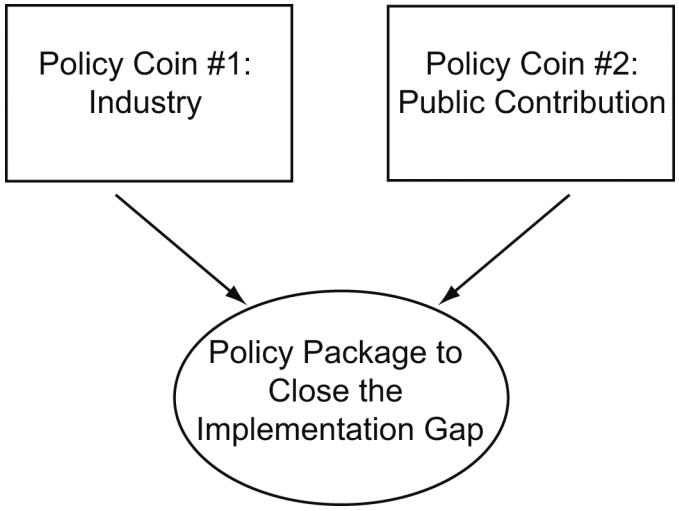


Figure 1. Carbon Cost Estimate Ranges

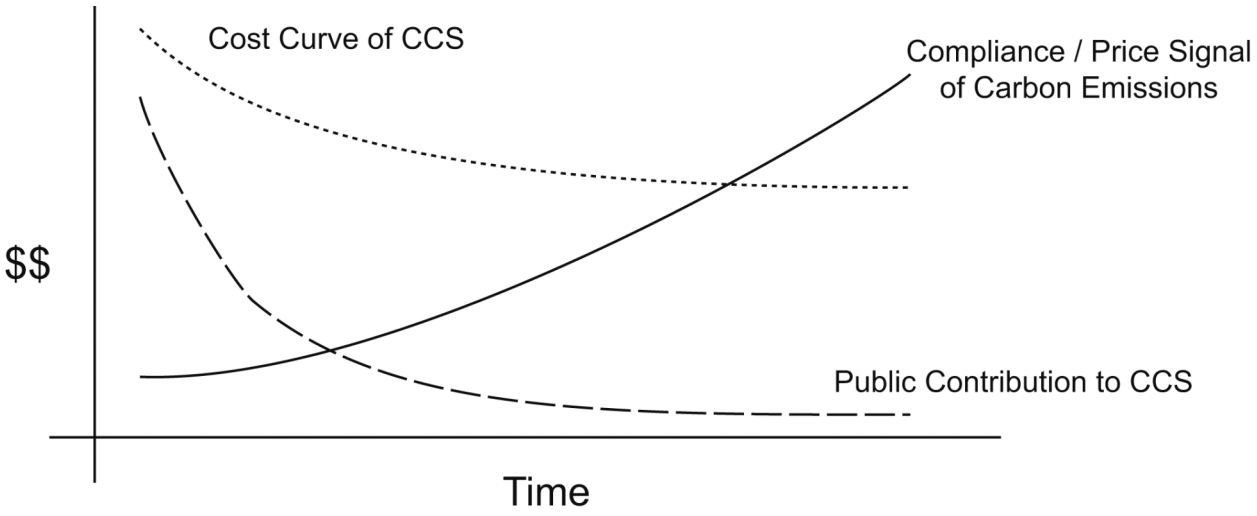
3. The Two Coins of CCS – Industry Pays and Public Pays

The essence of the discussion on closing the CCS implementation gap is on "who pays".

There are really "two coins" involved: 1) the **cost to polluter/industry** which is a cost to industry where some cost may be recovered through the consumer, and 2) the **cost to public**. The options presented here provide a range of options for each "coin" which will feed into a straw model for discussion and revision at the November 10th forum.



The end objective is to develop a CCS policy package designed to fulfill the most optimal environmental and economic deployment of CCS in Canada. It is also known that the economics of CCS will change over time. It is expected that initial start up barriers (primarily technological) will be overcome, and public policy on reducing GHG emissions will evolve over time both domestically and internationally. As a guide, we provide the following graph showing one possible path of the relationship between the "industry coin" expressed by a price signal on carbon emissions, the "public coin", and the cost curve of CCS.



When the invitees to the CCS forum were asked what portion of the cost gap they believed should be covered by industry versus the public during each phase of technology development, it became clear that there is a significant gap in opinion in the early phases, but the gap closes once the technology is more mature and able to widely penetrate the market (see Figure below). The widest spread in opinion is between the ENGO and industry sectors during the early adoption phase, where ENGOs believe industry should pay just over 70% of the cost and industry expressing just over 40%. This gap is expected, given the different interests, and is an important discussion point when evaluating the fairness of a policy package at the end. The difference in opinion is much smaller when the technology is more mature and able to fully penetrate the market. The challenge is how to get from the pilot phase today to full success in the future.

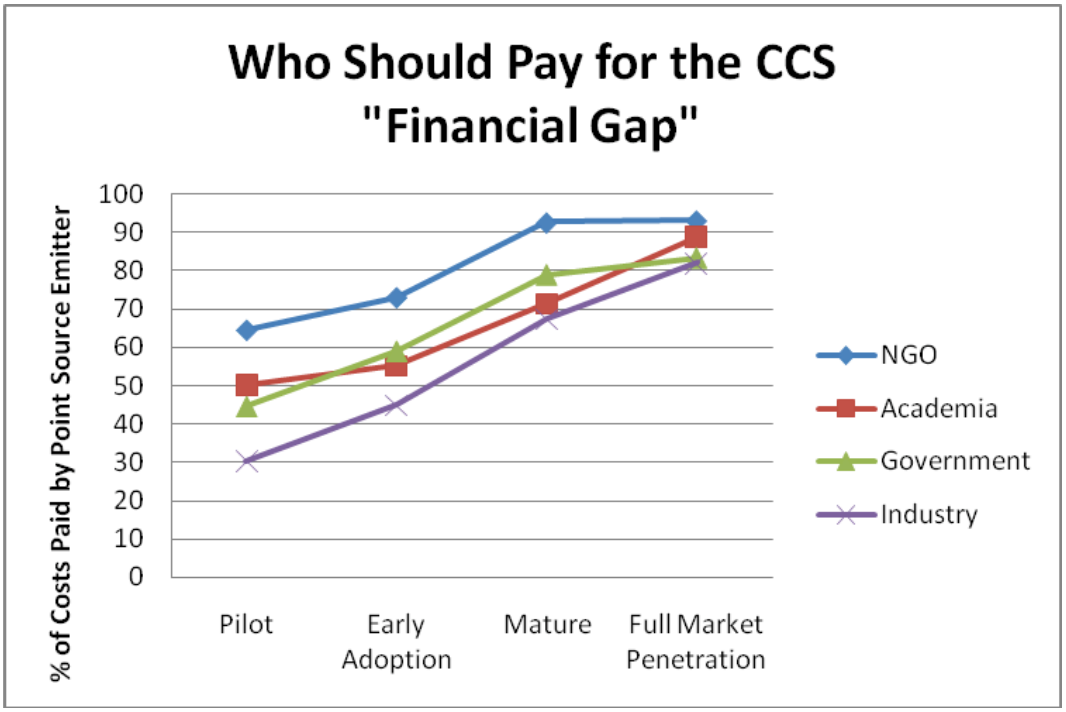


Figure 2. Who Should Pay for the CCS "Financial Gap"

4. Evaluation Criteria for Policy Options

In order to compare and evaluate policy options, it is often useful to articulate a set of evaluation criteria.

We are proposing the following evaluation criteria as a means to facilitate comparisons of the policy options and when designing a policy package.

Table 1. Evaluation Critera for Policy Options

	Evaluation Criteria	Description
1	Administrative Simplicity	Given the scale of challenge, policy options that are simpler and fit into existing policy frameworks and systems will be easier and faster to implement. “How fast can we implement this policy package?”
2	Ability to Result in Deployment of CCS Leading Towards Deep Reductions by 2025	Policy options may differ in their success of stimulating the rapid deployment of CCS. “With this policy in place, how quickly will we see the deployment of CCS?”
3	Investment / Policy Predictability for Industry	Although there is never complete certainty for any investment or public policy, policy options may differ in the level of predictability for industry when making investment decisions. “What level of predictability does this policy provide to investors in CCS?”
4	Distribution of Cost Between Industry and Public	Stakeholders will hold different views on what is a “fair distribution” of cost. “Given the distribution of cost from this policy, to what extent is there likely to be multi-stakeholder agreement on its fairness?”
5	Ability to Stimulate Innovation	Given that CCS technology will likely evolve in order to improve, it is important that the policy framework stimulates and does not stifle innovation. “How well does this policy stimulate innovation?”
6	Flexibility and Adaptability	“As the environmental, social and economic conditions change, to what extent is the policy package flexible and adaptable?”
7	Ability to Reveal Costs	“How well will this policy package allow us to reveal the full costs of CCS?”

8	Consistency with Policy for Other Low Carbon Technologies	CCS is one of many low-carbon technologies that must be advanced; where possible good policy will take a consistent approach to incenting the adoption and diffusion of all low carbon technologies.
9	Transferability of Knowledge	"To what extent does the policy enable leveraging and sharing of international efforts?"

When the invitees were surveyed for their opinion on evaluation criteria, a significant gap in opinion is found between industry and ENGOs where industry's most important criteria is "predictability" and this is least important for ENGOs. During discussions at the forum it will be important that this gap be discussed when working to find a policy package for CCS.

5. Policy Options

5.1 Policy Options for the Cost to Industry Coin

The following list of options have been identified as policies that require the industrial point source of emissions to pay for CCS:

1. Alberta's Climate Policy – No Modifications
2. Federal Government's Climate Policy – No Modifications
3. Alberta's Climate Policy – Modified Price Signal
4. Federal Government's Climate Policy – Modified Price Signal
5. Price Signal Carbon Tax
6. Reinvestment Carbon Tax
7. Cap and Trade – full auction
8. CCS Requirement – Approvals Conditional on CCS
9. Carbon Sequestration Standard – (similar to an RPS – see Jaccard's piece)

The following list briefly describes each of these "point source coin" policy options.

5.1.1 Alberta's Climate Policy – No Modifications

- Alberta's *Specified Gas Emitters Regulation* requires all established facilities with annual GHG emissions of at least 0.1 Mt to meet targets to limit their GHG intensity (emissions per unit of production) to 12% below average intensity for 2003–05, starting on July 1, 2007.
- "New" facilities — those beginning operation in 1999 or later — will be exempt for their first three years of operation and then face targets that gradually increase to reach, in the ninth year of operation, 12% below the intensity measured in the third year.
- Compliance options include on-site reductions; payments at a rate of $15/tonne CO_2e into the Climate Change and Emissions Management Fund ("technology fund"); and offset credits from projects undertaken in Alberta.[1]

[1] See "Specified Gas Emitters Regulation" under the *Climate Change and Emissions Management Act.* Available at http://www3.gov.ab.ca/env/air/pubs/Specified_Gas_Emitters_Regulation.pdf.

5.1.2 Federal Government's Climate Policy – No Modifications

Targets

- Overall target of an 18% improvement in GHG intensity (excluding fixed process emissions) for existing facilities in each sector, relative to 2006 levels, with an annual 2% improvement thereafter
- Targets for new facilities (beginning operation in 2004 or later) will apply starting in the fourth year of operation, and will be based on a sector-specific "cleaner fuel standard".
- Oil sands operations and coal-fired electricity plants that come on stream in 2012 or later will face emissions intensity targets "based on" carbon capture and storage (CCS) from 2018 on.

Compliance options include

- on-site reductions
- emissions trading with other regulated facilities
- purchases of domestic offset credits
- limited purchases of international project-based credits created through the Clean Development Mechanism (CDM) – eligible for up to 10% of target
- a Technology Fund, consisting mainly of a "deployment and infrastructure" component with an additional R&D component. Technology fund contribution rate starts at \$15/tonne CO_2e in 2010, and rises to \$20/tonne in 2013, with annual price escalations tied to the rate of nominal GDP growth after 2013. The use of this option is capped at 70% of an emitter's target in 2010; the cap tightens annually thereafter, falling to 10% by 2017 and to zero from 2018 on.
- "pre-certified investment credits," which are available to companies "for investing directly in large-scale and transformative projects...selected by the firm from a menu set out by the federal government."[2] This option allows companies to meet their targets by setting aside funding for future emission reductions in their own operations. These credits are an alternative to the Technology Fund described above.
- one-time allocation of 15 Mt in bankable, tradeable Credits for Early Action.

Timing

- proposed start date is January 1, 2010.
- draft regulations to be published in the fall of 2008 for public comment
- the proposal is to be reviewed in 2012

5.1.3 Alberta's Climate Policy – Modified Price Signal

- As above, but with the contribution rate to the Climate Change and Emissions Management Fund increased.

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[2] Government of Canada, *Regulatory Framework for Air Emissions*. http://www.ec.gc.ca/doc/media/m_124/report_eng.pdf. p. 12.

- This price increase would be complemented with a cap on offset credits stringent enough to make the contribution rate to the Climate Change and Emissions Management Fund an effective "price floor" for compliance options other than in-house emission reductions.

5.1.4 Federal Government's Climate Policy – Modified Price Signal

- As above, but with the contribution rate to the Technology Fund increased.
- This price increase would be complemented with a cap on offset credits stringent enough to make the contribution rate to the Technology Fund an effective "price floor" for compliance options other than in-house emission reductions.

5.1.5 Price Signal Carbon Tax

- Similar to British Columbia's carbon tax, this option would see a broad-based tax on emissions from burning fossil fuels. More specifically, B.C.'s tax covers the combustion of all fossil fuels included in Canada's National Inventory Report for GHG emissions, including gasoline, diesel, natural gas, coal, coke, propane, light and heavy fuel oil, aviation gasoline, aviation turbo fuel, and kerosene. The tax excludes emissions from biofuels (such as firewood, ethanol and biodiesel) and emissions from industrial processes that do not involve fuel combustion (e.g., aluminium production), as well as emissions from landfills. In BC, this approach results in a tax that covers about 70% of the province's emissions; a similar approach implemented federally would cover about 65% of Canada's total emissions.
- The tax may be revenue-neutral, with a legislated requirement to return all revenues raised through carbon taxes to taxpayers through equivalent cuts to other personal and/or corporate taxes. Alternatively a portion of the tax could be dedicated to GHG mitigation efforts.

5.1.6 Reinvestment Carbon Tax

- This option would see a government institute a carbon tax with the stipulation that 100% of the revenues raised be re-invested in emission reductions.
- Under its 2006–2012 Action Plan on climate change, the province of Quebec has instituted a carbon tax as a means of raising revenue for its GHG reduction activities.[3] As of October 1, 2007, Quebec's fossil fuel distributors are subject to a tax on CO_2 emissions that is expected to raise about $200 million per year. The tax is applicable to all fossil fuels sold in the province, including imports.
- Quebec's carbon tax rate is set annually by dividing the budget of the Green Fund — an entity created to finance the suite of GHG reduction, adaptation and education initiatives in Quebec's plan — by the province's CO_2 emissions from fossil fuel use. Between 2007 and 2012 (the end date of Quebec's Kyoto-based plan), the tax is expected to raise $1.2 billion.

[3] See "Bilan de la première année du plan d'action 2006–2012", p. 3. Available at http://www.mddep.gouv.qc.ca/changements/plan_action/bilan1.pdf.

- When calculated using 2005 emission levels, the tax level is approximately $3/tonne.
- In application towards CCS, a carbon tax would be applied to all point source emissions. The dollars raised would be put into a "Large Point Source GHG Mitigation Fund" and allocated based on an RFP competition.

5.1.7 Cap and Trade – full auction

- Cap-and-Trade system on large point sources implemented by year 01/01/2012 with full auctioning of permits.
- The cap amount would be staged over time with the end goal being full adoption of CCS levels (e.g. in the 2020 time period)
- Revenues generated go into a "Large Point Source GHG Mitigation Fund" and allocated based on an RFP competition.
- For example, US Presidential candidate Barack Obama is committed to 100% auctioning of allowances and to a cap-and-trade system[4]

5.1.8 CCS Requirement – Approvals Conditional on CCS

- Provincial regulatory boards adopt a policy of making approvals conditional on the implementation of CCS technology for upgraders and in-situ facilities in the oil sands and new coal-fired electricity generation facilities. There are two components of such approvals: designing in and building CCS technology, and then being subject to a CCS performance standard once the facility is in operation. To truly "require" CCS, this performance standard would likely have to include parameters that barred the use of offset credits and emissions trading, or other compliance mechanisms, as a means of meeting the performance target. However, the standard could also be set so that it allows companies to achieve the required performance through a number of options, including emissions trading, offset credits, efficiency and fuel switching, etc.
- While provincial governments can theoretically write such conditions into industrial approvals, this policy tool may not be directly available to the federal government.

5.1.9 Carbon Sequestration Standard – (similar to an RPS – see Jaccard's work)

- This policy option would see governments set a performance standard for facilities that requires them to capture and store emissions wherever possible. To truly require CCS, this performance standard would likely have to include parameters that barred the use of offset credits and emissions trading, or other compliance mechanisms, as a means of meeting the performance target. However, the standard could also be set so that it allows companies to achieve the required performance through a number of options, including emissions trading, offset credits, efficiency and fuel switching, etc.

[4] See "Barack Obama: Promoting a Healthy Environment" at http://www.barackobama.com/issues/pdf/EnvironmentFactSheet.pdf.

- Modelling by MJKA and Associates Inc found that imposing a regulation requiring all large industrial facilities built after 2015 in Alberta to capture and store GHG emissions would reduce emissions by 61 Mt relative to business as usual levels in 2025, and by 173 Mt in 2050.[5]
- This option differs than the one above in two ways:
  - it would be implemented by a broad-based regulation, not on a case-by-case basis in the approvals of individual facilities
  - because of this, it could theoretically cover existing facilities and is more likely to be a tool available to the federal government.

Technology Funds

Both the current Alberta regulatory framework and the proposed Federal framework include "technology funds". These funds set a price for carbon that industry pays, but they are also returned those funds for undertaking mitigation actions. A further modification on this could be a self-imposed "voluntary carbon levy" deposited voluntarily by industry into a technology fund which is then used to invest in mitigation efforts – in this case committed to CCS.

The results of the electronic survey of invitees provide some useful insights and considerations for participants at the forum when discussing policy options involving "industry pays":

- Industry and ENGOs are much closer in opinion on their preference for a carbon tax and/or cap-and-trade system than might normally be expected;
- Government officials tend to prefer the currently proposed policy solutions and differ most from industry, ENGOs and academics.

For the purpose of the forum discussion, it is quite possible that industry and ENGOs will be able to agree directionally on a preferred mechanism moving forward, but will likely need to discuss the rate and pace of carbon pricing.

5.2 Policy Options for the "Public Coin"

The following draft list of options have been identified as policies that have the public contributing funds to assist in covering the cost gap of CCS:

1. Direct public subsidy
2. Indirect public subsidy (ACCA, tax credits, royalty reductions)
3. Public ownership and/or investment in infrastructure (could be 1%–100% gov owned and/or operated) (e.g. PPP)
4. Government purchases reductions at least cost (reverse auction).
5. Guaranteed future value of GHG credits
6. Multiple credits for CCS
7. Loan guarantees / low interest loans

[5] MK Jaccard and Associates, *Final Report: Economic Analysis of Climate Change Abatement Opportunities for Alberta* (Vancouver, BC: Prepared for Alberta Environment, October 2007), p. 5.

8. Investment in the development of high quality people / training
9. Energy consumer levy for CCS
10. Voluntary purchase of CCS offsets
11. Voluntary purchase of "CCS Bonds"

Policy Option – Public Coin	Description	Experience to Date in Canada
Direct public subsidy (contribute money)	Government (Federal and/or Provincial) creates a "CCS fund" and through an expert review process chooses projects to support based on proposals.	Alberta announced a $2 billion fund in 2008. Expectation is distribution of these funds to a range of projects starting in 2009.
Indirect public subsidy – tax credits	Government (Federal and/or Provincial) provide tax reductions for CCS projects through an accelerated capital cost allowance for part or all of the CCS project. Alternatively, an incentive is created through a modified royalties scheduled. Challenge is how to define a "project" and what is covered. Can range from "only CCS infrastructure is eligible" to "full project that includes CCS is eligible".	Providing that the current CCS equipment (not including the pipeline) can be classified as Class 41A, which includes oil and gas equipment and gas plant equipment for a new project or project expansion, then it would be eligible for 100% ACCA. - If the project is established and the CCS is not qualified as an expansion of the existing project than it will not be eligible. - All pipeline expenditures would not qualify for the ACCA. - If part of the CCS project is classified as "clean energy generation equipment" then it is eligible for a 50% ACCA rather than 25% (which is the base for capital assets).
Public ownership and/or investment in infrastructure (could be 1%–100% gov owned and/or operated) (e.g. PPP)	Government makes a direct investment and retains ownership rights of CCS infrastructure.	None to date
Government purchases reductions at least cost (reverse auction)	Government uses public money to purchase X dollars worth of GHG reductions from CCS with the goal to maximize the reductions for the dollar spend.	None to date
Guaranteed future value of GHG credits	Government guarantees the future value of GHG credits by a schedule from 2012 to 2020, thereby providing certainty on a price signal for carbon. A company would be compensated	None to date

	for the difference between the guaranteed value and the regulatory regime in place.	
Multiple credits for CCS	In a cap and trade based regulatory framework, CCS activities are given multiple credits for each tonne of reduction.	None to date
Loan Guarantees / Low interest loans	Government provides a loan guarantee and / or access to low interest loans for CCS projects.	Not for CCS
Investment in the development of high quality people / training	Government provides funding and resources to attract and train skilled people specifically for CCS.	Not for CCS
Energy consumer levy for CCS	Consumers of electricity and vehicle fuels would be charged a "CCS levy". The funds would be invested into CCS projects.	Electricity currently has extra fees on the bill.
Voluntary purchase of CCS generated GHG offsets	Similar to the current voluntary GHG offset market, individuals and businesses have an option to purchase GHG offsets from CCS projects.	None to date
Voluntary purchase of "CCS Bonds"	To help finance CCS projects, government issues "CCS bonds" which individual investors can purchase.	None to date

From the electronic survey of invitees to the forum, the following observations are important to consider when discussing the various options for the "public coin" part of CCS:

- Government representatives and industry prefer direct subsidies, while ENGOs favour these the least;
- A number of ENGOs added a preference for "no public coin" or "none of the above";
- The ENGOs' preferred mechanism, and one of Governments' more favoured options, is public investment in CCS infrastructure, while this is one of the least preferred options for industry;
- Both ENGOs and industry share an opinion of value in a guaranteed future value of carbon reductions.

5.3 Reducing the Number of the Policy Options

Upon consideration of all the policy options identified above, we are proposing to remove the following options from further consideration in a long-term CCS policy package based on the following assessment:

Table 2. Policy Options to Remove from Consideration

Policy Option to Remove from Consideration for long-term CCS Policy Package	Due to poor performance against these criteria	Discussion
Alberta's Climate Policy – Without Modifications	Ability to Result in Deployment of CCS	Without a significant increase in the price signal, the current AB policy framework will not result in deployment of CCS.
Federal Government's Climate Policy – Without Modifications	Administrative Simplicity; Ability to Result in Deployment of CCS; Investment/Policy Predictability	The current Federal framework does not provide the price signal nor policy predictability to result in significant investment in CCS.
Cap and Trade – free allocation	Ability to Result in Deployment of CCS; Distribution of Cost	This option has essentially been removed from most serious discussions on cap and trade.
Multiple credits for CCS	Distribution of Cost; Administrative Simplicity	A multiple credit system first requires some form of credit trading system, and opens up complexities of why one technology should receive multiple credits over another.
Energy consumer levy for CCS	Ability to Expand Low Carbon Technologies; Distribution of Cost	A levy on energy to fund CCS would unlikely be seen as a fair tax on low or zero carbon sources of energy.
Voluntary purchase of CCS offsets	Ability to Result in Deployment of CCS; Administrative Simplicity	This is likely a very small market given the experience in voluntary offsets from renewable energy.

The remaining policy options will be used to formulate a straw model policy package for CCS, which will be used to stimulate the discussion at the November 10th forum.

6. Summary Observations for Developing the Policy Package for CCS

Based on the research presented in this paper, the following observations should be taken into account by forum participants when working to develop a policy package for CCS:

- The cost of CCS is expected to be in the range of $40–$140 per tonne of abatement during the Early Adopters phase. All else equal, costs will be lower in later phases as technology improves and, perhaps more importantly, as CCS is more systematically built into the base design of industrial facilities. Costs may rise if too many facilities are constructed at once driving up capital cost indexes and the cost for CCS-specific technologies;
- Enhanced Oil Recovery provides approximately $15–$35 per tonne of revenue for CCS, but it may to be limited due to the volume of CO_2 being captured by the Full Penetration phase;
- Regardless of the policy mechanism for the "industry coin" (e.g. carbon price, versus cap-and-trade), by the time CCS is a mature we expect technology the price on carbon will need to be on the order of $30–$100 per tonne to achieve substantial market penetration;
- Significant value exists in knowing the future price or value of CO_2 reductions;
- The "public coin" should be designed to transition the technology and market of CCS as quickly as possible and be phased out as the technology is proven;
- When designing a policy package leading towards deployment of CCS to achieve significant reductions, a balance will need to be found between "investment predictability" and "fairness in the distribution of costs", while trying to maintain "administrative simplicity" and an ability to "stimulate innovation" and "expand other low carbon technologies".