Canada's Climate Action Plans:

Are they cost-effective?

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Contents

Executive summary

Four provinces in Canada (Alberta, British Columbia, Ontario, and Quebec) have promulgated "action plans" to reduce greenhouse gas emissions. These plans have several broad components. There is a carbon pricing component; there are assortments of energy efficiency programs; there is a "renewable energy" component; and most of the plans have vehicle electrification components (or such programs have been enacted separately from the climate action plans).

For example, Alberta's Climate Leadership Plan consists of five key elements: a coal-power phaseout by 2030, a tripling of renewable energy generation to reach 30 percent of generation by 2030, reducing emissions from the oil and gas sector, creating Energy Efficiency Alberta to deliver cost-saving programs, and implementing an economy-wide price on carbon.

Ontario's climate action plan contains similar efforts, including a "Green Bank" to fund efficiency programs, increasing vehicle electrification, running education programs for homeowners seeking more efficient buildings, and, of course, supporting their "carbon market" which unlike Alberta is a cap-and-trade carbon emission trading system.

Quebec and British Columbia have similar programs. But a review of literature as well as an examination of how carbon pricing is being implemented in Canada suggests that the money of Canadians will not be well spent on these carbon action plans.

An examination of Canada's various carbon pricing programs reveals a history of flawed implementation that undermines the utility and efficiency of carbon pricing. Rather than obeying fundamental economic principles of true revenue neutrality, regulatory displacement, and allowing markets to find lower cost ways to reduce carbon, Canada's carbon taxes are piled on top of regulations, are not revenue neutral, and subvert the functioning of energy markets by mandating particular technologies such as wind and solar power, and electric vehicles.

With regard to efficiency programs, studies from the US and abroad suggest that home efficiency programs often underperform, proving less effective than predicted at reducing energy use, and coming in at a cost far in excess of what was originally planned. In some cases, this inverts the cost-benefit analyses used to justify the programs.

Vehicle electrification is the newest intervention into energy markets and consumer behavior. Ontario, for example, offers up to $14,000 worth of subsidies for buying an electric car, waives HST on the purchase, and throws in "free energy" for overnight charging. BC is a bit less generous, with only $6,000 subsidies for the electric cars, but is another with more lucre on tap if you install a charging station. But the laboratory of electrification has to be California, which has pushed vehicle electrification for more than 20 years. California's experience is telling. As *Los Angeles Times* reporter Russ Mitchell points out, "[o]ver seven years, the state of California has spent $449 million on consumer rebates to boost sales of zero-emission vehicles. So far, the subsidies haven't moved the needle much. In 2016, of the just over 2 million cars sold in the state, only 75,000 were pure-electric and plug-in hybrid cars. To date, out of 26 million cars and light trucks registered in California, just 315,000 are electric or plug-in hybrids." And the cost of GHG reductions for this program? Researchers have estimated that Ontario's spending on electric cars reduces greenhouse gases at a cost of $523/tonne, while Quebec's price of avoided emissions comes in at $288/tonne.

Finally, all of Canada's climate action plans feature the expansion of renewable energy. But Canada's own experience with that in Ontario has been nothing short of disastrous. Ontario's renewable expansion has come at a stunningly high cost, with electricity prices in Ontario having risen by 71 percent from 2008 to 2016, over twice the average growth in electricity prices elsewhere in Canada. From 2008 to 2015, electricity prices also increased two-and-a-half times faster than household disposable income in Ontario. The growth in electricity prices was almost four times greater than inflation and over four-and-a-half times the growth of Ontario's economy (real GDP).

Canada's climate action plans include carbon pricing, but also rely heavily on regulatory interventions that undermine its efficiency properties, such as expanding renewable sources, energy efficiency measures, and vehicle electrification. There is little reason to believe that money will be well spent on these efforts. Every jurisdiction in Canada with a carbon pricing program has violated the fundamental economics of such programs in ways that will greatly inflate their costs and impair their effectiveness. Evidence from the economic literature suggests that the energy efficiency programs proposed by the various provincial climate plans are likely to cost more than projected and deliver fewer savings than promised. Electric vehicle subsidies are likely to hit Canadians in the pocketbooks, producing at best small quantities of greenhouse gas emission reductions at exorbitant costs.

Canadian governments have aggressively, and with little up-front analysis, rolled out climate action plans that are going to cost a great deal of money, but, most likely, will yield very little return in terms of environmental benefits. Governments would be well advised to slow or temporarily halt their climate action program implementation, and give the public solid analysis of their proposed programs' economic costs and benefits.

Overview of climate action plans

Four provinces in Canada (Alberta, British Columbia, Ontario, and Quebec) have promulgated "action plans" to reduce greenhouse gas emissions. These plans have several broad components. There is a carbon pricing component; there are assortments of energy efficiency programs; there is a "renewable energy" component; and most of the plans have vehicle electrification components (or such programs have been enacted separately from the climate action plans).

The provincial climate action plans contain far too many sub-projects and small individual components (such as Alberta's rebates to consumers who buy efficient light bulbs) to assess their benefits and costs individually—and many initiatives are still under development, with little detailed explanation of how they will work.

Consequently, this paper will address the main components as they are more generally described in each of the provincial climate action plans, and then review the economic literature to assess whether comparable approaches have been following the least-cost paths for reducing greenhouse gases as they have been tried before, mostly in the United States where the data are most plentiful.

Alberta

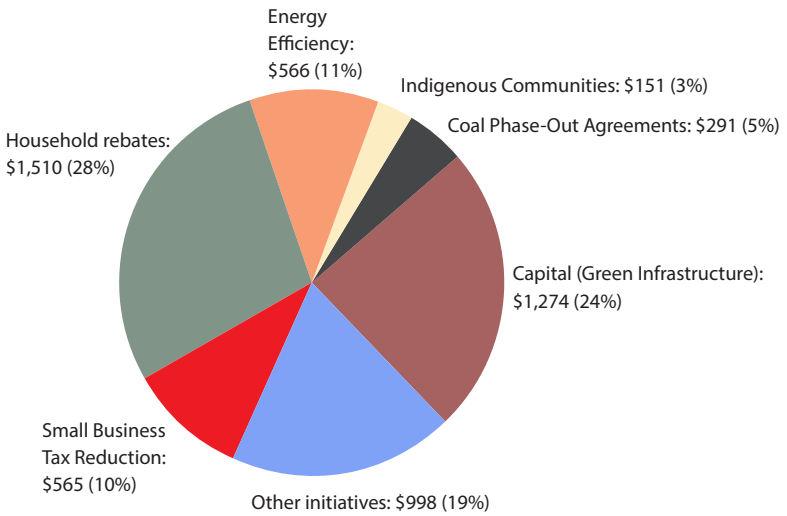
Alberta's Climate Leadership Plan (Alberta, 2017a) consists of five key elements (paraphrased for clarity):

- Phasing out coal-generated electricity by 2030;
- Tripling renewable energy to supply 30 percent of generation by 2030;
- Reducing emissions from the oil and gas sector;
- Creating Energy Efficiency Alberta to deliver cost saving programs; and
- Implementing an economy-wide price on carbon.

The three-year funding for the plan totals $5.4 billion. Interestingly, the Alberta Climate Leadership Plan estimates that the carbon levy will only bring in $3.9 billion over that period, while the levy on large industrial emitters will bring in another $1.3 billion over that span. **Figure 1** shows how that spending is to be allocated.

According to Statistics Canada (2017), Alberta has some 1.5 million households. Allocating the costs of the Climate Action Plan equally would mean the average Albertan household would pay $3,600 over the next three years to fund the Alberta Climate Leadership Plan. Some of these households will get full or partial rebates (28 per cent of households), so in theory the cost to the non-rebate households will be higher still.

Figure 1
Distribution of Alberta carbon tax revenues ($ millions)



Note: "Other initiatives" includes revenue recycling into bioenergy, renewable energy, innovation and technology, coal community transition, and other Climate Leadership Plan implementation initiatives.

Source: Alberta, 2017a.

Ontario

Ontario's Climate Change Action Plan (CCAP), published in 2016, is comparably far-reaching. In terms of concrete actions, the Ontario CCAP calls for the following (paraphrased for clarity and conciseness).

- Creating a green bank to help homeowners and businesses access and finance energy-efficient technologies to reduce greenhouse gas emissions from buildings.

- Creating a cleaner transportation system by addressing greenhouse gas emissions from cars on the road today, by increasing the availability of zero-emission vehicles on the road tomorrow, by deploying cleaner trucks, and by making transit more available.

- Giving Ontarians "more choices, incentives and tools to make the right energy choice for their homes and businesses, by providing better information about energy use by buildings and homes, and by making new buildings increasingly energy efficient over time."

- Making Ontario one of the easiest and most affordable jurisdictions in North America for homeowners and businesses to install or retrofit clean-energy systems like solar, battery storage, advanced insulation and heat pumps.

- Supporting a carbon market that drives the lowest cost greenhouse gas emission reductions. Actions in this plan, supported by cap and trade proceeds, will help business and industry make investments that reduce greenhouse gas pollution.

- Acting on opportunities to make government operations carbon neutral. Ontario will achieve this by reducing greenhouse gas pollution across our facilities, operations and procurement (Ontario, 2016).

Ontario's carbon price component, its cap-and-trade program, is projected to take in $1.9 billion per year. Assuming that each of Ontario's 5.2 million households pay an equal share of that spending, the average Ontario household would be out $365 per year. Of course, that's on top of the vast sums that Ontarians have paid out since the implementation of their Green Energy Act in 2009, which they continue to pay as energy prices continue to rise, as we document elsewhere.

Quebec

Quebec's Climate Change Action Plan 2013–2020 is a very broad initiative to implement 30 separate "priorities" (**table 1**). The predicted price is about $2.7 billion, presumably spent between 2013 and 2020. As of this writing, Quebec (2017b) has implemented some 15 programs related to their priorities, including projects aimed at reducing fossil fuel use through building and vehicle efficiency programs, expanding mass transit, accelerating the electrification of transport, broadening the use of renewable energy, and encouraging research and development on clean technology.

As with the other provinces, Quebec's Climate Change Action Plan features a carbon pricing mechanism (2017a). As of 2013, large emitters in the industrial and electricity sectors (with emissions over 25,000 tons of CO_2 equivalents[1]) were subject to the province's new cap and trade program, with distributors and importers of fuel to follow in 2015.

Interestingly, more so than other climate action plans in Canada, Quebec's plan places an explicit emphasis on facilitating adaptation to climate change and strengthening Quebec's resilience to climate change impacts.

British Columbia

In addition to having a broad-based carbon tax ($30/tonne of CO_2 emissions at the time of writing), British Columbia's Climate Leadership Plan (2016) has 6 "action areas" meant to address climate change. These include plans to transition from using other fossil fuels to using natural gas (developed using electricity from new hydro capacity), tightening the province's Low Carbon Fuel Standard, expanding support for vehicle electrification, creating additional mass transit, reforms to forestry and agricultural practices, and energy efficiency standards for gas-fired boilers (British Columbia, 2016).

1. As there are several different greenhouse gases with differing warming strengths and atmospheric endurance, greenhouse gases are usually discussed in terms of CO_2 equivalents in which the differential factors are used to convert say, methane emissions into the equivalent CO_2 emissions that would have the same atmospheric impact.

Table 1: Quebec's Climate Change Action Plan Priorities

	PRIORITIES	Budget ($ millions)
Plan - Québec communities at the forefront		
1	Foster sustainable land-use planning of the territory in a perspective of combating climate change	6.0
2	Support municipal and community initiatives to reduce GHG, adapt to climate change, and engage in sustainable land-use planning	94.0
3	Promote risk management that minimizes the vulnerability of communities	21.2
Innovate - develop knowledge and technology		
4	Support innovation and research and the development, demonstration and marketing of technologies aimed at reducing GHG emissions	40.0
5	Pursue the development of climatological monitoring networks	15.0
6	Support research in adaption	45.6
Mobilize Québec		
7	Disseminate knowledge, know-how and solutions pertaining to GHG reduction and adaptation to climate change	26.5
8	Mobilize Québec by supporting initiatives in civil society and in communities	44.0
9	Raise Québec's profile in Canada and on the international scene	2.5
Lead the way – Québec government committed to set the example		
10	Integrate the concern for climate change into the public administration	4.5
11	Foster a reduction of GHG generated by the operations of the public administration	14.0
Establish a carbon market		
12	Send a carbon price signal by establishing a GHG emission cap-and-trade system	8.0
Foster the sustainable mobility of people and goods		
13	Promote public transit and alternative transportation by enhancing their availability, developing infrastructure and facilitating sustainable choices	1536.7
14	Create a greener car fleet through more fuel-efficient and better maintained vehicles	40.0
15	Invest in intermodality and logistics to optimize freight and passenger transportation	85.0
16	Enhance the efficiency of maritime, rail, air and off-road transportation	38.0
17	Reduce the environmental footprint of road freight transport	77.0
Support Québec firms in the transition to a lower carbon economy		
18	Enhance the carbon balance and energy efficiency of Québec firms	200.0
Foster the emergence of sustainable buildings		
19	Adopt greener building standards	34.0
20	Promote renewable energies and energy efficiency in residential, commercial and institutional buildings	123.3
21	Reduce the use of halocarbons	19.7
Contribute to the development of sustainable agriculture		
22	Equip farmers to better manage GHG emissions from crop and livestock production	10.0
Link the environment and the economy the management of residual materials		
23	Support GHG emission reduction linked to the management of residual material	10.3
Take advantage of the potential of renewable energy in Québec		
24	Foster the emergence of bioenergy	50.0
25	Enhance the energy efficiency of commonly used devices	0.5
Maintain the health of individuals and communities		
26	Prevent and limit diseases, injuries, mortality and psychosocial impacts	22.3
Preserve economic prosperity		
27	Support vulnerable economic players	16.4
Strengthen the durability and safety of buildings and infrastructure		
28	Revise infrastructure design criteria and management and maintenance methods	11.5
Conserve biodiversity and the benefits that ecosystems offer		
29	Update biodiversity and ecosystem evaluation, protection and management tools	9.0
30	Update knowledge and adapt water resource management tools	15.0
	Coordination, monitoring and accountability	45.0
TOTAL		**2,665.00**

Source: Quebec, 2017b: Appendix.

The tax component

Many economists and special interest groups have argued that carbon taxes are the most efficient way to reduce greenhouse gas emissions. Canada's "Ecofiscal Commission" (n.d.) claims that: "Our research shows that carbon pricing is the most practical and cost-effective way to lower greenhouse gas emissions while encouraging low-carbon innovation." According to environmental group EcoJustice (n.d.):

> Several studies have shown that the single most effective solution to rising greenhouse gas (GHG) emissions is to allow the market to respond to a price on carbon. Putting a price on carbon is a broadly effective approach to emission reductions that is superior to subsidies or voluntary programs and more economically efficient than regulations. (Ecojustice, n.d.)

Citizens for Public Justice (2015) argue that "Canada should put a price on carbon. The money raised from a carbon tax (or cap-and-trade system) should be used as credits for low income people, for programs that help families and businesses to adapt their practices and their homes and buildings, to encourage the development of new, green practices and technologies, and as investments into clean energy infrastructure in order to facilitate the transition off fossil fuels."

Are Canada's carbon taxes living up to their promise? As we've shown (Green, 2017), to be efficient and economically benign (in the theoretical sense), carbon pricing must:

- Be 100% revenue neutral, with revenues rebated to lower other distortionary taxes such as the personal income tax or the corporate income tax;
- Be in lieu of regulations, not on top of them; and
- Revenues must not be used to distort energy markets by government interventions that favour some technologies over others. Doing so undercuts the very idea of letting markets find the most efficient ways to reduce greenhouse gas emissions (Green, 2017).

But no province in Canada comes close to these requirements for efficient and benign carbon taxation.

In Ontario, the province's cap-and-trade system will raise $2 billion in revenue per year (Ontario, 2017). According to the Ontario Auditor General, out of the $8 billion to be collected in the first four years of implementation, only $1.32 billion will be earmarked to help with residential and business electricity bills, which could be characterized as revenue offsets in theory, though not distributed across the entire population (Jones, 2016). The rest will be spent on the usual governmental preferences—transit, subsidies to renewable energy, dubious efficiency programs, etc.

Ontario's Climate Action Plan also leans heavily toward government picking and choosing carbon control technologies (Ontario, 2016) instead of leaving those choices to consumers within a competitive energy market. The Plan would, among other things, create a "green bank" that could be accessed by homeowners and business owners to reduce emissions from buildings. The Plan established a province-wide electric and hydrogen passenger vehicle sales target of five per cent in 2020. Ontario's plan also calls for new renewable fuel requirements, and massive incentives for electric vehicle purchasers who can claim up to $14,000 in rebates on the vehicle itself, as well as $1,000 for installing home charging stations. Other components on the plan call for more spending on mass transit, additional bicycling infrastructure, additional land-use planning, and many other actions that violate the principle of not spending revenues on economic distortions.

Alberta's new carbon tax of $30/tonne (phased in by 2018) is expected to generate some $4 billion in revenues from 2017 to 2020 (Alberta, 2017b). A portion of the revenues from the carbon tax ($1.5 billion over the same period) will also be given to low-income Albertans. The rest, $2.6 billion per year, or 44 percent of revenues, will be spent on favoured government projects (Johnson, 2015).

Alberta's Climate Leadership Plan, like that of Ontario, does not meet the requirements for optimal carbon pricing. Not only does the plan impose a cap on annual emissions from the oil sands, but it is also marred with other inverventions such as a phase-out of coal power by 2030, a push to build "renewable" sources of energy, and the establishment of a new agency, called Energy Efficiency Alberta, to "help" Albertans improve their energy efficiency. Again, these actions directly contradict the tenets of optimal carbon pricing.

Quebec's cap-and-trade system has brought in revenues of $330 million, but is expected to bring in $3 billion by 2020 (and probably more, as they will have to match the escalating national price floor established by the federal government) (Québec, n.d.). Where does the revenue go? According to a government website discussing the "Green Fund" (translated), the revenues "allow the Government of Quebec to reinvest in our economy in order to reduce our consumption of hydrocarbons and stimulate the development

and use of green technologies and the export of Québec know-how. They also improve the quality of life of citizens and communities through interventions that focus on sustainable mobility, energy efficiency and adaptation to the impacts of climate change." Quebec is also focused on increasing transit use, and offers an $8,000 rebate for the purchase of a fully electric vehicle (Québec, 2017b, 2011).

Like Ontario, Quebec is not eschewing additional regulations focusing on carbon emissions. Indeed, like Ontario, Quebec has enacted an electric vehicle standard with a goal of seeing 100,000 plug-in vehicles on the roads by 2020 (Quebec, 2016).

British Columbia has been lauded for creating a revenue-neutral carbon tax. And they did, for about 5 years, by which time they had changed the way they accounted for revenue neutrality and started collecting net revenues. A recent study by the shows that in the earlier years of the BC carbon tax, the tax was truly revenue neutral, at least in the academic sense. In fact, it was revenue-negative—more revenues were given back to BC taxpayers in reduced taxes than were collected by the carbon tax (Lammam and Jackson, 2017). Personal and corporate taxes were reduced, and additional tax reductions were introduced to ensure revenue neutrality. But by 2013/2014, only 5 years into the tax system, the government had taken to counting pre-existing tax credits as outlays to preserve the appearance, but not the reality of revenue neutrality. Indeed, when the Fraser Institute researchers backed out some pre-existing tax credits that had been redefined as carbon tax reductions, they found that the province actually netted $226 million in 2013/2014, with a cumulative tax take of $377 million for 2013/2014 and 2014/2015. Projecting forward when the study was released, the researchers estimate a cumulative $865 million tax increase by 2018/2019. That's about $800 for a family of four.

A closer look at the details shows that rather than solely rebating revenues to the general population, diversions from those types of tax reductions began in only the second year with measures targeted to specific subgroups of the population. As **table 2** shows, the number of those special interest tax credits rose from one in year two, to six by year seven, at which point $140 million (12 percent) of actual offsetting tax measures were being directed to specific subpopulations such as Northern and Rural Homeowner Credits, Children's Fitness and Art Credits, the Small Business Venture Capital Credit, Small Business CIT, Industrial Property Tax Credits for Major Industry, the Industrial Property Tax Credit for Light Industry, and School Property Tax Reduction for Farm Land (Lammam and Jackson, 2017).

The previous BC government under Christie Clark promised to restore the BC tax to revenue neutrality, but lost an election before it could implement that in a budget. Both parties of the new BC coalition government ran on a platform of raising BC's carbon tax (BC Party Platform Promises, 2017). The NDP proposed raising it beginning in 2020, to reach the $50/tonne

federal mandate by 2022. The Green party proposed raising the tax starting in 2018, reaching $70/tonne by 2021. Neither of the parties specified revenue neutrality in the sense of fully rebating revenues through reductions to the Personal Income Tax or Corporate Income Tax. The NDP campaigned on "expanding" rebates to consumers, while the Green party called for revenues to be spent on "facilitating a low carbon economy."

The first budget of the new NDP/Green government in BC explicitly rejects the objective of revenue neutrality (emphasis added):

> The Province will act to reduce carbon emissions by increasing the carbon tax rate on April 1, 2018 by $5 per tonne of CO2 equivalent emissions, while increasing the climate action tax credit to support low and middle income families. *The requirement for the carbon tax to be revenue-neutral is eliminated so carbon tax revenues can support families and fund green initiatives that help us address our climate action commitments.* (British Columbia, 2017)

Finally, the federal government threw its hat into the carbon price ring back in 2016 (Global News, 2016). The new plan would impose a "carbon price floor" of $10/tonne of carbon emissions in 2018, rising to $50/tonne in 2022 (Canada, 2017). Any province that does not implement its own carbon pricing plan (that is deemed to meet the federal price floor) will have a carbon tax imposed on them. Economist Trevor Tombe (2016) estimates that after accounting for the percentage of emissions that will actually be covered under the tax, the average Canadian household would be paying about $600 per year with a carbon tax at $50/tonne.

And while Prime Minister Trudeau proclaimed that the federal carbon tax would be completely revenue neutral, and that all revenues raised in a province will be returned to the province, he overlooked one small thing: the additional proceeds from the GST that will be applied to goods and services made more expensive by the carbon tax. One estimate from the Library of Parliament estimates that the federal government will scoop up $280 million dollars in the next two years alone in Alberta and British Columbia (Rabson, 2017).

Table 2
BC's Carbon Tax revenue and actual offsetting tax measures with pre-existing credits excluded, 2008/09-2018/19 ($ millions)

	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Carbon Tax Revenue	306	542	741	959	1,120	1,222	1,198	1,216	1,234	1,252	1,275
Actual Offsetting Tax Measures	313	729	865	1,141	1,337	996	1,047	1,061	1,108	1,150	1,170
Balance	-7	-187	-124	-182	-217	226	151	155	126	102	105
Breakdown of Actual Offsetting Tax Measures											
Original Offsetting Tax Measures											
Low Income Tax Credit	106	153	165	184	195	194	193	192	195	195	195
Cut to Two PIT Rates	107	206	207	220	235	237	269	283	288	302	315
General CIT Rate Cut	65	152	271	381	450	200	216	218	236	250	253
Small Business CIT Rate Cut	35	164	144	220	261	220	229	226	244	256	260
New Offsetting Tax Measures											
Northern and Rural Homeowner Credit	-	-	19	66	67	69	83	83	83	84	84
BC Seniors' Home Renovation Tax Credit	-	-	-	-	27	-	-	1	2	2	2
Children's Fitness Credit & Children's Arts Credit	-	-	-	-	9	8	8	8	8	8	8
Small Business Venture Capital Credit Budget Increase	-	-	-	-	3	3	3	3	5	5	5
Small Business CIT Threshold Increased	-	-	-	-	20	20	21	21	21	21	21
Industrial Property Tax Credit	-	54	58	-	-	-	-	-	-	-	-
Industrial Property Tax Credit for Major Industry	-	-	-	19	22	23	23	24	24	25	25
Industrial Property Tax Credit for Light Industry	-	-	-	49	46	20	-	-	-	-	-
School Property Tax Reduction for Farm Land	-	-	1	2	2	2	2	2	2	2	2

Note: Data are in nominal dollars.

Source: Lammam and Jackson, 2017

Efficiency measures

After carbon pricing, the next major component of Canadian climate action plans can generally be described as promoting energy efficiency. From an economic efficiency perspective, even if the programs work as advertised, they are inherently wasteful, since they target energy consumption rather than greenhouse gas emissions, which in many provinces are only weakly related. As explained in McKitrick (2015), the way to make policies efficient is to make sure they are targeted directly on the desired outcome. Energy efficiency programs fail to do this. What is worse, ample empirical evidence has accumulated in recent years showing that these programs do not work nearly as well as their promotors argue they will.

The most comprehensive study on home efficiency programs to date, conducted by researchers Meredith Fowlie, Michael Greenstone, and Catherine Wolfram (2015) at UC Berkeley, studied the impacts of home efficiency programs for 30,000 homes participating in the largest US energy efficiency program, the federal Weatherization Assistance Program. Households in the Fowlie study received an average of US$5,150 worth of home improvements, at no cost to the participants. The most common measures included "furnace replacement, attic and wall insulation, and infiltration reduction." Fowlie et al. point out that these measures all had passed cost-benefit testing based on "ex ante engineering estimates," such as those that Alberta has invoked to justify its home energy efficiency programs (Dunsky Energy Consulting, 2017). Fowlie et al. came to two major findings:

- Participation rates in the programs were low, and getting that participation was labor-intensive. Even with "aggressive intervention" to get people to enroll in the Weatherization Assistance Program, participation was less than 1 percent in the control group and only 6 percent in the encouraged group. Field activities "included 7,000 home visits, more than 32,000 phone calls, and 2,700 follow-up appointments." After all of that, participation in the program was only increased by 5 percent, at a cost of another $1,000 per weatherized household.

- Consumer savings were below what was projected, and came at higher costs. While Fowlie et al. found that the WAP energy efficiency investments lowered monthly energy consumption by 10–20 per cent on average, the upfront investment costs were 2.5 times higher than the savings.

The researchers concluded that "[a]cross a variety of metrics, the WAP energy efficiency investments appear to be poor performers on average." While the households involved did not have to pay for their improvements, Fowlie et al. estimate that if they had, their rate of return on the investments would have been -2.2 per cent.

Finally, Fowlie et al. calculated that the cost of greenhouse gas reductions under the WAP was approximately US$329 per ton, "an order of magnitude larger than the US government's estimate of the social cost of carbon of roughly $38/ton (at the time of the study)."

Another blow to the idea that Canada will reap benefits from energy efficiency programs such as green office building codes and incentives comes from a 2014 study by Arik Levinson, also published by the National Bureau of Economic Research. Levinson (2014) studied the experience of California, which was one of the first states in the US to enact energy building codes in 1978, when they were projected to reduce residential energy use and associated pollution by 80 percent.

Levinson (2014) compared current electricity use in California homes of "different vintages," controlling for the size of the house, the local weather, and the nature of the tenants. He also studied how electricity use in the homes varied based on outdoor temperatures, and compared electricity use in California buildings under strict energy codes to houses in other states. In all three cases, Levinson found "no evidence that homes constructed since California instituted its building energy codes use less electricity today than homes built before the codes came into effect."

Most recently, in a working paper published by three US universities (Burlig et al., 2017) researchers studied the performance of energy efficiency upgrades in K–12 schools in California. Using unique analytical methods involving machine learning, the authors found that energy efficiency upgrades do reduce electricity consumption by 3 percent, but that the reductions total only 24 percent of *ex ante* expected savings.

A 2017 article published by Yale Environment 360 contributor Richard Conniff asks, "Why Don't Green Buildings Live Up to Hype on Energy Efficiency?" Conniff observes that in studies in Germany (Cali et al., 2016) as well as the UK (2016), so-called "green buildings" routinely fall short of predicted energy savings. In the German example, a study of refurbished buildings built in the 1950s found predicted energy savings fell short by 117 percent in 2011, 107 percent in 2012, 41 percent in 2013, and 60 percent in 2014.

Changed behavior by the building occupants is identified as the cause for the shortfall in energy savings.

In the UK example, a 2016 study by Innovate UK which looked at 50 non-domestic "leading edge modern buildings" including supermarkets, schools, offices, and health centres, the authors found that the buildings routinely used up to 3.5 times more energy than their design had allowed for, and they produced 3.8 per times the quantity of greenhouse gases they were designed to emit.

A big reason why efficiency programs fail is the *rebound effect*: if you make something genuinely less expensive, some people will react by consuming more of it, rather than by lowering their consumption. Alternately, they may take the money they've saved via improved efficiency, and use that to buy other goods that also consume energy to produce, consuming all of the efficiency gains they have made elsewhere.

In the energy efficiency context, the rebound effect explains why actual energy savings fall short of expected energy savings from the implementation of energy efficiency measures and sometime even backfire. While there's less concrete evidence available to help analyze these types of effects, the models that do exist seem to suggest that there's serious cause for concern. According to the Breakthrough report, "A number of CGE modeling studies … typically find macroeconomic rebounds across a relatively wide range of national economies to be on the order of 30–50% or greater, with a surprising number projecting backfire rebound greater than 100%."[2]

A more recent study examined the rebound effect across 30 economic sectors in the US, finding rates of rebound in direct energy use ranging from -16 percent in services, to up to 378 percent in electricity utilities. **Table 3** shows the "all factors" rebound effect estimated for the 30 sectors. The "All factors rebound" column shows that, for many sectors, the rebound effect of efficiency improvements is massive. (There are generally accepted to be two classes of rebound, direct and indirect, which play out over different time frames.)

2. See page 49 of <http://thebreakthrough.org/blog/Energy_Emergence.pdf>.

Table 3
All-source rebound in 30 US economic sectors

			All factors rebound		All factors rebound components			
			Short term	Long term	Short term		Long term	
	SECTOR	Energy use share of economy in 1980			Substi-tution/ Intensity	Output	Substi-tution/ Intensity	Output
30	Electric Utilities	20%	868%	169%	97%	3%	66%	34%
28	Transportation	16%	889%	179%	97%	3%	73%	27%
34	Services	10%	164%	179%	98%	2%	90%	10%
15	Chemicals	8%	285%	147%	92%	8%	67%	33%
6	Construction	6%	120%	135%	97%	3%	90%	10%
20	Primary Metal	6.0%	1472%	172%	98%	2%	71%	29%
1	Agriculture	4.8%	388%	381%	89%	11%	63%	37%
33	Financial Industries	3.8%	618%	190%	97%	3%	86%	14%
35	Government Enterprises	3.6%	955%	182%	98%	2%	75%	25%
7	Food & Kindred Products	2.7%	393%	338%	98%	2%	94%	6%
13	Paper & Allied Products	2.7%	472%	69%	97%	3%	73%	27%
19	Stone, Glass, Clay	2.3%	636%	64%	97%	3%	63%	37%
22	Machinery, non-Electrical	1.6%	503%	67%	94%	6%	17%	83%
21	Fabricated Metal	1.6%	1193%	164%	99%	1%	89%	11%
23	Electrical Machinery	1.3%	367%	81%	93%	7%	47%	53%
11	Lumber and Wood	1.1%	594%	89%	97%	3%	73%	27%
17	Rubber & Miscellaneous Plastic	1.0%	816%	133%	98%	2%	85%	15%
9	Textile Mill Products	1.0%	403%	34%	94%	6%	-7%	107%
24	Motor Vehicles	0.8%	773%	235%	97%	3%	80%	20%
5	Non-metallic Mining	0.9%	583%	76%	96%	4%	44%	56%
29	Communications	0.7%	257%	104%	89%	11%	54%	46%
25	Transportation Equipment & Ordnance	0.6%	383%	118%	97%	3%	86%	14%
14	Printing, Publishing & Allied	0.6%	396%	56%	95%	5%	55%	45%
26	Instruments	0.6%	222%	197%	90%	10%	72%	28%
10	Apparel	0.4%	774%	255%	96%	4%	79%	21%
2	Metal Mining	0.3%	613%	74%	96%	4%	46%	54%
12	Furniture & Fixtures	0.3%	909%	230%	98%	2%	88%	12%
27	Misc. Manufacturing	0.3%	468%	59%	97%	3%	62%	38%
18	Leather	0.1%	434%	125%	97%	3%	84%	16%
8	Tobacco	0.06%	136%	104%	87%	13%	70%	30%
	OVERALL	100%	649%	172%	96%	4%	72%	28%

Source: Saunders, 2013.

Vehicle electrification

Another significant component of Canada's climate action plans is a focus on vehicle electrification. Ontario's Climate Change Action Plan calls for maintaining a rebate program that gives up to $14,000 to electric car buyers, eliminates the HST on zero emission vehicles, and offers free overnight electric vehicle charging.

Other provinces are a bit less aggressive than Ontario, but BC and Quebec also have programs to promote electric car growth. BC's Climate Leadership Plan (2016) also contains a component that focuses on expanding electric vehicle adoption by subsidizing purchases of zero-emission vehicles, by "increasing awareness," investing in infrastructure, etc. British Columbians can get $6,000 point-of-sale rebates for buying or leasing a hydrogen fuel cell vehicle, $5,000 for buying or leasing a new battery electric vehicle, and between $2,500 and $5,000 for buying or leasing a plug-in hybrid vehicle.

In Quebec, buying or leasing a qualifying vehicle can get buyers a subsidy of up to $8,000 for a new vehicle, and up to $4,000 on a used vehicle, and get rebates on charging stations as well (Quebec, 2012).

The first question to ask is how well such rebate plans have worked in the past, and for that question, there is no better example than California. In a recent article in the *Los Angeles Times*, reporter Russ Mitchell (2017) points out that "[o]ver seven years, the state of California has spent $449 million on consumer rebates to boost sales of zero-emission vehicles. So far, the subsidies haven't moved the needle much. In 2016, of the just over 2 million cars sold in the state, only 75,000 were pure-electric and plug-in hybrid cars. To date, out of 26 million cars and light trucks registered in California, just 315,000 are electric or plug-in hybrids." The California example is not unique.

In an economic note by Germain Belzile and Mark Milke at the Montreal Economic Institute, the authors calculate what the cost of greenhouse gas reduction is in Ontario and Quebec for their vehicle electrification programs (2017). Belzile and Milke estimate that Ontario's spending on electric cars reduces greenhouse gases at a cost of $523/tonne, while Quebec's price of avoided emissions comes in at $288 per tonne. Of course, the authors point out that at the time of writing, emission permits sold in the California

market were only about $18/tonne, making EV emission reductions more expensive by an order of magnitude.

Belzile and Milke also estimate future program costs in the two provinces:

> The Quebec government set a target of 100,000 electric or rechargeable hybrid vehicles on the road by 2020, and 1,000,000 by 2030. Public spending on these vehicles could therefore reach from $460 million to $860 million by 2020, and from $4.6 billion to $8.6 billion by 2030. Once again, this scenario is very prudent, since it supposes that none of these cars will be replaced over the course of 13 years. The Ontario government, for its part, instead set an annual sales target for electric vehicles, namely 5% of total sales in 2020, which represents government spending of from $980 million to $1.7 billion, and from $4.9 billion to $8.6 billion if projected to 2030. (Belzile and Milke, 2017)

But without the subsidies discussed above, the sales of electric vehicles plummet. Canada's provinces, once on the electric car subsidy path, are going to find it hard to back away without causing a crash in electric car sales, and a consequent reduction in zero-emission vehicles on the road as called for in the climate action plans.

In an article in the *Wall Street Journal*, Tim Higgins and Charles Rollet (2017) report that after Hong Kong slashed its electric car subsidies in April of this year, sales of the previous hot-selling Tesla plummeted to zero. They also observe that the reduction of electric car incentives in Denmark in 2016 led to a 70 percent reduction in new car registration for all-electric vehicles.

In April of 2017, analysts at auto-research firm Edmunds profiled a case study of cancelled electric vehicle subsidies in the state of Georgia. The state had seen the second-highest sales rate in the US, coming in just behind California. Georgia's overall subsidy to zero-emission vehicles was close to that of Ontario, with the state offering a $5,000 tax credit on top of the $7,500 US federal tax credit. When the state tax credit was eliminated in 2015, sales of electric vehicles plummeted, from 17 per cent of all US electric vehicle sales to just 2 per cent. Edmunds points to another problem with electric car subsidies: many of them go to people who are already quite well off economically. Some 49 percent of Georgia's electric car buyers had an annual income of USD $150,000 (Edmunds, 2017).

The cost of operating electric cars will have to fall considerably before they are adopted in large measure without subsidies. In a 2016 article in the *Journal of Economic Perspectives* entitled Will We Ever Stop Using Fossil Fuels?, authors Thomas Covert et al. calculate that (for the US) "[a]t a battery cost of $325/kWh [the US Dept. of Energy current cost estimate] the price

of oil would need to exceed $350 per barrel before the electric vehicle was less expensive to operate."

The authors further evaluate the future prospects for electric vehicles with a variety of battery types, and in comparison to internal combustion vehicles that become 2 percent more efficient each year:

> Even at the US Department of Energy target price for 2020, oil prices would have to rise to $115 per barrel for electric vehicles to be cost-competitive with internal combustion engines under the assumptions discussed above. If battery costs remain at $325 per kWh, oil prices would have to exceed $420 per barrel. For comparison, the current December 2020 oil futures price using the West Texas Intermediate benchmark (observed on December 18, 2015) was $55/barrel, requiring a battery cost that would fall to $64 per kWh. (Covert et al., 2016)

These basic calculations make it clear that at least for the next decade or two, electric vehicles face an uphill battle. Not only are large continuing decreases in the price of batteries necessary, but oil prices would have to increase by more than financial markets currently predict (Covert et al., 2016).

The rebound effect also applies to electric vehicles. One study of drivers in the United states using data from the National Household Travel Survey (2009) showed that a one percent reduction in the cost of driving resulted in increased driving of between 0.56 and 0.78 per cent. (Cochi Ficano and Thompson, 2014).

Given Canada's higher power prices, oil would have to be significantly higher still to convince Canadians to buy electric cars (Jackson et al., 2017).

Renewable energy expansion

No greater example of the effects of a rapid expansion of renewable energy (i.e., wind and solar power) can be found in Canada than the experience of Ontario, in the aftermath of their Green Energy Act, the phase-out of coal power, and the deployment of large quantities of wind and solar power.

A recent study at the Fraser Institute (Jackson et al., 2017) found that Ontario's renewable expansion has come at a stunningly high cost:

- Electricity prices in Ontario have increased dramatically since 2008 based on a variety of comparative measures. Ontario's electricity prices have risen by 71 percent from 2008 to 2016, far outpacing electricity price growth in other provinces, income, and inflation. During this period, the average growth in electricity prices across Canada was 34 percent.

- Ontario's electricity price change between 2015 and 2016 alone is also substantial: the province experienced a 15 percent increase in one year. This was two-and-a-half times greater than the national average of 6 percent during the same period.

- From 2008 to 2015, electricity prices also increased two-and-a-half times faster than household disposable income in Ontario. In particular, the growth in electricity prices was almost four times greater than inflation and over four-and-a-half times the growth of Ontario's economy (real GDP). The large electricity price increases in Ontario have also translated to significant increases in monthly residential electricity bills. Between 2010 and 2016, monthly electricity bills (including tax) in major Canadian cities increased by an average of $37.68.

- During the same period, electricity bills in Toronto and Ottawa increased by $77.09 and $66.96, respectively. This means that residents in Toronto experienced electricity price increases of double the national average between 2010 and 2016.

- In Toronto and Ottawa, the average monthly bills for residential consumers including taxes in 2016 were $201 and $183, respectively. On average in 2016, residents of major Canadian cities paid $141 including taxes for monthly electricity bills.

- This means that Toronto's monthly electricity bills (including tax) are $60 more per month ($720 more per year) than the Canadian average. Consumers in Ottawa pay $41 more per month ($492 more per year) on electricity bills than Canadians in other provinces. Montreal had the lowest monthly electricity bills for residential consumers at $83.

What did Ontario's residents receive in the way of conventional air pollution reductions that were the rationale for the phaseout of coal power and its partial replacement with wind power? A recent study for the Fraser institute (McKitrick and Aliakbari, 2017) evaluated the impact of eliminating coal power on Ontario's air pollution, finding:

- The elimination of coal was associated with a reduction in average urban PM2.5 levels by about 1 to 2 mg/m3 (about 6–12 percent from the peak levels), but the effect was not statistically significant in Toronto or Hamilton. There was no evidence that the coal phase-out reduced NOx levels, which were instead strongly affected by reduction in US NOx emissions.

- A statistically significant reduction in peak O_3 levels from the coal phaseout, offset by a significant increase associated with natural gas plant emissions.

- Overall, the coal phase-out yielded small improvements in air quality in some locations, consistent with projections done prior to the plant closures, which were comparable in size to projected air quality improvements that could have been achieved through installation of new pollution control systems rather than closing the plants.

Adding insult to injury, as McKitrick observed in a separate study, wind power in Ontario is concentrated at times of the year when demand is at a minimum, and declines during times when demand is rising (McKitrick, 2013). Consequently, according to McKitrick, about 80 percent of Ontario wind energy is generated at times when there is no demand for it domestically, requiring it to be exported at a loss (mostly to the US) of about 9¢/kWh, at an annual cost of about $200 million.

Conclusion

Canada's climate action plans include carbon pricing, but also rely heavily on regulatory interventions that undermine its efficiency properties, such as expanding renewable sources, energy efficiency measures, and vehicle electrification. As we have seen from the literature, there is little reason to believe that Canadians' money will be well spent on these efforts. Every jurisdiction in Canada with a carbon pricing program has violated the fundamental economics of such programs in ways that will greatly inflate their costs and impair their effectiveness. Evidence from the economic literature suggests that the energy efficiency programs proposed by the various provincial climate plans are likely to cost more than projected, and deliver fewer savings than promised. Electric vehicle subsidies are likely to hit Canadians in the pocketbooks, producing at best small quantities of greenhouse gas emission reductions at exorbitant costs.

Canadian governments have aggressively, and with little up-front analysis, rolled out climate action plans that are going to cost a great deal of money, but, most likely, will yield very little return in terms of environmental benefits. Governments would be well advised to slow or temporarily halt their climate action program implementation, and give the public solid analysis of their proposed programs' economic costs and benefits.

References

Alberta (2017a). *Climate Leadership Plan*. Web page. Government of Alberta. <http://finance.alberta.ca/publications/budget/budget2017/fiscal-plan-climate-leadership-plan.pdf>

Alberta, Ministry of Finance (2017b). *Fiscal Plan: Revenue*. Government of Alberta.

Belzile, Germain, and Mark Milke (2017). *Are Electric Vehicle Subsidies Efficient?* Montreal Economic Institute. <https://www.iedm.org/sites/default/files/web/pub_files/note0417_en.pdf>

Burlig, Fiona et al. (2017). *Machine Learning from Schools about Energy Efficiency.* University of Berkeley. <http://e2e.haas.berkeley.edu/pdf/workingpapers/WP032.pdf>

British Columbia (2016). *Climate Leadership Plan*. Government of British Columbia. <https://climate.gov.bc.ca/app/uploads/sites/13/2016/10/4030_CLP_Booklet_web.pdf>

British Columbia (2017, September 11). *Budget 2017, September Update*. News Release. Government of British Columbia. <http://bcbudget.gov.bc.ca/2017_Sept_Update/newsrelease/2017_Sept_Update_NewsRelease.pdf>

Bryce, Robert (2010) *Power Hungry: The Myths of Green Energy and the Real Fuels of the Future*. Public Affairs.

Cali, Davide, Tanja Osterhage, Rita Streblow, and Dirk Muller (2016). Energy Performance Gap in Reburbished German Dwellings: Lesson Learned from a Field Test. *Energy and Buildings* 127, 1: 1146–58.

All websites retrievable as of October 25, 2017.

Canada, Environment and Climate Change (2017). *Technical Paper on The Federal Carbon Pricing Backstop*. Government of Canada. <https://www.canada.ca/content/dam/eccc/documents/pdf/20170518-2-en.pdf>

Canada's Ecofiscal Commission (n.d). *Carbon Pricing*. McGill University. <https://ecofiscal.ca/carbon-pricing/>

Citizens for Public Justice (2015). *Fact Sheet #6: Putting a Price on Carbon*. <https://cpj.ca/sites/default/files/docs/files/FS6-Putting%20a%20Price%20on%20Carbon.pdf>

Cochi Ficano, Carlena, and Patrick Thompson (2014). Estimating Rebound Effects in Personal Automotive Transport: Gas Price and the Presence of Hybrids. *The American Economist* 59, 2. <http://journals.sagepub.com/doi/pdf/10.1177/056943451405900207>

Conniff, Richard (2017, May 25). *Why Don't Green Buildings Live Up to Hype on Energy Efficiency*. Yale Environment 360. <https://e360.yale.edu/features/why-dont-green-buildings-live-up-to-hype-on-energy-efficiency>

Covert, Thomas, Michael Greenstone, and Christopher Knittel (2016). Will We Ever Stop Using Fossil Fuels? *Journal of Economic Perspectives* 30, 1. <https://www.aeaweb.org/articles?id=10.1257/jep.30.1.117>

Dunsky Energy Consulting (2017). *Alberta Energy Efficiency Program Design: Phase 2 Final Report*. Alberta Climate Change Office. <https://www.efficiencyalberta.ca/app/uploads/2017/01/Dunsky-Alberta-Program-Design-Phase-2-Report-2017.04.04-ES.pdf>

Ecojustice (n.d.). *Essentials of a Carbon Tax for Canada*. <https://www.ecojustice.ca/wp-content/uploads/2015/01/Essentials-of-a-Carbon-Tax-for-Canada.pdf>

Edmunds (2017). *Elimination of Federal Tax Credits Likely to Kill U.S. EV Market.* Edmunds. <https://static.ed.edmunds-media.com/unversioned/img/industry-center/analysis/EV_Report_April17.pdf>

Fowlie, Meredith, Michael Greenstone, and Catherine Wolfram (2015). *Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Program*. NBER Working Paper No. 21331. National Bureau of Economic Research.

Global News (2016, October 3). *Trudeau Says Liberals Willing to Impose Carbon Price on Provinces*. Global News. <http://globalnews.ca/news/2979285/trudeau-announces-liberal-carbon-price-at-10-a-tonne-in-2018-rising-to-50-by-2022/>

Green, Kenneth P. (2017). *Poor Implementation Undermines Carbon Tax Efficiency in Canada*. Fraser Institute. <https://www.fraserinstitute.org/studies/poor-implementation-undermines-carbon-tax-efficiency-in-canada>

Higgins, Tim, and Charles Rollet (2017). Tesla Sales Fall to Zero in Hong Kong After Tax Break is Slashed. *Wall Street Journal*. <https://www.wsj.com/articles/teslas-hong-kong-sales-gutted-by-tax-change-1499598003>

International Risk Governance Council (2013). *The Rebound Effect: Implications of Consumer Behavior for Robust Energy Policies*. <https://www.andrew.cmu.edu/user/ilimade/Ines_Azevedo/papers/IRGC_ReboundEffect-FINAL.pdf>

Jackson, Taylor, Ashley Stedman, Elmira Aliakbari, and Kenneth P. Green. (2017). *Evaluating Electricity Price Growth in Ontario*. Fraser Institute. <https://www.fraserinstitute.org/sites/default/files/evaluating-electicity-price-growth-in-ontario.pdf>

Johnson, Tracy (2015, Nov. 23). *Alberta's Climate-Change Plan: Breaking Down the Numbers*. CBC. <http://www.cbc.ca/news/canada/calgary/carbon-tax-impact-consumers-business-1.3330391>

Jones, Allison (2016, Nov. 30). *Ontario Auditor General Report Reveals Cap and Trade to Cost $8B in First Years.* Global News. <http://globalnews.ca/news/3097838/cap-and-trade-to-cost-people-business-8b-in-first-years-auditor/>

Lammam, Charles, and Taylor Jackson (2017). *Examining the Revenue Neutrality of British Columbia's Carbon Tax*. Fraser Institute. <https://www.fraserinstitute.org/sites/default/files/examining-the-revenue-neutrality-of-bcs-carbon-tax.pdf>

Levinson, Arik (2014). *How Much Energy Do Building Energy Codes Really Save? Evidence from California*. NBER Working Paper No. 20797. National Bureau of Economic Research.

Mitchell, Russ (2017, August 28). Should California Spend $3 Billion to Help People Buy Electric Cars? *Los Angeles Times*. <http://www.latimes.com/business/la-fi-hy-electric-vehicle-subsidies-20170828-htmlstory.html>

McKitrick, Ross (2013). *Environmental and Economic Consequences of Ontario's Green Energy Act*. Fraser Institute. <https://www.fraserinstitute.org/sites/default/files/environmental-and-economic-consequences-ontarios-green-energy-act.pdf>

McKitrick, Ross (2015). *The Principle of Targeting in Energy and Environmental Policy*. Fraser Institute. <https://www.fraserinstitute.org/sites/default/files/principle-of-targeting-in-energy-and-environmental-policy.pdf>

McKitrick, Ross, and Elmira Aliakbari (2017). *Did the Coal Phase-out Reduce Ontario Air Pollution?* Fraser Institute. <https://www.fraserinstitute.org/sites/default/files/did-the-coal-phase-out-reduce-ontario-air-pollution.pdf>

Ontario (2016). *Ontario's Five Year Climate Change Action Plan: 2016 – 2020*. Government of Ontario. <https://www.ontario.ca/page/climate-change-action-plan>

Ontario (2017). *Cap and Trade in Ontario*. Web page. Government of Ontario. <https://www.ontario.ca/page/cap-and-trade-ontario>

Quebec (2011). *Rabais à l'achat ou à la location*. Web page. Government of Quebec. <http://vehiculeselectriques.gouv.qc.ca/particuliers/rabais.asp>

Quebec (2012). *Propelling Quebec Forward with Electricity*. Government of Quebec. <http://vehiculeselectriques.gouv.qc.ca/english/>

Quebec (2016). *An Act to increase the number of zero-emission motor vehicles in Québec in order to reduce greenhouse gas and other pollutant emissions*. Web summary. Government of Quebec. <http://www.mddelcc.gouv.qc.ca/changementsclimatiques/vze/index-en.htm>

Quebec (2017a). *The Carbon Market, a Green Economy Growth Tool*. Government of Quebec. <http://www.mddelcc.gouv.qc.ca/changementsclimatiques/marche-carbone_en.asp>

Quebec (2017b). *2013-2020 Climate Change Action Plan*. Web summary. Government of Quebec. <http://www.mddelcc.gouv.qc.ca/changementsclimatiques/plan-action-fonds-vert-en.asp>

Quebec (n.d.). *The Québec Cap-and-Trade System: Strengths and Advantages*. Government of Quebec. <http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/strengths-advantages.pdf>

Rabson, Mia (2017, April 18). GST on Carbon Taxes in Alberta, B.C. Will Put Millions into Federal Coffers. *Global News*. <http://globalnews.ca/news/3387209/gst-on-carbon-taxes-in-alberta-b-c-will-put-millions-into-federal-coffers/>

Saunders, Harry (2013). Historical Evidence for Energy Efficiency Rebound in 30 US Sectors and a Toolkit for Rebound Analysts. *Technological Forecasting and Social Change* 80, 7 (September): 1317–30.

Statistics Canada (2017). *Census Profile, 2016 Census*. Catalogue no. 98-316-X2016001.

Tombe, Trevor (2016, October 11). Here's How Much Carbon Pricing Will Likely Cost Households. *Maclean's Magazine*. <http://www.macleans.ca/economy/economicanalysis/heres-how-much-carbon-pricing-will-likely-cost-households/>

UK Government (2016, February 2). Non-Domestic Buildings: Best Practice and What to Avoid. <https://www.gov.uk/government/publications/low-carbon-buildings-best-practices-and-what-to-avoid>

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