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THE CASE FOR A CARBON TAX IN ALBERTA[†]

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SUMMARY

In 2007, Alberta demonstrated that it could be a leader in the effort to reduce greenhouse gas emissions by becoming the first North American jurisdiction to put a price on carbon. Given that the province had long been criticized for its central role in the carbon-based economy, Alberta's move was important for its symbolism. Unfortunately, the emissions policy itself has delivered more in symbolism than it has in actually achieving meaningful reductions in greenhouse gas emissions.

The Specified Gas Emitters Regulation (SGER), as the carbon-pricing system is formally called, has only helped Alberta achieve a three per cent reduction in total emissions, relative to what they would have been without the SGER. And emissions keep growing steadily, up by nearly 11 per cent between 2007 and 2014, with the SGER only slowing that growth by a marginal one percentage point. Alberta's carbon-pricing policy simply fails to combat emissions growth; the province needs a new one.

Lack of progress in reducing emissions appears to be partly attributable to the fact that many large emitters find it more economical to allow their emissions to rise beyond the provincially mandated threshold, and instead are purchasing amnesty at a lower cost through carbon offsets or by paying the levies that the SGER imposes on excess emissions.

But it is also partly attributable to the fact that the SGER only applies to large emitters who annually produce 100,000 tonnes of CO₂-equivalent all at one site: mainly oil sands operations and facilities that generate heat and electricity. This excludes operations that emit well over that threshold, but across diffuse locations. The transportation sector, which is typically spread out in just such a way, is the third-largest sector for emissions in Alberta. Its emissions are also growing faster than those of the mining and oil and gas sector, even as emissions in the electricity and heat generation sector are actually declining. And if we combine the emissions from the transportation sector with those of the manufacturing and industrial sector, which can also be characterized by scattered operations, they substantially exceed those of the electricity and heat generation sector. Indeed, over 58 per cent of Alberta emissions come from places other than oil and gas and mining.

There will surely be those who prefer strengthening SGER to a carbon tax; this is not likely to make enough of a difference for Alberta to meet its carbon-reduction goal of 218 Mt by 2020. The government would make far more progress by implementing a broad carbon tax, similar to the one in British Columbia, which applies to all emitters and consumers. The cost to the economy would not be steep: For a \$20 per tonne tax, the cost would be 0.9 per cent of gross output (or 1.7 per cent at \$40 a tonne). And the cost to households would be less than \$700 a year. As in B.C., the proceeds would be better recycled in the form of reduced corporate income taxes, personal taxes, and subsidies to low-income households, to offset the extra burden and distortions a carbon tax would create. But unlike the current SGER, a carbon tax would succeed in being more than a symbolic, largely futile gesture.

[†] An earlier version of this paper, entitled "An Assessment of Alberta's Specified Gas Emitters Regulation," was submitted for consideration to Alberta's Climate Change Advisory Panel.

INTRODUCTION

In preparation for the 2015 climate change conference in Paris,¹ the government directed an advisory panel to “review the province’s climate change policy, consult stakeholders, and provide advice on a permanent set of measures.”² An important part of this analysis is determining how effective current policies are at reducing emissions, and whether there are better alternatives. The panel’s report to the government was released Nov. 22, 2015; while it provides policy recommendations, it does not assess in detail the effectiveness of previous policies.

In this paper, we attempt to add insight to the debate by reviewing and assessing the efficacy of Alberta’s Specified Gas Emitters Regulation (SGER), the major policy instrument the government uses to regulate and reduce emissions in Alberta. While Alberta displayed leadership as the first jurisdiction in North America to introduce a price on carbon in 2007, SGER has been less than effective in reducing emissions. We find that SGER has only reduced emissions by a maximum of three per cent (relative to what emissions would have been in the absence of the policy) between 2007 and 2014. In contrast, emissions in Alberta have increased by almost 11 per cent in the same period; SGER can be attributed to reducing Alberta’s emissions growth by only one percentage point — a very small amount. In addition, we argue that the previously announced changes to SGER will result in increased payments into the technology fund rather than emissions reductions, simply due to the time and capital investments required to implement technologies aimed at emissions reduction. In short, SGER was likely to continue to be ineffective at reducing emissions in any significant way.

The Alberta government is moving towards a broad-based carbon tax that will incentivize emissions reductions;³ but, the devil is in the details. We approximate the effect of a carbon tax on the Alberta economy by calculating the implied tax burden based on 2013 emissions and no behavioural response to the tax. At a maximum, the cost would be 0.9 per cent of gross output⁴ at a tax rate of \$20 per tonne, and 1.7 per cent of output at a tax rate of \$40 per tonne. This is a relatively small cost to the Alberta economy. In terms of affecting households, the impact of a carbon tax ranges from increasing expenditure on energy from six per cent (at \$20/tonne) to just over 11 per cent (at \$40/tonne). In terms of increasing total household expenditures, the effect is less than a one per cent increase, even with a \$40 per tonne carbon tax.

In looking ahead to the next iteration of Alberta’s climate change strategy — and the policies and regulations that will support it — one would hope the province’s future emissions-reduction targets and regulations are better aligned. We do not provide recommendations on targets in this paper as that is beyond the scope of our expertise.

¹ The conference — formally the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) or COP21 for short — has the objective of a new international agreement on climate that will aim to keep global warming below the threshold of 2°C

² Government of Alberta, “Province takes meaningful steps toward climate change strategy,” media release, June 25, 2015, <http://alberta.ca/release.cfm?xID=38232B11A8C17-0B34-BB8E-6B03088D90D1C786>.

³ Government of Alberta, “Climate Leadership Plan speech,” November 22, 2015, <http://www.alberta.ca/release.cfm?xID=38886E9269850-A787-1C1E-A5C90ACF52A4DAE4>.

⁴ Gross output is equivalent to gross revenue from the production of goods and services.

However, assuming the province identifies any sort of a meaningful reduction target, in our assessment this means the policies that accompany it must go far beyond SGER in scope and stringency.

Our recommendation is a carbon tax, applied to all energy-based emissions in the province and with a revenue-recycling guarantee to minimize any negative impacts on households, firms and the province's economy as a whole. One of the benefits of the carbon tax, both to start and over time, is that its value can be tailored to support the province's reduction target. And most importantly, whatever the target, a carbon tax provides the broadest and most direct coverage of the province's emissions and emitters. It is also the simplest, most transparent and lowest-cost policy option. It is therefore the best choice to form the underpinnings of Alberta's next climate change strategy.

The paper proceeds as follows. We first briefly review the history of Alberta's emissions policies; readers already familiar with the topic can safely skip this section. Next, we provide an overview of Alberta's emissions profile by economic sector from 1990 to 2013. Thirdly, we explain the mechanics of the Specified Gas Emitters Regulation; again, readers already familiar with SGER can safely skip this section. Fourthly, we outline the percentage of Alberta's emissions that are subject to the regulation, as well as the percentage of emissions by sector. Fifth, we examine progress in reducing emissions under the regulation, and then proceed to estimate what effect the strengthened regulations announced in June 2015 will have on emissions reductions. We then discuss alternative policy approaches, and the pros and cons of each, before outlining our preferred policy, a carbon tax, and the upper bound on costs to the Alberta economy and consumers. We conclude with a brief summary of the arguments outlined in the following pages.

HISTORY OF ALBERTA'S EMISSIONS POLICIES

The government of Alberta released its first climate change strategy with long-term emissions targets in November 2002. In this strategy it committed, by 2020, to cut the province's emissions intensity — measured as emissions per unit of GDP — by 50 per cent below 1990 levels.⁵ Alberta's emissions⁶ in 1990 were 174,966,000 tonnes of CO₂-equivalent (CO₂e), and the corresponding emissions intensity was 1.3 kilograms of CO₂e per dollar of GDP (measured in chained 2007 dollars).⁷ The strategy stated this target would correspond

⁵ Government of Alberta, *Albertans & Climate Change: Taking Action*, 2002, <http://environment.gov.ab.ca/info/library/6123.pdf>.

⁶ All of the national and provincial GHG-emissions data reported in this paper are the same data that are reported in Environment Canada's National Inventory Report, which uses the UNFCCC reporting format, and has five emissions categories: energy; industrial processes; agriculture; waste; and land use, land-use change and forestry. Energy includes emissions from the combustion and production of fossil fuels across all industries and by individuals for personal transportation and in residential use (home heating, for example). Industrial processes include emissions that are produced as a result of the chemical or physical transformation of materials. Agriculture includes emissions from animal production, manure management and agricultural soils, and waste includes emissions from the treatment and disposal of waste. Land use, land-use change and forestry are net greenhouse gases resulting from fluxes between the atmosphere and managed land. These emissions are reported for Canada but not the provinces and territories, and are not included in Canada's emissions totals for each year. Source: Environment Canada, "About Canada's Greenhouse Gas Inventory," <https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=3E38F6D3-1>.

⁷ Authors' calculations. Source: (1) Environment Canada, National Inventory Report 1990–2013; and (2) Statistics Canada, *Table 384-0038 — Gross domestic product, expenditure-based, provincial and territorial, annual*, CANSIM (database), <http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3840038>.

to a 60-million-tonne (Mt) reduction in emissions below business as usual (BAU) in 2020.⁸ In 2002, BAU emissions in 2020 were forecast to be 278 Mt, implying that in absolute terms, the government was targeting an emissions level of 218 Mt in 2020.

The actions the government outlined for achieving this target included mandatory greenhouse-gas-emissions reporting for large sources, the development of an emission-offset⁹ trading program and sector-specific agreements to establish emissions-intensity targets. To measure its progress towards the 2020 target, the strategy also established an interim target for 2010. Specifically, the government stated the goal of achieving an emissions-intensity improvement of 20 per cent below 1990 levels by 2010, corresponding to a reduction in emissions of 20 Mt below BAU.¹⁰ Forecast BAU emissions in 2010 were 258 Mt, implying the government's interim target was an absolute emissions level of 238 Mt.

The second iteration of the province's climate change strategy was released in 2008.¹¹ While then-premier Ed Stelmach announced in the strategy that the government would be renewing its 2002 climate change plans, the province's long-term emissions-reduction targets were subtly changed. The 2020 target was updated to 50 Mt below BAU (compared to the 60 Mt below BAU target in the 2002 strategy) and no reference was provided to an emissions-intensity improvement relative to GDP, although as of fall 2015, this remains Alberta's legislated 2020 target.¹² In addition, although it was never stated in the strategy, the 2020 BAU emissions level was raised to 310 Mt.¹³ The province's legislated emissions-intensity target in 2020 therefore remained unchanged, while its absolute emissions target increased by nearly 20 per cent relative to 2002, rising from 218 to 260 Mt. In contrast, the interim 2010 target remained unchanged at a 20 Mt reduction below BAU, and the strategy made explicit reference to meeting the intensity target established in the 2002 plan.¹⁴

A significant new component of the 2008 strategy was the Specified Gas Emitters Regulation (SGER). Enacted in 2007, SGER requires large facilities that emit more than 100,000 tonnes of CO₂e per year to reduce their emissions intensity by 12 per cent relative to an established baseline.¹⁵ Facilities have a number of options for compliance with SGER — the most obvious being a reduction in emissions to the regulated level. If the required emissions reductions are not achieved, then a facility has a number of other options

⁸ The “business-as-usual” (BAU) emissions path refers to the path that future emissions are expected to follow if the government did not adopt any measures or regulations to encourage and achieve emissions reductions.

⁹ An offset is a reduction in emissions made in order to compensate for, or offset, emissions made elsewhere.

¹⁰ Government of Alberta, “Albertans & Climate Change: Taking Action”.

¹¹ Alberta Environment and Sustainable Resource Development, “Climate change strategy 2008, 2008”, <http://environment.gov.ab.ca/info/library/7894.pdf>.

¹² Government of Alberta, “Climate Change and Emissions Management Act”, Section 3(1), Current as of December 17, 2014, <http://www.qp.alberta.ca/documents/Acts/C16P7.pdf>.

¹³ To the best of our knowledge, the BAU emissions path from the 2008 climate change strategy is not publically available. The 2020 BAU value of 310 Mt was provided to us upon inquiry to Alberta Environment and Sustainable Resource Development. It was noted that this number was developed based on oil-production and economic forecasts in 2007 and does not take into account the 2008/09 financial crisis or the 2014/15 oil-price fall.

¹⁴ Alberta Environment and Sustainable Resource Development, “Climate change strategy 2008”.

¹⁵ Emissions intensity is typically defined as emissions from production divided by the dollar value of production. In the case of the Specified Gas Emitters Regulation, emissions intensity is emissions per unit of production, where “unit of production” is “the unit of measure of production of the facility” and “production” is the quantity of output or end product produced by the facility. See Section 1.1, Definitions, in the Specified Gas Emitters Regulation.

available for complying with the regulation, one of which is paying a levy, or emissions tax, on every tonne of emitted CO₂e that exceeds the facility's target.

SGER is Alberta's only regulation requiring emissions reductions, and Alberta was the first in North America to regulate greenhouse gas emissions and introduce a price on carbon as part of the compliance program.¹⁶ The regulation was originally set to expire Sept. 1, 2014 but was extended to Dec. 31, 2014.¹⁷ On Dec. 19, 2014 the government of Alberta announced a further extension to the end of June 2015.¹⁸ Just prior to this deadline, on June 25, 2015, the new NDP government announced that it was renewing and strengthening SGER. Under the strengthened regulation, the emissions-intensity reduction targets for large facilities will increase to 15 per cent in 2016 and 20 per cent in 2017, while the levy will increase from \$15 per tonne, to \$20 per tonne in 2016 and \$30 per tonne in 2017.¹⁹ The strengthened regulation is set to expire on Dec. 31, 2017.

At the same time as the SGER renewal, the NDP government also announced that it was forming an advisory panel to review the province's climate change policy, consult with stakeholders and provide advice on a more permanent and comprehensive strategy.²⁰ The panel's report was released on Nov. 22, 2015, along with an overview of the government's new strategy for addressing climate change.²¹ The new policies involve phasing out coal-based electricity, a new carbon price on emissions, a legislated limit on oil sands emissions, and a new methane emissions reduction plan.²² With an understanding of the current and historical policies in place in Alberta, we now turn to a discussion of Alberta's emissions trends between 1990 and the present.

CONTEXT: ALBERTA'S EMISSIONS PROFILE

Alberta's emissions in 2013 were 267 million tonnes, an increase of 92 million tonnes, or 34 per cent, relative to 1990.²³ Despite this significant increase in total emissions Alberta still managed to achieve its 2010 interim emissions-intensity goal of a reduction of 20 per

¹⁶ Peter Sopher, Anthony Mansell and Clayton Munnings, "Alberta, The World's Carbon Markets: A Case Study Guide to Emissions Trading", Environmental Defense Fund and International Emissions Trading Association, May 2013, http://www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_alberta_case_study_may_2013.pdf.

¹⁷ Calgary Herald, "Alberta extends deadline to review carbon levy," July 10, 2014, <http://calgaryherald.com/business/energy/alberta-extends-deadline-to-renew-carbon-levy>.

¹⁸ Alberta Government, "Alberta's climate change regulations extended," press release December 19, 2014, <http://alberta.ca/release.cfm?xID=37535EC25331A-C352-D068-3F2567BFFF6F3506>.

¹⁹ Nigel Bankes, "Province of Alberta Announces a Two-Step Process for Developing a New Climate Change Policy," *ABlawg.ca*, June 26, 2015, <http://ablawg.ca/2015/06/26/province-of-alberta-announces-a-two-step-process-for-developing-a-new-climate-change-policy/>.

²⁰ Government of Alberta, "Province takes meaningful steps towards climate change strategy," Media release, June 25, 2015, <http://alberta.ca/release.cfm?xID=38232B11A8C17-0B34-BB8E-6B03088D90D1C786>.

²¹ Government of Alberta, "Climate Leadership Plan," <http://alberta.ca/climate/leadership-plan.cfm>.

²² Ibid.

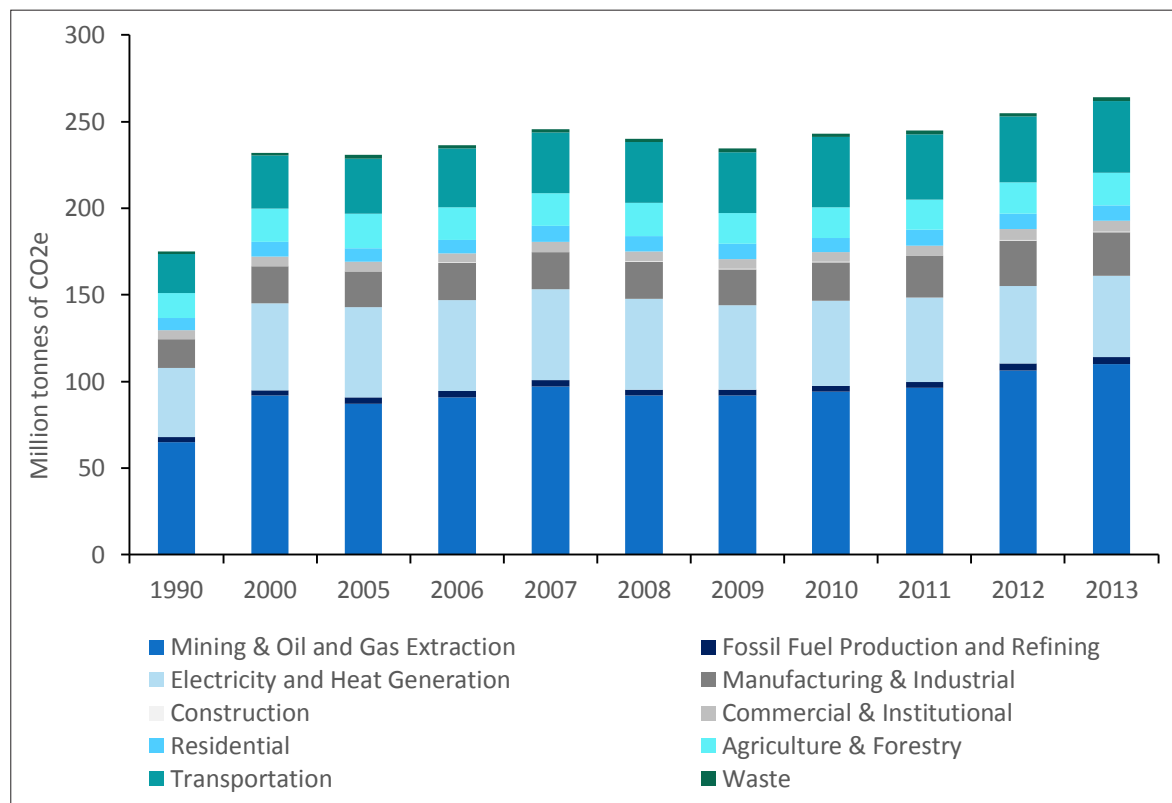
²³ The raw emissions data for all years from 1990 through to 2013 is available on the government of Canada's open data website. Sources: (1) Environment Canada, National Inventory Report 1990-2013: Greenhouse Gas Sources and Sinks in Canada, The Canadian Government's Submission to the UN Framework Convention on Climate Change, 2015; and (2) Government of Canada, "National and Provincial/Territorial Greenhouse Gas Emission Tables," <http://open.canada.ca/data/en/dataset/779c7bcf-4982-47eb-af1b-a33618a05e5b>.

cent relative to 1990.²⁴ More specifically, in 1990, the province had an emissions intensity of 1,272 tonnes of CO₂e per million dollars of GDP (measured in 2007 chained dollars).²⁵ In 2010, the province's emissions intensity had fallen to 920 tonnes of CO₂e per million dollars of GDP, corresponding to a reduction in its emissions intensity of almost 28 per cent. The province also came close to meeting its interim absolute emissions target of 238 Mt. It exceeded this amount by only two per cent, emitting 243 Mt of CO₂e in 2010.

Alberta's emissions by economic sector over time are shown in Figure 1. Figure 1(A) shows absolute emissions per year while Figure 1(B) shows the increase in emissions between 1990 and 2013. Figure 1(B) displays both the percentage change in emissions between 1990 and 2013, and the absolute growth in annual emissions. As expected, the mining and oil and gas extraction sector is the largest contributor to Alberta's emissions and is a rapidly growing source. From 1990 to 2013, emissions in the sector increased by 69 per cent — rising from 65.0 to 109.9 million tonnes of CO₂e per year — and the sector's share of total emissions in Alberta rose from 37.2 to 41.6 per cent.

FIGURE 1 ALBERTA'S EMISSIONS BY ECONOMIC SECTOR 1990-2013 (MILLION TONNES OF CO₂E)

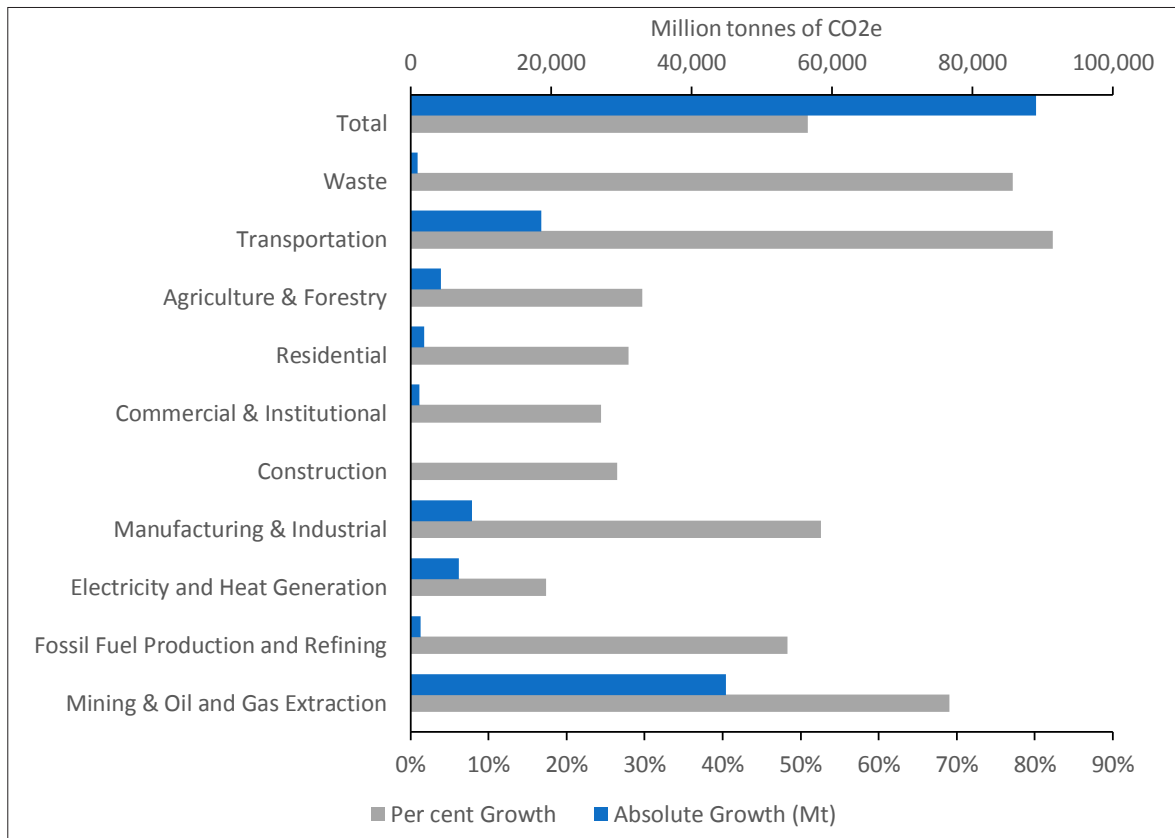
(A) ABSOLUTE EMISSIONS



²⁴ Government of Alberta, *Albertans & Climate Change*; and Alberta Environment and Sustainable Resource Development, *Climate change strategy*.

²⁵ Authors' calculations. Source: (1) Environment Canada, National Inventory Report 1990–2013; and (2) Statistics Canada, Table 384-0038 — *Gross domestic product, expenditure-based, provincial and territorial, annual*, CANSIM (database), <http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3840038>.

(B) TOTAL CHANGE IN EMISSIONS, 1990-2013



Source: Authors' calculations, based on Government of Canada, National and Provincial/Territorial Greenhouse Gas Emissions Tables.

The next three largest-emitting sectors in the province in 2013 were electricity and heat generation (17.7 per cent), transportation (15.6 per cent) and manufacturing and industrial (9.6 per cent). Perhaps unexpectedly, the transportation sector surpasses the mining and oil and gas extraction sector as the fastest-growing source of emissions in Alberta. From 1990 to 2013, transportation emissions increased by 82 per cent, rising from 22.6 to 41.2 million tonnes of CO₂e per year. Relative to 1990, emissions have also increased in Alberta's manufacturing and industrial sector (+8.7 Mt/+53 per cent) and electricity and heat generation sector (+6.9 Mt/+17 per cent). The electricity and heat generation sector, however, is the only sector in Alberta where emissions have been trending downwards in more recent years. From 2008 to 2013 emissions have declined from 52.7 to 46.7 million tonnes.

Emissions in all of the remaining economic sectors in Alberta have also been on the rise since 1990, displaying a combined growth rate of 32 per cent (+9.9 Mt). In 2013 these remaining sectors accounted for 15.5 per cent of Alberta's emissions. In total then, over 58 per cent of Alberta's emissions come from outside mining and oil and gas extraction. None of these sectors has observed a decrease in emissions relative to 1990, and only one sector — electricity and heat generation — has observed persistent emissions reductions in more recent years. This underlines the importance of considering all sectors in the province in any emissions reduction policy. With an understanding of the role of each sector in contributing to emissions and emissions growth, the next section will explain the mechanics of the Specified Gas Emitters Regulation.

MECHANICS OF SGER

Alberta's Specified Gas Emitters Regulation applies to any facility that has emitted 100,000 tonnes or more of CO₂e in 2003 or a subsequent year.²⁶ It is important to note that the regulation applies at the facility, rather than the firm level. For example, a firm that has multiple small facilities — a trucking company, perhaps — with total emissions greater than 100,000 tonnes of CO₂e in a given year, will not be covered by the regulation because the individual facilities do not meet the test of being a large emitter. Emissions covered by the regulation include 24 different gasses identified as having global-warming potential.

The original regulation, enacted in 2007, required facilities with emissions at or above 100,000 tonnes of CO₂e to reduce their emissions intensity by 12 per cent relative to a government-determined baseline, where emissions intensity for the facility is defined as tonnes of CO₂e per unit of production. The regulation distinguishes between established and new facilities. An established facility is one that completed its first year of operation prior to Jan. 1, 2000, or alternatively, was starting a minimum ninth year of operations on Jan. 1, 2007. A new facility is one that completed its first year of operations post-Jan. 1, 2000, or alternatively, a facility that had completed less than eight years of operations on Jan. 1, 2007.

When SGER was first introduced, established facilities were required to immediately reduce their emissions intensity to 12 per cent below their baseline. The baseline emissions intensity for established facilities was defined in the regulation as the average of the facility's emissions intensity in 2003, 2004 and 2005. New facilities, alternatively, were required to reduce their emissions intensity by two per cent per year — starting in the fourth year of operations — until they reached 88 per cent of their baseline intensity in the ninth year of operations. The baseline emissions intensity for a new facility is defined as the facility's emissions intensity from the third year of commercial operations. For example, a facility in its first year of operations in 2007 was not required to reduce emissions until 2010, while a facility in its third year of operations in 2007 was required to reduce emissions starting in 2008. In contrast, a facility in its sixth year of operations in 2007 was required to reduce its emissions intensity by six per cent below its baseline.

The change to SGER in June 2015 strengthened the emissions-intensity targets for new and established facilities — increasing them to a maximum of 15 per cent below the baseline in 2016 and 20 per cent in 2017. To the best of our knowledge, the baseline for each facility has remained the same. Under the new regulation, new facilities are still required to start reducing their emissions intensity in year four of operations, and to reach the maximum emissions-intensity reduction in year nine. As a result, as summarized in Table 1, the schedule of emissions-intensity reductions for new facilities has changed, with annual reduction steps now ranging from two to four per cent. Established facilities are subject to the emissions-intensity reduction reported in the “Year 9” row of Table 1.

²⁶ Our description of the mechanics of SGER is based on the official regulation. Source: Province of Alberta, *Climate Change and Emissions Management Act: Specified Gas Emitters Regulation, Alberta Regulation 139/2007*, http://www.qp.alberta.ca/documents/Regs/2007_139.pdf.

TABLE 1 SCHEDULE OF REQUIRED EMISSIONS-INTENSITY REDUCTIONS UNDER STRENGTHENED SGER

Year of Commercial Operations	Emissions-Intensity Reduction		
	2015	2016	2017
Year 1 to 3	0%	0%	0%
Year 4	2%	3%	3%
Year 5	4%	5%	7%
Year 6	6%	8%	10%
Year 7	8%	10%	13%
Year 8	10%	13%	17%
Year 9	12%	15%	20%

Source: Climate Change and Emissions Management Act: Specified Gas Emitters Regulation.

Firms have several compliance options for meeting the facility-specific emissions-reduction targets required under SGER. They can reduce emissions, use or purchase emissions-performance credits, purchase offset credits, or pay a levy per tonne of emissions not abated. Emissions-performance credits are credits earned by regulated facilities that have reduced their emissions below the mandated intensity target. Credits earned in any given year can be saved for future use at the facility, applied to a different facility owned by the same company, or registered with the Alberta Emission Performance Credit Registry and sold to other regulated facilities that have not met their targets. Emissions-offset credits, alternatively, are available from facilities, municipalities and agricultural producers that are not covered by SGER. These groups receive credits for emissions reductions registered with the Alberta Offset Registry. These credits can then be sold as offsets to facilities covered by SGER.

If a firm fails to reduce its emissions intensity and does not use or purchase emissions-performance credits or offset credits, then it must pay a levy on every tonne of emissions that exceeds its regulated baseline. The original levy was \$15 per tonne, and this amount is set to increase to \$20 per tonne in 2016 and \$30 per tonne in 2017. Payments are deposited into Alberta's Climate Change and Emissions Management Fund (hereafter referred to as the technology fund), and managed by Alberta's Climate Change and Emissions Management Corp. (CCEMC). The CCEMC was established in 2009 as a main component of Alberta's 2008 climate strategy. A key function of the CCEMC is administration of the technology fund, which is used to provide financial support in the form of government grants to initiatives that either reduce the province's greenhouse gas emissions or improve the province's ability to adapt to climate change.

As an emissions-intensity regulation, a key characteristic of SGER is that it creates different incentives for firms in comparison to a more broad-based policy — such as cap-and-trade or a carbon tax — that applies to all of a firm's emissions. More specifically, under SGER, a facility still pays a levy on each unit of production, but only on the portion of emissions that exceeds its baseline. As a result, the average and marginal costs of emissions reductions under SGER will be less than the marginal and average costs of emissions reductions under a cap-and-trade program or carbon tax, for the same price on emissions.

For example, the Shell Peace River Complex is an in situ oil sands project that has been operating since 1986 and was therefore classified as an established facility under the

original regulation.²⁷ In 2003, 2004 and 2005, the facility had an emissions intensity of 96.2, 108.7 and 109.4 kilograms of CO₂e per barrel of bitumen produced.²⁸ The average of these values — 104.8 kilograms of CO₂e per barrel of bitumen produced — is the facility's baseline emissions intensity. A 12 per cent reduction in emissions intensity, as required by SGER, corresponds to a regulated emissions intensity of 92.2 kilograms of CO₂e per barrel.

In 2013 the Shell Peace River Complex produced 260,409.50 cubic metres of bitumen (approximately 1,637,924 barrels) and had CO₂e emissions of 270,180 tonnes. This implies the facility's emissions intensity in 2013 was 165.0 kilograms of CO₂e per barrel of bitumen. It therefore exceeded its regulated emissions intensity by an average of 72.8 kilograms of CO₂e per barrel.

If we assume for simplicity that every unit of production at the Peace River Complex had the same emissions intensity and that Shell opts to comply with SGER via the levy, then it pays a fee of \$1.09 per barrel (\$15/tonne CO₂e x 0.0728 tonnes CO₂e/barrel). This corresponds to an average and marginal cost of emissions of \$6.62 per tonne. In comparison, if Shell faced an emissions tax or cap-and-trade system where emissions were priced at \$15 per tonne, then its average and marginal cost of emissions would be exactly this amount. This difference comes from the fact that, under cap-and-trade or a tax, all emissions are priced, not just those above the regulated emissions intensity.

By lowering the cost of emissions relative to a cap-and-trade system or carbon tax, an emissions-intensity regulation like SGER provides an implicit subsidy to output.²⁹ A benefit of this characteristic is that it helps to reduce the negative impact of the regulation on the competitiveness of firms. It will also generally lead to lower output prices, which provides a benefit to consumers but also has the drawback of discouraging an increase in end-use energy efficiency and conservation.³⁰ These characteristics also mean that an emissions-intensity-based regulation will generally require a much higher price on emissions in order to incent the same absolute level of emissions reductions as a more broad-based policy.³¹ As SGER imposes a relatively low price ceiling of \$15 per tonne, this suggests the emissions reductions that Alberta will achieve under SGER will be notably lower than those that would be achieved with an emissions tax or cap-and-trade system that imposed the same price on emissions.

Although overall emissions reductions are likely to be lower under SGER in relation to a comparable emissions tax or cap-and-trade program, it is also incorrect to assume that

²⁷ Shell, "Peace River Operations," <http://www.shell.ca/en/aboutshell/our-business-tpkg/upstream/oil-sands/peace.html>. We chose this project as an example to illustrate the mechanics of SGER because of the easily available information on production and emissions.

²⁸ Alberta Environment and Sustainable Resource Development, "GHG Emissions Intensity History for Oil Sands Projects: Shell — Peace River," <http://osip.alberta.ca/library/Dataset/Details/22>.

²⁹ The subsidy comes from the fact that costs of production are lower than under an explicit tax on emissions, essentially subsidizing production; the implicitness of the subsidy is due to there being no payment to producers. For a derivation of this result see Nicholas Rivers and Mark Jaccard, "Intensity-Based Climate Change Policies in Canada," *Canadian Public Policy* (Volume 36, No. 4), 2010, 409-428.

³⁰ Richard G. Newell, "Climate Technology Deployment Policy," in *Assessing US Climate Policy Options*, ed. Raymond J. Kopp and William A. Pizer, Washington, DC: Resources for the Future, 2007.

³¹ See, for example, the model simulation results in (1) Rivers and Jaccard, "Intensity-Based Climate Policies in Canada"; and (2) Carolyn Fischer and Alan K. Fox, "Output-Based Allocation of Emissions Permits for Mitigating Tax and Trade Interactions," *Land Economics* (Volume 83, Issue 4), 2007, 575-599.

SGER always leads to a lesser incentive for a firm to reduce emissions. A 2012 paper by Andrew Leach — chair of Alberta's Climate Change Advisory Panel — compares the incentives that existing facilities face for reducing emissions under SGER versus a carbon tax.³² For existing facilities, he finds the incentive to reduce emissions per unit of output is equivalent under SGER and a carbon tax, the incentive to reduce emissions by reducing production is stronger with a carbon tax, and the incentive to reduce emissions by improving productivity per unit of emissions is stronger with SGER. The paper also considers the impact of SGER versus a carbon tax on the investment decision for new facilities. Assuming a new facility has a constant emissions intensity over its lifetime, the paper finds that the net-present-value cost of a carbon tax is over 15 times larger than the net-present-value cost of SGER. In addition, SGER provides a much weaker incentive for a facility to invest upfront in technologies that will result in a lower emissions intensity from the start of operations. Rather, a facility under SGER receives a much higher benefit by reducing its emissions intensity after its baseline has been set. As a result, facilities are rewarded more highly by investing in technologies that will provide continual improvements in emissions intensity over the life of the project. With an understanding of how the regulation operates and of the emissions-reduction incentives it creates, we now explore the effectiveness of the regulation in the next two sections.

EMISSIONS AND EMITTERS SUBJECT TO SGER

An important part of assessing the effectiveness of a policy or regulation is how broad its coverage is; that is, how many emitters are subject to the regulation. Using Environment Canada's Reported Facility Greenhouse Gas Data,³³ we can calculate what percentage of Alberta's emissions in each sector fall under SGER. As summarized in Figure 2, the overall average for the province is just under 50 per cent, but this percentage varies drastically by sector. From 2007 to 2013, an average of 95 per cent of emissions in the electricity and heat generation sector were from large emitters and are therefore subject to, and covered by,

³² Andrew Leach, "Policy Forum: Alberta's Specified Gas Emitters Regulation", *Canadian Tax Journal* (Volume 60, Issue 4), 2012, 881-898.

³³ This is a database of facility-level emissions from 2004 to 2013 for all facilities in Canada with emissions greater than or equal to 50,000 tonnes of CO₂e per year from 2009 onwards, and greater than or equal to 100,000 tonnes of CO₂e per year from 2004 to 2008. The government of Alberta also tracks information on large emitters, as required by the Specified Gas Reporting Regulation. However, the most recent information release from Alberta was in May 2013 and provided facility-level emissions data for 2011. We opt to use the Environment Canada database as it provides facility-level emissions data through to 2013. A comparison of the two databases for 2011 finds the average difference in facility-level emissions is 1.15 per cent. This suggests the two databases provide very similar information on emissions.

SGER.³⁴ In contrast, in the transportation sector, the average was just over eight per cent.³⁵ In the mining and oil and gas extraction, and manufacturing sectors the averages were closer to the provincial average, at 52 and 60 per cent respectively. The mining and oil and gas extraction sector stands out, as it is the only sector where coverage has been steadily increasing since SGER was introduced. This is reflective of the fact that the majority of the growth in emissions from this sector comes from new oil sands projects, virtually all of which meet the threshold for SGER to apply.

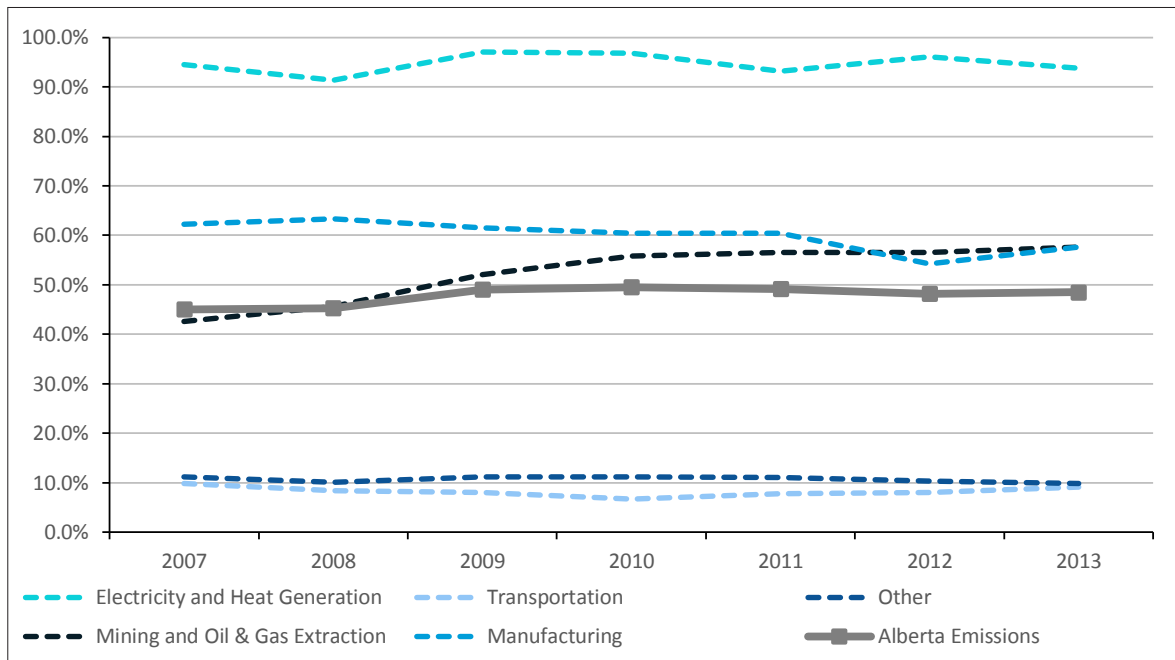
When considering the coverage of SGER, perhaps of most concern is the small proportion of emissions that are covered in the transportation sector, particularly considering that emissions from this sector have historically been the fastest-growing in Alberta, as shown in Figure 1(B). This again underlines the importance of looking at all parts of the economy when designing an emissions-reduction policy and suggests that a policy with greater inclusiveness than SGER will be needed to achieve significant emissions reductions going forward.

While SGER coverage is lacking with respect to the volume of total emissions that are covered by the regulation, a more promising characteristic is that it provides comprehensive coverage of all types of greenhouse gas emissions from large emitters. Most notably, this means that SGER covers not only emissions from combustion of fossil fuels — those included in the UNFCCC energy category — but also non-combustion emissions — those included in the UNFCCC industrial processes, agriculture and waste categories. For practical purposes, large emitters in Alberta with non-combustion emissions are primarily landfills and manufacturers of products such as cement and lime. While the agricultural sector is the second-largest category of UNFCCC emissions in Alberta, SGER coverage of agricultural emissions is zero, since individual agricultural producers do not have emissions that are large enough to exceed the large-emitters' threshold.

³⁴ In the National Inventory Report, the treatment of emissions from industrial cogeneration facilities (facilities that produce both heat and electricity) differs depending on the ownership of the cogeneration facility (see Table 2-15, footnote 29, in National Inventory Report 1990-2013). If the cogeneration facility is owned by a utility, then the emissions from the facility are classified in the public electricity and heat generation sector. Alternatively, if the cogeneration facility is owned by an industrial facility, then the emissions are classified in the industrial facility's sector. For example, Imperial Oil owns the cogeneration facility at its Cold Lake in situ project. As a result, emissions from this facility are categorized in the mining and oil and gas extraction sector. We attempt to follow this convention when categorizing emissions from cogeneration facilities that are reported in Environment Canada's facility database: emissions from cogeneration facilities that are jointly owned by a utility and an industrial operator are allocated to the industrial operator's sector. This is primarily because, in most cases, emissions from the cogeneration facility are not reported separately from those of the industrial facility.

³⁵ The transportation emissions category from the National Inventory Report includes emissions from on-road vehicles, off-road vehicles (including transportation vehicles that are used at facilities in the mining and oil and gas extraction, manufacturing and agriculture sectors), rail, aviation, and navigation transport sectors, as well as emissions from pipelines. Large facilities in these sectors will include on-site transportation emissions in their reports to Environment Canada, and these emissions will be covered by SGER, but they will be categorized under the facility's sector in the reporting database. For example, emissions from a heavy hauler at an oil sands mine will be classified as transportation emissions in the National Inventory Report but as mining and oil and gas extraction emissions in the Environment Canada database. As a result, we cannot make a perfect comparison, and the proportion of emissions that we report as covered by SGER will be an underestimate in the transportation sector and an overestimate in the mining and oil and gas extraction, and manufacturing sectors. (Note: In the agriculture sector there are no facilities that report under Environment Canada's program.) Source: Environment Canada, "Table 2-15" National Inventory Report 1990-2013.

FIGURE 2 PROPORTION OF ALBERTA EMISSIONS COVERED BY SGER



Note: The “other” category includes emissions from the fossil fuel production and refining, agriculture and forestry, construction, commercial and institutional, residential, and waste sectors.

Source: Environment Canada, Reported Facility Greenhouse Gas Data; and Government of Canada, National and Provincial/Territorial Greenhouse Gas Emissions Tables.

PROGRESS IN REDUCING EMISSIONS UNDER SGER

The goal of this section is to outline emissions reductions attributable to the regulation, as well as to discuss how the various compliance options have influenced emissions reductions. We start with reviewing the measured emissions reductions, as recorded by the government of Alberta. We then review the compliance options available, and their contribution to emissions reductions. Finally, we examine emissions-intensity reductions, including evaluations of the oil sands and electricity generation sectors.

Measuring Emissions Reductions

As noted above, Alberta’s Specified Gas Emitters Regulation became effective in July 2007. Between 2007 and 2014, emissions reductions attributed to SGER by the Alberta government totalled 61.2 million tonnes.³⁶ The largest category of emissions reductions is via offsets, at a total of 24.3 Mt over the 6.5 years that SGER has been in place. This is followed by cogeneration credits at 22.3 Mt and, finally, emissions reductions at the facility level, which have totalled only 14.6 Mt. Table 2 details the emissions savings in each year for each reduction category defined by the provincial government, total emissions savings and total emissions.

³⁶ Alberta Environment and Parks, “Industrial Emissions Management: Specified Gas Emitters Regulation Results,” <http://esrd.alberta.ca/climate-change/programs-and-services/industrial-emissions-management.aspx>.

TABLE 2 SGER IMPACT AND ALBERTA'S EMISSIONS, 2007-2014

	2007	2008	2009	2010	2011	2012	2013	2014	TOTAL
SGER breakdown									
Emissions saved at facility (Mt)	1.60	1.35	0.89	1.02	3.06	1.20	0.45	5.01	14.58
Offsets submitted (Mt)	0.88	2.68	3.74	3.85	5.40	3.20	2.04	2.55	24.34
Cogeneration (Mt)	1.28	2.58	2.66	2.55	2.51	3.41	4.17	3.11	22.27
Total (Mt)	3.76	6.61	7.29	7.43	10.96	7.80	6.66	10.66	61.17
Total Alberta emissions (Mt)									
	249	244	235	243	247	258	267	276*	2,019
Emissions without SGER (Mt)									
	252.76	250.61	242.29	250.43	257.96	265.80	273.66	286.66	2,080
Technology fund payments (\$ million)									
	41.3	85.4	61.3	67.4	55.0	87.7	98.6	83.4	580.1
Emissions not abated (Mt)									
	2.75	5.69	4.09	4.49	3.67	5.85	6.57	5.56	38.67

*Estimate based on the compound annualized growth rate in emissions from 2010 to 2013.

Source: Alberta Environment and Parks, Industrial Emissions Management: Specified Gas Emitters Regulation Results; and Government of Canada, National and Provincial/Territorial Greenhouse Gas Emission Tables.

Total emissions in Alberta from 2007 to 2014 were 2,019 Mt.³⁷ Adding the reported emissions reductions to this number gives what emissions would have been in the absence of the policy: 2,080 Mt. This means that between 2007 and 2014, SGER has only reduced emissions by three per cent relative to a scenario in which the policy did not exist — a very small amount. This calculation, however, assumes all of the emissions reductions that have been attributed to SGER are reductions that would not have occurred in the absence of the regulation. This is commonly referred to as “additionality.” A reduction in emissions that does not satisfy additionality would have occurred without SGER in place. In that case, the reduction arguably should not be attributed to SGER as it is not an additional emissions reduction that is a direct result of the regulation.

The question of additionality is of particular concern in any emissions-reduction scheme that allows for emissions credits. The logic of an emissions credit is that, if a regulated facility is unable to achieve a required emissions reduction, then it can substitute an emissions reduction that has been achieved elsewhere — either from a regulated facility that has exceeded its target or from a non-regulated facility that has been incented to reduce emissions by the prospect of selling the carbon offset. The regulation therefore achieves the same reduction in emissions relative to business as usual (BAU), even though individual regulated facilities may have failed to meet their targets. This logic fails, however, if the offset is an emissions reduction that would have been achieved along the BAU path. When a facility uses a credit for compliance in this scenario, the reduction in emissions relative to BAU is less than what would have been achieved if the reduction had occurred — as required — at the regulated facility.

³⁷ Government of Canada, “National and Provincial/Territorial Greenhouse Gas Emission Tables.”

A concern over this outcome led to a lawsuit in California in 2013. The Citizens' Climate Lobby filed a petition against the California Air Resources Board, claiming that the rules for offsets in California's cap-and-trade system are not sufficient for ensuring the offset represents a real and sufficient emissions reduction. While the court ruled against the petitioners, it also recognized the potential for non-additional offsets to enter the market. More recently, two studies identified blatant abuse in Russia and Ukraine of an international emissions-credit system — the Joint Implementation mechanism — developed as part of the Kyoto Protocol. The first study found evidence of facilities deliberately increasing emissions in order to obtain credits for then reducing them.³⁸ The second found credits being issued that did not correspond to emissions reductions; the authors estimate this ultimately allowed global emissions of CO₂e to increase by 600 Mt.³⁹

Due to the concerns around additionality, many policies for reducing greenhouse gas emissions that allow for emissions credits also place a limit on the number or proportion of credits that a facility can use. In California, for example, offset credits can be submitted for a maximum of eight per cent of a facility's allowed emissions.⁴⁰ SGER, however, places no limit on the number of emissions performance or offset credits that a facility can use to meet its compliance obligation. Furthermore, a theoretical model of firm behaviour under SGER, recently developed in a working paper that assesses the effectiveness of the regulation, predicts it will have no significant impact on annual emissions or the emissions intensity of the average regulated facility.⁴¹ An empirical test of the model supports this result, finding — consistent with Table 2 — that facilities have tended to achieve compliance primarily through the purchase of offset credits and payments into the technology fund.⁴² This arguably amplifies the importance of additionality as it creates the possibility that a regulated facility will have zero emissions reductions, relative to a scenario without SGER, if additionality is not met.

Additionality and Offset Credits

Alberta Environment uses a five-step process, summarized in Figure 3, to determine additionality of a proposed offset protocol. In short, if the proposed emissions reduction results from an activity that is not required by law and not widely adopted in the sector in which it is occurring, then it meets the province's additionality requirement.⁴³ Notably, however, the province does not explicitly consider the economics of the project and whether

³⁸ L. Schneider and A. Kollmuss, "Perverse effects of carbon markets on HFC-23 and SF6 abatement projects in Russia," *Nature Climate Change* (2015), doi:10.1038/nclimate2772.

³⁹ A. Kollmuss, L. Schneider and V. Zheherin, "Has Joint Implementation reduced GHG emissions? Lessons learned for the design of carbon market mechanisms," Stockholm Environment Institute working paper 2015-07, <http://www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-WP-2015-07-JI-lessons-for-carbon-mechs.pdf>.

⁴⁰ Center for Climate and Energy Solutions, "California Cap-and-trade," <http://www.c2es.org/us-states-regions/key-legislation/california-cap-trade>.

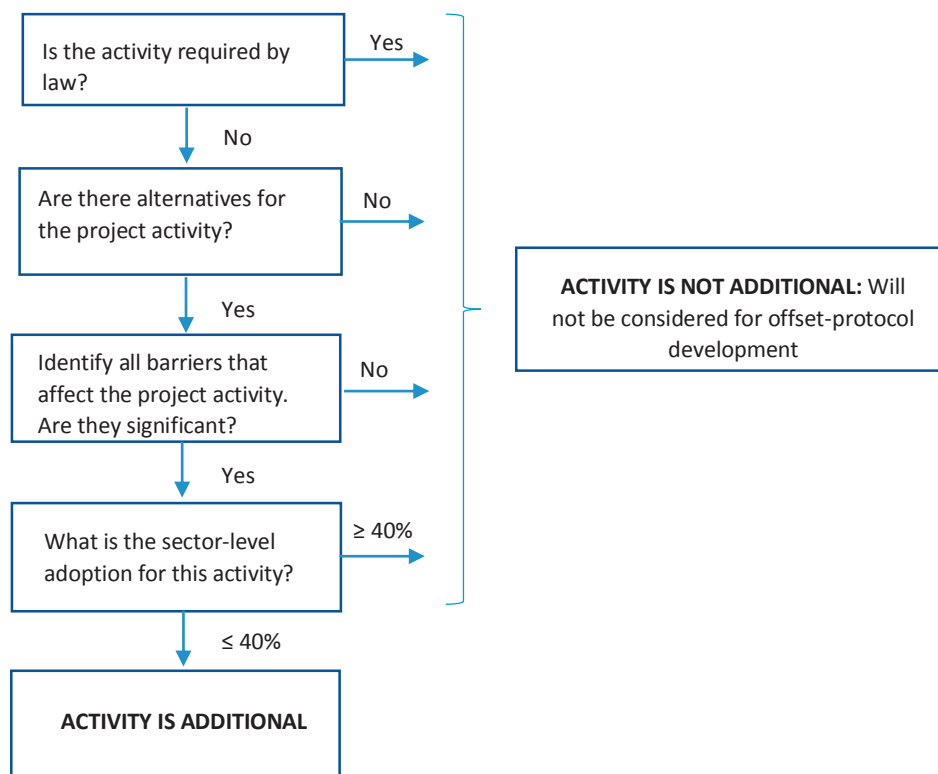
⁴¹ Deepak Rajagopal, "Firm behavior and emissions under emission intensity regulation: Evidence from Alberta's Specified Gas Emitter's Regulation," UCLA Institute of the Environment and Sustainability Working Paper Series, October 17, 2014, <https://escholarship.org/uc/item/5t40p9ht#>.

⁴² D. Rajagopal, "Firm behaviour and emissions."

⁴³ Alberta Environment, "Technical Guidance for Offset Protocol Developers", January 2011, <http://environment.gov.ab.ca/info/library/8331.pdf>.

it would be optimal for the developer to proceed even without the possibility of selling the offset credits. This suggests additionality is not likely met by all projects and emissions reductions — over 33 million tonnes generated by 191 projects⁴⁴ — in the province.

FIGURE 3 PROCESS FOR DETERMINING ADDITIONALITY OF ALBERTA OFFSET CREDITS



Source: Government of Alberta, Technical Guidance for Offset Protocol Developers.

For example, there are currently 18 wind-power projects registered in Alberta’s offset registry.⁴⁵ Over their combined lifetimes they are estimated to provide a 17.3 Mt reduction in emissions. As the majority of Alberta’s electricity is generated by fossil fuels — 90 per cent in 2014⁴⁶ — wind-energy projects will meet the criteria for not being widely adopted in the electricity sector. However, given that a number of projects were constructed well before the offset credit system was announced in 2007, and that the prevalence of wind energy is growing across Canada,⁴⁷ this suggests that a wind-energy project is generally economic on its own merits and that the additionality criteria for its emissions reductions are not necessarily met.

The government of Alberta is significantly more stringent in ensuring the validity of the emissions reductions generated by offset projects. All emissions reductions must be generated within the province and projects require supporting documentation. This includes

⁴⁴ CSA Group, “Alberta Emission Offset Registry: About,” http://www.csaregistries.ca/albertacarbonregistries/eor_about.cfm.

⁴⁵ CSA Group, “Alberta Emission Offset Registry Listings,” http://www.csaregistries.ca/albertacarbonregistries/eor_listing.cfm.

⁴⁶ Authors’ calculations. Source: Alberta Utilities Commission, “Annual electricity data collection: Total generation,” <http://www.auc.ab.ca/market-oversight/Annual-Electricity-Data-Collection/Pages/default.aspx>.

⁴⁷ CANWEA, “List of Wind Farms in Canada,” <http://canwea.ca/wind-energy/installed-capacity/>.

a third-party-verified project plan and project report, a verification report, and a greenhouse gas assertion that describes the offsets the project will generate in each calendar year.⁴⁸

Additionality and Emissions-Performance Credits

Concern around additionality also applies to emissions-performance credits in Alberta. The majority of emissions-performance credits in the province have historically been generated by cogeneration facilities. Cogeneration plants are typically located at industrial facilities and simultaneously produce both heat and electricity from a single fuel source. The industrial facilities consume both outputs in their production process and excess electricity supply is offered to the competitive market, generally at very low prices to ensure dispatch.⁴⁹ Cogeneration facilities are significantly more efficient, and offer significant greenhouse-gas-emissions reductions in comparison to sourcing heat and electricity from separate, standalone sources. As a result, their emissions have received special treatment under SGER.

More specifically, cogeneration facilities can earn emissions-performance credits based on the difference between their actual emissions and deemed emissions. Deemed emissions are calculated separately for the facility's production of heat and electricity and are an estimate of what emissions would have been if the heat and electricity were produced separately.⁵⁰ In addition, emissions associated with electricity are excluded from the compliance calculation. In practice, this means that a facility's deemed electricity emissions are subtracted from actual emissions when calculating its emissions intensity for compliance purposes. The resulting emissions intensity is for heat production only, and is compared against a baseline emissions intensity that is calculated using deemed emissions for heat production. The difference between these two intensities determines a facility's emissions-performance credits per unit of production.

A large number of oil sands projects include cogeneration facilities, many of which were constructed and operational prior to the introduction of SGER in 2007. Arguably then, the emissions-performance credits that these facilities receive correspond to emissions reductions that would have occurred without SGER in place and therefore do not satisfy additionality. This suggests the emissions reductions that SGER has achieved, relative to a scenario without the policy in place, are likely less than the three per cent previously calculated. If we take an extreme view and discount all cogeneration, this eliminates 36 per cent of reported emissions reductions, weakening the limited impact of SGER even further.

⁴⁸ CSA Group, "Alberta Emission Offset Registry: About."

⁴⁹ Nigel Bankes, "The SGER Amendments and the New Treatment of Cogeneration," "ABlawg.ca", July 25, 2015, <http://ablawg.ca/2015/07/14/the-sger-amendments-and-the-new-treatment-of-cogeneration/>.

⁵⁰ Deemed emissions for heat production are calculated assuming the heat was sourced from a conventional boiler operating at an efficiency of 80 per cent. Deemed emissions for electricity production are calculated assuming the electricity was produced from a natural gas combined-cycle generation with an emissions intensity of 0.418 tonnes of CO₂e per MWh. Source: Government of Alberta, "Technical Guidance for Completing Specified Gas Compliance Reports Version 7.0" (January 2014), <http://uat.open.alberta.ca/dataset/1dac8a36-a586-4786-9f34-ef0cddb13cfc/resource/58fbc932-c0dc-4c4c-8968-8bccaf61b89/download/zz-4904445-2014-01-Technical-Guidance-Completing-Specified-Gas-Compliance-Version7.0.pdf>.

Technology-Fund Compliance

In addition to the recorded emissions reductions, SGER has resulted in payments to the technology fund of \$577.9 million between 2007 and 2014;⁵¹ this corresponds to 38.5 million tonnes of emissions that exceeded facility baselines and were not abated. This is presumably because the cost of abatement (or purchasing performance credits or offsets) was greater than \$15 per tonne. Had these emissions instead been abated, then the province's reduction in emissions, relative to a scenario without SGER, would have averaged five per cent over the period of 2007 to 2014. This is an improvement of at least two percentage points, or an increase of at least 60 per cent relative to observed emissions reductions that - once accounting for a likely lack of additionality - correspond to a maximum reduction in emissions of only three per cent. While this is a significant improvement, it also suggests that, even without the technology fund option, the stringency of SGER is far below what is needed to achieve Alberta's 2020 climate change target.

One of the primary purposes of the technology fund, however, is to provide support to projects that will generate future emissions reductions. As summarized in Table 3, the Climate Change and Emissions Management Corp. (CCEMC) currently supports 85 projects across seven categories.⁵² The categories span projects that will result in measurable emissions reductions, projects that will help the province adapt to climate change, and projects focused on carbon capture and storage or alternative carbon uses. As of November 2015, the CCEMC has provided total combined funding of \$212,334,059.⁵³

TABLE 3 CCEMC FUNDED PROJECTS

Project Category	Number of Projects	Funding	Forecast Emissions Reductions by 2020
Carbon Capture and Storage	8	\$11,442,331	N/A
Renewable Energy	13	\$74,321,788	6,453,653
Clean Energy	12	\$67,101,984	247,352
Energy Efficiency	13	\$35,501,957	3,326,486
Climate Change Adaptation	3	\$7,000,000	N/A
Carbon Uses	24	\$11,976,215	N/A
Biological Projects	15	\$4,989,784	1,100,000
TOTAL	85	\$212,334,059	11,127,891

Source: Climate Change and Emissions Management Corp., "Projects," <http://ccec.ca/projects/>.

Emissions reductions across all projects are forecast to be 11.1 Mt of CO₂e by 2020.⁵⁴ This implies that, on average across all projects, approximately one tonne of emissions reductions is achieved for every \$19 of funding provided by the CCEMC. Or alternatively, for every \$15 contribution to the CCEMC — corresponding to one tonne of CO₂e that has not been reduced by regulated facilities — the CCEMC achieves emissions reductions of only 0.8 tonnes. It is also worthwhile to note, however, that the CCEMC is only a partial

⁵¹ Alberta Environment and Parks, "Industrial Emissions Management."

⁵² Climate Change and Emissions Management Corporation, "Projects," <http://ccec.ca/projects/>.

⁵³ *ibid.*

⁵⁴ *ibid.*

funding source for most projects. The total value of all projects funded by the CCEMC exceeds \$1.5 billion.⁵⁵ When considering the total investment in these projects, the full cost of emissions reductions increases starkly to \$143 per tonne.

These numbers represent an upper bound on the cost of emissions reductions achieved through the CCEMC, as forecast emissions reductions are not provided for all projects (and projects in the climate change adaptation category are not expected to result in measurable emissions reductions). If we look only at the subset of projects for which emissions reductions are forecast, then the CCEMC has provided funding of \$126,211,352 to 29 projects with a total value of just over \$1.2 billion. Among these projects, approximately one tonne of emissions reductions is achieved for every \$11 in funding provided by the CCEMC, or for every \$107 in total funding. The range of emission-reduction costs across projects, however, is massive. When considering only CCEMC funding, costs range from \$0.74 per tonne for a project to improve energy efficiency in chemical manufacturing to \$4,468 per tonne for a greenhouse solar energy project. When considering all sources of funding, the range of emission-reduction costs spans \$1.48 to \$11,426 per tonne. While an evaluation of the cost-effectiveness of CCEMC-funded projects is beyond the scope of this paper, the range of costs associated with emissions reductions does suggest that the current levy in Alberta is insufficient to incentivize meaningful emissions reductions.

If CCEMC's current forecast emissions reductions of 11.1 Mt of CO₂e by 2020 are achieved, then these reductions could account for 20 per cent of the 50 Mt reduction below BAU that Alberta is targeting in 2020. While these forecast reductions are significant, they fall far short of the total emissions reductions that are required to meet Alberta's 2020 target and again point towards the insufficiency of SGER as a standalone regulation for reducing the province's greenhouse gas emissions.

Improvements in Emissions Intensity

As SGER is emissions-intensity-based, it is also informative to evaluate its effectiveness along this measure. This is made somewhat challenging, however, in that emissions-intensity targets for SGER are measured in tonnes of CO₂e per unit of production.⁵⁶ Production from individual facilities covered by SGER is generally difficult to identify, and would be extremely labour-intensive to uncover. Sector-level production data is available, however, for Alberta's two largest greenhouse-gas-emitting sectors, the oil sands and electricity and heat generation, which respectively accounted for 23 and 17 per cent of the province's total greenhouse gas emissions in 2013.⁵⁷ In addition, the coverage of SGER is quite high in both of these sectors. Specifically, from 2004 to 2013, an average of 95 per

⁵⁵ *ibid.*

⁵⁶ For example, intensity measurements for an oil sands company may be measured in tonnes of CO₂e per barrel of bitumen produced, while intensity measures for an electrical power plant may be in tonnes of CO₂e per gigawatt hour. By using an emissions intensity that is measured per unit of production, SGER insulates the measure from price fluctuations that are outside the control of a facility, which can create an artificial variance in the facility's emissions intensity. For example, as a result of the 2014–15 fall in oil prices, GDP in the mining and oil and gas extraction sector in 2015 will be down relative to 2014. If we assume the production technology that a facility is using has not changed, then the emissions intensity with respect to production likely has not changed, while the emissions intensity with respect to GDP will have increased, driven up by the lower GDP that is the result of a lower oil price.

⁵⁷ Authors' calculations, Source: Environment Canada, National Inventory Report 1990-2013.

cent of emissions in the electricity and heat generation sector, and 89 per cent of emissions in the oil sands, came from facilities that are subject to SGER.^{58, 59} Given this high coverage, it is not unreasonable to use sector-level emissions and production data to estimate the effectiveness of SGER at achieving production-based emissions-intensity improvements.

Electricity

Looking first at the electricity sector, we can consider the effectiveness of SGER in improving the emissions intensity of electricity production from both coal and natural gas facilities. Alberta had between six and seven coal plants in operation from 2004 to 2013, all of which are large emitters, with reported emissions available from Environment Canada's reported facility greenhouse gas database. The average emissions intensity of coal electricity production from these plants in 2004 and 2005 was 1,040 tonnes per GWh.^{60, 61} In 2013, the average emissions intensity was 988 tonnes per GWh, an improvement of just under five per cent, or less than half of SGER's targeted improvement.

The evaluation of the impact of SGER on the emissions intensity of electricity production from natural gas is more difficult. First, as noted previously, emissions from electricity production at cogeneration facilities are not subject to SGER. Ideally we would want to exclude the emissions from cogeneration facilities from an emissions-intensity calculation. We are limited in what we can exclude, however, due to the categorization methods used in the National Inventory Report. Specifically, if the facility is owned by a public utility, then emissions are categorized in the electricity and heat generation sector and cannot be disentangled from the emissions of non-cogeneration natural gas facilities.⁶²

As a result, we are only able to approximate the emissions intensity of electricity production from natural gas at all facilities — cogeneration and non-cogeneration — that are owned by public utilities. In addition, the earliest year we can calculate the emissions intensity is 2005 (the final year of the baseline period) as data that specifies electricity production from natural gas at public utilities are not available for earlier years. From 2005 to 2013, we find

⁵⁸ Authors' calculations. Sources: (1) Environment Canada, "Environment Canada Reported Facility Greenhouse Gas Data"; (2) Government of Canada, "National and Provincial/Territorial Greenhouse Gas Emissions Tables"; and (3) Environment Canada, *National Inventory Report 1990-2013*.

⁵⁹ Data on oil sands emissions, broken down by mining, in situ and upgrading, are provided in Environment Canada's National Inventory Report. The 2015 report includes this data for the years 1990, 2000, 2005 and 2009 through to 2013. The full data set, which includes emissions data from the oil sands for all years from 1990 to 2013, was provided upon request from Environment Canada.

⁶⁰ Authors' calculations. Sources: (1) Environment Canada, "Reported Facility Greenhouse Gas Data"; and (2) Alberta Utilities Commission, "Annual electricity data collection: Total generation."

⁶¹ We cannot calculate an average emissions intensity across the three-year baseline period of 2003 to 2005, as data on facility-level greenhouse gas emissions from 2003 are not available.

⁶² See footnote 34 for more details on how the National Inventory Report categorizes emissions from cogeneration facilities.

the emissions intensity increased, rising from 541 to 656 tonnes of CO₂e per GWh.⁶³ It is not possible to distinguish whether the increase in emissions intensity is driven entirely by cogeneration facilities, or also by those facilities subject to SGER. However, even if SGER has resulted in emissions-intensity improvements at non-cogeneration facilities, it seems they have not been significant enough to improve the overall emissions intensity of natural-gas-produced electricity in the province. These results suggest that in the electricity and heat generation sector, the effectiveness of SGER at achieving emissions-intensity improvements has been limited.

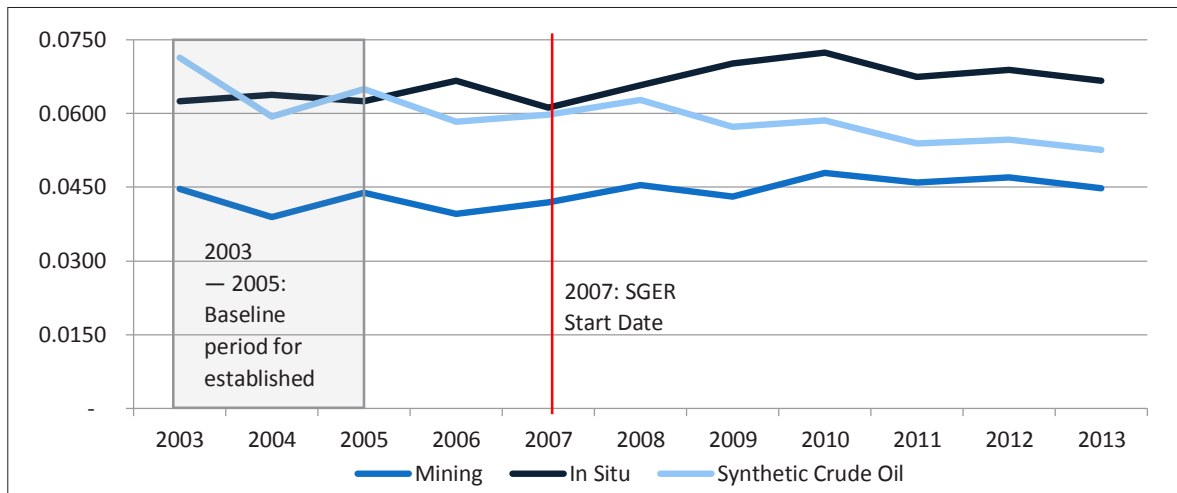
Oil Sands

Next we consider changes in emissions intensity per barrel in the oil sands. Emissions specific to mining, in situ and upgrading are tracked by Environment Canada, and production in these same categories is reported by the Alberta Energy Regulator.⁶⁴ As shown in Figure 4, relative to the average from the baseline period, as of 2013 the emissions intensity per barrel of production has decreased for oil sands upgrading (-19.4 per cent), but increased for both mining (+5.5 per cent) and in situ production (+5.9 per cent). At first glance, these results suggest that upgraders are meeting the SGER requirements through emissions reductions, while mining and in situ facilities are relying more on emissions-performance credits (potentially from integrated upgraders and cogeneration facilities), offset credits and payments into the technology fund.

⁶³ Authors' calculations. To approximate total emissions from natural gas production at public utilities in the province, we use data on total greenhouse gas emissions for the electricity and heat production sector from the 2015 National Inventory Report and subtract emissions from coal facilities (estimated by facility reports to the Environment Canada Reported Facility Greenhouse Gas Database) and emissions from other fuels and other sources (obtained from *Table A11-10, Electricity Generation and GHG Emission Details for Alberta* in the 2015 National Inventory Report). Electricity produced from natural gas at public utilities is obtained from Statistics Canada. Sources: (1) Environment Canada, National Inventory Report 1990-2013; and (2) Statistics Canada, *Table 127-0006 — Electricity generated from fuels, by electric utility thermal plants, annual (megawatt hour)*, CANSIM (database), <http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1270006>.

⁶⁴ See footnote 57 for a description of the Environment Canada oil sands emissions data. Oil sands production data were obtained from the Alberta Energy Regulator (AER), ST-98: *Alberta's Energy Reserves and Supply/Demand Outlook* annual report. The current and archived reports are available on the AER website at <http://aer.ca/data-and-publications/statistical-reports/st98>.

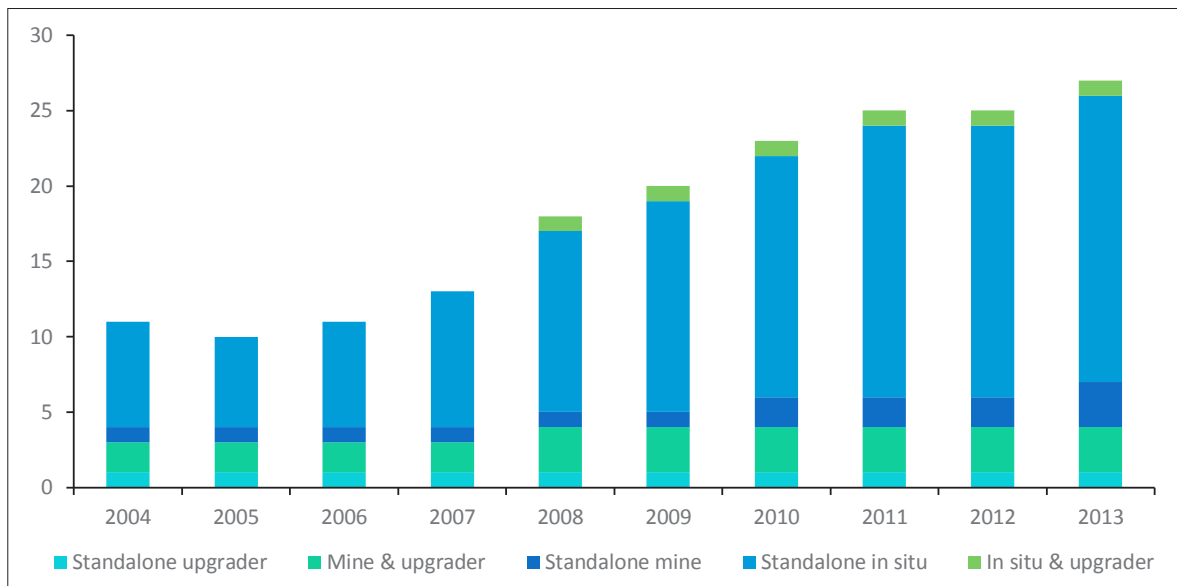
FIGURE 4 EMISSIONS INTENSITIES IN THE OIL SANDS



Source: Environment Canada National Inventory Report; Statistics Canada CANSIM Table 379-0030 (Gross Domestic Product at Basic Prices by North American Industry Classification System); and Alberta Energy Regulator, ST98: Alberta's Energy Reserves and Supply/Demand Outlook.

Also playing a likely role, however, is the fact that many oil sands projects commenced operations post-2005. As shown in Figure 5, the number of oil sands facilities that exceeded the large-emitters' threshold grew from 11 in 2004 to 27 in 2013. As a result, the 2003 to 2005 baseline period may not represent the baseline emissions intensity for a majority of oil sands projects. If this is the case, then at the industry level, the 2003 to 2005 period may not provide an accurate approximation of the baseline against which to measure SGER's progress.

FIGURE 5 NUMBER OF LARGE-EMITTING OIL SANDS FACILITIES BY PRODUCTION TYPE



Source: Environment Canada Reported Facility Greenhouse Gas Data.

Also acting as a confounder when evaluating the emissions-intensity changes at the industry level is that many new oil sands projects are not yet facing the maximum emissions-intensity reductions required by SGER. It is not unreasonable to expect that the emissions intensity of these new projects may therefore be higher than the regulated level

that established facilities are required to meet. The emissions intensity of these new projects may therefore mask progress that has been made by the subset of established facilities. This suggests that it is difficult to assess the impact of SGER in reducing oil sands emissions at the industry level,⁶⁵ and provides another possible explanation for why SGER appears to have been relatively ineffective in the oil sands to date.

We have shown that SGER has had limited success in reducing emissions in Alberta overall, and it is difficult to see progress even among sectors of the economy where the majority of emitters are subject to the regulation. In the next section, we evaluate whether the strengthening of the regulation can be expected to improve performance.

IMPACT OF THE SGER STRENGTHENING

The strengthening of SGER, announced in June 2015, had two main components and was set to be phased in over two years. While the November 22nd announcement appears to have scuttled the changes to SGER in favour of a carbon tax, it is worthwhile to evaluate the previously announced changes to SGER as an alternative policy option. Under the modified SGER, in 2016 the emissions-intensity reduction requirement will increase from 12 to 15 per cent, and the carbon levy on emissions that exceed a firm's regulated baseline (and which are not offset via offset credits or emissions-performance credits) will rise from \$15 to \$20 per tonne. In 2017, the emissions-intensity reduction requirement will increase from 15 to 20 per cent and the carbon levy to \$30 per tonne. The impact of these changes is likely to differ by sector, most notably because of different levels of coverage.

In the mining and oil and gas extraction sector, the effect of the strengthened SGER will be driven primarily by its impact on emissions in the oil sands. As of 2013, oil sands emissions accounted for 87 per cent of the large-facility emissions in the mining and oil and gas extraction sector. In addition, as shown in Figure 5, the number of large-emitting facilities in the oil sands has more than doubled since 2004. This implies there are a significant number of oil sands facilities that will be required to reduce their emissions intensities at a faster rate under the strengthened SGER. The relevant question then becomes whether facilities choose to meet these stricter requirements through actual emissions reductions, or through one of the alternative options — offset credits, emissions-performance credits or payment of a levy — allowed under SGER.

Capital investment decisions in the oil sands typically have a substantial lead time. This suggests that unless a company already had a plan in place to invest in carbon-abatement or carbon-reduction technologies at its facilities, it is unlikely to respond to the new regulations with emissions reductions. This is particularly true given the current low crude oil price (with no foreseeable increases) and the substantial clawbacks in capital investments that are being observed industry-wide. In addition, given that the strengthened

⁶⁵ The Oil Sands Information Portal provides greenhouse gas emissions intensities by oil sands project. We do not use these data here as the most recent available year is 2011 and the data are only provided for 16 projects. Of the established facilities in 2007, data going back to at least one year in the baseline period (2003 to 2005) are available for 10 of 11 facilities. In 2011, four of 10 facilities report an emissions intensity that is 12 per cent below their emissions intensity from the baseline period. Source: Alberta Environment and Parks, "GHG Emissions Intensity History for Oil Sands Projects," <http://osip.alberta.ca/library/Dataset/Details/22>.

SGER will expire in 2017, firms are more likely to delay long-term capital investment decisions until there is more certainty about what Alberta's long-term climate change policy will be. In particular, the potential cost of emissions beyond 2017 will be a key determinant in investment decisions. Over the next two years, therefore, the more likely outcome is that facilities will opt to purchase offset or emissions-performance credits, or pay the emissions levy. The price ceiling on this option is the value of the levy — \$20 in 2016 and \$30 in 2017.

To get a sense of what this may cost an oil sands facility, we assume the baseline emissions intensities for an example in situ facility and an example mining facility with nine years of operations in 2016 (and thereby facing the maximum emissions-intensity requirements under the strengthened SGER) are equal to the sector averages from 2003 to 2007: 0.063 and 0.042 tonnes of CO₂e per barrel respectively.⁶⁶ If we assume the facilities have a current emissions intensity that is equal to their baseline,⁶⁷ then as summarized in Table 4, under the strengthened SGER the average and marginal per barrel carbon levies are \$0.19 (in situ) and \$0.13 (mining) in 2016, and \$0.38 (in situ) and \$0.25 (mining) in 2017.⁶⁸ Even in the current low-price environment, these costs are not infeasible for a facility to absorb. Reported operating costs in the oil sands for a sample of companies in the first quarter of 2015 were \$30 to \$40 per barrel for mining projects and \$8 to \$18 for in situ projects,⁶⁹ suggesting the increase in operating costs from the strengthened SGER is only 0.1 to 3.4 per cent. These percentages will also decrease when considering that higher emission levies will offset other costs for a facility, most notably royalties and corporate taxes. Lastly, many oil sands companies have anticipated these costs by employing a carbon “shadow price” — an assumed market price for carbon that often increases over time — in financial-planning and project-evaluation decisions.⁷⁰

⁶⁶ We use 2003 to 2007 because pre-2007 emissions were unregulated; using this range gives an average unregulated emissions intensity for all facilities that are now subject to the 15 per cent reduction requirement under SGER. Authors' calculations. Source: (1) Environment Canada, "Table 2-14: Details of trends in GHG emissions by economic sector," National Inventory Report 1990-2013 (full time-series of Table 2-14, from 1990-2013, obtained by request from Environment Canada); and (2) Alberta Energy Regulation, ST98 Annual Reports.

⁶⁷ A facility's baseline and current emissions intensity together determine by how much, in tonnes of CO₂e, the facility exceeds or falls short of its regulated level. They thereby directly determine the per barrel carbon levy that a facility will face if it is not meeting its regulated target. As a result, our estimate of per barrel costs only applies to a facility to which these exact assumptions apply. In contrast, if a facility has the same baseline emissions intensity as assumed but a higher current emissions intensity, then the levy per barrel will be higher. If, alternatively, it has the same baseline emissions intensity but a lower current emissions intensity, then the levy per barrel will be lower.

⁶⁸ As SGER is an emissions-intensity regulation, the carbon levy is charged against the quantity of emissions on each barrel of production that exceeds a facility's regulated intensity. This also means that each additional unit of production increases the facility's total allowed emissions. As a result, if we assume a facility has a constant emissions intensity, then the average and marginal cost of complying with SGER, per unit of production, is the same.

⁶⁹ Estimates of cash operating costs per barrel are based on reported values from 2015 first-quarter reports by Cenovus, Suncor, Canadian Natural Resources Limited and Canadian Oil Sands. Sources: (1) Cenovus Energy, "First Quarter 2015", <http://www.cenovus.com/invest/docs/2015/Q1-2015-quarterly-report.pdf>; (2) Suncor Energy, "First Quarter 2015: Report to Shareholders", http://www.suncor.com/pdf/Suncor_English_2015_Q1_Report.pdf; (3) Canadian Natural Resources Limited, "First Quarter Report: Three months ended March 31, 2015", http://www.cnrl.com/upload/media_element/932/01/q115_interim-report.pdf; and (4) Canadian Oil Sands, "Q1 First Quarter Report", http://www.cdnoilsands.com/files/FinancialReports/Q1-2015-Report_FINAL_v001_c28zy3.pdf.

⁷⁰ Sustainable Prosperity, "Shadow Carbon Pricing in the Canadian Energy Sector", Policy Brief, March 2013, <http://www.sustainableprosperity.ca/sites/default/files/publications/files/Shadow%20Carbon%20Pricing%20in%20the%20Canadian%20Energy%20Sector.pdf>.

TABLE 4 IMPACT OF STRENGTHENED SGER ON EXAMPLE OIL SANDS FACILITIES

	2015		2016		2017		
	Baseline emissions intensity (tonnes of CO ₂ e per barrel)	Regulated emissions intensity (12 per cent reduction from baseline)	Per barrel carbon levy (\$15 per tonne)	Regulated emissions intensity (15 per cent reduction from baseline)	Per barrel carbon levy (\$20 per tonne)	Regulated emissions intensity (20 per cent reduction from baseline)	Per barrel carbon levy (\$30 per tonne)
In Situ Facility	0.063	0.056	\$0.11	0.054	\$0.19	0.051	\$0.38
Mining Facility	0.042	0.037	\$0.08	0.036	\$0.13	0.033	\$0.25

Source: Authors' calculations; baseline emissions intensity determined via (1) Environment Canada Oil Sands Emissions data; and (2) Alberta Energy Regulation, ST98 Annual Reports.

Turning to the electricity and heat generation sector, the emissions-intensity calculations for electricity production in the previous section suggest that most large-emitting facilities in the sector are not meeting the current SGER requirements. As a result, the strengthened regulations will require facilities to make further investments in emissions reductions, to purchase additional offsets or emissions-performance credits, or to pay larger levies on their current emissions levels.

As is the case for oil sands facilities, emissions reductions at electricity-generating plants will typically require large capital investments that are not reasonable to expect under the short timeframe of the strengthened SGER. Instead, it is arguably more likely that facilities will tend towards purchasing credits or paying the levy. An estimate of the upper ceiling of these costs on representative coal and natural gas facilities is provided in Table 5. We assume the baseline emissions intensity for a coal facility is equal to the average emissions intensity of coal-fired electricity production in the province over the entire baseline period of 2003 to 2005. Due to a lack of data availability, for a natural gas facility we assume the baseline emissions intensity is equal to the average emissions intensity of utility-owned natural-gas-fired electricity production in 2005. For both the example coal and natural gas facility we assume the current emissions intensity is equal to the baseline.

TABLE 5 IMPACT OF STRENGTHENED SGER ON EXAMPLE ELECTRICITY FACILITIES

	2015		2016		2017		
	Baseline emissions intensity (tonnes of CO ₂ e per MWh)	Regulated emissions intensity (12 per cent reduction from baseline)	Per MWh carbon levy (\$15 per tonne)	Regulated emissions intensity (15 per cent reduction from baseline)	Per MWh carbon levy (\$20 per tonne)	Regulated emissions intensity (20 per cent reduction from baseline)	Per MWh carbon levy (\$30 per tonne)
Coal Facility	1.040	0.915	\$1.87	0.884	\$3.12	0.832	\$6.24
Natural Gas Facility	0.541	0.476	\$0.97	0.460	\$1.62	0.433	\$3.25

Source: Authors' calculations; baseline emissions intensity determined via (1) Environment Canada, "Reported Facility Greenhouse Gas Data"; and (2) Alberta Utilities Commission, "Annual electricity data collection: Total generation."

Under the strengthened SGER, we find the average and marginal cost of the carbon levy per MWh of electricity production is \$3.12 (coal) and \$1.62 (natural gas) in 2016, and \$6.24 (coal) and \$3.25 (natural gas) in 2017. We do not have estimates of the marginal cost of

electricity supply in Alberta, although the average system marginal price — the price at which electricity is sold into Alberta’s power pool — from January to September 2015 was just under \$40 per MWh.⁷¹ This suggests the strengthened SGER could increase costs in the sector by roughly two to 11 per cent. This is a more significant impact than in the oil sands, but still not infeasible for a facility to absorb, particularly when considering that electricity producers face a more inelastic demand and can therefore pass a greater portion of their increased costs down to consumers.

The above arguments suggest the impact of the strengthened SGER on achieving emissions reductions in Alberta’s two largest-emitting sectors will be minimal. The remaining two large-emitting sectors in Alberta are transportation and manufacturing, which respectively accounted for 15.6 and 9.6 per cent of the province’s emissions in 2013. The only large-emitting facilities covered by SGER in the transportation sector are natural gas pipeline facilities, while in the manufacturing sector large-emitting facilities include fertilizer, lime, cement, chemical and petrochemical manufacturers.⁷²

In the transportation sector, the current impact of SGER appears to be limited. From 2004 to 2013 GDP associated with natural gas pipelines in Alberta is down — falling from \$1,270 to \$1,063 million dollars⁷³ — while emissions at facilities covered by SGER are up — rising from 3.386 to 3.736 million tonnes of CO₂e.⁷⁴ This suggests it is unlikely that these facilities have reached the improvements in production-based emissions intensities required by SGER and are rather meeting their obligations via credits or the emission levy.

In the manufacturing sector the current impact of SGER is more difficult to assess. Overall emissions in the sector are virtually unchanged from 2004 to 2013, and there is an essentially even split between facilities that have reduced emissions over this time period and those that have increased emissions.⁷⁵ It is difficult to say anything meaningful about emissions intensities for these facilities as production levels are not readily available and the GDP values for manufacturing in Alberta contain the value of output from many smaller facilities not covered by SGER. However, given that sector-level emissions are essentially unchanged, there is likely a mix of facilities that are meeting the current SGER requirements via emissions reductions versus those that are purchasing offsets or paying the levy.

Given the types of facilities covered by SGER in the transportation and manufacturing sector, it is reasonable to expect that, as is the case in the oil sands and the electricity sector, a reduction in emissions intensity will require capital investments that must be planned in advance. As a result, unless such an investment had already been planned, it seems most likely that if a facility was previously meeting its SGER obligations via offset credits or payment of the emissions levy, then it will continue with this option in the near-term. This suggests that over the next two years, the strengthening of SGER is likely to be more

⁷¹ Authors’ calculation. Source: Alberta Electricity System Operator, “Historical Reports, System Marginal Price,” <http://ets.aeso.ca/>.

⁷² Environment Canada, “Reported Facility Greenhouse Gas Data.”

⁷³ Statistics Canada, CANSIM Table 379-0030.

⁷⁴ Environment Canada, “Reported Facility Greenhouse Gas Data.”

⁷⁵ *ibid.*

effective in building up the value of the technology fund, as opposed to achieving emissions reductions that will move Alberta closer towards its 2020 target.

Where the strengthening of SGER may have more success in achieving emissions reductions is through the offset program. Regulated facilities are large industrial emitters that most often require a costly capital investment to achieve emissions reductions, but non-regulated facilities or small emitters often have less costly abatement options available. As of November 2014, over 33 million carbon offset credits had been created and registered in Alberta.⁷⁶ Examples of activities that have generated offsets include changes in agricultural practices (moving to low- or no-tillage agriculture and reducing feed days for cattle), improvements in energy efficiency at commercial institutions and school boards, wind-energy projects, and the use of vented-gas-capture systems at conventional oil and gas projects.⁷⁷

According to the SGER statistics provided in Table 2, just over 24 million offset credits have been used by large emitters to meet their SGER requirements. In comparison, facility-level emissions reductions have totalled less than 15 million tonnes. Looking ahead, the willingness-to-pay by large emitters for offset credits will increase to \$20 in 2016 and \$30 in 2017. In theory this should incent further investments in offsets by non-regulated facilities.

An increase in carbon offsets would be consistent with simulations completed by the International Institute for Sustainable Development (IISD). Its work considers what SGER compliance would look like in the oil and gas sector if the regulation was strengthened through to 2020 to a 24 per cent reduction in emissions intensity and a \$30 per tonne carbon levy (a “double-double” approach relative to the original regulation). The simulation forecasts the emissions compliance for the oil and gas sector in 2020 will be 29.2 Mt and that 15.5 Mt — over 50 per cent of the industry-wide compliance obligation — will be met by carbon offsets.⁷⁸

While carbon offsets seem the most feasible area for additional emissions reductions, the challenge that may arise in achieving this outcome is that the government has only committed to SGER through to the end of 2017. The two-year time frame may discourage non-regulated facilities from making the necessary investment to achieve and certify new offset programs.⁷⁹ The new policy announcement on November 22, 2015 adds even greater uncertainty.

At this point, the message is clear: SGER hasn't been effective, and a temporary strengthening will do little to improve its track record. What alternative policies are available, and would be more effective? The next section covers this.

⁷⁶ CSA Group, “Alberta Emission Offset Registry: About,” http://www.csaregistries.ca/albertacarbonregistries/eor_about.cfm.

⁷⁷ CSA Group, “Alberta Emission Offset Registry Listings,” http://www.csaregistries.ca/albertacarbonregistries/eor_listing.cfm.

⁷⁸ Dave Sawyer, “Regulation Carbon Emissions in Canada, A Timbit with that Double-Double? Costs and emission reductions of renewed carbon policy in Alberta”, International Institute for Sustainable Development (June 2014), https://www.iisd.org/sites/default/files/publications/costs_emission_reductions_renewed_carbon_policy_alberta.pdf.

⁷⁹ Nigel Bankes, “The SGER Amendments and the New Treatment of Cogeneration.”

ALTERNATIVE POLICY APPROACHES FOR EMISSIONS REDUCTION

Even in its strengthened form, SGER continues to have a significant number of gaps that limits its effectiveness in moving Alberta towards the 2020 emissions target. Most notable is the lack of coverage across all sources of Alberta's greenhouse gas emissions. In 2013, only 48 per cent of Alberta's emissions were directly covered by SGER. SGER provides an indirect incentive for emissions reductions at small facilities through the carbon-offset registry, but there is no regulated requirement. There is also no mechanism that requires or encourages emissions reductions at the individual level. A rough approximation using data from Natural Resources Canada's Energy Use database and Alberta Energy's customer-usage estimates suggest that individual and household emissions accounted for approximately nine per cent of Alberta's total emissions in 2012.⁸⁰

Another shortcoming of SGER is that it does not require any emissions reductions from covered facilities until they reach the fourth year of operations, and the maximum emissions reductions do not apply until the facility reaches year nine. Furthermore, the baseline for the facility is based on its emissions in its third year of operation and, even after year nine, the firm faces a potential emissions levy only on the portion of its emissions that exceed the established baseline. All of these factors combine to reduce the incentive of a facility to invest up front in carbon-reduction technologies. Rather, facilities have an incentive to delay improvements in emissions intensity until after their baseline has been established, to avoid more stringent emissions-intensity requirements.

Lastly, SGER requires large emitters to achieve reductions in emissions intensity per unit of production. In contrast, the province's stated climate change target is a reduction in absolute emissions of 50 million tonnes below business as usual by 2020. The different units — intensity-based versus absolute — create a significant disconnect between the province's target and its regulation for achieving it. In particular, the regulation does not ensure any minimum level of greenhouse-gas-emissions reductions will be achieved, particularly as facilities can — if they choose — meet their entire requirement by paying the carbon levy.⁸¹ A production-based emissions-intensity regulation also makes it more difficult to assess the effectiveness of the regulation, as units of production differ across facilities, production levels are often not readily available and in some cases — such as for landfills or pipelines — it is not immediately evident what a production unit would be.

Before detailing common policy approaches to reducing emissions, we should first consider what components are important for a policy to effectively reduce emissions. While we have discussed both stringency and coverage in the context of SGER, these are not the only considerations for effective policy. Other important considerations are comprehensiveness — the type of emissions subject to the policy — and breadth — what percentage of emissions from each emitter subject to the policy is affected by the policy.

⁸⁰ Authors' calculations. Source: (1) Natural Resources Canada, "Comprehensive Energy Use Database: Residential Sector and Transportation Sector: Passenger Transportation," http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm; (2) Alberta Energy, "Electricity Statistics: Customer Usage Estimates," <http://www.energy.alberta.ca/electricity/682.asp>; and (3) Government of Canada, "National and Provincial/Territorial Greenhouse Gas Emission Tables."

⁸¹ We note that the levy would have a longer-term effect by reducing profits and the ability of the firm to reinvest and expand production.

First, stringency refers to the strength of the emissions-reduction incentive created by the policy. This can be in the form of a price on emissions, or the goal for emissions reductions. The more stringent the policy, the greater the incentive to reduce emissions. For example, a \$1 per tonne carbon tax on all emissions and all parts of the Alberta economy would be comprehensive, but would do little to incentivize emissions reductions due to the minimal price on emissions. In the case of SGER, the strengthening has increased the stringency by both increasing the price and increasing the emissions-intensity reduction target.

Second, coverage refers to the type of emitters subject to the policy. Any economy has a distribution of emitters, based on consumption habits in the case of households (driving a Hummer or a Prius, for example) and, in the case of firms, the type of goods and services they produce (a bank branch compared to an oil sands operation). The broadest coverage is if all emitters are subject to the policy; this also limits distortions caused by treating different emitter types differently.⁸² In the case of SGER, only large emitters are covered, leaving the remaining emitters in the province without an incentive to reduce emissions.

A third element to consider is the comprehensiveness of the policy, in terms of the type of greenhouse gasses the policy is attempting to reduce. While carbon dioxide is likely the most familiar to readers, there are 24 different gasses identified by the United Nations as having global-warming potential.⁸³ In this, SGER does well, as all 24 gasses are included in the regulation. In contrast, B.C.'s carbon tax only applies to emissions associated with the use of fuels in the province.⁸⁴ While a more comprehensive policy is preferable in incentivizing reductions in all emissions, policy-makers do face increasing administrative complexity associated with regulating or pricing all greenhouse gasses.

Finally, we should consider breadth of the policy, or the coverage of emissions within emitters subject to the policy. In the case of SGER, its breadth is limited, as only emissions above the mandated emissions-intensity target are priced. As noted above, this means the average and marginal costs of emissions are less than the value of the levy, decreasing the incentive to reduce emissions. Compare this to a hypothetical situation where Alberta has an emissions tax of \$15 per tonne on all emissions from large emitters. In this case, the coverage of the policy is the same, but the breadth is substantially different, increasing the incentive to reduce emissions.

With the components of an effective policy in mind, we now turn to discussing alternatives to SGER that the government of Alberta should consider. The two most common alternative policy approaches for achieving emissions reductions are a cap-and-trade system or an economy-wide tax on emissions, colloquially referred to as a carbon tax. Both options are currently employed by other provinces in Canada. Québec has a cap-and-trade system that started operating in 2013, and which was formally linked with a similar regime in

⁸² For a discussion of the consequences of non-uniform carbon policies, see Trevor Tombe and Jennifer Winter, "The Importance of Policy Neutrality for Lowering Greenhouse Gas Emissions," *SPP Research Papers* (Volume 6, Issue 4), March 2013.

⁸³ United Nations Framework Convention on Climate Change website, "Global Warming Potentials," http://unfccc.int/ghg_data/items/3825.php.

⁸⁴ B.C. Ministry of Finance, "How the Carbon Tax Works," <http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm>.

California in 2014.^{85,86} In April 2015, Ontario announced its plans to introduce a cap-and-trade system, which it intends to link with the systems in Québec and California.⁸⁷ British Columbia, in contrast, has had a carbon tax in place since 2008.⁸⁸

Cap-and-Trade

Under a cap-and-trade system, participating facilities require emission allowances for some or all of their carbon emissions. In Québec, emission allowances can take three forms: emission permits; offset credits obtained from individuals or facilities that are not required to participate in the cap-and-trade system; and early-reduction credits that can be earned by participating facilities that achieve verified emissions reductions prior to the start of the cap-and-trade system.⁸⁹

The core of a cap-and-trade system is the emission permit, typically equal to one tonne of emissions. The number of emission permits provided in any given year is set by the government and is typically declining over time, in order to ensure overall emissions reductions. In the Québec system, some emission permits are allocated to firms free of charge and others are sold via direct-sale agreements between facilities and the government.⁹⁰ The remaining permits are auctioned among all facilities required to participate in the system. The minimum auction price was set at \$10 per tonne in 2012, and this price rises by five per cent plus inflation each calendar year through to 2020.⁹¹ The price paid for emission permits at each auction is constant and is set equal to the lowest successful bid submitted by all facilities participating in the auction. This low bid thereby establishes the carbon price.

A key benefit of a cap-and-trade system is that the government can achieve a defined level of emissions reductions by rolling back the number of emission permits that it allocates each year. In Québec, for example, the number of emission permits is set to decline from 65.30 million in 2015 to 54.74 million in 2020.⁹² This provides the government with a guaranteed 10-million-tonne reduction in emissions that will contribute towards its 2020 climate-change-strategy goal of achieving a 20 per cent reduction in absolute emissions

⁸⁵ Gouvernement du Québec, "A Brief Look at the Québec Cap-and-trade System for Emission Allowances", <http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/in-brief.pdf>.

⁸⁶ Gouvernement du Québec, "A New North American Carbon Market: Linking Québec and California's Cap-and-trade Systems", <http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/linking-quebec-california.pdf>.

⁸⁷ Government of Ontario, "Cap-and-trade System to Limit Greenhouse Gas Pollution in Ontario," News Release, April 13, 2015, <http://news.ontario.ca/opo/en/2015/04/cap-and-trade-system-to-limit-greenhouse-gas-pollution-in-ontario.html>.

⁸⁸ British Columbia Ministry of Finance, "Carbon Tax," http://www.fin.gov.bc.ca/tbs/tp/climate/carbon_tax.htm.

⁸⁹ Gouvernement du Québec, "The Québec Cap-and-trade System for Greenhouse Gas Emission Allowances: Frequently Asked Questions", <http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/q&a.pdf>.

⁹⁰ Gouvernement du Québec, "Québec Cap-and-trade System for Greenhouse Gas Emission Allowances: Technical Overview", <http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/technical-overview.pdf>.

⁹¹ Gouvernement du Québec, "Québec Cap-and-trade System for Greenhouse Gas Emission Allowances: Technical Overview".

⁹² International Carbon Action Partnership, "Canada — Québec Cap-and-trade System", July 20, 2015, https://icapcarbonaction.com/index.php?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=73.

relative to 1990 levels.⁹³ Other benefits include the opportunity for linking cap-and-trade systems between markets, which creates a harmonized price across jurisdictions and should incent emissions reductions at the most efficient facilities. Lastly, cap-and-trade systems also provide the opportunity for broad coverage. Québec's system applies to facilities with emissions in excess of 25,000 tonnes of CO₂e per year and requires distributors of fossil fuels to account for emissions produced from products — such as gasoline, heating oil or natural gas — that they distribute in Québec.⁹⁴ This ensures that both facility-level and individual and household emissions are covered by the system.

The main downside of a cap-and-trade system is that it is administratively complex and can be costly and difficult to manage.⁹⁵ The complexity also increases the likelihood of policy failure. Some critics argue this has happened in the European Union Emissions Trading System (ETS) where there is a surplus of permits that is due in part to policy-makers giving too many away in the initial allocation.⁹⁶ The surplus sent permit prices tumbling to €3 (\$5 CAD) per tonne of CO₂e in 2013. As of fall 2015, the price is hovering around €8 per tonne (\$12 CAD).⁹⁷ Despite recent measures taken by the European Union to reduce the number of available permits, the surplus is forecast to grow through to 2020, creating the risk that the ETS will become irrelevant.⁹⁸ This is because permit prices are too low to incent firms to invest in emissions reductions or transition to cleaner energy sources.

Another downside of a cap-and-trade system is that since the carbon price is set through an auction process, it is unpredictable and may fluctuate over time. This can create significant uncertainty for facilities — particularly large emitters — when making long-term financial-planning and capital-investment decisions. The Québec cap-and-trade system addresses this potential volatility by having an allowance reserve that provides permits at set prices in three categories. These prices were \$40, \$45 and \$50 per tonne in 2013 and will rise by five per cent plus inflation through to 2020.⁹⁹ While this provides firms with some assurance of a maximum permit price for long-term planning decisions, the range of possible prices spans from approximately \$10 to \$50 per tonne. As a result, there is still significantly more uncertainty than with a carbon tax, which provides firms with an assurance of the exact carbon price they will face over a set number of years.

⁹³ Office of the Auditor General of Canada, "Chapter 1 — Mitigating Climate Change," *2014 Fall Report of the Commissioner of the Environment and Sustainable Development*, 2014, http://www.oag-bvg.gc.ca/internet/English/parl_cesd_201410_01_e_39848.html#ex6n1.

⁹⁴ Gouvernement du Québec, "The Québec Cap-and-trade System for Greenhouse Gas Emissions Allowances," <http://www.mddelcc.gouv.qc.ca/changements/carbone/Systeme-plafonnement-droits-GES-en.htm>.

⁹⁵ Canada's Ecofiscal Commission, *The Way Forward: A Practical Approach to Reducing Canada's Greenhouse Gas Emissions*, April 2015, <http://ecofiscal.ca/wp-content/uploads/2015/04/Ecofiscal-Commission-Report-The-Way-Forward-April-2015.pdf>.

⁹⁶ Brad Plumer, "Europe's cap-and-trade program is in trouble. Can it be fixed?" *The Washington Post*, April 20, 2013, <http://www.washingtonpost.com/news/wonkblog/wp/2013/04/20/europes-cap-and-trade-program-is-in-trouble-can-it-be-fixed/>.

⁹⁷ Eex, "EU Emission Allowances: Primary Market Auction," <https://www.eex.com/en/market-data/emission-allowances/auction-market/european-emission-allowances-auction#!/2015/09/11>.

⁹⁸ Ewa Krukowska, "Poised to Double by 2020: Sandbag," *Bloomberg Business*, October 14, 2014, <http://www.bloomberg.com/news/articles/2014-10-14/europe-carbon-permit-glut-poised-to-double-by-2020-sandbag-says>.

⁹⁹ Gouvernement du Québec, *Québec Cap-and-trade System for Greenhouse Gas Emission Allowances: Technical Overview*.

Emissions Taxes

An emissions tax is a price per unit of greenhouse gas emissions, typically a tonne. It is generally paid directly by the emitter and can therefore be equally applied to an industrial emitter of any size, a commercial institution, an agricultural producer or an individual or household. In British Columbia the tax applies to all carbon emissions produced in the province through combustion processes. This corresponds to an average coverage of just under 75 per cent of the province's emissions from all sources.¹⁰⁰ The price was first introduced on July 1, 2008, at a value of \$10 per tonne. It increased in five-dollar increments over the next four years, reaching \$30 per tonne on July 1, 2012.¹⁰¹ The province has committed to maintaining it at this level until 2018.¹⁰²

Another key attribute of British Columbia's system is that it is legislated to be revenue neutral. That is, each year the government is required by law to table an annual plan that shows how revenue collected from the carbon tax is returned to taxpayers through tax reductions in other areas.¹⁰³ Examples of tax reductions funded by the carbon tax are reductions in the first two personal income tax rates of five per cent, one to two per cent reductions in the general and small business corporate tax rates, and tax credits and benefits for low-income and rural and northern households.¹⁰⁴

British Columbia's carbon tax has been widely hailed as a success. The World Bank and the OECD have both identified it as an example of leadership in carbon pricing, with the OECD calling it "as near as we have to a textbook case."¹⁰⁵ The Economist has referred to its ability to curb emissions as a "roaring success."¹⁰⁶ A recent evaluation of the price suggests that it has reduced emissions in the province by five to 15 per cent and had little effect on the province's aggregate economic performance.¹⁰⁷

In comparison to a cap-and-trade system, an emissions tax is generally considered to be a much simpler and more transparent policy approach. The schedule for the tax is typically

¹⁰⁰ Authors' calculations. Source: Government of Canada, "National and Provincial/Territorial Greenhouse Gas Emission Tables."

¹⁰¹ British Columbia Ministry of Finance, "Carbon Tax Review," *June Budget Update — 2013/14 to 2015/16*, http://www.fin.gov.bc.ca/tbs/tp/climate/Carbon_Tax_Review_Topic_Box.pdf.

¹⁰² Government of British Columbia, *Discussion Paper: Climate Leadership Plan*, July 2015, <https://engage.gov.bc.ca/climateleadership/files/2015/07/ClimateLeadershipPlanDiscussionPaper.pdf>.

¹⁰³ British Columbia Ministry of Finance, "Tax Reductions, Funded by a Revenue Neutral Carbon Tax," http://www.fin.gov.bc.ca/tbs/tp/climate/tax_cuts.htm.

¹⁰⁴ Government of British Columbia, *Budget and Fiscal Plan 2015/16–2017/18*, 2015, http://bcbudget.gov.bc.ca/2015/bfp/2015_budget_and_fiscal_plan.pdf.

¹⁰⁵ World Bank Group Climate Change, *Climate Leadership in Action: Climate Pricing*, <http://www.worldbank.org/content/dam/Worldbank/document/Climate/climate2014-carbon-pricing-brief-091214.pdf>; OECD Environment Policy Papers, *Climate and Carbon: Aligning Prices and Policies*, October 2013, http://www.oecd-ilibrary.org/environment-and-sustainable-development/climate-and-carbon_5k3z11hjg6r7-en;jsessionid=01sds8pjjg6u0.x-oecd-live-02; OECD, "The climate challenge: Achieving zero emissions," Lecture by the OECD Secretary-General, Mr. Angel Gurría, October 9, 2013, <http://www.oecd.org/about/secretary-general/The-climate-challenge-achieving-zero-emissions.htm>.

¹⁰⁶ The Economist, "Climate policy in Canada: The land of green and money," August 4, 2013, <http://www.economist.com/blogs/americasview/2013/08/climate-policy-canada>.

¹⁰⁷ Brian C. Murray and Nicholas Rivers, *British Columbia's Revenue Neutral Carbon Tax: A Review of the Latest "Grand Experiment" in Environmental Policy*, Duke University, Nicholas Institute for Environmental Studies, Sustainable Prosperity and uOttawa Institute of the Environment, Working Paper NI WP 15-04, May 2015, https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_15-04_full.pdf.

well defined over a period of time, providing certainty with respect to the price, and thereby the average and marginal cost of emissions. There is also no need to discuss alternative methods for meeting an emissions-reduction obligation — such as offset credits, emission-performance credits or early-reduction credits — as there is no reduction requirement. Rather, emission reductions under the tax are all induced reductions that are a market response to paying for something that previously had no cost.

The reliance on a behavioural response to achieve emissions reductions is also, however, the main downside of a tax.¹⁰⁸ More specifically, whereas a cap-and-trade system provides some degree of certainty as to the level of emission reductions that will be achieved in a given year, the emissions reductions resulting from a tax will generally be more difficult to forecast. Beyond following the basic law of demand — that is, as the tax increases, emissions will decrease — it is difficult to predict the volume of emission reductions that will be achieved at a certain tax level, or alternatively, what the value of the tax must be in order to achieve a desired level of emissions reductions.

Another challenge with the tax is its impact on the competitiveness of trade-exposed industries and the potential for carbon leakage. Carbon leakage refers to a scenario where a carbon-pricing policy results in market share shifting from a jurisdiction with a high carbon price towards one with a lower price or none at all. This can be driven either by companies physically relocating to a jurisdiction with lower production costs, or by consumers shifting their consumption towards lower-priced goods from the lower-cost jurisdiction. In either scenario, the carbon-pricing policy will result in a higher cost to the economy due to the negative competitive impacts on trade-exposed industries. In addition, the impact of the jurisdiction's emissions reductions on global CO₂e levels will be negated by the increase in emissions in jurisdictions where market share — and production — increases.

A cap-and-trade system can directly address the impact of a carbon price on trade-exposed industries by providing operators in the industry with a free allocation of emission permits. Provided the allocation is not significantly beyond what the operator would otherwise emit, this will encourage a facility to control its emissions without imposing a significant negative impact on its competitiveness.¹⁰⁹ A reduction incentive is also provided when the facility has the option of selling its permits in the emissions-trading market. Protecting trade-exposed industries with a carbon tax, alternatively, can be more difficult. One option is to provide facilities in a trade-exposed sector with carbon-tax exemptions or relief grants. British Columbia, for example, currently employs both options in specific agricultural

¹⁰⁸ Canada's Ecofiscal Commission, *The Way Forward*.

¹⁰⁹ While free permits can be a benefit of the cap-and-trade system, it is important to recognize that they may create inadvertent distributional impacts. A forthcoming paper in the journal *Canadian Public Policy* finds that permit handouts in the Québec cap-and-trade system are likely to create “windfall profits” for firms. This revenue is passed down to shareholders, who are disproportionately high-income earners. To balance this impact, the paper recommends that future policy platforms include higher subsidies or energy-efficiency rebate programs for low-income families. Source: Christopher Barrington-Leigh, Bronwen Tucker and Joaquin Kritiz-Lara, *The short-run household, industrial and labour impacts of the Québec carbon market*, November 2014, <http://wellbeing.ihsp.mcgill.ca/publications/Barrington-Leigh-Tucker-2014-quebec-carbon-system.pdf>.

sectors.¹¹⁰ The challenge, however, is that unless there is a cap placed on the amount of the exemption or grant, it significantly reduces any incentive the facility has to control or reduce its emissions. A better alternative is arguably to use a cap-and-trade type approach that allows facilities in trade-exposed sectors to emit up to a threshold level of carbon emissions at zero cost, and then applies the full value of the carbon tax on all emissions that exceed the threshold.

A second option is to use trade mechanisms to adjust the prices of goods at the border — an import adjustment would raise the price of imports to account for their carbon content, while an export adjustment would provide a rebate of the carbon compliance cost on exported goods. Both options, however, have significant shortcomings. Import adjustments can act as a cover for trade protectionism and introduce a barrier to trade that is inefficient and imposes additional costs on consumers and industry.¹¹¹ An export adjustment, alternatively, is essentially another form of a relief grant. As a result, it significantly reduces the incentive of the domestic facility to control or reduce its emissions, thereby negating the intent of the carbon tax.

OUR RECOMMENDATION FOR ALBERTA: A CARBON TAX

Our recommendation is for Alberta to proceed with the simplest, least costly and most transparent emissions-reduction strategy going forward. In our view, that is a carbon tax with full revenue recycling. While a comprehensive emissions tax would be preferable, in that it would price all greenhouse gas emissions in Alberta, carbon emissions from combustion of energy sources are the easiest to track and measure, and administrative simplicity should also be a consideration. Following B.C.'s lead, if Alberta put a broad-based tax on emissions produced through combustion processes, it would cover approximately 87 per cent of emissions, 73 per cent when excluding fugitive emissions, based on 2013 emissions data.¹¹² Even excluding fugitive emissions, this would be a significant step forward from SGER, with not only more emissions priced, but facing a higher price as well.

As shown in previous work, a carbon tax has the significant benefit of being neutral across firms, making it less costly in terms of productivity.¹¹³ That is, the change in energy prices

¹¹⁰ Specifically, in 2012 British Columbia introduced a carbon-tax relief grant for commercial greenhouse growers that refunds 80 per cent of the carbon tax paid on natural gas and propane for heating and carbon dioxide production. In 2014, the province introduced a carbon-tax exemption on the purchase of coloured gasoline and coloured diesel fuel for farm use. These programs were introduced in response to concerns that the carbon tax was having an undue negative impact on the competitiveness of British Columbia's agricultural sector. A 2014 study, however, found little evidence that the carbon tax had a statistically significant effect on agricultural competitiveness or trade in the province. Source: Nicholas Rivers and Brandon Schaufele, *The Effect of British Columbia's Carbon Tax on Agricultural Trade*, Pacific Institute for Climate Solutions, July 2014, http://pics.uvic.ca/sites/default/files/uploads/publications/Carbon%20Tax%20on%20Agricultural%20Trade_0.pdf.

¹¹¹ Sustainable Prosperity, *The Competitiveness of a Trading Nation: Carbon Leakage and Canadian Climate Policy* (Policy Brief), March 2011, <http://www.sustainableprosperity.ca/sites/default/files/publications/files/The%20Competitiveness%20of%20a%20Trading%20Nation.pdf>.

¹¹² Environment Canada, "National Inventory Report 1990-2013."

¹¹³ Trevor Tombe and Jennifer Winter, "The Importance of Policy Neutrality for Lowering Greenhouse Gas Emissions," *SPP Research Papers* (Volume 6, Issue 4), March 2013, <http://www.policyschool.ucalgary.ca/?q=content/importance-policy-neutrality-lowering-greenhouse-gas-emissions>.

is the same for all firms, regardless of size or industry, meaning no distortions to economic activity are introduced by the policy. The carbon tax can also be equally and directly applied to emissions attributable to individuals. This makes it the option with the broadest and most direct coverage.

At the facility level, cost neutrality is not a characteristic that is shared by SGER, which only applies to large emitters and affects these firms differently depending on their productivity and the emissions-intensity of their production. While a cap-and-trade program would be an improvement over SGER, the price of carbon can vary from one auction to the next, creating the potential for differential treatment among firms and uncertainty with respect to planning for long-term emission costs. A cap-and-trade system will generally also have the additional complexity of managing a credit system for emissions. Lastly, while it has broader facility coverage than does SGER, it will typically still have a minimum threshold for participation. Below this threshold there will be emissions that are not covered by any policy.

When considering a policy to address emissions reductions at the individual level, SGER is irrelevant, as there is no mechanism through which it applies to individuals. Québec's cap-and-trade system indirectly includes individual emissions by requiring distributors of fossil fuels to obtain emission permits. For example, a refinery distributing gasoline must obtain emission permits for the amount of carbon that is released when the gasoline is combusted in a vehicle engine. The permit price is equivalent to a carbon tax applied to the producer side of the market, and economic theory tells us the tax incidence — the share of the tax paid by producers versus consumers — will be the same as if the carbon tax was applied directly to consumption.

If the incidence of a cap-and-trade program versus a carbon tax on consumers is the same, then this suggests the consumption response will also be the same. This conclusion, however, ignores the fact that the carbon cost to individuals under a cap-and-trade system is arguably less transparent and less certain than in the case of a direct carbon tax, and this can affect a consumer's behavioural response. For example, recent research on the salience of British Columbia's carbon tax on motor gasoline demand found that, holding all else constant, a five-cent increase in a carbon tax on gasoline will lead to an 8.4 per cent decline in demand. In contrast, an identical five-cent increase in the market price of gasoline will lead to a decline in demand of only 2.1 per cent.¹¹⁴ The authors therefore conclude that the carbon tax is four times more salient than the market price of gasoline. It is not unreasonable to expect similar results to apply to natural gas for residential heating. As the cost of the cap-and-trade policy is likely to get passed down to consumers as higher market prices for fuels — as opposed to a dedicated line item explicitly stating the amount of the carbon tax — this suggests a cap-and-trade system will be less effective than a carbon tax at achieving individual-level emissions reductions.

With broad coverage, the largest downside risk of a carbon tax is likely to be its competitive impact on trade-exposed industries. A study of the effect of a national carbon price on Canada's competitiveness found the largest impact to be in fossil-fuel-extraction industries,

¹¹⁴ Nicholas Rivers and Brandon Schaufele, "Salience of carbon taxes in a gasoline market," *Journal of Environmental Economics and Management*, Volume 74 (November 2015), 23-36.

suggesting companies in the oil and natural gas sector may be particularly at risk.¹¹⁵ The authors assume, however, a carbon price that rises from \$15 per tonne of CO₂e in 2010 to \$115 per tonne in 2020, which is likely well beyond the value of a potential carbon tax in Alberta. Given the value of Alberta's proposed carbon tax is in the sub-\$50 range, we recommend all sectors be covered to start, but for the government to monitor the impacts on trade-exposed industries. If negative competitive impacts are found, then the tax can be amended to introduce measures such as those previously described to help mitigate competitive impacts. In addition, if revenue from the carbon tax is used to lower corporate income taxes, this would mitigate some of the negative consequences to trade-exposed firms.

Potential Costs of a Carbon Tax

To get a rough sense of the cost of a broad-based carbon tax on various sectors of Alberta's economy, we use sector-level emissions and estimated gross output¹¹⁶ data from 2013¹¹⁷ to approximate the annual cost of a \$20, \$30 and \$40 per tonne carbon tax as a percentage of gross revenues by sector. Note, this approach assumes no behavioural response to the carbon tax. That is, it assumes emissions from each sector would remain unchanged at observed 2013 levels. This is clearly not a desirable response, as the motivation of the carbon tax is not to raise the maximum amount of revenues (with full revenue recycling, its net impact on government revenues will be zero), but rather to reduce Alberta's emissions. Forecasting the precise impacts of a carbon tax, however, is beyond the scope of this paper. In particular, we lack the economic model that is required for such an analysis. Rather, our objective is to provide a high-level overview of the potential magnitude of costs, and identify how they may differ between sectors. We also use all emissions for the calculation, rather than the 87 per cent emissions associated with combustion and fossil fuel development. We use all emissions for simplicity, as well as to demonstrate the maximum possible cost to the Alberta economy resulting from an emissions tax. In the remainder of this section, we will use carbon tax and emissions tax synonymously.

By failing to assume a behavioural response, our estimates provide an upper bound on what the true costs to each sector will be. These estimates correspond most closely to a “very short-run” scenario in which firms do not adjust their prices, or invest in emissions

¹¹⁵ Chris Bataille, Benjamin Dachis and Nic Rivers, *Pricing Greenhouse Gas Emissions: The Impact on Canada's Competitiveness*, C.D. Howe Institute Commentary, February 2009, https://www.cdhowe.org/pdf/commentary_280.pdf.

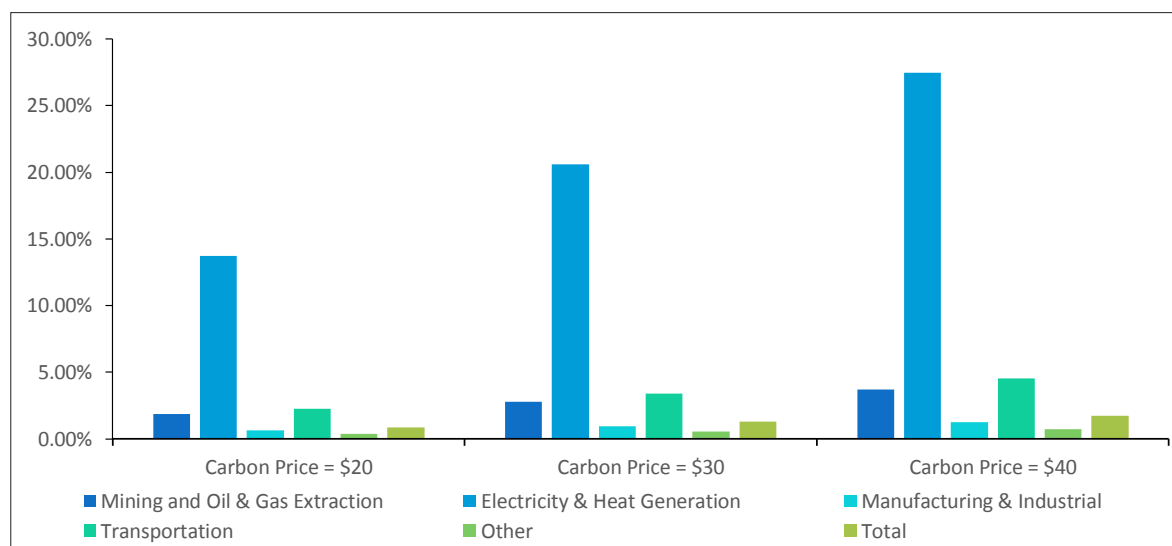
¹¹⁶ We use gross output as it is equivalent to the revenue of a sector and so, calculating the carbon tax as a percentage of gross revenue indicates how revenue will fall as a result of the carbon tax.

¹¹⁷ Gross output by sector is available from Statistics Canada, but the most recent available year is 2011. To approximate gross output in 2013, we assume that gross output in each sector grows at the same rate as sector-specific nominal GDP. To obtain the nominal GDP growth rates by sector, we calculate sector-specific nominal GDP in 2011 and 2013 using Alberta's expenditure-based GDP in current dollars and the sector shares of GDP (at basic prices). Using the two different measures of GDP (expenditure-based versus basic prices) introduces some error to our calculations as the former includes taxes and subsidies and is therefore consistently higher than GDP measured at basic prices. Sources: (1) Statistics Canada. *Table 381-0031 — Provincial gross output, by sector and industry, annual (dollars)*, CANSIM (database), <http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3810031>; (2) Statistics Canada. *Table 384-0038 — Gross domestic product, expenditure-based, provincial and territorial, annual (dollars unless otherwise noted)*, CANSIM (database), <http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3840038>; and (3) Statistics Canada. *Table 379-0028 — Gross domestic product (GDP) at basic prices, by North American Industry Classification System (NAICS), provinces and territories, annual (percentage share)*, CANSIM (database); <http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=3790028>.

reductions, in response to the carbon tax.¹¹⁸ As a result, revenues fall by the total amount of the carbon-tax payments. In going beyond the very short-run, the burden will be less than what we calculate. Specifically, in the short term, firms will be able to adjust output prices and pass a portion of the tax burden downstream to consumers and intermediate producers. In the medium to long term, assuming a sufficiently high tax, firms will likely invest in alternative production technologies that result in emissions reductions.

Figure 6 shows sector and province-wide costs as a percentage of gross output for an assumed carbon tax of \$20, \$30 and \$40 per tonne. As expected, the sector most heavily impacted by the carbon tax is the electricity and heat generation sector. This is consistent with our previous results that showed the electricity and heat generation sector had the highest emissions intensity per unit of GDP in the province. The cost of the carbon tax in this sector ranges from 14 per cent of gross output at a price of \$20 per tonne to 27 per cent of gross output at a price of \$40 per tonne.^{119,120} This does not account, however, for the fact that a portion of the higher cost on electricity producers will almost certainly be passed down to consumers through higher electricity rates. As higher electricity rates will increase the sector's gross output, the burden of the carbon tax on electricity producers will be less, although likely still high in relation to other sectors in the province.

FIGURE 6 COST OF CARBON TAX AS A PERCENTAGE OF GROSS OUTPUT



Source: Authors' calculations using Statistics Canada CANSIM Tables 381-0031, 384-0038 and 379-0028, and Government of Canada, National and Province/Territorial Greenhouse Gas Emissions Tables. See footnote 117 for a description of the methodology for calculating gross output.

In the mining and oil and gas extraction sector, the cost of the carbon tax represents only two to four per cent of gross output. This suggests the carbon tax is unlikely to represent

¹¹⁸ Barrington-Leigh, Tucker and Kritz-Lara, "The short-run household, industrial and labour impacts of the Québec carbon market".

¹¹⁹ Authors' calculations. Source: (1) Statistics Canada, CANSIM Table 381-0031; (2) Statistics Canada, CANSIM Table 384-0038; (3) Statistics Canada, CANSIM Table 379-0028; and (4) Government of Canada, National and Provincial/Territorial Greenhouse Gas Emission Tables.

¹²⁰ These cost estimates are based on current emissions from Alberta's electricity sector. Given the high cost to the sector, it is not unreasonable to expect that in the long term, the sector will respond to carbon pricing by shifting away from coal and towards less-emissions-intensive sources of electricity such as natural gas and renewables. In this scenario the carbon cost to the sector — and thereby consumers — will decrease in the long term.

an undue burden on the sector, particularly when also considering that, if the carbon tax is set up in a similar fashion to the carbon levies that are paid under SGER, then it will lower other costs, such as corporate income taxes and royalties, for firms. For example, if we assume an in situ project has an emissions intensity of 0.67 tonnes of CO₂e per barrel — the average for 2011 — then a carbon tax of \$20 to \$40 per tonne will result in a per barrel carbon levy ranging from \$1.33 to \$2.67. If the in situ project has paid off its initial capital investment, then it pays a royalty of 25 to 40 per cent of net revenues. Assuming the carbon tax is an allowable deduction for royalty obligations, the per barrel royalty owed by the project would be reduced by \$0.33 to \$1.07. That is, the project would essentially receive 25 to 40 per cent of the carbon tax back through the lower royalty. In addition, with the corporate income tax now at 12 per cent, per barrel taxes owed by the project would decrease by \$0.12 to \$0.31. In total then, the per barrel cost of the carbon tax is effectively reduced by one-third to one-half as a result of a lower royalty and tax liability. However, making the carbon tax an allowable deduction undermines the effectiveness of the tax, as the price on emissions is now reduced by the amount of the deduction, reducing the incentive to lower emissions. We strongly suggest the carbon tax be excluded from allowable deductions, and that lowering the corporate income tax rate is a preferable policy alternative for reducing firms' costs.

In the transportation sector, the burden of the carbon tax is two to five per cent of gross output. Again, this is to be expected given that the transportation sector has a higher emissions intensity than that of most other sectors in the province. In contrast, in the manufacturing and industrial sector, which also encompasses fossil fuel production and refining, the cost of the carbon tax is much lower, at only 0.6 to 1.3 per cent of gross output. Similar, in the “other” category — which accounts for 46 per cent of the province's gross output and includes emissions from agriculture, waste, construction and commercial and institutional facilities — the cost of the carbon tax is estimated at only 0.37 to 0.75 per cent of gross output. The small burden of the carbon tax in these sectors, combined with their large share of the province's gross output, pulls down the provincial impact of the carbon tax quite substantially. Province-wide, the estimated cost of the carbon tax ranges from 0.9 per cent of gross output at a price of \$20 per tonne to 1.7 per cent at a price of \$40 per tonne.

As noted above, one of the benefits of a carbon tax with respect to coverage is that it can be levied directly against carbon emissions resulting from energy consumption by individuals (and will have more salience than an equivalent price increase). The primary areas of individual energy consumption are transportation and residential use, including heating (home and water) and electricity. In the case of transportation and heating, individuals typically purchase the fossil fuel directly — gasoline for vehicles or natural gas for residential heating, for example — and in these cases they will pay the carbon tax directly. Alternatively, in the case of electricity generated by fossil fuels (coal or natural gas in Alberta), the carbon tax will be levied against the producer. Alberta's fossil-fuel-electricity producers have influence over the price of electricity in Alberta through the prices they submit for providing supply. Therefore, it is likely that a portion of their higher costs will be passed down to the consumer through higher electricity rates.

We can approximate the impact of the carbon tax on individuals by looking at both energy prices and household expenditures on energy. Starting with energy prices, as is the case

in British Columbia, the tax per unit of consumption will be determined by the amount of carbon dioxide that is released upon combustion. Table 6 summarizes the emissions-intensity factors for motor gasoline and natural gas (the most common fuel in Alberta for home heating). It also provides the average emissions-intensity factor for electricity generation from all sources in Alberta. Based on these emissions intensities, at a value ranging from \$20 to \$40 per tonne, the tax on gasoline would be \$0.05 to \$0.09 per litre, on natural gas it would be \$1.01 to \$2.01 per GJ, and on electricity it would be \$0.01 to \$0.03 per kWh.

Prices for energy in Alberta — as in other jurisdictions — are highly variable. Gasoline prices fluctuate on a weekly or even daily basis, while natural gas and electricity prices can either fluctuate monthly based on current market conditions, or households can sign fixed-price contracts for a set term. As we cannot use an exact price, Table 6 provides example prices for motor gasoline, natural gas and electricity that are reflective of market conditions in Alberta in September 2015. At these example prices, a carbon tax of \$20 to \$40 per tonne would correspond to an increase in price of 4.3 to 8.7 per cent for a litre of motor gasoline, 18.3 to 36.7 per cent for a GJ of natural gas and 22.3 to 44.7 per cent for a kWh of electricity. It is important to note, however, that these percentages are upper bounds as they assume the entire incidence of the carbon tax falls on consumers. The more likely scenario is the distribution of the tax will be shared, with producers lowering their base prices in order to mitigate a negative demand impact. It is also worthwhile to note that a household's total expenditures on natural gas and electricity do not only include the unit charges for energy, but also a range of fixed costs — most notably, delivery and distribution charges. As a result, the impact of the carbon tax on a household's natural gas and electricity bills will be less than the increases per consumption unit that are identified in Table 6.

TABLE 6 COST OF CARBON TAX TO HOUSEHOLDS BY EXAMPLE ENERGY PRICES

		Motor Gasoline		Natural Gas		Electricity	
Consumption Unit		Litre		GJ		kWh	
Emissions Intensity (g of CO ₂ e per unit)		2,322		50,321		614	
Sample Unit Price (September 2015)		\$1.069		\$5.49		\$0.055	
Carbon Tax per Consumption Unit (Value Per cent of sample price)	\$20.00	\$0.0464	4.3%	\$1.0064	18.3%	\$0.0123	22.3%
	\$30.00	\$0.0697	6.5%	\$1.5096	27.5%	\$0.0184	33.5%
	\$40.00	\$0.0929	8.7%	\$2.0128	36.7%	\$0.0246	44.7%

To estimate the impact of the carbon tax on total household energy expenditures we use 2012 energy-consumption data from Natural Resources Canada. Again we assume no behavioural response to the carbon tax. That is, we assume household energy consumption remains unchanged at 2012 levels, an assumption that once again corresponds most closely to the impact of the carbon tax in the very short term. As before, we acknowledge this is not an accurate or desired outcome of the carbon tax. However, as we do not have the means of accurately estimating the changes in consumption, we opt to present these results as an approximation of the upper threshold of the cost of the carbon tax. They also provide an indication of the direction and relative magnitude of the tax burden on different energy-consumption categories.

The results of our estimates are summarized in Table 7. Starting with direct residential fuel costs, in 2012 the average Alberta household generated 5.98 tonnes of CO₂e emissions per year from water heating, space heating and appliances (i.e., natural gas stoves).¹²¹ This implies that at a carbon tax of \$20, \$30 and \$40 per tonne, at 2012 consumption levels the average household will pay a total annual carbon cost of \$120, \$179 and \$239 respectively. Statistics Canada household-expenditure data from 2012 show that the average Alberta household spent a total of \$953 annually on natural gas and other fuel for their primary residence.¹²² As a rough approximation, this suggests the carbon tax will increase the average household's residential fuel costs by between 13 and 25 per cent. Note these estimates are approximately five to 12 per cent lower than the impact of the carbon tax on the per GJ cost of natural gas. Again, this reflects the impact of the fixed costs from a household's natural gas bill, which remain unchanged with the introduction of a carbon tax.

TABLE 7 ANNUAL COST OF CARBON TAX TO HOUSEHOLDS BY ENERGY USE

			Residential Fuel	Road Transportation	Air Transportation	Electricity	Total Energy Expenditures	Total Household Expenditures
Average Annual Household Expenditures			\$953	\$2,581	\$1,041	\$1,406	\$5,981	\$77,501
Average Annual Household Emissions (t)			5.98	5.08	1.65	4.32	17.03	
Annual Impact of Carbon Tax	\$20 per tonne	Cost Increase	\$119.55	\$101.68	\$32.98	\$86.40	\$340.61	
		Per cent Increase	12.54%	3.94%	3.17%	6.15%	5.69%	0.44%
	\$30 per tonne	Cost Increase	\$179.32	\$152.52	\$49.47	\$129.60	\$510.91	
		Per cent Increase	18.82%	5.91%	4.75%	9.22%	8.54%	0.66%
	\$40 per tonne	Cost Increase	\$239.09	\$203.37	\$65.96	\$172.80	\$681.22	
		Per cent Increase	25.09%	7.88%	6.34%	12.29%	11.39%	0.88%

Source: Authors' calculations using Natural Resources Canada Comprehensive Energy Use Database and Statistics Canada CANSIM Table 203-0021.

We perform a similar calculation to approximate the impact of the carbon tax on individual transportation expenditures. In 2012, the average household generated 5.08 tonnes of CO₂e from road transportation and 1.68 tonnes from air transportation.¹²³ A carbon tax ranging from \$20 to \$40 per tonne will therefore cost the average household an additional \$102 to \$203 per year in road transportation costs, and \$33 to \$66 per year in air transportation costs. Average household expenditures in each of these categories in 2012 were \$2,581 and \$1,041 annually.¹²⁴ While it is again only a rough approximation, this suggests a carbon tax will increase the average household's vehicle-fuel expenditures by four to eight per

¹²¹ Natural Resources Canada, "Comprehensive Energy Use Database, Residential Sector: Alberta," http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_res_ab.cfm.

¹²² Statistics Canada, *Table 203-0021 — Survey of household spending (SHS), household spending, Canada, regions and provinces, annual (dollars)*, CANSIM (database), <http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=2030021>.

¹²³ Natural Resources Canada, "Comprehensive Energy Use Database, Transportation Sector: Alberta," http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_tran_ab.cfm.

¹²⁴ Statistics Canada, *Table 203-0021*.

cent, and air-transportation expenditures by two to five per cent. Note that, in this case, the estimate of the impact of the carbon tax on annual vehicle-fuel expenditures is very close to the estimate of the impact of the carbon tax on the unit price of motor gasoline. This is expected since the unit price of motor gasoline is inclusive of all additional taxes and fees and is the only price component of a household's vehicle-fuel expenditures. That is, a household's vehicle-fuel expenditures is simply equal to the unit price of motor gasoline multiplied by the quantity purchased. They do not face any additional fixed costs or taxes as in the case of natural gas and electricity.

The impact of the carbon tax on a household's electricity expenditures is more difficult to approximate since, as noted previously, in this case the carbon tax is not paid directly by the household, but rather passed down through higher electricity rates. However, we can again look at average consumption and expenditure information for a rough approximation. In 2012, the average Alberta household spent \$1,406 per year on electricity¹²⁵ and consumed 7,044 kWh.¹²⁶ Alberta's average electricity-emissions intensity in 2012, accounting for all sources of electricity production (renewable and fossil fuel), was 0.61 tonnes of CO₂e per 1000 kWh,¹²⁷ implying the average household produced 4.32 tonnes of CO₂e per year from electricity consumption. At a carbon tax of \$20 to \$40 per tonne, and assuming 100 per cent of the cost to the electricity producer is passed down to the consumer (an upper threshold), this would increase the average consumer's electricity costs by \$86 to \$173 per year, or by six to 12 per cent. This is significantly less than the per unit costs estimated in Table 6, and again reflects high fixed costs on electricity bills that act as a cushion on the overall impact of the carbon tax on total electricity expenditures.

In total then — across all three primary areas of individual energy consumption — we can roughly approximate that a carbon tax of \$20, \$30 and \$40 per tonne will increase annual household expenditures on energy by \$341, \$511 and \$681 per year respectively. This represents an increase in energy expenditures of six to 11 per cent. Relative to total average household expenditures, excluding income taxes, of \$77,501 per year, however, the increase due to a carbon tax is only 0.44 to 0.88 per cent.

It is also worth noting the increase in household energy expenditures will likely be offset, in part, by lower personal income taxes as a result of revenue recycling. British Columbia, for example, has used revenues from the carbon tax to lower its first two personal income tax rates by five per cent. The forecast decrease in personal income taxes for the 2014/15 fiscal year is \$269 million,¹²⁸ corresponding to an average of \$147 per household.¹²⁹ Using the same methodology as we used to derive the results in Table 7, we can estimate the cost

¹²⁵ Statistics Canada, *Table 203-0021*.

¹²⁶ Authors' calculations using electricity-usage statistics from Alberta Energy and number of households from Natural Resources Canada Energy Use database. Source: (1) Alberta Energy, "Electricity Statistics: Customer Usage Estimates," <http://www.energy.alberta.ca/electricity/682.asp>; and (2) Natural Resources Canada, "Comprehensive Energy Use Database, Residential Sector."

¹²⁷ Authors' calculations. Source: (1) Government of Canada, "National and Provincial/Territorial Greenhouse Gas Emission Tables"; and (2) Alberta Utilities Commission, "Annual electricity data collection: Total generation."

¹²⁸ Government of British Columbia, *Budget and Fiscal Plan: 2015-16–2017-18* (2015), http://bcbudget.gov.bc.ca/2015/bfp/2015_budget_and_fiscal_plan.pdf.

¹²⁹ Authors' calculations using the estimate of number of households from the Natural Resources Canada Energy Use database. Source: Natural Resources Canada, "Comprehensive Energy Use Database, Residential Sector: British Columbia," http://oe.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_res_bc.cfm.

of the carbon tax in British Columbia at \$381 per year for the average household.¹³⁰ This suggests that, on average, 40 per cent of a household's carbon tax expenditures are being offset by lower personal income taxes.

Again, our estimates of changes in household energy expenditures represent upper-threshold estimates of the impact of a carbon tax on the average household in Alberta. Looking specifically at lower-income households, the burden has the potential to be higher, as these households tend to spend a greater proportion of their disposable income on necessities such as energy. We can roughly approximate the additional burden of the carbon tax on lower-income households using Statistics Canada expenditure data that report household spending by quintile. In Alberta in 2012, the lowest quintile of households spent, on average, \$532 per year on natural gas, \$997 per year on electricity, \$1,141 per year on motor gasoline and \$268 per year on airline travel.¹³¹ These values correspond to decreases of 29 to 75 per cent relative to the average household. If we assume, as a rough approximation, that the carbon-tax burden falls by the same amount, then for a low-income household we find the total cost of the carbon tax per year ranges from \$181 to \$363, or an increase in after-tax household expenditures of 0.5 to 1.0 per cent.¹³²

This suggests the burden of the carbon tax on low-income households will, at most, only be slightly higher than for the average household. In addition, with revenue recycling, it is arguably more likely that the overall tax burden on low-income households will remain relatively unchanged — and may even decrease. Again looking to British Columbia as an example, that province offers a low-income climate-action tax credit — equal to \$114.50 per adult and \$34.50 per child (or \$114.50 for the first child in a single-parent family) — for households that fall below set income thresholds. The credit is non-taxable and paid out quarterly in conjunction with the GST/PST refund. If Alberta were to offer a tax-credit of a similar amount, a two-parent, two-child low-income household would receive an additional payment of \$298 per year, well exceeding the lower bound of the carbon-tax estimate and equal to 82 per cent of the upper bound.

Lastly, we can consider the impact of a carbon tax on government revenues. As with our other calculations, this assumes no behavioural response to the carbon tax and is therefore only an approximate upper bound on revenues that may be collected. As shown in Figure 7, based on 2013 emission levels, a carbon tax of \$20, \$30 and \$40 per tonne will generate

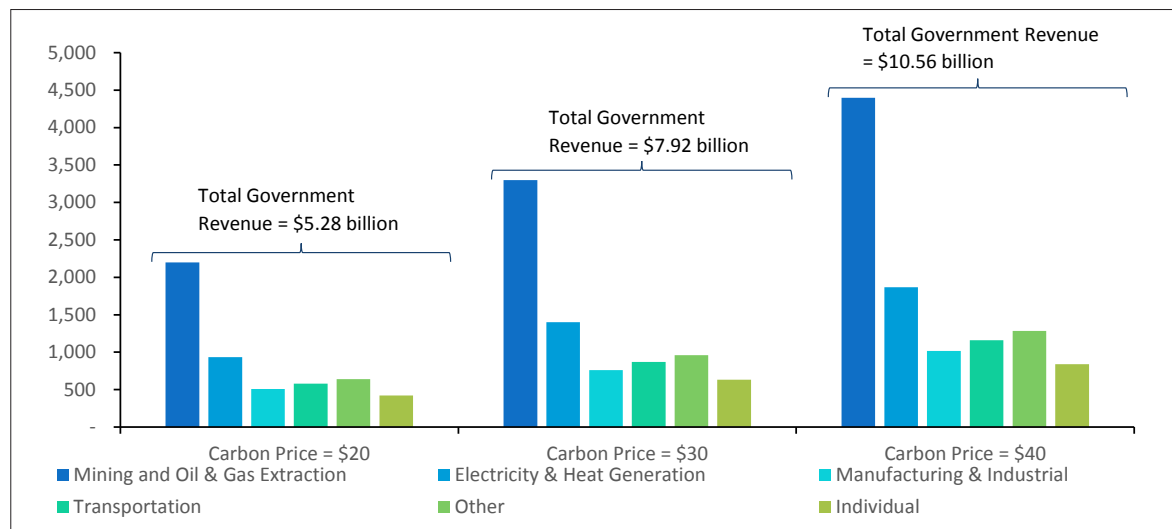
¹³⁰ Authors' calculations. Source: (1) Natural Resources Canada, "Comprehensive Energy Use Database, Residential Sector: British Columbia"; (2) Natural Resources Canada, "Comprehensive Energy Use Database, Transportation Sector: British Columbia," http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menu/trends/comprehensive/trends_tran_bct.cfm; and (3) Statistics Canada, *Table 203-0021*.

¹³¹ Statistics Canada. *Table 203-0022 — Survey of household spending (SHS), household spending, Canada, regions and provinces, by household income quintile, annual (dollars)*, CANSIM (database), <http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=2030022>.

¹³² Due to the fixed costs included on natural gas and electricity bills, the actual decrease in energy use will be greater than proportional to the decrease in energy expenditures. As a result, our rough approximation is an upper threshold on the cost of the carbon tax to low-income households as it overestimates energy consumption.

approximate government revenues of \$5.28, \$7.92 and \$10.56 billion respectively.¹³³ As a point of reference, estimated government revenues collected in the 2014/15 fiscal year were \$49.0 billion. This included \$11.0 billion in personal income tax revenue and \$5.7 billion in corporate income tax revenue.¹³⁴

FIGURE 7 ANNUAL GOVERNMENT REVENUES FROM CARBON TAX



Source: Authors' calculations using "Government of Canada, National and Provincial/Territorial Greenhouse Gas Emissions Tables."

As is the case in British Columbia, our recommendation is that a carbon tax in Alberta be introduced with a revenue-recycling guarantee. With this guarantee, all government revenue generated from the carbon tax would be used to offset other taxes collected in the province. Research on environmental taxes, including a carbon tax, has shown that they can lead to negative welfare effects — that is, they make the economy worse off as a whole — as a result of a tax-interaction effect.¹³⁵ This occurs when a new tax that distorts the economic decisions of firms and individuals is introduced on top of pre-existing taxes — such as corporate and personal income taxes — that carry their own distortions. This negative welfare effect can be offset, however, and the carbon price can lead to welfare gains — that is, the economy is made better off as a whole — when a revenue-recycling

¹³³ The carbon tax of \$30 per tonne in British Columbia generated \$1.222 billion in government revenues in the 2013/14 fiscal year (Source: Government of British Columbia, *Budget and Fiscal Plan*). Our estimate of government revenues from an equivalent tax in Alberta is \$7.92 billion per year, nearly six times this amount. There are three primary contributions to this discrepancy. First, Alberta's emissions in 2013 were 4.25 times larger than emissions in British Columbia. Second, the carbon tax in British Columbia applies only to combustion emissions (70 per cent of British Columbia's emissions), whereas we are estimating carbon-tax revenues for Alberta assuming the tax is applied to all of the province's emissions. Finally, 2013 was the first full year of the carbon-tax relief program for greenhouse growers in British Columbia. This further reduced the base of combustion emissions that qualified to pay the full carbon tax.

¹³⁴ Government of Alberta, "*Budget 2015: Fiscal Plan Tables*," <http://finance.alberta.ca/publications/budget/budget2015/fiscal-plan-tables.pdf>.

¹³⁵ See for example: (1) Lawrence H. Goulder, "Effect of Carbon Taxes in an Economy with Prior Tax Distortions: An Intertemporal General Equilibrium Analysis," *Journal of Environmental Economics and Management* (Volume 29, Issue 3), 1995, pp. 271-297; (2) Ian W.H. Parry, "Pollution Taxes and Revenue Recycling," *Journal of Environmental Economics and Management* (Volume 29, Issue 3), 1995, pp. S64-S77; and (3) A. Lans Bovenberg and Ruud A. de Mooij, "Environmental Levies and Distortionary Taxation," *American Economic Review* (Volume 84, No. 4), 1994.

approach is employed.¹³⁶ This scenario is referred to as the “double dividend”: first, the carbon price reduces carbon emissions, and second, as a new source of revenue, it allows the government to reduce marginal tax rates and their accompanying distortions, in other economic sectors.¹³⁷ Research looking specifically at carbon-abatement policies has shown that a revenue-neutral carbon tax can make an economy better off at any level of damages from carbon emissions.¹³⁸

A revenue-recycling guarantee will improve the likelihood that a carbon price in Alberta will not negatively impact the province’s economy as a whole. This is not an unreasonable expectation given both the academic research findings referenced above, as well as the experience in British Columbia, which has provided an empirical test of the research by implementing tax reductions that are at least as large as the revenues generated from the province’s carbon tax. As noted previously, a recent study on the impact of the carbon price in British Columbia found that it has reduced emissions in the province by an estimated five to 15 per cent relative to baseline trends, and had little impact on both household welfare and the province’s economy.¹³⁹

CONCLUSION

Alberta’s 2020 climate change target, announced in its 2008 climate change strategy, is a 50 Mt reduction in emissions below its projected business-as-usual path. Based on the BAU path from 2008, this puts the province’s targeted emissions level at approximately 260 Mt in 2020. Emissions in 2013 were 267 Mt, a continuation of a strong upward trend in the province that dates back to 1990, the start date for greenhouse-gas-emissions tracking in Canada. While Alberta displayed leadership as the first jurisdiction in North America to introduce a price on emissions in 2007, SGER’s lack of coverage and its overdue strengthening, which is likely “too little, too late,” means Alberta is not currently on track to meet its 2020 target. Rather, in the 12 years Alberta had to achieve the target, it looks now as though the province will have spent at least 10 years with insufficient regulation to meet the task at hand.

In looking ahead to the next iteration of Alberta’s climate change strategy — and the regulations that will support it — one would hope the province’s future emissions-reduction targets and regulations are better aligned. With the announcement of a new strategy that includes a cap on total oil sands emissions, this outcome seems promising. We do

¹³⁶ See for example: (1) Lawrence H. Goulder, “Environmental Taxation and the double dividend: A reader’s guide,” *International Tax and Public Finance* (Volume 2, Issue 2), 1995, pp. 157-183; (2) Lawrence H. Goulder, Ian W.H. Parry and Dallas Burtraw, “Revenue Raising versus other Approaches to Environmental Protection: The Critical Significance of Pre-existing Tax Distortions,” *The RAND Journal of Economics* (Volume 28, Issue 4), 1997, pp. 708-731; and (3) Ian W.H. Parry and Antonio M. Bento, “Tax Deductions, Environmental Policy and the ‘Double Dividend’ Hypothesis,” *Journal of Environmental Economics and Management* (Volume 39, Issue 1), 2000, pp. 67-96.

¹³⁷ The idea of the “double dividend” was first introduced in 1991 in the following article on carbon taxes: David Pearce, “The Role of Carbon Taxes in Adjusting to Global Warming,” *The Economic Journal* (Volume 101, No. 407), 1991, pp. 938-948.

¹³⁸ Ian W.H. Parry, Robertson C. Williams III and Lawrence H. Goulder, “When Can Carbon Abatement Policies Increase Welfare? The Fundamental Role of Distorted Factor Markets,” *Journal of Environmental Economics and Management* (Volume 37, Issue 1), 1999, pp. 52-84.

¹³⁹ Brian C. Murray and Nicholas Rivers, *British Columbia’s Revenue Neutral Carbon Tax*.

not provide recommendations on targets in this paper as that is beyond the scope of our expertise. However, assuming the province identifies any sort of a meaningful reduction target, in our assessment this means the policies that accompany it must go far beyond SGER in scope and stringency.

Our recommendation is a carbon tax, applied to all energy-based emissions (those that fall under the “energy” category for UNFCCC reporting) in the province along with a revenue-recycling guarantee to minimize any negative impacts on households, firms and the province’s economy as a whole. One of the benefits of the carbon tax, both to start and over time, is that its value can be tailored to support the province’s reduction target. And most importantly, whatever the target, a carbon tax provides the broadest and most direct coverage of the province’s emissions and emitters. It is also the simplest, most transparent and lowest-cost policy option. It is therefore the best choice to form the underpinnings of Alberta’s next climate change strategy.

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