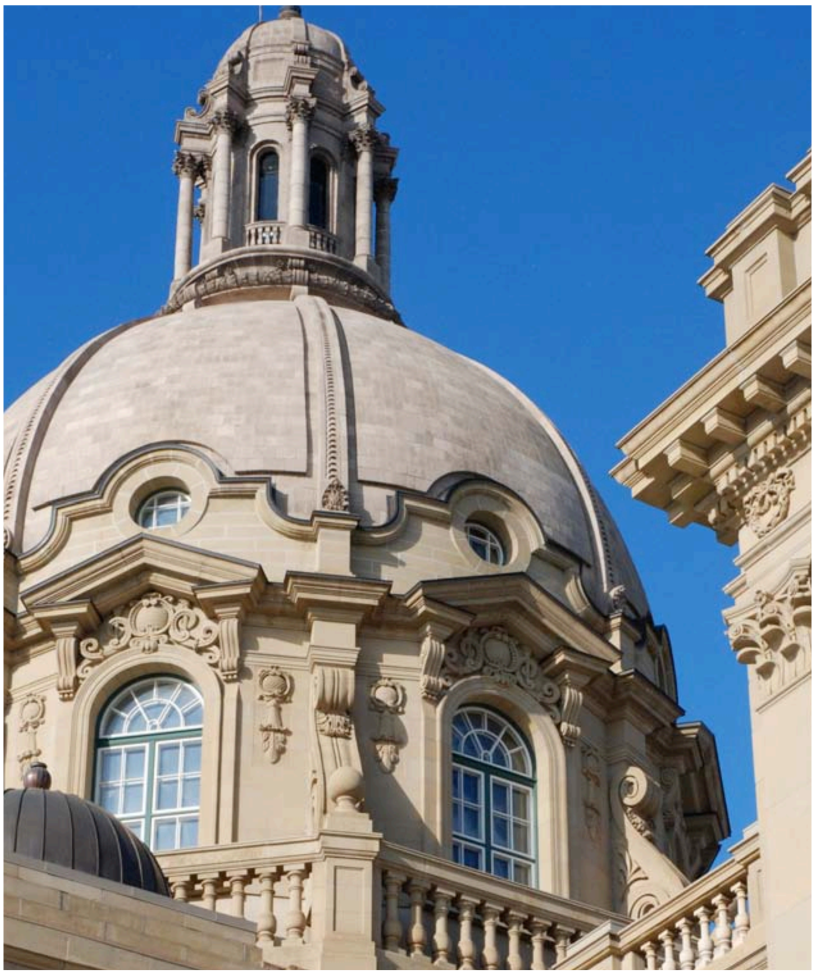
responsible action?
an assessment of alberta's greenhouse gas policies



the PEMBINA institute

Sustainable Energy Solutions

Matthew Bramley
Marc Huot
Simon Dyer
Matt Horne

December 2011

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About the Pembina Institute

The Pembina Institute is a national non-profit think tank that advances sustainable energy solutions through research, education, consulting and advocacy. It promotes environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance. For more information about the Pembina Institute, visit www.pembina.org or contact info@pembina.org. Our engaging monthly newsletter offers insights into the Pembina Institute's projects and activities, and highlights recent news and publications. Subscribe to Pembina eNews: http://www.pembina.org/enews/subscribe.

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Responsible Action? An assessment of Alberta's greenhouse gas policies

Contents

List of Figures

List of Tables

1. Introduction

Reducing the world's greenhouse gas (GHG) emissions enough to prevent a potentially disastrous[1] level of climate change is a huge challenge. National governments worldwide have unanimously accepted the need to limit average global warming to 2°C (relative to pre-industrial temperatures), based on a large and longstanding body of science.[2] G8 governments (including Canada's) have accepted that developed countries' contribution should be to reduce their combined emissions by at least 80 per cent below recent levels by 2050.[3]

This requires nothing less than a complete transformation of our energy system to one in which most energy is emissions-free, and used much more efficiently than now. Starting the transformation is urgent because it will take decades. It will only happen if governments move quickly to implement policies strong enough to shift the bulk of energy investments from high-emitting fossil fuel-based energy to zero-emission options.

There isn't time for governments to wait for full international agreement on who will do exactly what, because such an agreement is not currently in sight. Pointing fingers and waiting for others to move is simply a recipe for uncontrolled and costly[4] global warming. What the world currently needs most is for jurisdictions with the greatest resources and energy expertise to start making the necessary changes, which will encourage others to follow.

Alberta is under a spotlight when it comes to climate change because its GHG emissions, on a per capita basis, are extraordinarily high. If Alberta were a country, it would have the joint-highest per capita GHG emissions in the world (along with Qatar).[5] Even on an absolute basis, it would be the world's 30th top emitter despite having a population of less than four million (Canada as a whole is 8th in absolute terms and 10th per capita).[6] The main sources of Alberta's emissions, and of their recent growth, are shown in Table 1.

There is, of course, an obvious geographical and economic reason for Alberta's unusually high GHG emissions: the province sits atop vast fossil fuel resources which bring significant economic benefits. If the province used those resources only for its own needs, its emissions would be high, but they are about 40 per cent higher still[7] as a result of producing large volumes of fossil energy for export — particularly from the oilsands. This creates an extra and important constituency that cares about what the province is doing about GHGs, and whose displeasure could be a problem: the jurisdictions that buy Alberta's energy.

What Alberta does about its GHG emissions matters a lot to Canada because the province's emissions are a third of Canada's total[8] and heading sharply upwards. What Alberta does or does not do could therefore be critical to whether Canada meets its international commitments and responsibilities. In theory Canada can meet its commitments regardless of Alberta policy, because the federal government has the constitutional authority to regulate harmful emissions, as well as extensive taxation and spending powers. But in practice the Alberta government has resisted federal regulation of emissions. Instead it has adopted its own GHG targets and created an expectation that it will take the necessary actions to meet them.

Table 1: Alberta's greenhouse gas emissions 1990–2009[9]

Source	Emissions 1990 (Mt CO_2e*)	Emissions 2009 (Mt CO_2e)	Share of emissions 2009	Growth in emissions 1990–2009	Share of 1990–2009 growth in total emissions
Industrial facilities	124	167	71%	35%	69%
Electricity generation	39	48	21%	24%	15%
Oil and gas production, transmission and distribution	66	97	41%	47%	49%
Oilsands extraction and upgrading[10]	17	45	19%	167%	45%
Other oil and gas industry[11]	49	52	22%	6%	5%
Other industrial facilities	19	22	10%	18%	5%
Transportation	21	34	14%	62%	20%
Cars and light trucks	8	11	5%	41%	5%
Heavy-duty vehicles (on-road)	5	10	4%	105%	8%
Railways and aviation	3	4	2%	42%	2%
Other transportation (mostly off-road)	5	8	3%	66%	5%
Buildings	12	14	6%	21%	4%
Residential buildings	7	9	4%	28%	3%
Commercial/institutional buildings	5	6	2%	12%	1%
Agriculture	13	17	7%	29%	6%
Landfills	1	2	1%	33%	1%
Total	**171**	**234**		**37%**	

* megatonnes (millions of tonnes) of carbon dioxide equivalent

Climate change matters to Alberta because the province faces major impacts, particularly when it comes to water. Albertans should expect a greater frequency of both flooding and severe drought.[12] Water scarcity may constrain the province's economic growth,[13] and the grassland ecoregion of southern Alberta is at risk of desertification, with serious consequences for agriculture.[14] Climate change is likely to bring billions of dollars of additional costs related to water supply infrastructure,[15] responding to droughts[16] and increased forest fires.[17] People can expect to face increasing health impacts from air pollution, heat-related illnesses and vector-borne diseases.[18]

The Alberta government has often made bold claims about its actions to curb GHG emissions. For example, Environment Minister Rob Renner said in 2009: "We're taking tremendous steps forward on climate change. We're setting achievable targets and laying out ways we will get there. The world is looking for leadership on climate change. The opportunity is there for the taking. Alberta is taking it."[19] Claims like these require scrutiny — especially at a time when

Alberta is undergoing a leadership transition. Albertans need to know how well their province is managing GHG emissions, and what the opportunities are to do better. Other Canadians also have an interest in these questions for the reasons given above.

Section 2 of this report looks at Alberta's current GHG policies, how much they are reducing emissions and how they measure up against common-sense criteria such as economic efficiency, good use of public resources, good design and accountability. Section 3 focuses on the challenge faced by Alberta's policymakers in limiting GHG emissions from the oilsands, the biggest driver of increased emissions in the province. Section 4 examines Alberta's GHG targets in relation to those of Canada and those recommended by the scientific community. Section 5 offers recommendations.

2. Alberta's greenhouse gas policies

2.1 Historical context

Canada's federal and provincial governments began discussing and promising GHG reductions in the 1990s, with Alberta playing a prominent role. As early as 1990, the federal-provincial National Action Strategy on Climate Change stated that "the limitation of emissions must begin now."[20] In November 1997, federal and provincial energy and environment ministers "agreed that it is reasonable to seek to reduce aggregate greenhouse gas emissions in Canada back to 1990 levels by approximately 2010."[21] In October 1998, the Alberta government published its first Strategy for Action on Climate Change, but it contained little in the way of concrete commitments.[22]

In 2002, as national discussion heated up on whether Canada would ratify the United Nations' Kyoto Protocol, the Alberta government published a new, detailed climate plan while spending nearly $2 million on advertising to oppose Kyoto.[23] The plan committed to reduce the province's GHG intensity (emissions per dollar of GDP) by 50 per cent between 1990 and 2020, equivalent to reducing annual emissions by about 60 megatonnes (Mt) below the business-as-usual level by 2020, with an interim target of reducing annual emissions by about 20 Mt below business as usual by 2010.[24] The plan committed to immediate work on emission reduction agreements with key sectors like oil and gas, and to implement "regulatory backstops" for those agreements.[25] The plan also confirmed a new policy of requiring all new coal-fired power plants to offset their GHG emissions to the level of combined cycle natural gas power plants, the so-called "clean-as-gas standard."[26]

Apart from the clean-as-gas standard, and the enactment of enabling legislation,[27] by 2005 the Alberta government had made no apparent progress in requiring GHG reductions from key sectors. In April of that year, however, the federal government announced its intended approach for regulating industrial GHG emissions,[28] and soon afterwards Alberta Environment proposed a virtually identical policy using provincial regulations.[29] At the end of that year, Alberta formally opposed the federal government's addition of GHGs to the Canadian Environmental Protection Act,[30] a necessary preparatory step to regulating GHGs federally.

After the new Conservative government took office in Ottawa, Alberta's work on regulating industrial GHG emissions appeared to cease. However, in March 2007, the Alberta government unveiled the *Specified Gas Emitters Regulation* for large GHG emitters, to take effect less than four months later on July 1.[31] The suddenness of this move appeared to be explained by Premier Ed Stelmach's desire to set a provincial precedent in advance of the new federal government's first detailed proposal to regulate industrial GHG emissions, announced just a few weeks later (the now abandoned Turning the Corner plan[32]).

Alberta's current climate plan,[33] titled Responsibility / Leadership / Action, was published in January 2008. It reiterates the previous plan's target to reduce annual emissions by 20 Mt below the business-as-usual level by 2010. However, while the 2002 plan's GHG intensity target for 2020 is still included in legislation,[34] the 2008 plan does not mention it explicitly, instead re-casting it both as a 50 Mt reduction in annual emissions below business as usual by 2020, and a goal of halting the growth in Alberta's absolute GHG emissions by that year.

The 2008 plan adds a target to halve business-as-usual emissions in 2050, and also states this target as a 14 per cent reduction in annual emissions below the 2005 level. The plan quantifies three broad "wedges" of emission reductions, each corresponding to a distinct technological approach: energy conservation and efficiency; carbon dioxide (CO_2) capture and storage (CCS); and "greening energy production," which includes renewable energy. Two-thirds of the emission reductions are to come from CCS (see Figure 1). The plan commits to a number of specific policy actions, but it does not attempt to show that the policies will be strong enough to achieve each wedge.

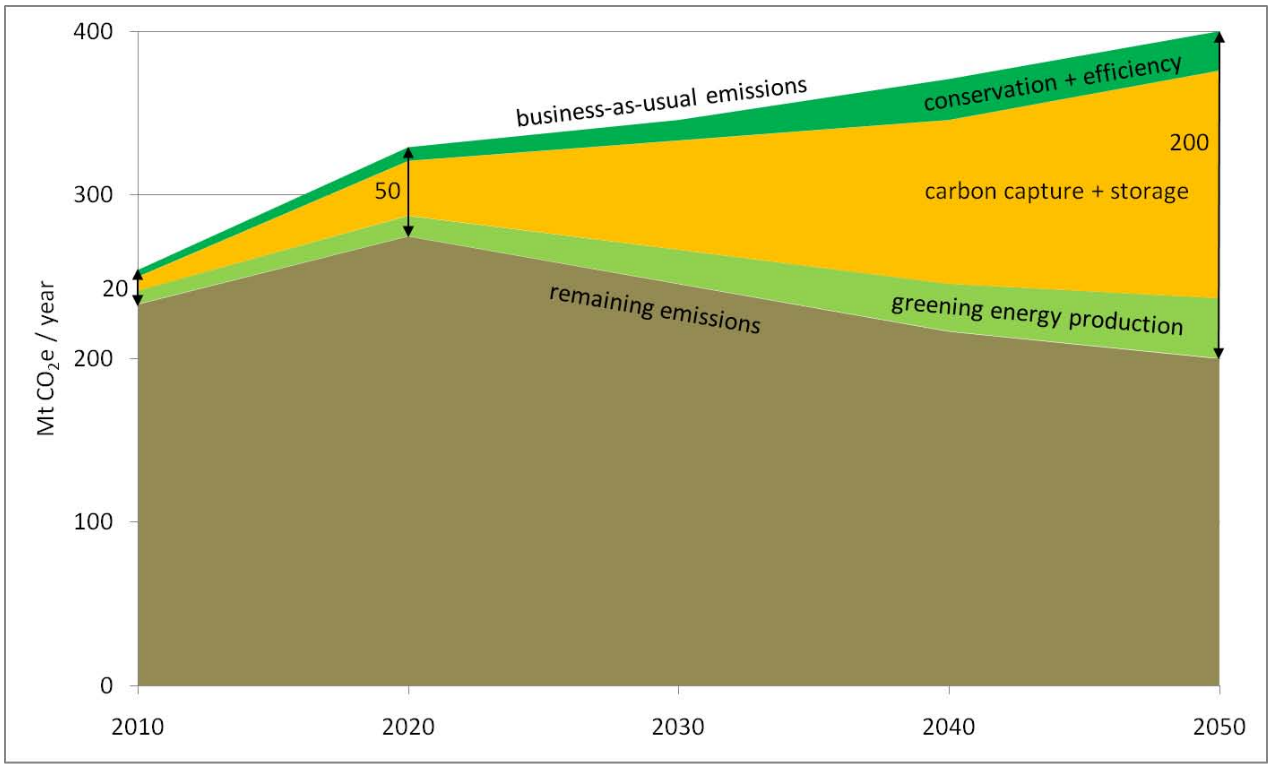


Figure 1: Alberta's current climate plan

Note: The figure is reproduced faithfully from the Alberta plan, with one exception: we have included the commitment to a 20 Mt reduction in annual emissions in 2010, not depicted in the equivalent figure in the plan. The plan quantifies the size of the wedges only graphically pre-2050, but explicitly in 2050: 24 Mt for conservation and efficiency, 139 Mt for CCS, 37 Mt for greening energy production.

2.2 Alberta's current policies

Table 1 lists all the provincial policies currently in effect that limit GHG emissions through regulations or financial incentives. Some of these stem from the 2008 plan, and some pre-date it. We focus on regulations and financial incentives because these are the only types of policies that are likely to bring about the large-scale shift in investments needed to meet meaningful GHG targets. (We do not consider, for example, policies limited to provision of information or research and development.[35]) The table includes order-of-magnitude estimates of the likely reduction in annual emissions in 2020 from each policy. Details of how we arrived at these estimates are provided in Table 8 in the Appendix.

Table 2: Alberta's principal greenhouse gas policies today, and their likely contribution to meeting Alberta's 2020 emissions target

Name of policy	Main sectors where emissions reduced	Description	Likely reduction in annual emissions in 2020 (Mt CO_2e) relative to the absence of the policy				
			<0.05	0.05–0.15	0.15–0.5	0.5–1.5	1.5–5
Specified Gas Emitters Regulation (SGER)	Industrial facilities (electricity, oil and gas, other)	This regulation, which took effect in July 2007, sets GHG intensity (emissions per unit of production) targets for all facilities emitting more than 0.1 Mt CO_2e per year. The target for a facility beginning operation before 1999 is 12 per cent below the average intensity for 2003–05. Newer facilities are exempt for their first three years of operation and then face targets that gradually increase to reach, in the ninth year of operation, 12 per cent below the intensity measured in the third year. Facilities with emissions higher than their targets can comply by making payments of $15 per tonne CO_2e into the Climate Change and Emissions Management Fund (see below) and by purchasing offset credits from projects in Alberta.[36]					◆
CCS Major Initiatives	Industrial facilities (electricity, oil and gas, other)	In 2009 the Alberta government selected four large-scale CCS projects to receive grants totalling $2 billion over 15 years.[37] The projects — a coal-fired power plant retrofit, an oilsands upgrader, an underground coal gasification project and a CO_2 pipeline — are expected to start up by 2015.[38] However, it is not yet certain that all four projects will be constructed.					◆
Climate Change and Emissions Management Fund (CCEMF)	Industrial facilities (electricity, oil and gas, other)	The $15 per tonne payments into the CCEMF, made under the SGER, are reinvested in a wide range of emission reduction projects. In 2007–10, $256 million were paid into the CCEMF;[39] to date $126 million has been committed to approved projects.[40]				◆	
Government purchase of green power	Electricity generation	Since 2005 the Alberta government has been purchasing close to 100 per cent of the electricity it uses in government buildings from green power facilities, such as wind farms.[41]			◆		

<table>
<tr><th rowspan="2">Name of policy</th><th rowspan="2">Main sectors where emissions reduced</th><th rowspan="2">Description</th><th colspan="5">Likely reduction in annual emissions in 2020 (Mt CO_2e) relative to the absence of the policy</th></tr>
<tr><th><0.05</th><th>0.05–0.15</th><th>0.15–0.5</th><th>0.5–1.5</th><th>1.5–5</th></tr>
<tr><td>Micro-generation Regulation</td><td>Electricity generation</td><td>Since January 2009, electricity distribution companies have been required to allow the sale of small-scale consumer-generated green power (e.g., from rooftop solar panels) back to the grid.[42] Consumers generating less than 10 kW (the majority) are compensated at the retail electricity price.[43] This represents a modest financial incentive when the retail price is higher than the wholesale price normally paid to power generators.</td><td></td><td>◆</td><td></td><td></td><td></td></tr>
<tr><td>Light it Right</td><td>Electricity generation</td><td>Commercial building owners/operators are currently eligible for rebates on energy-efficient lighting products.[44] Total funding is $4 million, available on a first-come first-served basis.[45]</td><td></td><td>◆</td><td></td><td></td><td></td></tr>
<tr><td>Renewable Fuels Standard Regulation</td><td>Cars and light trucks, heavy-duty vehicles</td><td>Starting in January 2012, wholesale and retail sellers of fuel in Alberta will be required to meet average renewable fuel content levels of 5 per cent for gasoline and 2 per cent for diesel (less stringent "transitional" requirements began in April 2011).[46]</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">◆</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Bioenergy Producer Credit Program</td><td>Cars and light trucks, heavy-duty vehicles</td><td>This program provides biofuel producers with per-litre production subsidies. It was recently extended until 2016, with $336 million of funding over the next three years.[47] The program is intended to increase the local supply of biofuels to comply with the Renewable Fuels Standard Regulation.[48] (The program also subsidizes certain forms of electricity generation from biomass.)</td></tr>
<tr><td>GreenTRIP</td><td>Cars and light trucks</td><td>In 2010 the Alberta government confirmed that it would make a one-time $2 billion capital investment in public transit. To date about $500 million has been committed to specific projects, with the bulk of this going to an expansion of Edmonton's electric light rail system.[49]</td><td></td><td>◆</td><td></td><td></td><td></td></tr>
<tr><td>Hybrid Taxi</td><td>Cars and light trucks</td><td>Since July 2008, purchasers of new gasoline-electric hybrid taxis have been eligible for a rebate of between $2,000 and $3,000 depending on model type.[50]</td><td>◆</td><td></td><td></td><td></td><td></td></tr>
</table>

Name of policy	Main sectors where emissions reduced	Description	Likely reduction in annual emissions in 2020 (Mt CO_2e) relative to the absence of the policy				
			<0.05	0.05–0.15	0.15–0.5	0.5–1.5	1.5–5
Trucks of Tomorrow	Heavy-duty vehicles	Commercial truck owners are currently eligible for rebates when purchasing a diesel-electric hybrid vehicle or installing fuel-saving features such as auxiliary power units.[51] Total funding is $2 million, available on a first-come first-served basis.[52]	◆				
Rebates for energy efficient home upgrades	Residential buildings	Homeowners are eligible for rebates on energy-saving upgrades to insulation and heating systems, as well as for purchases of new homes with high energy efficiency.[53] Rebates totalling $16 million were paid out in 2010, with a typical amount in the vicinity of $1,000 per home for upgrades,[54] and the amount for a new home in the range of $1,500–10,000.[55]			◆		
Initiatives for public buildings	Commercial/ institutional buildings	The Alberta government requires new government-funded buildings to meet the LEED silver environmental standard.[56] In addition, the operation of all large government-owned buildings is certified under the BESt (Building Environmental Standards) program.[57] LEED and BESt both target energy efficiency.	◆				
On-Farm Energy Management	Agriculture	This program provides agricultural producers with financial incentives to install high-efficiency equipment in existing operations or new buildings. Incentives temporarily ceased in July 2011, and will re-start in April 2012. The total funding available is unclear.[58] The program relies significantly on federal funding.[59]			◆		
TOTAL			**≤14 Mt**				

Of note is our omission from Table 2 of the clean-as-gas standard for electricity generation. The government has now abandoned this policy and its Utilities Commission recently approved a new conventional coal-fired power plant with no GHG constraints other than the modest ones in the *Specified Gas Emitters Regulation*.[60]

2.3 Evaluation of Alberta's greenhouse gas policies

We have developed a set of six criteria for evaluating GHG policies, shown in Table 3. They cover the key issues that most interested parties would see as important for success: reducing emissions adequately in both the medium and long term, doing so in an economically efficient way, ensuring public money is spent wisely, and ensuring good design and accountability. The criteria make specific reference to Alberta, but they could be easily adapted to any jurisdiction. They assume that once a jurisdiction has adopted targets, policies must be implemented to meet them.

Before applying the criteria to Alberta's policies, we should note that the provincial government has clearly failed to meet its target for 2010 — to reduce annual emissions by 20 Mt below the business-as-usual level (see Sec 2.1). The government reaffirmed this target as recently as 2008, but Table 2 shows that current policies will not come close to reducing emissions by this amount in 2020, let alone 2010. We mention this now because the criteria that we apply below focus on 2020 and beyond, not 2010.

The *Specified Gas Emitters Regulation* (SGER), the CCS Major Initiatives and the Climate Change and Emissions Management Fund are the Alberta GHG policies that have by far the greatest significance based on the provincial government's public communications, the sums of money involved, these policies' primary focus on GHGs, and the scale of potential emission reductions. We therefore begin by evaluating each of these three policies separately. Afterwards we take into account all of the remaining policies to evaluate Alberta's GHG policies as a whole.

In each of the following subsections we apply the six criteria from Table 3 and attempt to arrive at a qualitative evaluation along a spectrum from "very good" to "very poor." The evaluations are summarized in Table 4 (at the end of Sec. 2.3.4). They obviously have a degree of subjectivity, but we have striven to apply the criteria fairly and consistently. We should note that some of the evaluations are interdependent; for example, the level of the carbon price set by the SGER has consequences not just for the SGER itself but also for how well public resources are used under other policies.

There is a wide spectrum of possible standards for applying the two effectiveness criteria: policies could be evaluated in terms of consistency with Alberta's targets, with Canada's targets or with GHG targets derived from climate science. As we demonstrate in Section 4, Alberta's targets are considerably weaker than Canada's, both are far weaker than science-based targets; yet both Alberta and Canada could still do well economically if Canada met a science-based GHG target in 2020. We therefore view Alberta's targets as clearly inadequate. It suffices, however, to use them as the standard in our evaluations below because as the policies fare poorly against these weak standards, they would still fare poorly against the stronger targets.

Table 3: Our policy evaluation criteria

Criterion	Why it's important
Effectiveness — near term: What is the estimated effect of Alberta's current policies (i) in terms of the reduction in emissions in 2020 relative to a scenario without those policies, and (ii) in terms of Alberta's absolute emissions in 2020?	The Government of Alberta has a target to reduce the province's emissions in 2020 by 50 Mt relative to business as usual (Sec. 2.1); Canada's current target is to reduce absolute emissions 17 per cent below the 2005 level by 2020 (Sec. 4.1); and there is a scientific consensus that it is urgent to substantially reduce emissions.
Effectiveness — longer term: How clearly do Alberta's current policies put the province on track to achieve much deeper reductions in emissions between 2020 and 2050?	The Government of Alberta has an absolute emissions target for 2050 that is equivalent to a 50 per cent reduction relative to business as usual (Sec. 2.1); Canada has agreed, based on scientific analysis, that developed countries must reduce their total emissions by 80 per cent or more by 2050 (Sec. 1).
Economic efficiency:[61] To what extent do current policies seek to exploit the full range of opportunities to reduce emissions in any given year at a cost per tonne less than some chosen value?	Overall economic efficiency is maximized (i.e., the total cost to the economy is minimized) when all opportunities to reduce emissions up to some cost per tonne[62] are implemented.
Good use of public resources: To what extent is current policies' allocation of public funds and carbon value* justified by objectives that are demonstrably in the public interest?	Public resources are very limited and should therefore be targeted to compelling objectives such as protection of vulnerable industries from a shift in activity to foreign competitors, protection of low-income individuals from energy cost increases, and investment in GHG reductions not reasonably achievable through other means.[63]
Good design: Are current policies simple and clear; do they require rigorous measurement; how much certainty do they provide about the future; and how well are they informed by consultation of diverse stakeholders?	Simple and clear policies are less costly to implement for both government and those affected by them, less likely to be "gamed" and more likely to win public confidence. Rigorous measurement is needed to ensure real results. Reasonable certainty about the future allows confident investment in long-lived projects. Consultation allows those who are most concerned to provide input and helps policymakers anticipate pitfalls.
Accountability and adaptiveness: How transparent and effective are the processes in place to evaluate the performance of current policies, determine the size of any gaps between those policies and the government's emissions targets, and adjust the policies accordingly?	Since climate policies take significant effort to implement and time to deliver results, emissions targets are unlikely to be met if there is little public understanding and scrutiny of progress towards them. There needs to be an assurance that lessons learned from policy implementation will be acted upon.

* Carbon value refers to the total of allowed emissions covered by a carbon pricing policy multiplied by the carbon price. Carbon value is the total amount that emitters would have to pay if they were required to pay the carbon price for every tonne emitted. Carbon value measures the atmosphere's limited capacity to absorb emissions, and can therefore be seen as belonging to society as a whole.[64]

2.3.1 Specified Gas Emitters Regulation

The SGER was a pioneering policy — the first in North America to apply a carbon price (a price on GHG emissions) to all large emitters. However, while a pioneering policy usually requires expenditure of significant political capital, and often influences other jurisdictions, it is not necessarily a good policy. To determine the merits of the SGER we evaluate it against our criteria.

Effectiveness — near term

The GHG intensity targets set by the SGER have little relation to the likely emission reductions resulting from it, because emitters can comply with the targets by making $15 per tonne payments into the Climate Change and Emissions Management Fund (CCEMF) and by purchasing offset credits from projects in Alberta. We treat the CCEMF as a policy separate from the SGER, so we do not count here emission reductions stemming from use of the money in the fund. We explain in the following paragraphs why offset credits do not necessarily correspond to emission reductions attributable to the SGER.

Offset credits represent emission reductions in Alberta that would not count directly towards meeting large emitters' intensity targets in the SGER. For example, many of the offset projects that have received credits so far are low-till agriculture projects or wind farms. (Although the emission reductions associated with wind farms do physically occur at fossil-fuelled power plants, which have targets under the SGER, those reductions do not count directly towards meeting the targets because they do not affect the GHG intensity of the fossil-fuelled plants.)

If the emission reductions represented by offset credits are to be attributed to the SGER, the offset projects must have faced barriers preventing their implementation in the absence of the SGER — barriers that were overcome by the revenue stream created by the sale of offset credits to large emitters. If offset projects would have occurred in the absence of the SGER, then they must be the result of some other policy or simply part of business as usual.

An examination of Alberta's offset registry shows that more than 82 per cent of the 10 Mt of credits used for compliance with the SGER during 2008–10 came from projects that started up between January 2002 and January 2007 — that is, before the SGER was unveiled in March 2007.[65] Clearly these credits do not represent emission reductions attributable to the SGER. It is not plausible that investors or project developers would have committed to projects on the basis of a future revenue stream (from credit sales) that depended on government regulations that had not yet been drafted and whose implementation could have been delayed many years.

Although Alberta Environment is now moving to make some aspects of the offset system more rigorous, its latest guidance (as well as the text of the SGER) still allows projects that started as early as 2002 to receive credits.[66] The system will continue to allow whole categories of activities to qualify for credits as long as those activities represent less than 40 per cent of current practice in a sector, with no project-by-project scrutiny to check whether a project is already profitable without the revenue from offset sales.[67] This approach is certain to result in large volumes of credits continuing to be issued to projects that cannot credibly be attributed to the SGER.

The Alberta government has also recently amended the SGER in a way that further weakens the offset system: allowing for double offset credits — two tonnes of credits for one tonne of emission reductions — for certain CCS projects. This provision will, for example, apply to Shell's Quest CCS project (one of those being subsidized under the CCS Major Initiatives Program), which could generate more than 2 Mt of credits per year.[68] Because credits are used by large emitters in lieu of on-site emission reductions or payments into the CCEMF, double crediting will result in higher emissions from large emitters or lower payments into the CCEMF (relative to single crediting). This will reduce the emission-reduction effectiveness of the SGER or the CCEMF respectively.

Economic modelling probably provides the best available way to estimate the likely impact of the SGER. It suggests that the reduction in annual emissions attributable to the regulation is likely more than 1.5 Mt but not more than 5 Mt in 2020 (see Table 8 for details). This conclusion is consistent with the fact that a carbon price of $15 per tonne represents a cost to industry that in many cases will be too small to affect investment decisions. For example, an oilsands producer, emitting 0.11 tonne CO_2 per barrel of oil (an average GHG intensity level),[69] will receive an incentive of no more than 20 cents per barrel (0.11 tonne/barrel × 1,500 cents/tonne × 12%) to reduce GHG intensity by 12 per cent or to limit production. This is only about 0.2% of the oil price.

The SGER has certainly prompted large emitters to take GHG management more seriously, but the policy as it currently stands is clearly very far from able to prevent continued increases in Alberta's absolute emissions, since halting the growth in Alberta's absolute GHG emissions by 2020 — as per the 2008 climate plan — corresponds to an estimated 50 Mt reduction in annual emissions below business as usual by that year (see Figure 1). The government knows that the current SGER is much weaker than what is required by the plan, because the economic modelling it commissioned when preparing the plan showed that a carbon price much higher than $15 per tonne would be needed by 2020 to achieve the necessary emission reductions.[70] In light of this analysis, the SGER's near-term effectiveness must be considered poor.

Effectiveness — longer term

To date, the government has announced no intention of increasing the carbon price set by the SGER (currently the ceiling price is $15 per tonne, because emitters can comply by making payments into the CCEMF at this rate). For the policy to be considered effective post-2020, the government would need to have signalled its intentions regarding the future level of the price, preferably in legislation to increase certainty.[71] Given the rapidly increasing scale of GHG reductions that Alberta needs to achieve post-2020 to achieve the government's targets (see Figure 1), the longer-term effectiveness of the SGER, as it currently stands, must be considered very poor in the absence of any commitment to increase the ceiling price. (And if the ceiling price were increased to the point where the market carbon price were lower than the ceiling, then the targets and compliance options in general would also need to be strengthened to increase the market price.)

Economic efficiency

As a carbon pricing policy, the SGER should have very good economic efficiency, providing a financial incentive to undertake all emission reductions that cost less than $15 per tonne. However, in some cases the SGER does not actually provide such an incentive. Notably:

- The incentive to undertake emission reductions by lowering the output of an industrial activity is at most $1.80 per tonne (12% × $15) because of the SGER's intensity targets.

- Industrial process emissions (emissions from processes other than combustion) are exempted, as are emissions from land disturbance in the oilsands.
- Outside the large emitter sectors, the incentive to reduce emissions is less than $15 per tonne because of the transaction costs associated with creating and trading offset credits, and the probability that business-as-usual offset projects crowd out offset projects that would really need a financial incentive to proceed.

The SGER is therefore not capturing significant opportunities to reduce emissions at a cost of less than $15 per tonne, and its economic efficiency can be considered at most "good."

Good use of public resources

As noted under Table 3, carbon value — the total amount that emitters would have to pay if they were required to pay the carbon price for every tonne emitted — can be seen as a public resource. The Pembina Institute agrees with this view, because every tonne uses up limited space in the atmosphere (which belongs to everyone) and causes damage to our shared environment. We therefore see any exemptions from payment of a carbon price as a subsidy, or allocation of a public resource to emitters.

Under the SGER, large emitters pay the carbon price (by paying into the CCEMF or purchasing offset credits) on less than 10 per cent of their emissions.[72] The lowness of this number is mostly a result of the fact that the SGER targets are intensity reductions of only 12 per cent from past levels (it is also affected by the exemption of industrial process emissions). In other words, the SGER allocates more than 90 per cent of carbon value — worth about $1.5 billion per year[73] — to large emitters free of charge.

We consider this to be a very poor use of public resources. It is even worse if the SGER is regarded as an economy-wide carbon pricing policy (in view of offsets), because the SGER retains no carbon value at all from smaller emitters, whether inside or outside the industrial sector.[74] The need to protect international competitiveness might justify some allocation of carbon value to certain industry sectors under a high carbon price,[75] but it is unlikely to do so at $15 per tonne. (Even under a much higher carbon price, the electricity generation and oil production sectors would not have a good case for receiving carbon value free of charge. For electricity, this is because there is little international competition; for oil, it is because profit margins are large.)

Good design

The SGER combines strengths and weaknesses when it comes to good design. Its rules are relatively simple, at least compared to some other emissions-trading frameworks. It is less clear how rigorously emissions (and emission reductions in the case of offsets) are being measured under the SGER, as this is determined by government officials and is not open to public scrutiny. The technical guidance that Alberta Environment issues to large emitters signals a fair degree of rigour — insisting, for example, on the same methodology being used to quantify emissions for target-setting and compliance.[76] However, audits undertaken by the department have uncovered significant problems. In 2009 (the latest year for which audit results are available), five out of the 13 compliance submissions from large emitters that were audited were found to have "material discrepancies."[77] Alberta Environment has also recognized the need to tighten up multiple aspects of how emission reductions from offset projects are quantified.[78]

It can be argued that offset systems fail the test of good design by their very nature. They are highly complex because they try to measure emission reductions from a business-as-usual baseline that is intrinsically difficult to determine, and they attempt to do this for project types from all parts of the economy. Offset systems are therefore extremely vulnerable to "gaming" — the attempt to get a benefit (credits, in this case) without real action.[79] One strong aspect of Alberta's offset system is the transparency of the offsets registry, which provides considerable public information on the creation and ownership of credits.

As noted above, the SGER provides little certainty about the future because the government has not signalled its intentions regarding the future level of the carbon price. The SGER could hardly be said to have benefitted from adequate consultation before it was introduced, because it took effect less than four months after the legal text was published. Alberta Environment has subsequently consulted widely on many aspects of the regulation's implementation, although environmental organizations were not consulted on the recent double offset-crediting amendment.

Overall, the SGER could be considered to be average on this criterion.

Accountability and adaptiveness

Each spring Alberta's Environment Minister issues a news release and backgrounder that briefly summarizes the performance of the SGER during the previous year, quantifying the aggregate use of each of the compliance options. Although they are improving, these summaries continue to be highly misleading. The most recent one:[80]

- Refers repeatedly to emission reductions without acknowledging that total emissions from Alberta's large emitters continue on an upward trend in spite of the SGER. Alberta's Auditor General took the government to task on the same point as long ago as 2008, complaining that "the Ministry reported greenhouse gas reductions that, as worded, appear to inaccurately convey reductions in emissions intensity as absolute emissions reductions."[81]
- States, incorrectly, that the SGER "require[s] mandatory greenhouse gas reductions," when in fact emitters can comply simply by making payments into the CCEMF.
- Portrays offset credits as emission reductions resulting from the SGER, despite the fact that this is plainly untrue for most credits (see above).

On a more positive note, Alberta Environment has published one full annual report on the SGER, providing much more detail, including the choice of compliance options at the facility level.[82] However, this report only covers compliance up to the end of 2008, and the aggregate compliance results it presents[83] do not agree with the summary on Alberta Environment's website.[84] This raises questions about the reliability of these numbers.

So while the government clearly does have a process in place to evaluate the performance of the SGER, it lacks transparency, and the results are publicly communicated by the Environment Minister in a manner that hinders accountability. The government appears to have no process to strengthen the SGER in keeping with the emission reduction commitments in its 2008 climate plan. Overall, therefore, the level of accountability and adaptiveness of the SGER appears to be poor.

2.3.2 CCS Major Initiatives

Effectiveness — near term

The projects funded under this program are expected to prevent at most 5 Mt of annual emissions if they go ahead (see Table 8). But since the federal government is providing the same projects with $526 million[85] to complement the $2 billion from the Alberta government, the reduction in annual emissions attributable to the provincial program alone must be somewhat less than 5 Mt.

Regardless, 5 Mt is a small number compared to the more than 30 Mt reduction in annual emissions that Alberta's 2008 climate plan aims to obtain from CCS by 2020 (see Figure 1). On that basis, given that this is Alberta's main policy for implementing CCS, its near-term effectiveness must be considered poor.

It should be noted that since CCS projects will receive offset credits under the SGER (see Sec. 2.3.2), the emission reductions should be counted under the SGER rather than under this program. However, these reductions are likely to replace large emitters' payments into the CCEMF (rather than other large-emitter reductions or offset credits), in which case they would add to the reductions attributable to the SGER. In other words, reductions currently attributed to CCS Major Initiatives in Table 2 would shift to the SGER row of the table, and the reductions attributed to the CCEMF would shrink because the fund would now be smaller.

Effectiveness — longer term

To date, the government has announced no intention of going beyond the $2 billion currently allocated to this program. For it to be considered effective post-2020, the government would need to have explained how it intends to scale up CCS in the long term. (This would include setting out how the balance between public subsidies, mandatory CCS and the incentive from a carbon price should shift over time.)

In the absence of such information, we can nonetheless recognize that this program begins to address the need for large-scale deployment after 2020, by aiming to prove CCS at the commercial scale now. Also, the initial CCS projects should last several decades. But if 5 Mt is a small fraction of the 30+ Mt reduction in annual emissions that Alberta's climate plan aims to obtain from CCS by 2020 (see Figure 1), then it is an even smaller fraction of the plan's 65 Mt reduction from CCS by 2030 or its 139 Mt reduction from CCS by 2050. Accordingly, given that this program is, again, Alberta's main policy for implementing CCS, its longer-term effectiveness must be considered poor at best.

Economic efficiency

The economic modelling study that Alberta Environment commissioned to inform the 2008 climate plan indicates that if a high carbon price is used to achieve large emission reductions, most of those reductions will come from CCS.[86] Since a carbon price should be economically efficient, the government therefore has a good economic-efficiency basis to focus on beginning large-scale deployment of CCS.

This program can, however, be criticized on an economy efficiency basis. First, the four CCS projects selected appear to have been chosen for the diversity rather than the low cost of the CCS applications. (It may be reasonable, however, to say that we do not yet have a good idea of the relative long-term costs of different applications, and need to pursue many until the answer becomes clearer.) Second, since this program is subsidizing emission reductions that cost on the order of $100 per tonne (see Sec. 3.2.1) we can ask why it is limited to CCS rather than open to any technology capable of reducing GHG emissions at a comparable (or lower) cost per tonne. Notably, renewable energy is a fundamentally more sustainable alternative that does not require continued massive resource extraction.

Given these various considerations, the economic efficiency of this program can probably be considered average.

Good use of public resources

Although the use of public funds through this program may be average from an economic efficiency perspective, it is more questionable when one considers alternative ways to achieve the same outcome. The need for subsidies to implement CCS falls as the carbon price rises; CCS could also be implemented without any public expenditure by requiring it as a condition of approval of new industrial facilities. In other words, this program could achieve the same outcome for less money (or a bigger outcome for the same amount of money) if the Alberta government were willing to increase the carbon price, contemplate mandatory CCS, or both.

A far higher carbon price and mandatory CCS are both economically feasible options. A modelling study conducted by the same consultants as used by Alberta Environment has shown that Alberta could continue to have Canada's fastest growing provincial economy with a carbon price reaching $200 per tonne by 2020 and mandatory CCS for all new natural gas processors, coal-fired power plants and oil sands operations.[87] This program's use of public resources must therefore be considered poor.

It is important to note that this evaluation is not a criticism of the management of the program. Nor does it mean that the Pembina Institute is opposed to CCS or to some degree of public subsidy for initial CCS demonstrations (see Section 3.2.1 for more information on our perspective on CCS). The evaluation is, rather, a consequence of the way Alberta's GHG policies have been established at a broader level.

Good design

This program is relatively simple, but the way that it overlaps with the SGER via offset credits is complex. It is not clear at this point what detailed conditions will be attached to the payments to companies, or whether those conditions will be made public. It is also not yet clear how rigorously the program's emission-reduction benefits will be measured, especially for the two projects in which the CO_2 will be used for enhanced oil recovery (see Table 8). It appears that those measurements will occur primarily via offset protocols.

The program does provide certainty for the selected projects, but otherwise it provides no indication of the government's future intentions as to how to scale up CCS. The government has consulted fairly widely on this topic through the Alberta CCS Development Council.[88] Overall it is probably too soon to tell how well the program fares on this criterion.

Accountability and adaptiveness

Again, given that this program is in the early stages, it is too soon to tell how well the government will evaluate its performance and make adjustments. However, the government has given the impression that its $2 billion investment is a one-off gesture, not part of a longer-term plan.

2.3.3 Climate Change and Emissions Management Fund

The money paid into the Climate Change and Emissions Management Fund (CCEMF) by large emitters, for purposes of compliance with the SGER, is reinvested in emission-reduction projects by the Climate Change and Emissions Management Corporation (CCEMC). The CCEMC is an independent not-for-profit corporation that is authorized to play this role by a regulation.[89]

Effectiveness — near term

Based on the amount that the CCEMC is likely to invest over the next few years, the resulting reduction in annual emissions by 2020 is likely to be on the order of 1 Mt (see Table 8). While it is possible that emissions reductions could be significantly greater than this (if their cost per tonne is relatively low), there are two key reasons why they might instead be less.

First, the Alberta government has to date taken no steps to prevent emission reductions from projects in which CCEMC invests counting towards large emitters' compliance with the SGER. This would occur if the reductions occur directly at large-emitter facilities or if the projects receive offset credits. Such emission reductions should be counted under the SGER rather than under the CCEMF. It is likely that they would replace large emitters' payments into the CCEMF (rather than other large-emitter reductions or offset credits), in which case they would add to the reductions attributable to the SGER. In other words, some of the reductions currently attributed to the CCEMF in Table 2 would shift to the SGER row of the table, and the remaining reductions attributed to the CCEMF would shrink a little more because the fund would now be smaller.

The CCEMC has recently developed detailed guidance for quantifying emission reductions from the projects it invests in, but the guidance document[90] is silent about this accounting issue.

Second, it is possible that projects in which the CCEMC invests might have gone ahead without its participation, either as the result of some other policy or as part of business as usual. If the emission reductions associated with a project are to be attributed to the CCEMF, then the project must have faced barriers preventing its implementation in the absence of the CCEMC's investment — barriers that were overcome by that investment. This issue applies equally to offset credits (see Sec. 2.3.2). While it is not yet being adequately addressed in the case of offsets, the CCEMC does now require[91] project proponents to submit a validation report that confirms significant barriers exist to the project, based on a careful analysis.[92] Hopefully this approach will be robust enough to largely prevent the CCEMC from investing in projects that would have been able to proceed without its involvement.

In addition, it should be noted that the provision of double offset credits for certain CCS projects may result in lower payments into the CCEMF (see Sec. 2.3.1) and commensurately lower emission reductions resulting from investment of this money.

The CCEMF is inherently a mechanism that defers emission reductions until later, because payments into the fund are an alternative to immediate emission reductions under the SGER. In practice, most of the projects in which the CCEMC has invested to date aim for relatively near-term emission reductions,[93] but there appears to be nothing to prevent the CCEMC's board from shifting its emphasis to funding more projects focused on long-term technology development, rather than near-term deployment.

Overall, given that the CCEMF is one of the three most significant Alberta GHG policies, its near-term effectiveness must be seen as poor in the context of the government's target to reduce annual emissions by 50 Mt below business as usual in 2020, and in light of the accounting issues raised above.

Effectiveness — longer term

The significant investments that the CCEMC is making in technologies that are not yet widely used hold the promise of paving the way for greater emission reductions in the longer term than in the near term. One way in which this might happen is that investments now could help reduce the cost of technologies so that their degree of adoption later is higher for a given carbon price. However, it is not clear whether the CCEMC is investing strategically in this regard. Notably, it not clear whether it is focusing on areas where the emission-reduction potential of technology cost reductions is greatest, and whether it is coordinating investments with other jurisdictions.

This means that it is too soon to tell how effective the CCEMF will be for the longer term.

Economic efficiency

It is not clear how the CCEMC is selecting projects with reference to their cost per tonne of emissions reduced. If it wanted to maximize economic efficiency, the CCEMC would systematically search for emission reduction opportunities that have the lowest cost above $15 per tonne (opportunities below $15 per tonne should already result from the SGER). However, it seems unlikely that this is the case. On the other hand, the CCEMC does appear to be investing in a fairly full spectrum of technology types, encompassing energy efficiency, renewable energy and CCS.[94]

At this point not enough information is available about CCEMC's selection criteria or the projects in which it is investing to be able assess economic efficiency.

Good use of public resources

We consider the funds invested by the CCEMC to be public funds because they are a portion of the carbon value of emissions from large emitters. As explained in Sec. 2.3.2, the Pembina Institute regards carbon value as a public resource.

We welcome using carbon value to achieve further emission reductions — which is what the CCEMF does — as opposed to using it for a purpose unrelated to climate policy. However, when emission reductions can be reasonably achieved without expending public funds, it is better to reserve those funds for emission reduction activities that have a greater need for public support. As noted in Sec. 2.3.3, the need to subsidize emission reductions falls as the carbon price rises, and a far higher carbon price than Alberta's current $15 per tonne would be economically feasible. The CCEMC's existing projects would need less investment, and it could devote more funds to higher-cost, more innovative emission reductions while maintaining economic efficiency, if the Alberta government were willing to increase the carbon price.

In light of this, the CCEMF's use of public resources must be considered poor for the same reason as for the CCS Major Initiatives program.

We should emphasize that this is not a criticism of the CCEMC's specific project choices but rather a consequence of the way Alberta's GHG policies have been established at a broader level. However, one use of public funds that *is* a specific choice of the CCEMC is its lobbying of governments. The CCEMC's annual report for 2010 states that "strong leadership and a significant, concerted presence in major political centres have been required to deliver our message of progress;"[95] the report lists visits to Ottawa and Washington as part of "telling our story." We note that lobbying is not a legally authorized use of the CCEMF,[96] if that was the source of funding for those visits.

Good design

The CCEMF is a complex policy. Projects to be funded are selected using numerous criteria[97] that are open to interpretation and subject to change. Just like an offset system, the CCEMF tries to measure emission reductions from business-as-usual baselines that are intrinsically difficult to determine, and for project types from all parts of the economy. It can be argued that this type of approach cannot pass the test of good design. In addition, the CCEMF has a complicated accounting overlap with the SGER.

The CCEMC's contribution agreements with project proponents, detailing the conditions attached to payments, are not public.[98] The CCEMC is subject to Freedom of Information legislation,[99] but Alberta's Auditor General does not appear to be empowered to audit the corporation[100] (Alberta Environment does have the power to carry out an audit[101]).

The CCEMC's guidance for quantifying emission reductions from projects gives reason to believe that measurement will be rigorous, although not necessarily transparent. The CCEMC's stream of future funding from the SGER provides reasonable certainty about continued future investments. But the composition of the CCEMC's board indicates that the implementation of the CCEMF is overly dominated by one category of stakeholders, with representatives of large-emitter industry sectors occupying a majority of the seats, and no seats for "clean economy" sectors like renewable energy, energy efficiency or sustainable transportation.[102]

Based on the above analysis, we would have to consider that the CCEMF fares poorly on the criterion of good policy design.

Accountability and adaptiveness

Since the projects funded from the CCEMF are only just beginning to be implemented, it is too soon to tell how well performance will be evaluated and adjustments made. However, the CCEMC's guidance for quantifying emission reductions lays the groundwork for future evaluations and suggests that they will be robust.

2.3.4 Alberta's policies as a whole

As argued earlier, the three policies evaluated individually above are the most significant of Alberta's GHG policies. How do they fare against our evaluation criteria when looked at in combination? Do any of those combined assessments change when we consider the remaining policies listed in Table 2?

Effectiveness — near term

Table 2 shows that Alberta's current GHG policies as a whole will reduce annual emissions in 2020 by no more than 14 Mt relative to business-as-usual, and possibly by less than 10 Mt.[103] The policies that we have not evaluated individually make only a modest contribution. Alberta's GHG policies as a whole fall far short of the government's target to reduce annual emissions by 50 Mt below business as usual in 2020, which corresponds to halting the growth in Alberta's absolute GHG emissions by that year. This means that with its current policies, Alberta's emissions are set to grow even more rapidly between now and 2020 than its climate plan foresees (see Table 6 in Sec. 4.2), and to continue increasing in the 2020s. On this basis the policies as a whole are poor.

Since Alberta accounts for a third of Canada's total emissions, the analysis summarized in Table 2 is not inconsistent with Environment Canada's estimate that current provincial policies for all the provinces combined will only reduce annual emissions in 2020 by about 32 Mt relative to business as usual.[104] In theory federal policies could significantly reduce the work that the Alberta government needs to do to meet its 2020 target. Environment Canada estimates that current federal policies will also reduce annual emissions in 2020 by about 32 Mt relative to business as usual,[105] of which roughly one third, or 11 Mt, might reasonably be expected to be located in Alberta. If so, the combination of roughly 12 Mt from Alberta's policies and roughly 11 Mt from federal policies would still leave Alberta far short of meeting the provincial government's 50 Mt target.

Effectiveness — longer term

The government has, to our knowledge, announced no intention of increasing the future stringency or scale of any of its current GHG policies. And it has not explained how it intends to scale up key technologies like CCS in the long term. The government has provided some signals that it intends to implement some additional GHG policies. For example, the Minister of Municipal Affairs has indicated that Alberta will adopt the forthcoming new National Energy Code for Buildings,[106] and Alberta Energy recently began consulting stakeholders on an Alternative and Renewable Energy Policy Framework.

However, given the contradiction between the general stasis in Alberta's GHG policies and the rapidly increasing scale of GHG reductions that Alberta needs to achieve post-2020 to achieve its targets, we consider the longer-term effectiveness of the policies as a whole to be very poor.

Economic efficiency

The three most significant policies have a combined economic efficiency that appears to be at least average, based on the individual analyses described in the preceding sections. The remaining policies will certainly reduce the overall economic efficiency, because they target specific technologies or practices, some of which will have a relatively high cost per tonne of emissions reduced, and others a relatively low cost. In addition, Alberta currently lacks some policies that are widely recognized as being part of an economically efficient climate plan. These include up-to-date energy codes for buildings and, perhaps most importantly, a truly economy-wide carbon price.[107] (The SGER can be seen as economy-wide, in view of offsets, but the offset system only imperfectly transmits the carbon price to non-industrial emissions.)

Overall economic efficiency is also likely reduced as Alberta falls short on its near-term climate targets. To catch up, and then meet the 2050 target, a disproportionate effort will be needed in the later years — which is likely to be more costly than an effort more evenly distributed over time.

Nonetheless, taking all factors into account, the overall economic efficiency of Alberta's policies can probably still be considered average.

Good use of public resources

The three most significant policies make poor use of public resources — a conclusion that results mostly from $1.5 billion per year of carbon value being allocated to large emitters free of charge, and from the low level of the carbon price. Of the remaining policies, those that make by far the biggest use of public resources are the Bioenergy Producer Credit Program (over $100 million per year) and GreenTRIP ($2 billion in total). Subsidies for biofuels are generally thought to be very expensive on a cost per tonne basis.[108] Subsidies for transit are very expensive for governments, but transit permits large cost savings for users and has other important benefits, such as reducing congestion.

There appears to be little reason to consider that the degree of good use of public resources differs overall from that of the three most significant policies.

Good design

The three most significant policies have a roughly average combined score on this criterion. Most of the remaining policies appear individually to be relatively simple and clear. However, it can also be argued that a broad collection of subsidy policies fails the test of good design for the same reasons as offset systems: measurement of emission reductions is very difficult because it is hard to determine which actions are truly attributable to the subsidies, and this problem appears in a wide variety of situations. We nonetheless consider this argument insufficient to clearly change the overall evaluation.

Accountability and adaptiveness

The Alberta government has no apparent process to evaluate the performance of its GHG policies overall. It has certainly not published any such evaluation since its current climate plan was published nearly four years ago. Unfortunately this is not a surprise: the government made no attempt in the 2008 plan to explain how specific policies would meet its emissions targets, and it evidently continues to have the same attitude now.

Alberta Environment knew that the policies described in the 2008 plan were far too weak to meet the plan's targets, as the Auditor General pointed out in October 2008.[109] In the same report the Auditor General called on the government to produce "a master implementation plan with the specific actions to allow it to meet the targets, and with regular progress reporting... the implementation plan should clearly state the milestone dates for key decisions."[110] Three years later the government has not fulfilled that recommendation. This strongly indicates that the government has little or no interest in strengthening its policies to meet its emissions commitments.

This is a serious failure of accountability and a near-absence of adaptiveness. The government's performance in this area is, without a doubt, very poor.

Table 4: Summary of our evaluations of Alberta's current greenhouse gas policies

Criteria	*Specified Gas Emitters Regulation*	CCS Major Initiatives	Climate Change and Emissions Management Fund	Policies as a whole
Effectiveness — near term	**–**	**–**	**–**	**–**
Effectiveness — longer term	**– –**	**–**	Too soon to tell	**– –**
Economic efficiency	**+**	**o**	Insufficient information	**o**
Good use of public resources	**– –**	**–**	**–**	**–**
Good design	**o**	Too soon to tell	**–**	**o**
Accountability and adaptiveness	**–**	Too soon to tell	Too soon to tell	**– –**

Note: Rating system:

+ + very good

+ good

o average

– poor

– – very poor

3. Limiting greenhouse gas emissions from the oilsands

3.1 Significance of the oilsands for climate policy

Oilsands extraction and upgrading accounted for almost one-fifth of Alberta's GHG emissions in 2009, and close to half of the growth in Alberta's emissions since 1990 (see Table 1). The large scale and rapid expansion of this industry give it great national as well as provincial significance, and this is particularly true from a climate policy perspective. For not only Canada, but also the U.S. (purchaser of the majority of oilsands output) as well as other international customers, manufacture of transportation fuels from oilsands bitumen helps perpetuate business-as-usual use of fossil fuels and correspondingly high GHG emissions — at a time when curbing climate change requires an urgent transformation of our energy system to one in which most energy is emissions-free.

Below we take a closer look at the challenge faced by Alberta's policymakers in limiting GHG emissions from the oilsands sector.

3.1.1 Background

Oilsands GHG emissions have soared as a result of the industry's rapid expansion over the past two decades. Between 1990 and 2009, oilsands GHG emissions more than doubled, increasing by 165 per cent (see Table 1). According to the most recent projection from Environment Canada, the rapid pace of oilsands emissions growth is set to continue for at least the next decade, with emissions forecast to double between 2009 and 2020 under current federal and provincial government policies.[111] The historical and projected future growth in oilsands GHG emissions are shown below in Figure 2.

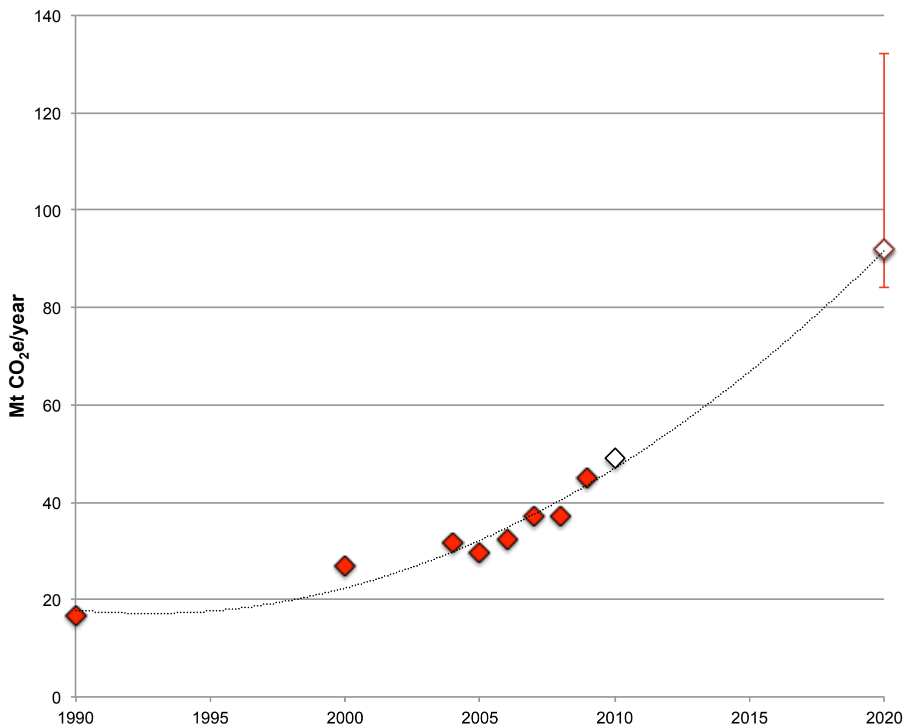


Figure 2: Greenhouse gas emissions from oilsands extraction and upgrading

Data from 1990 to 2009[112] are measured values; data for 2010 to 2020[113] represent Environment Canada's latest forecast values; the uncertainty range only reflects extraction since Environment Canada has not quantified the uncertainty in future upgrading emissions

In the absence of dramatic changes in technology, ongoing expansion of the industry will result in continued growth in emissions. Multiple government and industry forecasts show large increases in production not just until 2020 but beyond. For example, a prominent forecast by the Canadian Energy Research Institute (CERI) includes a "realistic scenario" in which oilsands production increases continuously up to 2035. In this scenario, shown below in Figure 3, production increases by 150 per cent between 2010 and 2035, reaching 4.9 million barrels per day by the end of the period.[114] Over 4 million barrels per day of capacity have already been approved in Alberta and an additional 4 million barrels per day have been announced[115] — far more than shown in Figure 3.

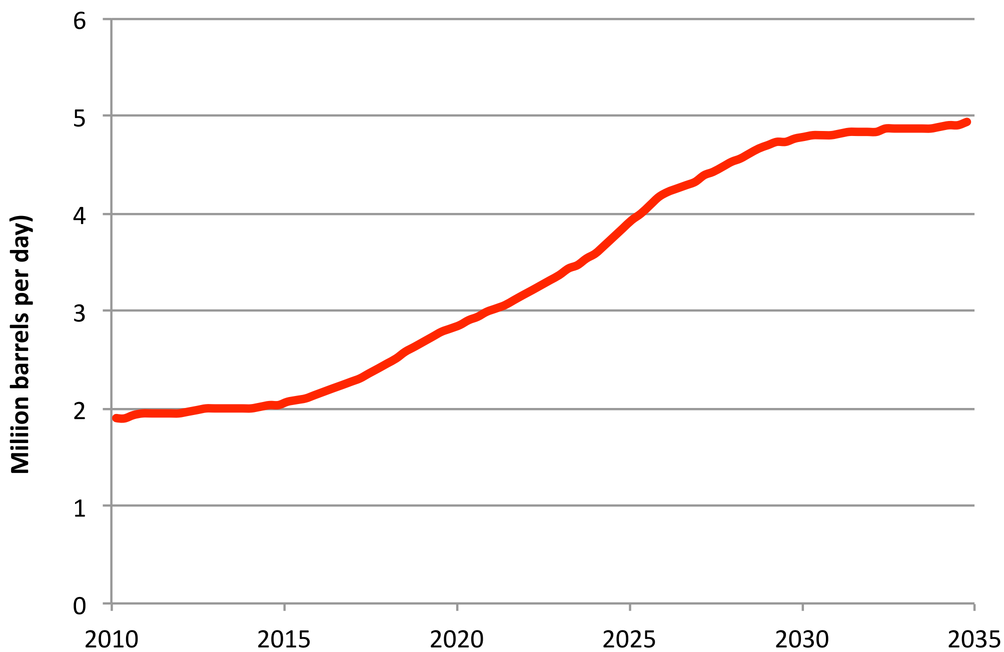


Figure 3: Oilsands production forecast in CERI's "realistic scenario"[116]

3.2 Opportunities for limiting oilsands greenhouse gas emissions

Given the large projected growth in oilsands production and the associated GHG emissions, it is clear that the sector poses a significant challenge to Alberta's ability to meet its GHG targets for 2020 and 2050. In the following sections we look at the key technological opportunities to limit oilsands GHG emissions.

3.2.1 Carbon capture and storage

According to Alberta Energy, "Carbon capture and storage will enable Alberta's economy to continue to grow, while reducing carbon emissions from large-scale operations like coal-fired electricity generation, oil sands extraction and value-added upgrading. Essentially, this technology will deliver the majority of our GHG reductions to allow us to meet our climate change goals, while providing Albertans with the economic advantage and quality of life they expect."[117]

The Pembina Institute's research points to a more nuanced view of CCS. Our 2005 report, "Carbon Capture and Storage: an arrow in the quiver or a silver bullet to combat climate change?" found that CCS may play a role in reducing Canada's emissions but that a range of issues mean it is not a "silver bullet." These issues include high cost, energy penalties (meaning that CCS requires extra production of fossil fuels, with attendant environmental impacts), limited experience with underground CO_2 storage, and the risk of leakage.[118] Similarly, a survey of participants at a 2008 "thought leader forum" on CCS, held by the Pembina Institute and the

University of Calgary, found that seven out of 10 participants saw CCS contributing less than a third of Canadian GHG emissions reductions.[119]

The Pembina Institute continues to see much evidence indicating that CCS is only one of a number of technologies that can contribute to reducing GHG emissions and that its development should be conditional on:[120]

- a massive scale-up of energy efficiency and low-impact renewable energy production — fundamentally more sustainable means of reducing GHG emissions;
- a consideration of regional contexts, notably the availability of more sustainable energy options and the suitability of the geology;
- implementation of a strong regulatory framework to minimize the risk of leaks, monitor movement of the CO_2 and address outstanding issues such as the ownership of pore space and long-term liability;
- a fair distribution of investment between taxpayers and polluters, with polluters quickly shouldering the full cost of CCS deployment (consistent with our "good use of public resources" criterion in Sec. 2.3);
- establishment by government of a price on emissions high enough to stimulate the adequate deployment of low- or no-emission technologies, including CCS where appropriate (an economically efficient means of implementing the previous bullet point); and
- an increase in public education and awareness in order for CCS to be more widely accepted as a viable technology within a portfolio of solutions for reducing GHG emissions.

Below we examine the application of CCS specifically to oilsands extraction and upgrading, from both a technical and economic perspective.

Technology

By 2010, there were 77 large-scale integrated CCS projects (projects combining capture, transport and storage) at various stages of development around the world.[121] Eight of those projects were already operating, four were under construction and 65 were planned. The operating projects capture a total of 11 Mt CO_2 per year; six of them are in the gas processing sector, one in synfuel production and one in fertiliser production.[122] The planned projects are for a wider range of applications including power generation and oil production.

But despite the range of projects being developed around the world, the Alberta Carbon Capture and Storage Development Council called CCS an "embryonic" technology as recently as 2009;[123] it is clearly still far from being an established technology to reduce GHG emissions. More experience is required and more large-scale projects must be demonstrated before CCS can be considered a commercially available technology. This is particularly true for the oilsands industry, which currently lacks any operational experience with CCS.

To date there are no operating CCS projects in the oilsands. Two large-scale projects are planned (aided by major financial support from the federal and provincial governments — see Table 2 and Sec. 2.3.2). Shell's Quest project is an integrated project that aims to capture 35 per cent or over 1 Mt of the annual emissions from the company's Scotford Upgrader and inject it into a deep saline acquifer.[124] The Alberta Carbon Trunk Line proposes to transport CO_2 — initially around 1.8 Mt annually — from an oilsands upgrader and other industrial facilities in central Alberta to conventional oil fields for use in enhanced oil recovery.[125]

CCS could, in principle, be applied at several different stages in oilsands operations, including both the bitumen recovery and upgrading phases. One report estimates total theoretical CO_2 capture potential for oilsands GHG emissions at 86–91 per cent, although this is without regard to cost.[126] However, some CO_2 streams are more easily captured than others. To simplify the matter, the oilsands industry can be broken into three main components, each with different types of CO_2 streams and, accordingly, different potential for CCS application: mining, in situ extraction, and upgrading.

The oilsands extraction process

In the oilsands, bitumen is recovered by either mining the resource with large trucks and shovels or through in situ techniques that heat the bitumen underground and pump it to the surface using steam assisted gravity drainage or cyclic steam stimulation. In situ extraction is projected to increase from 47 per cent of oilsands production in 2010 to 55 per cent in 2020.[127] This shift is set to continue past 2020 as the majority of oilsands reserves are accessible only through in situ techniques. Once recovered, bitumen must be upgraded to synthetic crude oil before being refined into petroleum products like gasoline and diesel. Some upgrading takes place in Alberta and some bitumen is sent for upgrading to the U.S.

Production of hydrogen (currently from natural gas) is part of many upgrading processes, and it creates a concentrated stream of CO_2 that is the easiest type to capture in oilsands operations.[128] Other sources of CO_2 from the combustion of natural gas — either in cogeneration facilities or boilers used in mining, in situ extraction or upgrading — are either smaller or have lower CO_2 concentrations. While it is technically possible, albeit more challenging, to capture emissions from these sources, it can be significantly more costly to do so (see below). CCS cannot be applied at all to sources like mine fleet vehicles (large mining trucks, cable shovels, etc.), methane offgassing from tailings ponds and the mine face, and other fugitive emissions.[129] The most abundant sources of oilsands CO_2 have low concentrations, and these sources will become increasingly dominant as in situ production grows.[130]

Major energy consultants IHS CERA confirm in a recent report that upgraders present the best opportunity for CCS implementation in the oilsands and that it could result in a net decrease in GHG intensity of 11–14 per cent for the oil production (well to retail pump) to which it is applied (these numbers are relatively low because CCS is applied only to upgraders, where it increases energy consumption).[131] According to the forecast scenario in the report, CCS implementation in the oilsands will begin around 2020 and, as it expands, will lead to industry-wide GHG reductions of 10 per cent from business as usual by 2035.[132] This scenario assumes strong government policies to limit GHG emissions (including a carbon price reaching $100 per tonne of CO_2 by 2020, a U.S. low carbon fuel standard and a North American economy-wide cap-and-trade program[133]) and includes industry and government collaboration to construct a CO_2 pipeline network, aggressive oilsands technology improvements and implementation of CCS at more than half of all upgraders by 2035.[134]

> "Carbon capture and storage is appealing from the perspective of GHG policy as a whole but does not appear to be very feasible for oil sands production in general and in-situ in particular. Bitumen upgrading could provide a more promising source of applications for carbon capture and storage. Substantial questions remain to be answered about the feasibility and reliability of carbon capture and storage in all applications."[135]
>
> — Royal Society of Canada Expert Panel (2010)

The likely extent to which technology advances will make CO_2 from oilsands operations easier and more economic to capture in the future is unclear.[136] What is clear is that existing technology is technically capable of capturing a significant proportion of CO_2 emissions but is not being applied for economic reasons.

Economics

Because implementing CCS will always be more expensive than not doing so, CCS will remain uneconomic until some combination of subsidies, carbon price and/or regulated requirements is strong enough to overcome the cost barrier.

As of April 2010, global public funding commitments for CCS were between US$26.6 billion and US$36.1 billion.[137] Canada has committed a total of about $3 billion including $2 billion from the Alberta government (see Table 2) and $850 million from the federal government.[138]

Alberta's $2 billion commitment has been allocated to four large-scale CCS projects with a capture potential of 5 Mt CO_2 per year (see Table 8). As noted above, two of the four are oilsands projects. The Shell Quest project will receive $865 million in subsidies from the federal and provincial governments,[139] and the Alberta Carbon Trunk Line will receive $558 million from the two governments.[140] (The two other projects are in the power generation sector.[141])

Globally, the International Energy Agency, an intergovernmental organization to which Canada belongs, makes clear that current government policies (including subsidies for demonstration projects) are "insufficient to drive large-scale development and deployment of CCS to meet the required levels of CO_2 mitigation."[142] Apart from the two subsidized demonstration projects, CCS is very far from being economic in the oilsands.

> "The Government of Alberta's $2-billion carbon capture and storage fund provides a kick-start to full-scale carbon capture and storage implementation. Alone, it will not deliver the government's longer-term carbon capture and storage and GHG emission reduction goals. Significant additional investment will be required from the federal and provincial governments and industry to further develop the technology and capture additional CO_2 over and above the 5 Mt annually sought from the initial wave of funding."[143]
>
> — Alberta Carbon Capture and Storage Development Council (2009)

The key reason is the high cost of capturing CO_2 in the oilsands. Because of their higher concentrations (see above), CO_2 streams from hydrogen production at oilsands upgraders have the lowest capture costs, estimated at $75 to $155 per tonne.[144] These costs are within the range of other capture sources like coal-fired electricity production and oil refining. However, CO_2 streams from in situ operations have significantly higher capture costs, estimated at $175 to $230 per tonne.[145] Figure 4 shows the cost of CO_2 capture in the oilsands sector relative to other sectors. Note that upgraders fall under two categories in this figure: the blue and the orange zone.

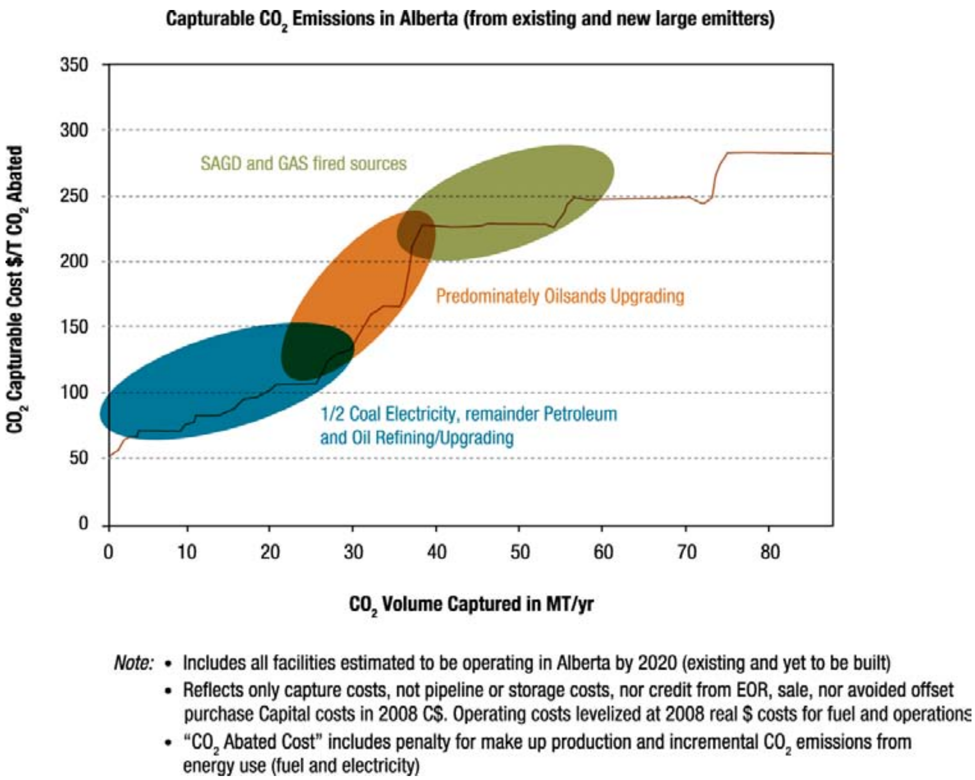


Figure 4: CO_2 capture costs for different industries[146]

Reproduced from WWF-UK, *Carbon Capture and Storage in the Alberta Oil Sands — A Dangerous Myth*; data from Murray, *Alberta CO_2 Capture Cost Survey and Supply Curve.*

In addition to the CO_2 capture costs, transporting the captured CO_2 to the storage site in a pipeline (for example, from Ft. McMurray to Edmonton) adds about $15 per tonne, and underground storage adds $5–10 per tonne.[147] Therefore, the cost for oilsands CCS projects including capture, transportation and storage could range from $95–$255 per tonne of CO_2.

3.2.2 Other new or improved technologies

New technologies and efficiency improvements could help reduce the GHG intensity of oilsands production without capturing CO_2. Historically, new technologies and efficiency gains have resulted in significant intensity reductions. As illustrated below in Figure 5, from 1990 to 2009 oilsands GHG intensity declined by 29 per cent.[148]

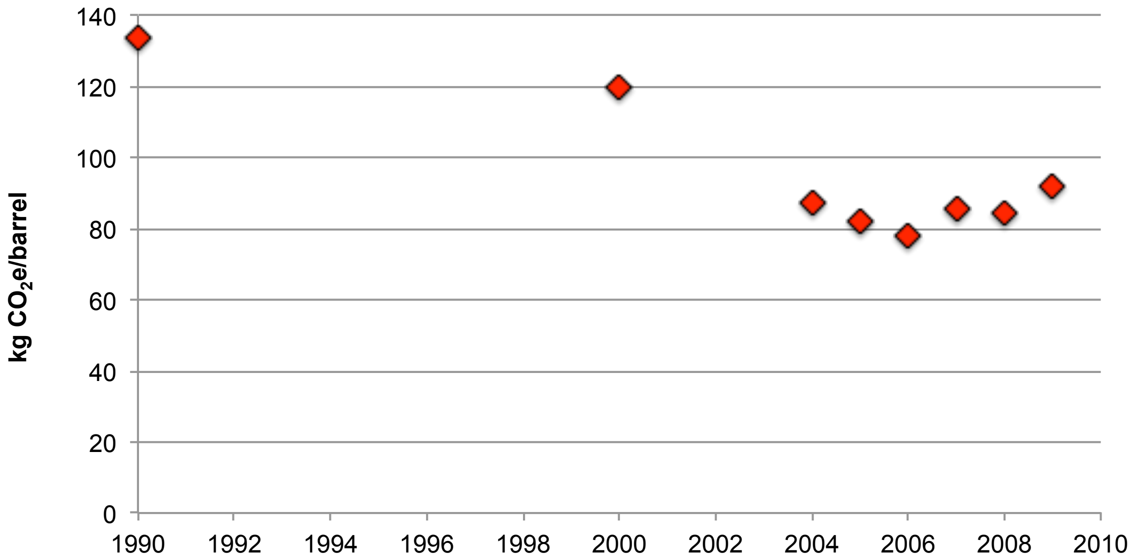


Figure 5: Past changes in industry-wide greenhouse gas intensity in the oilsands[149]

> Over the past 20 years, industry-wide GHG intensity in the oilsands declined by 29 per cent. With the anticipated growth in production simply maintaining emissions at the 2009 level (45 Mt per year) would require further intensity reductions of 53 per cent by 2020 and 72 per cent by 2030, relative to the 2009 level.[150] This is more than twice the level of improvement previously shown over a similar time period and would still not result in absolute emissions reductions.

According to IHS CERA,[151] intensity reductions over the past two decades were largely the result of

- improvements to the energy efficiency of bitumen extraction
- fuel switching from petroleum coke to natural gas,[152] and replacement of grid electricity by onsite heat and electricity cogeneration
- upgrading efficiency gains from optimization and integration of processes
- addition of new facilities —facilities that started up in the mid 2000s were more efficient than the older mining operations.

What can this tell us about the potential for future intensity reductions? Fuel switching to natural gas and cogeneration have been widely adopted and so offer little further prospect for improvement. Similarly, the ability of newer, more efficient facilities to improve the industry's average GHG intensity is limited by the long lifespans (30–50 years) of the dominant older technologies. Table 5 summarizes emerging technologies that could, however, potentially contribute to future reductions in GHG intensity. They are at widely varying stages of development.

Table 5: Emerging technologies with potential to reduce oilsands GHG intensity

Technology	Description	Status
Efficiency gains (general)	Improved extraction efficiency for mining and in situ oil sands	Ongoing incremental improvements
Solvents	Use of solvents for in situ extraction either in combination with steam or in place of steam	Development stage — not yet commercially applicable[153]
In situ combustion	Burning of portions of the deposits underground to provide heat for in situ extraction (e.g., Toe-to-Heel Air Injection (THAI))	Pilot stage — one demonstration project has been operating since 2006[154]
Electric heating	In situ extraction using electrodes to directly heat the bitumen	Early testing[155] and funded demonstration[156]
Second generation fuel switching	Replacement of natural gas with biofuels or nuclear power to generate heat or electricity	Proposed but untested

It is beyond the scope of this report to evaluate the effectiveness and prospects of each of these emerging technologies, but a recent technical journal article provides some useful analysis.[157] It concludes that some of these technologies offer the potential to significantly reduce GHG intensity, but in many cases the benefits may come with other environmental costs and some have limited applicability. The article concludes: "there are also no technologies that are clearly superior [in comparison with the others] in terms of both reducing costs and significantly reducing GHG emissions. In addition, other environmental impacts must also be considered. There are strong trade-offs between these disparate objectives." Furthermore, as noted in Table 5, many of the technologies are still in the research or pilot stage and may not be able to be widely implemented for many years.

> "Beyond the next two decades, new methods of extracting oil sands are likely to lead to more reductions in GHG intensity and environmental impacts, but these trends are not inevitable. More research and development is needed… Because of the time lag between a successful pilot and broad commercial deployment, the potential benefits from these revolutionary technologies are probably 15 to 20 years away."
>
> — IHS CERA (2011)[158]

It is important to note that two ongoing trends in the oilsands industry are applying upward pressure on GHG intensity, counteracting the intensity reductions promised by future technologies. The first is falling reservoir quality. Development of a resource generally starts with the best deposits, and later moves on to those of lower quality. Current oilsands operations are likely consuming the easiest-to-access bitumen, and future oilsands operations will likely take place in reservoirs that are less easily accessible, requiring more energy and producing relatively higher emissions.[159] The second trend is the industry-wide shift from mining to in situ extraction. In situ extraction is a significantly more GHG-intensive means of production (on average 2.5 times more intensive than mining[160]). Looking back at Figure 5, it is worth noting that the past intensity reductions have now halted: the industry-wide intensity has now levelled out and even increased somewhat during 2006–09. It is too soon to determine whether this is a hiccup or a long-term trend, but it is a strong warning signal that continued GHG intensity reductions in the oilsands are not guaranteed.

3.2.3 Less rapid production growth

Although it is not a technology in the sense of CCS, energy efficiency or fuel switching, slower expansion of oilsands production presents another important means of limiting GHG emissions from the sector. For example, reducing the rate of expansion between 2010 and 2020 by one-third would cut emissions in 2020 by about 15 Mt relative to business as usual (see Figure 2). There are several other reasons why a less rapid expansion would be in the interests of Albertans and Canadians.

First, authorities such as the Royal Society of Canada have noted that provincial and federal environmental regulatory capacity is not keeping pace with the growth of the oilsands.[161] Evidence of this is apparent in the October 2011 report of the federal Commissioner of the Environment and Sustainable Development, which notes that weaknesses in baseline data collection, aspects of regulatory approval, and environmental monitoring are hindering a full analysis of cumulative environmental effects of oilsands operations.[162] Environment Canada's review of the current water monitoring system found serious flaws and concluded that the system is insufficient in quantity and quality to detect and quantify the environmental effects of oilsands development.[163]

In addition to regulatory and monitoring concerns, other critical components of sound environmental management are still missing. These include a land use plan for the oilsands region, a sufficient network of protected areas, and a wetlands policy.[164] Less rapid expansion would help provide some breathing space to allow these missing components to be put in place and ensure that development proceeds responsibly.[165]

There are also economic arguments for moderating the pace of large-scale oilsands expansion. Parts of Canada are now being impacted by "Dutch disease," a term to describe the decline of the manufacturing sector resulting from increased emphasis on natural resource extraction, notably oil production.[166,167] Slowing oilsands expansion would reduce upward pressure on the Canadian dollar, increasing the competitiveness of the manufacturing sector. At the provincial level, rapid expansion of the oilsands has historically overheated the Alberta economy, causing excessive increases in the costs of housing, consumer goods and labour.[168] As former Premier Peter Lougheed has argued, slowing the expansion of the oilsands could prevent similar economic impacts from occurring again in the future.[169] Alberta's rate of GDP growth could still be the highest in Canada even with significantly less rapid oilsands expansion than under business as usual.[170]

The current pace of large-scale oilsands expansion also has significant social and cultural impacts. Regional infrastructure, particularly in the city of Fort McMurray, struggles to keep up with oilsands growth, and the municipal government has called for development to be slowed to deal with infrastructure challenges.[171] For decades, Aboriginal people in northern Alberta have raised concerns about ongoing and escalating impacts of oilsands operations on human health, air quality, water quality, water diversions and wildlife. The pace of expansion has prompted these communities to question whether negative impacts outweigh economic benefits.[172] In 2008, 44

First Nations communities from Alberta asked for a moratorium on oil sands approvals until comprehensive land management planning occurs.[173]

Last but not least, putting brakes on the race to build would allow sober second thoughts in the project design process. Under the appropriate regulatory framework, oilsands developers would have the opportunity to optimize project design based on previous project performance, consider novel technologies that offer step change performance improvements, and have more time to move ideas from concept to practice. These could include collaborative efforts to achieve "industrial symbiosis" (where waste products and heat are put to economic use, and operators share infrastructure); to integrate land management among operators, the forestry industry and other stakeholders; and to effect rescue plans for wildlife. Without breathing space, innovations like these are much less likely to be implemented.

3.3 Lessons for policymakers

CCS represents an important, relatively near-term technological opportunity for substantially reducing oilsands GHG emissions below business-as-usual levels. But with estimated costs in the range of $95–$255 per tonne (Sec. 3.2.1), it comes at a high price. Public subsidies can pay this price for demonstration projects, such as Alberta's two planned oilsands CCS projects, but clearly not for the bulk of the new oilsands production capacity expected in the coming years — that would require tens of billions of dollars and citizens would rightly view it as a poor use of public resources. The costs of CCS should fall with experience from the demonstration projects and technology development, but we cannot count on dramatic cost reductions occurring any time soon.

The only serious options for widespread application of CCS to new oilsands production are therefore a large increase in the carbon price, mandatory implementation of CCS for new facilities, or equivalent GHG intensity standards. By setting a carbon price ceiling of $15 per tonne, the current SGER can only bring about emission reductions costing less than that amount; the ceiling would have to be raised by an order of magnitude to allow large-scale CCS. The other option, mandating CCS or equivalent performance, has, in the case of coal-fired electricity generation, already been adopted in British Columbia[174] and some U.S. states,[175] and is currently being proposed by Canada's federal government.[176]

Apart from CCS, other new or improved technologies offer the potential to significantly reduce GHG intensity in the oilsands beyond business as usual, although it should be noted that declining resource quality and the shift towards in situ extraction are applying upward pressure on business-as-usual intensity. None of these technologies appear, at this stage, to promise industry-wide GHG intensity reductions comparable to those that are theoretically possible with CCS. On the other hand, some of these other technologies could have significantly lower costs than CCS and be made economic with a lower carbon price than would be needed for broad implementation of CCS. A GHG intensity standard consistent with significant implementation of CCS could potentially be met using these other technologies.

Reducing the pace of expansion of the oilsands sector is another important means of limiting the sector's emissions and there are several other reasons why it would be in the interests of Albertans and Canadians.

In light of the high cost of CCS, the Alberta government could try to secure the bulk of its targeted emission reductions in sectors other than oilsands. However, this is unlikely to be economically efficient: although there are significant emission reduction opportunities through conservation, efficiency and renewable energy in the electricity sector,[177] modelling nonetheless suggests that an efficient approach to meeting the targets in Alberta's climate plan would rely on CCS for the bulk of the emission reductions.[178] Focusing on sectors other than the oilsands would likely place out of reach the plan's 30+ Mt per year of CCS by 2020, let alone its 65 Mt per year of CCS by 2030 (see Figure 1).

4. Alberta's contribution in context

4.1 What the science says, and Canada's commitment

As noted in Section 1, national governments worldwide have unanimously accepted the need to limit average global warming to 2°C (relative to pre-industrial temperatures), based on a large and longstanding body of science.[179] The Intergovernmental Panel on Climate Change, the world's leading climate science body, has shown that to have a chance of not exceeding the 2°C limit, the most developed countries' combined GHG emissions should fall to 25–40 per cent below the 1990 level by 2020 and 80–95 per cent below the 1990 level by 2050, if they are to make a fair contribution to the necessary cuts in global emissions.[180] Major jurisdictions including the UK,[181] Norway[182] and Japan[183] have made reduction commitments within this range.

Although developed countries as a whole could, in principle, meet a target within the 25–40 per cent range even if Canada met only a weaker target, there are good reasons[184] why Canada's target for 2020 should be at least a 25 per cent reduction below the 1990 level. Assuming that this target is now too challenging to meet purely through domestic emission reductions, it could be met in part by financing reductions in less wealthy countries.[185] However, the federal government has committed Canada to a weaker target for 2020, a 17 per cent reduction below the 2005 level,[186] equivalent to a 3 per cent increase above the 1990 level.[187]

4.2 Sharing the effort among provinces

As Canada's provinces face widely varying economic and geographic conditions, it is too simplistic to apply Canada's emission reduction commitment to each province individually. Notably, Alberta can legitimately argue that it should be allowed some extra space for emissions associated with expanding oilsands operations, because scenarios in which GHG emissions are reduced consistently with the 2°C global warming limit typically show oilsands expanding in the near-to-medium term (albeit much more slowly than under business as usual) to offset the decline of conventional oil.[188]

Modelling studies that calculate how Canada can reduce emissions in an economically efficient manner provide a good indication of how much each province should reasonably contribute. In 2009 the Pembina Institute and the David Suzuki Foundation published a modelling study conducted by M.K. Jaccard and Associates, the same consultants hired by Alberta Environment to assist with preparation of Alberta's 2008 climate plan.[189] The Pembina-Suzuki study remains the only one to examine how Canada could meet both the federal government's GHG target for 2020 and a more ambitious science-based target (25 per cent below the 1990 level). The study modelled policies chosen to minimize the total costs of meeting the targets while limiting interprovincial financial flows. The results show Alberta continuing to have Canada's fastest-growing provincial economy and to expand oilsands production (with heavy use of CCS), and

Canada's economy continuing to grow steadily, even when Canada meets the science-based target.[190]

We use the 2009 Pembina-Suzuki study as our best available estimate of how much each province should reasonably reduce its emissions when Canada meets, in an economically efficient manner, either the 2020 target that Canada has committed to internationally or the more ambitious science-based target. The two central columns of Table 6 show the predicted emission reductions by province, relative to business as usual (BAU), for the two national targets. They show that to make a reasonable contribution to meeting Canada's current target, Alberta would have to reduce annual emissions in 2020 by 83 Mt, considerably more than the 50 Mt target in its climate plan. And for Canada to meet a science-based target, Alberta would have to reduce its 2020 emissions by 146 Mt, almost three times more than the target in its plan.

Table 6: Calculated provincial greenhouse gas reduction targets for 2020

	Annual emissions (Mt CO_2e)[191]		Reduction in annual emissions in 2020 below BAU (Mt CO_2e)[192]		Targets relative to 2005 allowing Canada's current target to be met (%)		
	Measured 2005	Business-as-usual projection 2020	To meet Canada's current target	To meet science-based target	Modelling study	Alberta's plan	Alberta's current policies
BC+territories	65	83	26	35	−17	−27	−33
Alberta	**225**	**322**	**83**	**146**	**1**	**21**	**33**
Saskatchewan	58	50	15	21	−43	−50	−54
Manitoba	17	16	5	5	−39	−47	−51
Ontario	203	220	53	73	−22	−32	−38
Quebec	89	101	26	36	−20	−30	−36
Atlantic	57	56	15	20	−32	−40	−45
Canada	714	849	223	335	−17	−17	−17
International			33	80			

Note: "international" denotes emission reductions that Canada would finance in less wealthy countries to fully meet our targets. The international reductions needed to meet Canada's current target are smaller than those in the 2009 Pembina-Suzuki study because the federal government has weakened its 2020 target since the study was conducted.

On the right-hand side of Table 6 are three sets of provincial emission reduction targets for 2020, relative to 2005, allowing Canada in each case to meet its current national target. In the first case, provinces reduce emissions in accordance with the modelling study. In the second case, Alberta meets the target in its climate plan (50 Mt reduction below business as usual in 2020). In the third case, Alberta continues with its current policies, estimated to reduce annual emissions by roughly 23 Mt below business as usual in 2020 (12 Mt from provincial policies and 11 Mt from federal policies — see Sec . 2.3.4). For example, if Alberta continued with current policies, for Canada to meet its target Saskatchewan would have to reduce its emissions to 54 per cent below the 2005 level by 2020.

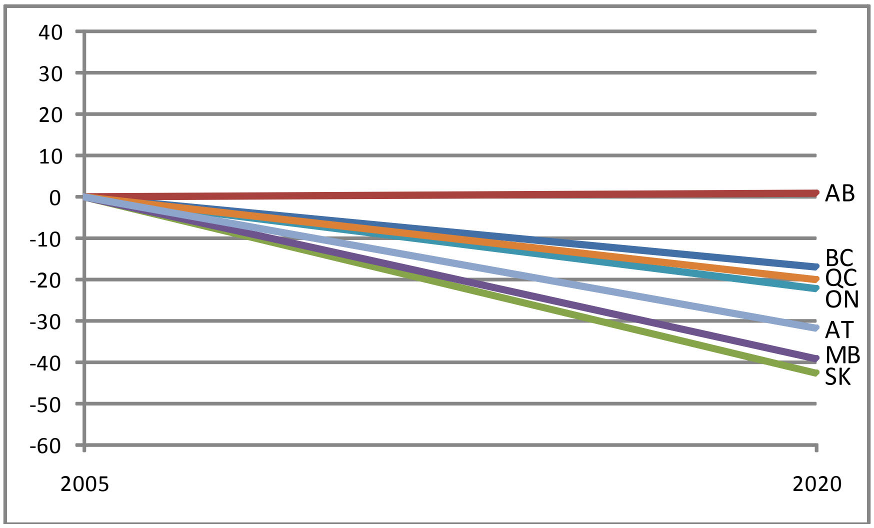
In the first case, the international emission reductions are distributed among the provinces such that each province internationally offsets 5 per cent of its domestic emissions. In the second and third cases, all the provinces other than Alberta have to internationally offset 11 and 15 per cent of domestic emissions respectively, to compensate for Alberta's smaller domestic emission reductions. (In practice provinces would have a choice between domestic and international reductions.) In the second and third cases Alberta does not internationally offset any of its emissions, as it is not the province's policy to do so.

These three sets of provincial emission reduction targets for 2020 are depicted in Figure 6. It illustrates, first, how oilsands growth in Alberta pushes other provinces into deeper-than-average emission reductions even when Alberta is making what might be considered a fair share effort. Second, the figure shows how, if Alberta continues on its current path, its emissions growth dictates increasingly heroic emission-reduction efforts on the part of the other provinces.

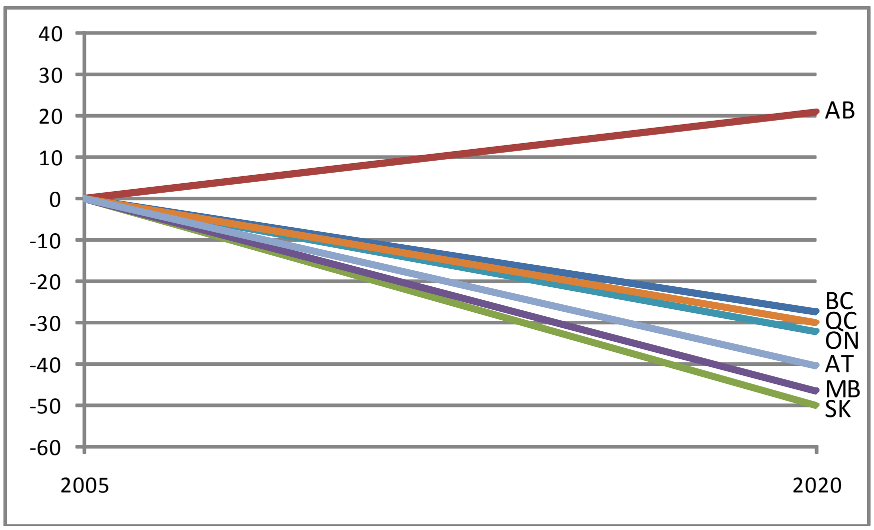
It is difficult to say with certainty that Alberta's current targets and policies make it impossible for Canada to meet its current 2020 target. We do, however, know that Canada (including Alberta) would likely need an economy-wide carbon price of at least \$100 per tonne CO_2e to meet that target,[193] far above the level any governments in Canada have so far been willing to contemplate. It stretches credulity to suggest that other provinces would be willing to go above \$100 per tonne to compensate for Alberta staying well under that level.

In the case of 2050 targets, it is even clearer that Alberta's current target would prevent Canada from achieving adequate emission reductions. Alberta's target, a 14 per cent reduction in annual emissions below the 2005 level, equates to 199 Mt of emissions in 2050.[194] Even if Canada eliminated *all* emissions outside Alberta, this would leave Canada's emissions at 73 per cent below the 2005 level or 66 per cent below 1990.[195] As noted in Section 1, G8 governments (including Canada's) have accepted that developed countries' contribution should be to reduce their combined emissions by at least 80 per cent below recent levels by 2050. And as noted in Section 4.1, a science-based 2050 target for developed countries' combined emissions would be 80–95 per cent below the 1990 level. It would be difficult for Canada to still be arguing in four decades' time that it should be reducing emissions less sharply than other rich countries.

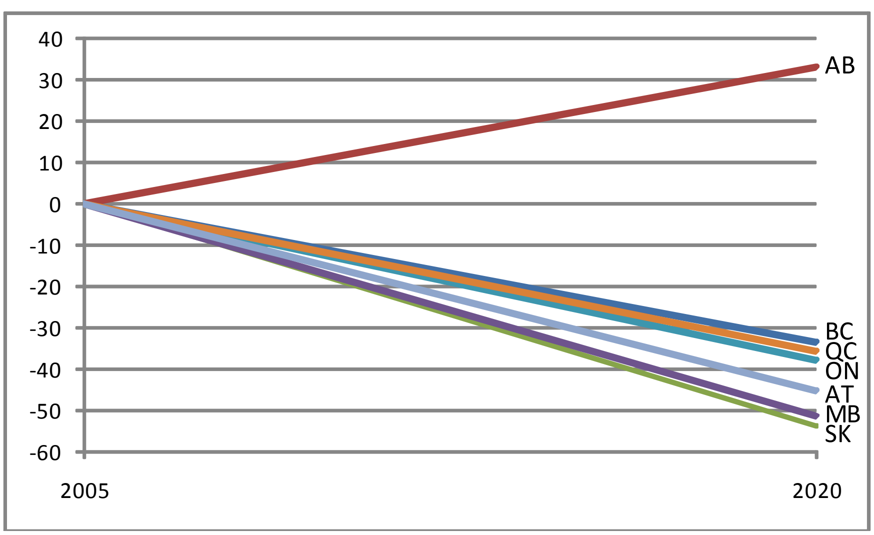
Figure 6: Provincial greenhouse gas percentage reduction targets for 2020 when Canada meets its target (17 per cent below 2005)



(a) Alberta does its "fair share" (modelling study prediction)



(b) Alberta meets the 2020 target in its climate plan



(c) Alberta continues with current policies

5. Recommendations

The preceeding sections of this report demonstrated that

- the Alberta government's current GHG policies fall far short of its emissions targets, and fare poorly against other important criteria such as accountability and good use of public resources (Section 2);
- Alberta needs to enable large-scale application of CCS and other GHG reduction technologies in the oilsands — the biggest driver of increased GHG emissions in the province — by making a large increase in the carbon price or mandating appropriate GHG intensity standards; moderating the pace of oilsands expansion would also have considerable GHG (and other) benefits (Section 3);
- Alberta's current GHG targets represent much less than a reasonable contribution to Canada's current targets (let alone more ambitious science-based ones), and if Alberta's policies continue to fall far short of its targets, other provinces would have to make implausible efforts to compensate (Section 4).

Alberta's government is far from alone in failing to take sufficient action on GHG emissions. No other provincial government has yet committed to a set of specific policies capable of fully meeting its 2020 GHG target. The U.S. is also far from being on track to meet its own 2020 target.[196] But these are not valid excuses for the current weakness of Alberta's policies. If a government commits to meet targets, it should make a serious attempt to meet them, and clearly explain how it is doing so. This is a basic standard of good governance; a government that fails to meet this standard misleads citizens, investors and other governments by stating intentions but then not acting on them.

It is true that Alberta was the first jurisdiction in North America to apply a carbon price to all large emitters, and that few others are yet following. But even if other jurisdictions fail to strengthen their efforts, Alberta could implement far stronger GHG policies while maintaining a strong economy. Neighbouring British Columbia arguably has the strongest set of climate policies in Canada, and will have a price of $30 per tonne CO_2e on three-quarters of its GHG emissions by July of next year.[197,198] Most oil producers have large profit margins; even if they had to pay for CCS at all new facilities, Alberta would continue to expand oilsands production, economic modelling suggests.[199] If Alberta truly expanded energy conservation and efficiency, CCS and renewable energy in keeping with its climate plan, it would create enormous opportunities for business and innovation.

As argued in the introduction to this report, what the world currently most needs in the fight to curb climate change is for jurisdictions with the greatest resources and energy expertise — and that undoubtedly includes Alberta — to show the way. This is increasingly important to the jurisdictions that buy Alberta's energy.

We address the six recommendations below to the Alberta government in a spirit of evolution from the province's current GHG policies. We recognize that the current policies are in some respects pioneering, and have some positive features that can be built on. Although Alberta's current GHG targets are clearly too weak, our recommendations focus for now on strengthening specific policies; as long as the province is far from on track to meet its targets, strengthening the targets will make little difference.

Recommendation 1

Substantially increase Alberta's ceiling carbon price as set by the Specified Gas Emitters Regulation, in the form of the rate for payments into the Climate Change and Emissions Management Fund. This rate should initially be at least doubled to $30 per tonne CO_2e from the current level of $15 per tonne.

The low level of Alberta's current carbon price is, arguably, the biggest reason for the poor environmental effectiveness of its current GHG policies. The low carbon price constrains the economic signal that directly prompts emission reductions, and limits the funds available (in the CCEMF) to be recycled into further reductions. The low price also means that key subsidy policies make poor use of public resources, because those policies subsidize investments that would require less subsidy if the carbon price were higher. The Alberta government knew when it prepared its current climate plan that a much higher carbon price would be needed by 2020, and the province can certainly afford the same level as neighbouring British Columbia ($30 per tonne CO_2e by July 2012).

Recommendation 2

Transition Alberta's current partial carbon tax — created by the Specified Gas Emitters Regulation — into a full carbon tax, by moving towards pricing every tonne of emissions and eliminating the use of offset credits for compliance.

The SGER is a partial carbon tax, placing a fixed price (currently $15 per tonne CO_2e) on GHG emissions, but with key exemptions:

- only the last few per cent of emissions are taxed
- some important types of emissions, such as industrial process emissions, are exempted
- the tax can be avoided by acquiring offset credits that cost less than the tax rate
- only large emitters are taxed.

While having a form of carbon tax in place is positive, the exemptions seriously degrade key aspects of Alberta's GHG policies and lack compelling justifications. The first two exemptions and the last mean the SGER allocates most carbon value (see Sec. 2.3.1) to emitters free of charge, a very poor use of public resources that curbs the funds available (in the CCEMF) to be invested in further emission reductions. The third exemption degrades the environmental effectiveness and economic efficiency of the SGER and makes it very vulnerable to gaming. Removing the last exemption and directing CCEMF funds appropriately would maintain or strengthen the incentive for smaller emitters to reduce emissions.

Again, British Columbia is demonstrating that a full carbon tax is feasible (without use of offsets for compliance); Alberta should follow suit. This should also include making the quantification of emissions more transparent.

Recommendation 3

Implement stringent mandatory greenhouse gas intensity standards for new large industrial facilities in the oilsands, coal-fired power, natural gas processing and potentially other sectors, set at a level corresponding to large-scale carbon capture and storage. Offset credits should not be allowed as a compliance option.

Large-scale application of CCS and other GHG reduction technologies is clearly needed in the oilsands, and this requires a large increase in the carbon price or mandatory GHG intensity standards. Because oilsands CO_2 capture costs start at around $75 per tonne, even a doubling of the current carbon price to $30 per tonne or more (Recommendation 1) will be far from sufficient. The government must therefore be prepared to mandate large-scale CCS or equivalent performance as part of oilsands project approvals.

Stringent mandatory GHG standards can be thought of as a policy needed to address the market failure whereby today's investors in new industrial infrastructure are not able to correctly anticipate the carbon prices that will be required to achieve increasingly deep emission reductions a decade or more from now, when that infrastructure is still intended to be operating. Putting it more plainly, we cannot afford to continue building long-lived, high-emitting facilities that will make it impossible to meet future emissions targets. Applying this reasoning more broadly, mandatory performance at the level of large-scale CCS should apply to any sector that has high GHG intensity (notably coal-fired power) or relatively low CCS costs (e.g., natural gas processing[200]).

Offset credits should not be allowed for compliance with these mandatory standards for reasons given earlier (see especially Sec. 2.3.1).

Since Alberta's climate plan aims for a 30+ Mt reduction in annual emissions from CCS as early as 2020 (see Figure 1), CCS-level performance will need to be mandatory from facility start-up for key emission sources at a sufficient number of new facilities. This will likely require modifying the approvals of facilities not yet under construction.

Recommendation 4

Moderate the rate of approval and construction of new oilsands facilities to ensure that development stays within clear cumulative environmental limits and is optimized for economic and social outcomes.

Reducing the pace of expansion of the oilsands sector is another important means of limiting GHG emissions, and there are several other reasons why it would be in the interests of Albertans and Canadians. It would help provide some breathing space to address inadequate regulatory oversight and environmental monitoring and to implement a land use plan, a sufficient network of protected areas, and a wetlands policy. Slower expansion would also reduce undesirable economic effects such as excessive increases in the costs of housing, consumer goods and labour; and allow more time to address social and cultural impacts in Fort McMurray and First Nations communities. Putting brakes on the race to build would, in addition, allow sober second thoughts in the project design process and make it more likely that operators can implement key innovations.

Recommendation 5

Strengthen the Climate Change and Emissions Management Corporation by adopting enforceable rules to (i) provide clear guidance on the selection and quantification of emission-reduction projects; and (ii) ensure that the corporation's board has a stronger representation of "clean economy" sectors and independent experts.

We welcome the fact that the CCEMF uses the proceeds of a carbon pricing policy (carbon value) to achieve further emission reductions, rather than for a purpose unrelated to climate policy. The CCEMC has had a relatively promising beginning: it has recognized the need to aim for relatively near-term emission reductions; it appears to be investing in a fairly full spectrum of technology types; and it is taking serious steps to validate the emission-reduction potential of projects it invests in.

Yet these important policy directions are not specified in any regulation,[201] public directive from the government, or the CCEMC's bylaws.[202] They appear to be simply decisions of the CCEMC's board, and could be easily reversed if the board changed its mind or its membership. We find it extraordinary — and unacceptable — that a private organization should be allowed such leeway to make public policy. As the CCEMC manages increasing sums of money (a trend that would accelerate sharply under recommendations 1 and 2), its investment choices should be guided by enforceable rules that confirm and enhance the current promising directions. These rules need to ensure

- near- and longer-term emission reductions are appropriately balanced
- emission reductions clearly attributable to the CCEMF are rigorously quantified
- emission reductions that could be counted under other policies are clearly identified
- projects are selected systematically, from all sectors, with reference to their cost per tonne of emissions reduced.

In addition, even if new rules constrain the CCEMC's decisions, the current stipulation in its bylaws that large-emitter industry sectors appoint a majority of board members[203] is unacceptable for a body playing such an important public policy role. "Clean economy" sectors like renewable energy, energy efficiency and sustainable transportation should have comparable representation to large emitters, and there should be more place for experts with no financial interests at stake.

Recommendation 6

Adopt a clear process for urgently developing, implementing and regularly updating a full plan to meet the province's GHG targets, as well as for regularly reporting on the implementation of the specific policies in the plan.

As noted above, basic good governance requires that if a government adopts targets, it should clearly explain how it intends to meet them. Alberta's Auditor General called on the government three years ago to produce "a master implementation plan with the specific actions to allow it to meet the [GHG] targets, and with regular progress reporting." In keeping with the structure of Alberta's current climate plan, the full implementation plan should include fully fleshed-out sets of policies for energy conservation and efficiency, CCS and renewable energy. Because circumstances evolve, and because policies' effectiveness cannot be known with certainty in advance, there must be a process of regular evaluation of the specific policies followed by adjustments to the plan to ensure it stays on track to meet the targets. Accountability requires that this process be public.

To ensure it occurs, the process of regularly publishing, evaluating and updating a full GHG reduction plan should be stipulated in law. Canada's federal Kyoto Protocol Implementation Act[204] provides a good model (the accountability process it sets out is independent of the Kyoto emissions target). The UK's Climate Change Act[205] provides another, similar, model.

As the Alberta government develops a full plan to meet its GHG targets, it should especially consider whether conservation, efficiency and renewable energy can play a greater role than it has envisaged in the past. For example, the Pembina Institute has shown that with a comprehensive energy conservation and efficiency strategy, and ambitious support for renewable energy, Alberta's electricity sector could become virtually free of conventional coal-fired power (without CCS) by 2028, and reduce annual GHG emissions by 28 Mt below business as usual by 2020.[206]

Table 7 shows how implementation of our six recommendations would strengthen the performance of Alberta's policies.

Table 7: How our recommendations address the performance of Alberta's current greenhouse gas policies

Table shows the current rating from Table 4 along with the number(s) of our recommendations that would address each issue

Criteria	*Specified Gas Emitters Regulation*	CCS Major Initiatives	Climate Change and Emissions Management Fund	Policies as a whole
Effectiveness — near term	– 1,2	–	– 1,2,5	– 1,2,3,4,5,6
Effectiveness — longer term	– – 1,2	–	Too soon to tell 1,2,5	– – 1,2,3,4,5,6
Economic efficiency	+ 2	o	Insufficient information 5	o 2,5
Good use of public resources	– – 2	– 1	– 1,5	– 1,2,5
Good design	o 2	Too soon to tell	– 5	o 2,5
Accountability and adaptiveness	– 6	Too soon to tell 6	Too soon to tell 6	– – 6

Note: Rating system:

+ + very good

+	good
o	average
–	poor
– –	very poor

In conclusion, Alberta's current GHG policies are, overall, poor, but they have some positive features that can be built on. By implementing the recommendations that we have proposed in a spirit of evolution from the current policies, Alberta could dramatically improve its performance on climate change while maintaining a strong economy.

Appendix

Table 8: Rationale for emission reduction estimates in Table 2

Name of policy	Rationale
Specified Gas Emitters Regulation (SGER)	The total gap in annual emissions between the historical baselines and targets defined in the SGER is around 10 Mt, based on the aggregate compliance results for 2008–10.[207] This is consistent with total emissions of 113 Mt from facilities emitting more than 0.1 Mt in 2009.[208] However, around half of the 10 Mt gap is closed by payments into the CCEMF (producing emission reductions that we account for separately below). The majority of the other half of the 10 Mt gap is closed by offset purchases. The vast majority of credits used for compliance during 2008–10 do not represent emission reductions attributable to the SGER, a situation that seems set to continue in the future; also, some future CCS projects will be eligible for bonus offset credits that do not correspond to extra emission reductions (see Sec. 2.3.2 for details). The remainder of the gap (around 2 Mt) is closed with reductions in industrial emissions below baselines. However, some portion of these reductions will be part of business as usual (BAU). Although the total volume of regulated emissions will expand significantly by 2020 as a result of oilsands expansion, targets for those emissions will be modest as they will be associated with new facilities. Economic modelling of a carbon price provides another way to estimate the likely impact of the SGER. A $15 per tonne carbon price applied economy-wide in Alberta is estimated to reduce annual emissions, relative to BAU, by about 7 Mt after 10 years.[209] However, this will be an over-estimate for the SGER because of the questionable nature of many offsets, and the fact that the price of offsets (the carbon price applied outside the industrial sector) is less than $15 per tonne.[210] Based on this analysis, it is unlikely that the reduction in annual emissions below BAU will exceed 5 Mt in 2020, but it will likely be more than 1.5 Mt.

Name of policy	Rationale
CCS Major Initiatives	The projects funded under this program are expected to capture 5 Mt of emissions annually.[211] However, it is not yet certain that all four projects will be constructed — because of the high cost of CCS, they may not be economically viable even with the government support. In addition, in two of the four projects, the CO_2 will be used for enhanced oil recovery (EOR), which may diminish the net global emission reduction benefit.[212] Furthermore, three of the four projects are receiving substantial federal funding;[213] the federal government may therefore legitimately claim a portion of the emission reductions under its own policies. Overall, it is clear that the reduction in annual emissions below BAU attributable to this program will not exceed 5 Mt in 2020, and could be significantly lower once the issues raised here are considered.
Climate Change and Emissions Management Fund (CCEMF)	The Climate Change and Emissions Management Corporation (CCEMC), which invests the CCEMF funds, reports combined estimates by the proponents of the projects receiving the first $71 million that the projects will cut emissions by 3–4 Mt.[214] However, it is not clear when these emission reductions would be secured, whether they are measured relative to a credible BAU baseline, or even whether they are reductions in annual emissions (as opposed to emissions over a longer period). The CCEMC reports that the subsequent $55 million of CCEMF funds will lead to reductions in annual emissions of 0.6 Mt (again, the timing and baseline are unclear).[215] It is probably more reliable to estimate emission reductions based on the cumulative funds likely to be invested and a range of plausible costs per tonne. Based on the experience of 2008–10, the CCEMC is likely to invest on the order of $1 billion in total by 2018, the latest date at which investments might plausibly have a significant impact on 2020 emissions. We would expect costs per tonne to be significantly more than $15, since reductions costing up to $15 per tonne are the focus of the SGER. If the average cost of emission reductions is $25, $50 or $100 per tonne, the resulting reduction in annual emissions can be expected to be roughly 2 Mt, 1 Mt or 0.5 Mt respectively.[216] However, not all of these reductions will occur by 2020 given the long-term nature of some of the projects funded. Based on this analysis, the reduction in annual emissions below BAU attributable to the CCEMF seems more likely to be in the range of 0.5 to 1.5 Mt than the range of 1.5 to 5 Mt.
Government purchase of green power	Alberta Infrastructure estimates that this policy reduces annual emissions by 0.22 Mt.[217] (It is not, however, clear to what extent this estimate takes into account the possibility that some of the green power capacity in question could have been installed as a result of other policies.)

Name of policy	Rationale
Micro-generation Regulation	We have not found data on the extra green power capacity resulting from this policy, but it seems unlikely to exceed 10 MW given the modest nature of the financial incentive involved and the fact that most participants are generating less than 10 kW (which is 1,000 times less than 10 MW). Using a capacity factor (for solar power) of 15 per cent, 10 MW is equivalent to 13 GWh/year, which would eliminate about 0.012 Mt of CO_2e emissions from grid-average Alberta electricity.[218]
Light it Right	Alberta's commercial/institutional sector used 18 PJ of energy for lighting in 2008, covering 100 million square metres of floor space.[219] Supply of this electricity would have resulted in 5.5 Mt of CO_2e emissions.[220] This program's funding has been fully absorbed by 115 buildings.[221] If all of them were medium-sized office buildings, with 25,000 square metres each, their total lighting-related emissions would be 0.16 Mt. With efficient lighting these emissions could plausibly be reduced by 50 per cent.[222] (However, it is not clear to what extent the buildings participating in this program might have installed energy-efficient lighting products even in the absence of the rebates.)
Renewable Fuels Standard Regulation	Environment Canada estimates that the federal renewable fuels standards, which set the same average renewable fuel content levels, will reduce annual emissions by 1.65 Mt below BAU in 2012, when the standards will be fully in effect.[223] Alberta accounts for about 18 per cent of the gasoline and diesel fuel consumed in Canada.[224] We can therefore estimate that the Alberta standards will reduce annual emissions by about 0.3 Mt. This will increase somewhat by 2020 in line with a foreseeable increase in Alberta's total gasoline and diesel consumption but should remain less than 0.5 Mt. It should be noted that the federal government committed to implement renewable fuel standards in 2006,[225] and they took effect in December 2010, while the Alberta government committed to implement such standards in 2008,[226] and they took effect in April 2011. The federal government could therefore legitimately claim 100 per cent of these emission reductions under its own policies. (It should also be noted that there is significant uncertainty about the extent to which the main current renewable fuel, corn ethanol, results in net GHG emission reductions.)
Bioenergy Producer Credit Program	The Bioenergy Producer Credit Program will increase the local supply of biofuels to comply with the Renewable Fuels Standard Regulation but it is not expected to increase biofuel content beyond what is required by the standards. We do not therefore attribute any additional emission reductions to the program.

Name of policy	Rationale
GreenTRIP	Economic modelling indicates that a $77 billion investment in current public transit plans across Canada over 10 years would reduce annual emissions in 2020 by about 3 Mt below BAU.[227] Pro-rating these numbers, Alberta's GreenTRIP program can be expected to reduce annual emissions in 2020 by about 0.08 Mt.
Hybrid Taxi	In 2010 this program subsidized the purchase of 18 taxis.[228] If it continues to subsidize 20 new taxis per year, the program will result in up to 200 hybrid taxis in use in 2020. Each hybrid taxi has annual CO_2 emissions up to 28 tonnes lower than a conventional taxi.[229] 200 hybrid taxis would therefore reduce annual emissions by up to 5,600 tonnes. (However, it is not clear to what extent hybrid taxis would be purchased even in the absence of the rebates.)
Trucks of Tomorrow	This program aims to achieve on the order of 10 tonnes lower annual GHG emissions per $1,000 rebate.[230] With a total budget of $2 million, it would therefore reduce annual emissions by about 0.02 Mt. (However, it is not clear to what extent truck owners would purchase hybrid trucks or fuel-saving upgrades even in the absence of the rebates.)
Rebates for energy efficient home upgrades	Environment Canada estimates that the federal government's rebates for energy efficient home upgrades,[231] which are similar to the Alberta rebates, reduce annual GHG emissions by an average of about 3 tonnes per house.[232] Alberta's program provided 12,700 rebates for new furnaces/boilers in 2010.[233] If we take this as the relevant number of houses (given that a new furnace is likely to have the biggest effect on emissions of any of the upgrades), then Alberta's program would have reduced annual emissions by about 40,000 tonnes. Dividing this by two, to share emission reductions equally between the provincial and federal programs, gives 20,000 tonnes. Assuming that the programs will continue to apply to similar additional numbers of homes every year, the reduction in annual emissions by 2020 will be on the order of 0.2 Mt. This is, however, likely to be an overestimate because some portion of homes receiving the rebates would have made the upgrades as part of business as usual.
Initiatives for public buildings	About 750,000 square metres of government office space are certified under the BESt program.[234] This is 0.75 per cent of the total 100 million square metres of commercial/institutional floor space in Alberta,[235] for which direct GHG emissions were 5.6 Mt in 2009 (see Table 1). If BESt certification results in a 20 per cent reduction in energy use, that translates into an 8,000 tonne reduction in annual emissions. Even taking into account indirect emissions (from electricity generation), and LEED-certified new buildings, the reduction seems unlikely to exceed 50,000 tonnes.

Name of policy	Rationale
On-Farm Energy Management	In 2008 Alberta's agriculture sector produced about 0.3Mt of direct annual emissions from natural gas use, and consumed 7.8 PJ of electricity,[236] supply of which would have resulted in 2.4 Mt of CO_2e emissions.[237] The scale of this program is unclear, but a reduction of more than 10 per cent in the sector's emissions seems very unlikely. The maximum reduction in annual emisisons will therefore be on the order of 0.24 Mt. In addition, given the significant federal role in the program, the federal government may legitimately claim a portion of the emission reductions under its own policies. (However, it is not clear to what extent agricultural producers would install high-efficiency equipment even in the absence of the rebates.)

Endnotes

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[1] Sea level rise alone can justify this term. Science now indicates that with no curbing of GHG emissions, sea level rise may well exceed 1 metre by 2100; 160 million people currently live less than 1 metre above sea level. See Ian Allison et al, *The Copenhagen Diagnosis, 2009: Updating the World on the Latest Climate Science* (Sydney, Australia: The University of New South Wales Climate Change Research Centre, 2009), 7, 37. Available at http://www.ccrc.unsw.edu.au/Copenhagen/Copenhagen_Diagnosis_LOW.pdf.

[2] *Outcome of the work of the Ad Hoc Working Group on long-term Cooperative Action under the Convention*, agreed at the UN climate conference in Cancun, Mexico, December 2010. Available at http://unfccc.int/files/meetings/cop_16/application/pdf/cop16_lca.pdf.

[3] *Responsible Leadership for a Sustainable Future*, G8 Leaders Declaration, July 8, 2009, paragraph 65. Available at http://www.g8italia2009.it/static/G8_Allegato/G8_Declaration_08_07_09_final,0.pdf.

[4] Former World Bank chief economist Nicholas Stern estimated in his 2006 Review that the "costs and risks" of uncontrolled climate change are equivalent to a loss in global GDP of at least 5 per cent and up to 20 per cent or more, "now and forever." See the short Executive Summary, available at http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/d/CLOSED_SHORT_executive_summary.pdf.

[5] Alberta's absolute and per capita emissions are from *National Inventory Report 1990–2009: Greenhouse Gas Sources and Sinks in Canada, Part 3* (Gatineau, QC: Environment Canada, 2011), 70. Available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5888.php. The international comparisons are based on data for 2005 from the *Climate Analysis Indicators Tool (CAIT) Version 8.0* (Washington, DC: World Resources Institute, 2011), available at http://cait.wri.org/. Alberta's per capita emissions in 2005 were slightly higher than those of Qatar, but they have since fallen slightly.

[6] Ibid.

[7] In 2009, Alberta exported 69 per cent of its oil production and 68 per cent of its natural gas production (including exports to the rest of Canada); it imported no oil or gas. We can therefore say that roughly 69 per cent of the 97 Mt of GHG emissions from oil and gas production, transmission and distribution (Table 1) — i.e., 67 Mt of emissions — were due to oil and gas exports. This means that total emissions (234 Mt) were about 40 per cent higher than emissions without oil and gas exports (167 Mt). Production and export data are from *Report on Energy Supply and Demand in Canada — 2009 Preliminary* (Ottawa, ON: Statistics Canada, 2011), 39. Available at http://www.statcan.gc.ca/pub/57-003-x/57-003-x2009000-eng.pdf.

[8] *National Inventory Report 1990–2009: Greenhouse Gas Sources and Sinks in Canada, Part 3*, 58.

[9] *National Inventory Report 1990–2009: Greenhouse Gas Sources and Sinks in Canada, Part 3*, 95.

[10] The *National Inventory Report 1990–2009* does not specify emissions from oilsands. The numbers on this row were provided in e-mail communications from Environment Canada officials.

[11] This category includes a small amount of emissions from mining (other than oilsands mining), because the *National Inventory Report 1990–2009* does not break out mining emissions separately.

[12] *Climate Change Impacts on Canada's Prairie Provinces: A Summary of our State of Knowledge* (Regina, SK: Prairie Adaptation Research Collaborative, 2008), 8, 9. Available at http://www.parc.ca/pdf/research_publications/summary_docs/SD2008-01.pdf. This summary cites over 100 scientific studies. Much more information is available at the website of the Prairie Adaptation Research Collaborative, which is supported by the Government of Alberta.

[13] Ibid., 15.

[14] Ibid., 11.

[15] Ibid., 9.

[16] Ibid., 11.

[17] Ibid., 12.

[18] Ibid., 13.

[19] Rob Renner, "Climate Change" (speech in Washington, DC, March 30, 2009). Available at http://environment.alberta.ca/documents/Climate-Change-Was-NY-speech-Mar-30-31-2009.pdf.

[20] Matthew Bramley, *A Climate Change Resource Book for Journalists* (Drayton Valley, AB: The Pembina Institute, 2001), Sec. 3.1. Available at http://www.pembina.org/pub/25.

[21] Ibid.

[22] Government of Alberta, "Alberta releases strategy for action on climate change," news release, October 15, 1998. Available at http://alberta.ca/home/NewsFrame.cfm?ReleaseID=/acn/199810/6865.html.

[23] Government of Alberta, "Government releases updated costs of Kyoto campaign," news release, December 30, 2002. Available at http://alberta.ca/home/NewsFrame.cfm?ReleaseID=/acn/200212/13695.html.

[24] Alberta Environment, *Albertans & Climate Change: Taking Action* (Edmonton, AB: Alberta Environment, 2002), 10–11. Available at http://environment.gov.ab.ca/info/library/6123.pdf.

[25] Ibid., 15–17.

[26] Ibid., 18.

[27] The *Climate Change and Emissions Management Act*, available at http://www.qp.alberta.ca/574.cfm?page=C16P7.cfm&leg_type=Acts&isbncln=9780779740956&display=html.

[28] *Project Green — Moving Forward on Climate Change* (Ottawa, ON: Government of Canada, 2005), 14–18.

[29] *Specified Gas Emitters Regulation Summary* (draft dated June 27, 2005) (Edmonton, AB: Alberta Environment, 2005).

[30] Alberta Environment, letter to Environment Canada, October 13, 2005. Available at http://www.ec.gc.ca/lcpe-cepa/documents/consultations/avis-notices/20050903_alberta_avis-notice.pdf.

[31] Alberta Environment, "Alberta first province to legislate greenhouse gas reductions," news release, March 8, 2007. Available at http://alberta.ca/home/NewsFrame.cfm?ReleaseID=/acn/200703/21142336C71FD-D012-F54F-468B7C8FB604858B.html.

[32] Environment Canada, "Canada's New Government Announces Mandatory Industrial Targets to Tackle Climate Change and Reduce Air Pollution," news release, April 26, 2007. Available at http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=4F2292E9-3EFF-48D3-A7E4-CEFA05D70C21.

[33] *Alberta's 2008 Climate Change Strategy: Responsibility / Leadership / Action* (Edmonton, AB: Alberta Environment, 2008). Available at http://environment.gov.ab.ca/info/library/7894.pdf.

[34] *Climate Change and Emissions Management Act*, Sec. 3.

[35] Research and development is unlikely to lead to significant emission reductions in the near term (2020) but could do so in the longer term (2050). However, this is subject to very high uncertainty.

[36] *Specified Gas Emitters Regulation*, available at http://www.qp.alberta.ca/574.cfm?page=2007_139.cfm&leg_type=Regs&isbncln=9780779758791&display=html.

[37] Alberta Energy, *CCS Major Initiatives*, http://www.energy.alberta.ca/Initiatives/1897.asp (accessed August 16, 2011).

[38] For Project Pioneer (Transalta and Capital Power), see Project Pioneer, *Key Dates*, http://projectpioneer.ca/about-pioneer/key-dates (accessed August 16, 2011). For the Quest project, see Shell Canada, *About Quest*, http://www.shell.ca/home/content/can-en/aboutshell/our_business/business_in_canada/upstream/oil_sands/quest/ (accessed August 16, 2011). For Swan Hills Synfuels, see Government of Alberta, "Clean energy project agreement in place," news release, July 27, 2011. Available at http://alberta.ca/acn/201107/309936C704039-C791-2E11-450AA4194BD5C4C0.html. For the Alberta Carbon Trunk Line, see Enhance Energy, *Q & A*, http://www.enhanceenergy.com/q_a (accessed August 16, 2011).

[39] Alberta Environment, *Greenhouse Gas Reduction Program*, http://environment.alberta.ca/01838.html (accessed August 17, 2011).

[40] Climate Change Emissions Management Corporation, *Funded Projects*, http://ccemc.ca/funded-projects (accessed August 17, 2011).

[41] Alberta Infrastructure, *Environmental Initiatives*, http://www.infrastructure.alberta.ca/501.htm (accessed August 17, 2011).

[42] Alberta Utilities Commission, *Rule 024 — Micro-Generation*, http://www.auc.ab.ca/rule-development/micro-generation/Pages/default.aspx (accessed August 17, 2011).

[43] *Micro-Generator Application Guideline* (Calgary, AB: Alberta Utilities Commission, 2008), 3, 13. Available at http://www.auc.ab.ca/rule-development/micro-generation/Documents/Micro_Generation/Micro_Generator_Application_Guide_July%2018.pdf.

[44] See http://www.lightitright.ca/.

[45] Climate Change Central, *Commercial Lighting*, http://www.climatechangecentral.com/my-rebates/commercial-lighting (accessed August 17, 2011).

[46] *Renewable Fuels Standard Regulation*, available at http://www.qp.alberta.ca/574.cfm?page=2010_029.cfm&leg_type=Regs&isbncln=9780779752706&display=html.

[47] *Budget 2011 Building a Better Alberta, Fiscal Plan* (Edmonton, AB: Alberta Finance and Enterprise, 2011), 41. Available at http://www.finance.alberta.ca/publications/budget/budget2011/fiscal-plan-spending.pdf.

[48] Alberta Energy, *Bioenergy Producer Credit Program Frequently Asked Questions*, http://www.energy.alberta.ca/BioEnergy/1826.asp (accessed August 17, 2011).

[49] Alberta Transportation, *Green Transit Incentives Program (GreenTRIP)*, http://www.transportation.alberta.ca/4280.htm (accessed August 17, 2011).

[50] Climate Change Central, *Hybrid Taxi*, http://www.climatechangecentral.com/my-rebates/hybrid_taxis (accessed August 17, 2011).

[51] See http://www.trucksoftomorrow.com/.

[52] Climate Change Central, *Commercial Vehicles*, http://www.climatechangecentral.com/my-rebates/commercial-vehicles (accessed August 17, 2011).

[53] Climate Change Central, *My Rebates*, http://www.climatechangecentral.com/my-rebates/available-rebates (accessed August 17, 2011).

[54] *Progress Report 2010* (Edmonton, AB: Climate Change Central, undated), 8–9. Available at http://climatechangecentral.com/about-us/business-plans-/-progress-reports/progress-report-2010. The $1,000 figure is based on $16 million of rebates in 2010 covering 390 new homes, 4,900 insulation upgrades, 12,700 new furnaces/boilers and 22,000 new clothes washers. We have considered a “typical” upgrade to be one including a new furnace/boiler.

[55] Climate Change Central, *New Home*, http://www.climatechangecentral.com/my-rebates/new_home (accessed August 17, 2011).

[56] Alberta Infrastructure and Transportation, “New standard for new provincial buildings will reduce energy costs,” news release, May 11, 2006. Available at http://www.gov.ab.ca/acn/200605/198592420D8D9-C123-56F9-40D43A37954C8E00.html.

[57] Alberta Infrastructure, *Environmental Initiatives*.

[58] Alberta Agiculture and Rural Development, *On-Farm Energy Management*, http://www.growingforward.alberta.ca/ProgramAreas/EnhancedEnvironment/EnergyEfficiency/On-FarmEnergyManagement/index.htm (accessed August 17, 2011).

[59] See, for example, *Terms and Conditions, Energy Efficiency Retrofits Program*, paragraph 5.4, available at http://www.growingforward.alberta.ca/cs/groups/growing_forward/@gf_energy_doc/documents/gf_energy_doc/mdaw/mdax/~edisp/agucm01-000964.pdf.

[60] Alberta Utilities Commission Decision 2011-337, available at http://www.auc.ab.ca/applications/decisions/Decisions/2011/2011-337.pdf.

[61] Maximizing employment is another economic criterion that would be valuable in evaluating GHG policies. We have not included it here because we do not have enough information about the employment effects of Alberta’s policies. International competitiveness is a further important economic issue that is covered under “good use of public resources.”

[62] To maximize economic efficiency, it doesn't matter what this cost per tonne is — just that all opportunities to reduce emissions up to this cost are implemented.

[63] We provide a fuller discussion of public-interest uses of carbon value in Matthew Bramley, *Key Questions for a Canadian Cap-and-Trade System* (Drayton Valley, AB: The Pembina Institute, 2009), 6–7. Available at http://www.pembina.org/pub/2015.

[64] Ibid.

[65] Calculation by the authors based on an analysis of data publicly available at http://www.carbonoffsetsolutions.ca/aeor/.

[66] *Technical Guidance for Offset Project Developers, Version 2.0* (Edmonton, AB: Alberta Environment, 2011), 19. Available at http://environment.gov.ab.ca/info/library/7915.pdf.

[67] Ibid., 32–33.

[68] Alberta Energy, "Alberta inks deal for Shell Quest CCS project," news release, June 24, 2011. Available at http://alberta.ca/home/NewsFrame.cfm?ReleaseID=/acn/201106/30771C28EE8FC-F24F-E03C-1BA374D3C893A32B.html. The 2 Mt figure reflects the double crediting.

[69] This value is an average for crude bitumen and synthetic crude supplied to U.S. refineries in 2005. See *Development of Baseline Data and Analysis of Life Cycle Greenhouse Gas Emissions of Petroleum-Based Fuels* (Washington, DC: National Energy Technology Laboratory, 2008), 12. Available at http://www.netl.doe.gov/energy-analyses/pubs/NETL%20LCA%20Petroleum-Based%20Fuels%20Nov%202008.pdf.

[70] Nic Rivers et al., *Economic Analysis of Climate Change Abatement Opportunities for Alberta* (report for Alberta Environment) (Vancouver, BC: M.K. Jaccard and Associates: 2007), 15, 32.

[71] For example, the GHG cap-and-trade system legislated by the U.S. House of Representatives in June 2009 (but not by the Senate) laid out the level of the cap and the compliance options — allowing the carbon price to be estimated — up to the year 2050.

[72] Based on the "compliance results overviews" provided at Alberta Environment, *Greenhouse Gas Reduction Program*, http://environment.alberta.ca/01838.html (accessed August 17, 2011).

[73] 100 Mt × $15/tonne = $1.5 billion. See Table 8 for the source of the 100 Mt.

[74] Another way of looking at this is that provision of offset credits (which means allocation of carbon value) can be a barrier to regulating emissions from sources for which there is nonetheless a good case for regulation.

[75] See, for example, Matthew Bramley, Pierre Sadik and Dale Marshall, *Climate Leadership, Economic Prosperity: Final report on an economic study of greenhouse gas targets and policies for Canada* (Drayton Valley, AB and Vancouver, BC: The Pembina Institute and the David Suzuki Foundation, 2009), 8. Available at http://www.pembina.org/pub/1909.

[76] *Technical Guidance for Completing Specified Gas Baseline Emission Intensity Applications, Version 3.2* (Edmonton, AB: Alberta Environment, 2010), 18. Available at http://environment.alberta.ca/documents/Technical-Guidance-for-Completing-Specified-Gas-Baseline-Emission-Intensity-Applications.pdf.

[77] Alberta Environment, "Alberta's Climate Change Regulatory Framework Update" (presentation to the SGER Annual Compliance and Offset Workshop, November 25, 2010), 26. Available at http://environment.alberta.ca/documents/SGER-Annual-Compliance-and-Offset-Workshop.pdf.

[78] Alberta Environment, "Alberta Offset System Update" (presentation to the SGER Annual Compliance and Offset Workshop, November 25, 2010). Available at http://environment.alberta.ca/documents/AB-Offset-System-Update.pdf.

[79] See, for example, Michael Wara, "Measuring the Clean Development Mechanism's Performance and Potential," *UCLA Law Review* 55, no. 6 (2008): 1759. Available at http://iis-db.stanford.edu/pubs/22226/wara_law_review_ucla.pdf.

[80] Alberta Environment, "Alberta results demonstrate responsible, clean energy production," news release and backgrounder, May 3, 2011. Available at http://www.alberta.ca/acn/201105/30322B6FFB035-F686-76DE-835193EEE98AC9B2.html.

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[81] *Report of the Auditor General* of Alberta — October 2008, 96. Available at http://www.oag.ab.ca/files/oag/Oct_2008_Report.pdf.

[82] Alberta Environment, *Annual Summary of Specified Gas Emitters Regulation: 2007–2008* (Edmonton, AB: Alberta Environment, undated). Available at http://environment.alberta.ca/documents/SGER_Summary_Report_2007-2008.pdf.

[83] Ibid., 14.

[84] Alberta Environment, *2008 Greenhouse Gas Emission Reduction Program Results*, http://environment.alberta.ca/02311.html (accessed September 7, 2011).

[85] Natural Resources Canada, *Large Scale CCS Demonstration Projects.*

[86] Rivers et al., 122.

[87] Bramley, Sadik and Marshall, 3–4, 11.

[88] *Accelerating Carbon Capture and Storage Implementation in Alberta* (Edmonton, AB: Alberta Carbon Capture and Storage Development Council, 2009), 68–70. Available at http://www.energy.alberta.ca/Org/pdfs/CCS_Implementation.pdf.

[89] *Climate Change and Emissions Management Fund Administration Regulation*, available at http://www.qp.alberta.ca/574.cfm?page=2009_120.cfm&leg_type=Regs&isbncln=9780779740437&display=html.

[90] *CCEMC Validation Guidance Document* (Sherwood Park, AB: Climate Change and Emissions Management Corporation, 2011). Available at http://ccemc.ca/_uploads/CCEMC-458-Validation-Guidance3.pdf.

[91] See, for example, *2011 Call for Proposals Guide and Instructions April 2011 — Cleaner Energy Production and Carbon Capture Expression of Interest Stage* (Sherwood Park, AB: Climate Change and Emissions Management Corporation, 2011), 6–7. Available at http://ccemc.ca/_uploads/Cleaner-Energy-and-CC-EOI.pdf.

[92] *CCEMC Validation Guidance Document*, 9–13.

[93] Climate Change Emissions Management Corporation, *Funded Projects.*

[94] Climate Change Emissions Management Corporation, *Funded Projects.*

[95] *2010 Annual Report: Charting a Path for Change* (Sherwood Park, AB: Climate Change and Emissions Management Corporation, undated), 8. Available at http://ccemc.ca/_uploads/CCEMC-2010-AnnualReport1r1.pdf.

[96] See *Climate Change and Emissions Management Act* and *Climate Change and Emissions Management Fund Administration Regulation*.

[97] See, for example, *2010 Call for Proposals: Renewable Energy* (Sherwood Park, AB: Climate Change and Emissions Management Corporation, 2010), 13. Available at http://ccemc.ca/_uploads/CCEMC-265-Renewable-EnergyFPP2.pdf.

[98] CCEMC staff, personal communication, May 2011.

[99] *Climate Change and Emissions Management Fund Administration Regulation,* section 13.

[100] Based on the *Auditor General Act* and the *Financial Administration Act*, and the apparent stipulation in the *Climate Change and Emissions Management Fund Administration Regulation* (paragraph 4(2)) that the money held by the CCEMC not public money.

[101] *Climate Change and Emissions Management Fund Administration Regulation,* paragraph 11(1).

[102] Climate Change and Emissions Management Corporation, *Board Members and Executive*, http://ccemc.ca/about/board-members-and-executive (accessed September 9, 2011).

[103] If each policy in Table 2 reduced emissions by no more than the low end of its "likely" range, the total reduction in annual emissions in 2020 would be 4.25 Mt. However, we do not necessarily consider it likely that every policy will be at the low end of its range.

[104] *Canada's Emissions Trends* (Gatineau, QC: Environment Canada, 2011), 33. Available at http://www.ec.gc.ca/Publications/E197D5E7-1AE3-4A06-B4FC-CB74EAAAA60F/CanadasEmissionsTrends.pdf.

[105] Ibid. This includes the effects of currently proposed regulations for GHG emissions from coal-fired electricity.

[106] Hector Goudreau, remarks in the Legislative Assembly, March 8, 2011. Available at http://www.assembly.ab.ca/Documents/isysquery/85f3629e-2084-4e6f-a484-4e33ad939df2/1/doc/.

[107] Bramley, Sadik and Marshall describe (pp. 11–13) a GHG reduction plan for Canada that contains the key elements that experts generally consider important to include in an economically efficient plan.

[108] See, for example, *Biofuels — At what cost? Government support for ethanol and biodiesel in Canada* (Winnipeg, MB: International Institute for Sustainable Development, 2009), 77–78. Available at http://www.iisd.org/pdf/2009/biofuels_subsidies_canada.pdf.

[109] *Report of the Auditor General of Alberta — October 2008*, 99.

[110] Ibid., 94.

[111] *Canada's Emissions Trends*, 25.

[112] *National Inventory Report 1990–2008: Greenhouse Gas Sources and Sinks in Canada, Part 1* (Gatineau, QC: Environment Canada, 2010), 86. Available at http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=492D914C-2EAB-47AB-A045-C62B2CDACC29. Note: the value for 2009 was provided in an e-mail communication from Environment Canada officials.

[113] *Canada's Emissions Trends*, 25.

[114] Afshin Honarvar et al., *Economic Impacts of New Oil Sands Projects in Alberta (2010–2035)* (Calgary, AB: Canadian Energy Research Institute, 2011), 3. Available at http://www.ceri.ca/images/stories/CERI%20Study%20124.pdf.

[115] Bob Dunbar, *Existing and Proposed Canadian Commercial Oil Sands Projects* (Calgary, AB: Strategy West, 2011), 1. Available at http://www.strategywest.com/downloads/StratWest_OSProjects_2011_01.pdf.

[116] Honarvar et al.

[117] Alberta Energy, *Key Initiatives: Carbon capture and storage*, http://www.energy.alberta.ca/Initiatives/1438.asp (accessed August 17, 2011).

[118] Mary Griffiths, Paul Cobb and Thomas Marr-Laing, *Carbon Capture and Storage: An arrow in the quiver or a silver bullet to combat climate change?* (Drayton Valley, AB: The Pembina Institute, 2005), ix. Available at http://www.pembina.org/pub/584.

[119] Mike Kennedy, *Carbon Capture and Storage Forum Proceedings* (Drayton Valley, AB: The Pembina Institute, 2008), 5. Available at http://pubs.pembina.org/reports/ccs-forum-proceedings.pdf.

[120] For more information, see Marlo Raynolds and Matthew Bramley, *The Pembina Institute's Perspective on Carbon Capture and Storage* (Drayton Valley, AB: The Pembina Institute, 2009). Available at http://www.pembina.org/pub/1787.

[121] *The Global Status of CCS: 2010* (Canberra, Australia: The Global CCS Institute, 2011), 48–49. Available at http://cdn.globalccsinstitute.com/sites/default/files/publication_20110419_global-status-ccs.pdf. The report defines large scale as not less than 80 per cent of 1 million tonnes per day captured and stored annually for coal-fired power generation or 80 per cent of 500,000 tonnes per day captured and stored by other industrial facilities.

[122] Ibid., 186–187.

[123] *Accelerating Carbon Capture and Storage Implementation in Alberta*, 72.

[124] Shell Canada, *About Quest*, http://www.shell.ca/home/content/can-en/aboutshell/our_business/business_in_canada/upstream/oil_sands/quest/ (Accessed September 13, 2011).

[125] Under its initial design, the pipeline will transport 4,600 to 5,100 tonnes of CO_2 per day from two sites: the North West Upgrading Inc. oilsands upgrader and Agrium Inc.'s Redwater Complex (fertilizer production). See *The ACTL Pipeline Project*, Enhance Energy, http://www.enhanceenergy.com/actl/ (accessed September 13, 2011).

[126] Guillermo Ordorica-Garcia, Sam Wong and John Faltinson, *CO_2 Supply from the Fort McMurray Area 2005–2020* (Edmonton, AB: Alberta Research Council, 2009), 17.

[127] *ST98: Alberta's Energy Reserves and Supply/Demand Outlook — Crude Bitumen*, Energy Resources Conservation Board, available at http://www.ercb.ca/docs/products/STs/st98-2011-bitumen.xls.

[128] The supply of highly concentrated streams of CO_2 from upgraders depends on the extent of hydrogen production used in the upgrading process (either through steam methane reforming or gasification). See Ordorica-Garcia, Wong and Faltinson, 15–17.

[129] Ordorica-Garcia, Wong and Faltinson, 21.

[130] Ibid., 23–24.

[131] The net intensity decrease is based on a 40 per cent reduction for the upgrading portion of the synthetic crude production but also takes into consideration a 30 per cent loss of efficiency resulting from the addition of CO_2 capture to an upgrader. See *Oil Sands Technology: Past, Present, and Future — Special Report* (Cambridge, MA: IHS CERA, 2011), 20, 22. Available at http://www2.cera.com/cos_form/.

[132] Ibid., 31–32.

[133] *Growth in the Canadian Oil Sands: Finding the New Balance — Special Report* (Cambridge, MA: HIS CERA, 2009), IV-7–IV-8. Available at http://www.ihs.com/products/cera/energy-industry/oil-sands-dialogue.aspx?tid=t5.

[134] *Oil Sands Technology: Past, Present, and Future — Special Report,* 30–31.

[135] Pierre Gosselin et al., *The Royal Society of Canada Expert Panel: Environmental and Health Impacts of Canada's Oil Sands Industry Report* (Ottawa, ON: The Royal Society of Canada, 2010), 283. Available at http://www.rsc-src.ca/documents/expert/RSC report complete secured 9Mb.pdf.

[136] Oilsands operators could, notably, gasify petroleum coke or asphaltenes, both waste products of upgrading, to produce heat and electricity. Gasification would create a CO_2 stream more amenable to capture than CO_2 from combustion. Based on numbers from the Canadian Energy Research Institute, we estimate that gasifying coke or asphaltenes and capturing CO_2 could result in a theoretical maximum 75 to 80 per cent reduction in total GHG emissions from oilsands operations relative to business as usual, although again this is without regard to cost. See *Impact of the Introduction of a Carbon capture and storage System in the Oilsands Sector on Air Contaminant Emissions — Part I* (Edmonton, AB: Canadian Energy Research Institute, 2008), xvii, 25, 26, 31, 51.

[137] *Carbon Capture and Storage: Progress and Next Steps* (Paris, France: International Energy Agency, 2010), 13. Available at http://www.iea.org/papers/2010/ccs_g8.pdf.

[138] *Carbon capture and storage (CCS)*, Natural Resources Canada, http://www.nrcan.gc.ca/eneene/science/ccsscc/index-eng.php (accessed September 14, 2011).

[139] The Alberta government will provide $745 million and the Canadian government will provide $120 million. See Alberta Energy, "Alberta inks deal for Shell Quest CCS project."

[140] Enhance Energy, *Q & A*.

[141] Alberta Energy, *CCS Major Initiatives*.

[142] *Carbon Capture and Storage: Progress and Next Steps*, 7.

[143] *Accelerating Carbon Capture and Storage Implementation in Alberta*, 72.

[144] Note: CO_2 capture from coal power generation is the lowest cost at $60–130 per tonne. See *$ICO_2N$ GHG Alternatives Report* (Ottawa, ON: The Delphi Group, 2009), 79, Available at http://delphi.ca/images/uploads/IC02N_GHG_Alternatives_Report.pdf.

[145] Ibid.

[146] *Carbon Capture and Storage in the Alberta Oil Sands — A Dangerous Myth* (Godalming, UK: WWF-UK, 2009), 29. Available at http://www.co-operative.coop/Corporate/PDFs/Tar%20Sands%20CCS.pdf.

[147] *ICO_2N GHG Alternatives Report* , 79–80.

[148] Note: having made revisions to historical data, Environment Canada now estimates intensity improvements to be 29 per cent rather than the 39 per cent figure that was previously cited widely.

[149] The source for emissions data is *National Inventory Report 1990–2008: Greenhouse Gas Sources and Sinks in Canada, Part 1*, 86. Note: the value for 2009 was provided in an e-mail communication from Environment Canada officials. The source for production data is *Table 126-0001 — Supply and disposition of crude oil and equivalent, monthly (cubic meters),* (CANSIM database), Statistics Canada (accessed July 22, 2010).

[150] Calculated using the production levels as shown in Figure 3.

[151] *Oil Sands Technology: Past, Present, and Future — Special Report*, 9–10.

[152] Petroleum coke is a much more carbon-intensive fossil fuel than natural gas.

[153] *VAPEX and Solvent Technology*, The Oil Sands Developers Group, http://www.oilsandsdevelopers.ca/index.php/oil-sands-technologies/in-situ/the-process-2/vapex-and-solvent-technology/ (accessed August 29, 2011).

[154] Petrobank began testing the Whitesands pilot scale THAI project in 2006 and has applied for a commercial scale project. See *May River Phase 1 Project — Fact Sheet*, Petrobank Energy and Resources Ltd., http://www.petrobank.com/webdocs/whitesands/mayriver_sheet.pdf (accessed Aug. 29, 2011).

[155] Testing of electrical heat has been conducted by Athabasca Oil Sands Corp. at the Dover facility. See Laricina Energy Ltd., *SAGD "Continues To Work Well" In Bitumen Carbonate Pilot At Saleski-Laricina*, http://www.laricinaenergy.com/news/68/84/SAGD-Continues-To-Work-Well-In-Bitumen-Carbonate-Pilot-At-Saleski--Laricina.html (accessed August 29, 2011).

[156] Two demonstration projects have been funded a total of $23 million through the CCEMF to develop electric heat-based in situ oilsands technologies. See *Cleaner Energy Production and Carbon Capture and Storage Project* (Sherwood Park, AB: Climate Change and Emissions Management Corporation, 2010), Available at http://ccemc.ca/_uploads/CLEAN-TECHNOLOGY-PROJECT-INFORMATION5.pdf.

[157] Joule A Bergerson and David W Keith, "The truth about dirty oil: is CCS the answer?," *Environmental Science & Technology* 44, no. 16 (2010): 6010–6015. Available at http://www.ncbi.nlm.nih.gov/pubmed/20704193.

[158] *Oil Sands Technology: Past, Present, and Future — Special Report*, "Summary of Key Insights."

[159] Gosselin et al., 89.

[160] Based on 2007 operational data. See Marc Huot and Simon Dyer, *Mining vs In Situ Factsheet* (Drayton Valley, AB: The Pembina Institute, 2010). Available at http://www.oilsandswatch.org/pub/2017.

[161] The Royal Society of Canada's recent expert panel stated: "The environmental regulatory capacity of the Alberta and Canadian Governments does not appear to have kept pace with the rapid growth of the oil sands industry over the past decade." See Gosselin et al., "Report Findings in Brief."

[162] The report expresses concerns about inadequate information on issues relating to water quality, water quantity, fish habitat, land and wildlife. It also highlights weaknesses with environmental impact assessments, a regulatory component of the approval process of many oilsands projects. See: *2011 October Report of the Commissioner of the Environment and Sustainable Development, Chapter 2: Assessing Cumulative Environmental Effects of Oil Sands Projects* (Ottawa, ON: Office of the Auditor General of Canada), 70–76. Available at http://www.oag-bvg.gc.ca/internet/docs/parl_cesd_201110_02_e.pdf.

[163] *Lower Athabasca Water Quality Monitoring Plan, Phase 1* (Gatineau, QC: Environment Canada, 2011), 4–5. Available at http://www.ec.gc.ca/Publications/1A877B42-60D7-4AED-9723-1A66B7A2ECE8/LowerAthabascaWaterQualityMonitoringPlanPhase1.pdf.

[164] Jennifer Grant et al., *Solving the Puzzle: Environmental responsibility in oilsands development* (Drayton Valley, AB: The Pembina Institute, 2011), 11–13. Available at http://www.pembina.org/pub/2210.

[165] Dan Woynillowicz, *Oilsands Fever: Blueprint for Responsible Oilsands Development* (Drayton Valley, AB: The Pembina Institute, 2007), 1–8. Available at http://www.pembina.org/pub/1404.

[166] *Duty Calls: Federal responsibility in Canada's oilsands* (Montreal, QC, Toronto, ON and Drayton Valley, AB: Équiterre, Environmental Defence and the Pembina Institute, 2010), 14–15. Available at http://www.pembina.org/pub/2101.

[167] Michael Beine, Charles Bos and Serge Coulombe, *Does the Canadian Economy Suffer from Dutch Disease?* (Luxembourg: Center for Research in Economic Analysis, University of Luxembourg, 2009), 23–24. Available at http://wwwen.uni.lu/content/download/23994/291645/file/2009-06_Does%20the%20Canadian%20economy%20suffer%20from%20Dutch%20Disease.pdf.

[168] *A New Direction for Alberta's Energy Economy* (Edmonton, AB: Alberta Federation of Labour, April 2009). Available at http://www.afl.org/index.php/View-document/26-2009-A-New-Direction-for-Alberta-s-Energy-Economy.html.

[169] See, for example "Former premier Peter Lougheed raises job fears over Keystone pipeline plan," *Calgary Herald*, September 14, 2011, http://www.calgaryherald.com/story_print.html?id=5397764&sponsor (accessed October 4, 2011).

[170] Bramley, Sadik and Marshall, 4.

[171] "Fort Mac grapples with oil sands growth (again)," *Alberta Oil*, September 1, 2011, http://www.albertaoilmagazine.com/2011/09/growing-up-bitumen/ (accessed October 4, 2011).

[172] See Danielle Droitsch and Terra Simieritsch, *Canadian Aboriginal Concerns With Oil Sands: A compilation of key issues, resolutions and legal activities* (Draton Valley, AB: The Pembina Institute, 2011). Available at http://www.pembina.org/pub/2083.

[173] Keepers of the Athabasca, "Unanimous passing of No New Oil Sands Approvals resolution at the Assembly of Treaty Chiefs Meeting," news release, February 25, 2008. Available at http://www.aenweb.ca/node/2131.

[174] *The BC Energy Plan* (Victoria, BC: Ministry of Energy, Mines and Petroleum Resources, 2009), 12. Available at http://www.energyplan.gov.bc.ca/default.htm.

[175] P.J. Partington, *Tackling emissions from industry: Federal regulation of industrial greenhouse gas emissions in the United States, and the implications for Canada* (Drayton Valley, AB: The Pembina Institute, 2010), 6. Available at http://www.pembina.org/pub/2125.

[176] Environment Canada, "Canada's Environment Minister Announces Important Step Towards Reducing Electricity Sector Emissions," news release, August 19, 2011. Available at http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=2E5D45F6-E0A4-45C4-A49D-A3514E740296.

[177] Jeff Bell and Tim Weis, *Greening the Grid: Powering Alberta's Future with Renewable Energy* (Drayton Valley, AB: The Pembina Institute, 2009), 69–70. Available at http://www.pembina.org/pub/1763.

[178] Rivers et al., 2–3.

[179] *Outcome of the work of the Ad Hoc Working Group on long-term Cooperative Action under the Convention*, agreed at the UN climate conference in Cancun, Mexico, December 2010.

[180] Sujata Gupta et al., "Policies, Instruments and Co-operative Arrangements," in B. Metz et al., eds., *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK and New York, NY: Cambridge University Press, 2007), 776. Available at http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter13.pdf. The Panel's analysis applied to stabilization of the atmospheric GHG concentration at 450 parts per million of CO_2e. This corresponds to about a 50 per cent chance of limiting average global warming to 2°C relative to the pre-industrial level. See Bill Hare and Malte Meinshausen, "How Much Warming Are We Committed to and How Much Can Be Avoided?," *Climatic Change* 75, nos. 1–2 (2006): 111.

[181] Department of Energy and Climate Change, *Carbon Budgets*, http://www.decc.gov.uk/en/content/cms/emissions/carbon_budgets/carbon_budgets.aspx (accessed October 14, 2011).

[182] Ministry of the Environment, *Climate*, http://www.regjeringen.no/en/dep/md/Selected-topics/climate.html?id=1307 (accessed October 14, 2011).

[183] Ministry of the Environment, *Overview of the Bill of the Basic Act on Global Warming Countermeasures*, http://www.env.go.jp/en/earth/cc/bagwc/overview_bill.pdf (accessed October 14, 2011).

[184] Bramley, Sadik and Marshall, 15.

[185] Ibid., 7.

[186] Environment Canada, "Canada Lists Emissions Target under the Copenhagen Accord," news release, February 1, 2010. Available at http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=EAF552A3-D287-4AC0-ACB8-A6FEA697ACD6.

[187] Recalculation of the target relative to the 1990 level is based on *National Inventory Report 1990–2009: Greenhouse Gas Sources and Sinks in Canada, Part 1* (Gatineau, QC: Environment Canada, 2011), 19. Available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5888.php.

[188] See, for example, *World Energy Outlook 2010* (Paris, France: International Energy Agency, 2010), 449–450. Canada can make the same argument to justify a weaker target than other countries, but analysis suggests that when other factors are included, Canada's percentage reduction target for 2020, relative to the 1990 level, should be close to the percentage reduction target for developed countries as a whole. See Bramley, Sadik and Marshall, 15.

[189] Bramley, Sadik and Marshall.

[190] Ibid., 4.

[191] The data in these two columns were provided by Chris Bataille, M.K. Jaccard and Associates, personal communication, November 19, 2009.

[192] The data in these two columns are from Chris Bataille et al., *Exploration of two Canadian greenhouse gas emissions targets: 25% below 1990 and 20% below 2006 levels by 2020* (report for the Pembina Institute and the David Suzuki Foundation) (Vancouver, BC: M.K. Jaccard and Associates, 2009), 33, 35, 50, 52. Available at http://www.pembina.org/pub/1910. The numbers are for the "Canada goes further" scenario.

[193] Bramley, Sadik and Marshall, 3.

[194] *National Inventory Report 1990–2009: Greenhouse Gas Sources and Sinks in Canada, Part 3*, 95.

[195] Ibid., 15.

[196] Nicholas Bianco and Franz Litz, *Reducing Greenhouse Gas Emissions in the United States Using Existing Federal Authorities and State Action* (Washington, DC: World Resources Institute, 2010), 2–3. Available at http://pdf.wri.org/reducing_ghgs_using_existing_federal_authorities_and_state_action.pdf.

[197] Matt Horne, *Building a Low-Carbon Economy in British Columbia: Recommendations to Strengthen B.C.'s Carbon Tax* (Drayton Valley, AB: The Pembina Institute, 2010), 3. Available at http://www.pembina.org/pub/1961.

[198] *Carbon Tax Act*, Schedule 1, available at http://www.leg.bc.ca/38th4th/3rd_read/gov37-3.htm.

[199] Bramley, Sadik and Marshall, 4.

[200] *Technology Roadmap: Carbon Capture and Storage* (Paris, France: International Energy Agency, 2009), 22. Available at http://www.iea.org/papers/2009/CCS_Roadmap.pdf.

[201] *Climate Change and Emissions Management Fund Administration Regulation.*

[202] *Bylaws of Climate Change and Emissions Management (CCEMC) Corporation*, available at http://ccemc.ca/_uploads/TOC-A-3-CCEMC-Bylaws-as-sent-to-Corporate-Registry.pdf.

[203] Ibid., article 6.2.

[204] *Kyoto Protocol Implementation Act*, available at http://laws.justice.gc.ca/eng/acts/K-9.5/FullText.html.

[205] *Climate Change Act 2008*, available at http://www.legislation.gov.uk/ukpga/2008/27/contents.

[206] Bell and Weis, 69–70.

[207] Alberta Environment, *Greenhouse Gas Reduction Program*, http://environment.alberta.ca/01838.html (accessed August 17, 2011).

[208] *Alberta Environment: Report on 2009 Greenhouse Gas Emissions* (Edmonton, AB: Alberta Environment, 2011), iii. Available at http://environment.gov.ab.ca/info/library/8383.pdf.

[209] Rose Murphy et al., *Cost Curves for Greenhouse Gas Emission Reduction in Canada: The Kyoto Period and Beyond* (report for Natural Resources Canada) (Vancouver, BC: M.K. Jaccard and Associates: 2006), 67.

[210] "Alberta offsets seen in C$8–13 range," *Carbon Market North America*, March 12, 2010, 5. Available at http://www.pointcarbon.com/polopoly_fs/1.1423116!CMNA20100312B.pdf.

[211] Alberta Energy, *CCS Major Initiatives*. The 5 Mt figure is also confirmed by adding up emission reductions for the individual projects as stated on this page, in linked news releases and at http://www.enhanceenergy.com/actl/.

[212] In a global perspective, using CO_2 for EOR will tend to increase oil supply, thus eventually reducing the oil price and encouraging more oil consumption and consequent CO_2 emissions relative to a scenario with no EOR.

[213] Natural Resources Canada, *Large Scale CCS Demonstration Projects*, http://www.nrcan.gc.ca/eneene/science/ceffep/lsddgp-eng.php (accessed August 17, 2011).

[214] *2010 Annual Report: Charting a Path for Change* (Sherwood Park, AB: Climate Change and Emissions Management Corporation, undated), 5–6.

[215] We have calculated the 0.6 Mt by adding the figures provided in the CCEMC's backgrounders dated February 28, June 21 and June 29, 2011. These are available at http://ccemc.ca/_uploads/CCEMC-Backgrounder_Feb281.pdf, http://ccemc.ca/_uploads/CCEMC-Backgrounder-June21.pdf and http://ccemc.ca/_uploads/CCEMC-Backgrounder-June28.pdf respectively.

[216] A $1 billion investment represents an annual cost (in perpetuity) of $50 million assuming an 5 per cent cost of capital. Therefore, if emission reductions cost $100 per tonne, a $1 billion investment will reduce annual emissions (also in perpetuity) by 0.5 Mt.

[217] Alberta Infrastructure, *Environmental Initiatives*.

[218] Generation of grid-average Alberta electricity in 2009 had a GHG intensity of 880 tonnes CO_2e per GWh. See *National Inventory Report 1990–2009: Greenhouse Gas Sources and Sinks in Canada, Part 3*, 53.

[219] Natural Resources Canada, *Commercial/Institutional Sector Alberta Table 2: Secondary Energy Use and GHG Emissions by End-Use*, http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tablestrends2/com_ab_2_e_4.cfm (accessed August 18, 2011).

[220] Consumption of grid-average Alberta electricity in 2008 had a GHG intensity of 1,100 tonnes CO_2e per GWh. See *National Inventory Report 1990–2009: Greenhouse Gas Sources and Sinks in Canada, Part 3*, 53. Consumption of 18 PJ, equal to 5000 GWh, would therefore result in 5.5 Mt of annual CO_2e emissions.

[221] *Progress Report 2010* (Edmonton, AB: Climate Change Central, undated), 13.

[222] See http://www.lightitright.ca/about/.

[223] *A Climate Change Plan for the Purposes of the Kyoto Protocol Implementation Act* (Gatineau, QC: Environment Canada, 2011), 9–11. Available at http://www.climatechange.gc.ca/Content/4/0/4/4044AEA7-3ED0-4897-A73E-D11C62D954FD/COM1410_KPIA%202011_e%20-%20May%2031%20v2.pdf.

[224] Natural Resources Canada, *Comprehensive Energy Use Database, 1990 to 2008*, http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/comprehensive_tables/ (accessed August 18, 2011).

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[227] Bataille et al., 23–25, 65.

[228] *Progress Report 2010* (Edmonton, AB: Climate Change Central, undated), 19.

[229] *Hybrid Taxi Pilot Program Final Report* (Edmonton, AB: Climate Change Central, 2008), 19. Available at http://www.climatechangecentral.com/files/Hybrid_Taxi_Pilot_Program_Final_Report.pdf.

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[231] Natural Resources Canada, *ecoENERGY Retrofit — Homes Program*, http://oee.nrcan.gc.ca/residential/personal/grants.cfm (accessed August 18, 2011).

[232] *A Climate Change Plan for the Purposes of the Kyoto Protocol Implementation Act*, 16.

[233] *Progress Report 2010* (Edmonton, AB: Climate Change Central, undated), 8–9.

[234] Alberta Infrastructure, *Environmental Initiatives*.

[235] Natural Resources Canada, *Commercial/Institutional Sector Alberta Table 2: Secondary Energy Use and GHG Emissions by End-Use*.

[236] Natural Resources Canada, *Agriculture Sector Alberta Table 1: Secondary Energy Use and GHG Emissions by End-Use and Energy Source — Excluding Electricity-Related Emissions*, http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tablestrends2/agr_ab_1_e_4.cfm (accessed August 18, 2011).

[237] Consumption of grid-average Alberta electricity in 2008 had a GHG intensity of 1,100 tonnes CO_2e per GWh. See *National Inventory Report 1990–2009: Greenhouse Gas Sources and Sinks in Canada, Part 3*, 53. Consumption of 7.8 PJ, equal to 2200 GWh, would therefore result in 2.4 Mt of annual CO_2e emissions.