State and Provincial Efforts to Put a Price on Greenhouse Gas Emissions, with Implications for Energy Efficiency

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January 2019

An ACEEE White Paper

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Acknowledgments

This report was made possible through the generous support of the Tilia Fund. The authors also gratefully acknowledge the external and internal reviewers who supported this report. External expert reviewers were Dallas Burtrow, Resources for the Future and Brendan Haley, Efficiency Canada. External review and support do not imply affiliation or endorsement. Internal reviewers included Annie Gilleo, Neal Elliott, Sara Hayes, and Lowell Ungar. Last, we would like to thank Fred Grossberg for developmental editing and managing the editorial process; Elise Marton, Sean O'Brien, and Roxanna Usher for copy editing; Eric Schwass for graphic design; Mary Robert Carter for formatting; and Wendy Koch and Maxine Chikumbo for their help in launching this paper.

Abstract

Efforts to put a price on greenhouse gas emissions are growing. Approaches include carbon taxes and cap-and-trade programs. Currently carbon taxes are in effect in Alberta; British Columbia; and Boulder, Colorado. Cap-and-trade programs are in effect in California, Quebec, Nova Scotia, and the nine northeastern states that form the Regional Greenhouse Gas Initiative (RGGI). Several other states and provinces are now considering putting a price on emissions.

The British Columbia carbon tax has been in place for a decade, and multiple evaluations have found that it is reducing energy use and greenhouse gas emissions without a serious impact on the province's economy. Likewise, RGGI has been operational for just over 10 years, and evaluators have found that it has reduced energy use and emissions while saving consumers and businesses hundreds of millions of dollars. Evaluations of other carbon tax and cap-and-trade programs have been more limited but show results consistent with the British Columbia and RGGI findings.

Energy efficiency plays an important role in several of these states and provinces, due in particular to carbon price-funded programs that help reduce energy use and cushion the effect of a carbon price on energy costs. RGGI, Quebec, and Boulder devote more than half of their carbon price revenues to funding energy efficiency programs, helping to achieve net economic benefits by reducing energy use, energy bills, and energy-related emissions. Substantial funds are also spent on energy efficiency in California and in Alberta, where they fund a new Energy Efficiency Alberta organization.

On the basis of these findings, we recommend that other states and provinces seriously study and ultimately adopt a price on carbon that builds on lessons from these leaders. One key lesson is that a substantial portion of income from carbon pricing programs should be invested in energy efficiency. Such investments drive considerable energy savings and emissions reductions, helping to cut emissions beyond what a carbon price alone could achieve. In addition, these energy savings reduce the cost of carbon pricing to households and businesses. Without such reinvestment, the benefits of a carbon price, while still positive, are not as extensive.

While an important strategy, a price on carbon will need to be complemented by other approaches to reducing energy use and emissions. As shown by international efforts and supported by the experience in California, current carbon pricing programs have only a moderate impact on energy use and emissions, far less than the 80% reduction by 2050 that many countries, states, provinces, and cities are targeting.

Introduction

Many economists believe that the best way to address climate change is to put a price on emissions of carbon dioxide (CO_2) and other greenhouse gases (GHGs). If emitting gases increases costs, then market mechanisms will find ways to reduce emissions at the lowest possible cost (see, for example, Gale 2013 and Nuccitelli 2016).

Two major approaches are now in use for putting a price on carbon: a carbon tax (sometimes called a fee or levy) and a cap-and-trade system.

A carbon tax charges a fee for every tonne of carbon dioxide that is emitted (we use the international spelling *tonne* since tonnes, also called metric tons (1,000 kilograms), are the standard unit of measure for greenhouse gas emissions). The advantage of a carbon tax is that the cost is approximately known.[1] What is less certain is the effect on emissions.

A cap-and-trade system puts a cap on greenhouse gas emissions and issues emissions permits, often referred to as allowances or certificates. Typically, one certificate allows the owner to emit one tonne of carbon dioxide. Emitters operating under a cap can trade these certificates so that the market finds the lowest-cost emissions reductions available. With cap and trade, the level of emissions is known. What is less certain is the market price of the certificates.

Both carbon taxes and cap-and-trade programs affect energy efficiency in two ways. First, they can raise energy prices, improving the economics of energy efficiency (e.g., if the price of energy is 10% higher, then the value of energy savings from energy efficiency investments increases by 10%, all other things being equal). Second, in all of the jurisdictions examined for this report, some of the funds collected are invested in energy efficiency (or there are plans to do so in the future). We expand on these points later in this paper.

Efforts to put a price on carbon are becoming more common throughout the world. According to the World Bank (2018), currently 47 carbon pricing initiatives are underway, as summarized in figure 1. These initiatives affect about 13% of annual global greenhouse gas emissions and are expected to account for more than 20% of global emissions by 2020.

[1] We say "approximately" because costs can also be affected by details such as price floors and ceilings, automatic adjustments, and offsets.

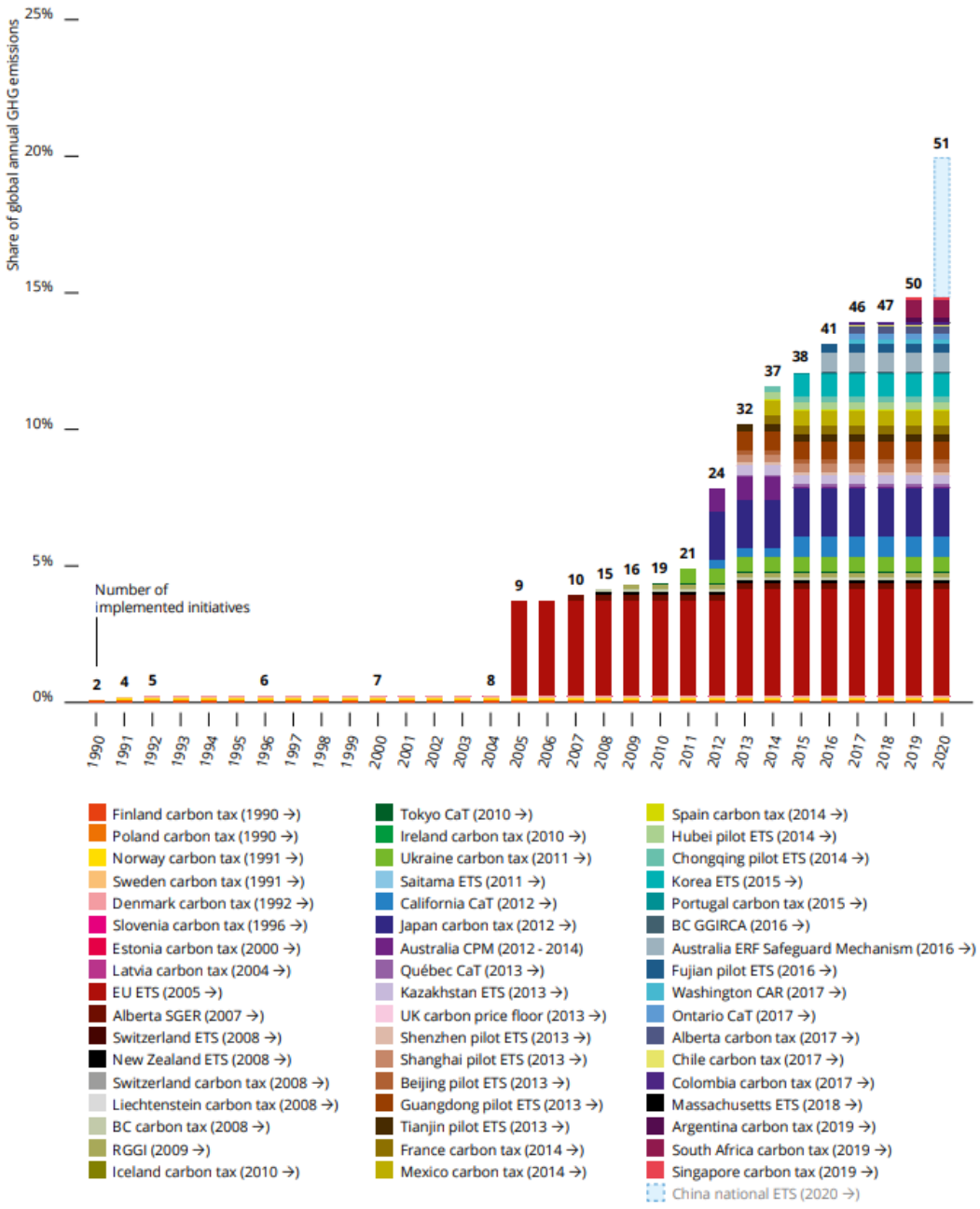

Figure 1. Regional, national, and subnational carbon pricing initiatives. *Source:* World Bank 2018.

In the United States, putting a price on carbon can potentially span the United States' left–right political divide, with carbon taxes endorsed by former Republican secretaries of state George Schultz and James Baker (Baker et al. 2017) and former Democratic vice president Al Gore (Pearce 2017).[2] However, in the current US national political climate, a federal price on carbon is not imminent. Instead, much of the activity around putting a price on carbon is

[2] Schultz and Baker served under Presidents Reagan and George H.W. Bush respectively.

occurring at the state or local level. In Canada, much of the activity is at the provincial level, with each of the major political parties taking the lead, depending on the province (discussed further below). In addition, the Canadian federal government is planning on placing a federal price on carbon for provinces that do not have their own programs (we discuss this further in a text box beginning on p. 21).

Currently in the United States and Canada, carbon taxes are being implemented in British Columbia, Alberta, and Boulder, Colorado; cap-and-trade systems are operating in California, Quebec, Nova Scotia, and the US Northeast.

This paper attempts to capture the status of state and provincial carbon taxes and cap-and-trade systems in the United States and Canada today. We discuss taxes and cap-and-trade systems now in place, how they are structured, and how they are working. We also discuss several pending proposals. Finally, we discuss implications of these programs for energy efficiency, patterns and lessons from these multiple states and provinces, and areas where further work is needed. The field is changing rapidly, and it is our intent to periodically update this paper.

Current Carbon Taxes and Cap-and-Trade Programs in the United States and Canada

The states and provinces that have current or pending prices on carbon are shown in figure 2. As noted above, carbon fees are currently in effect in the Canadian provinces of British Columbia and Alberta as well as the city of Boulder, Colorado, in the United States. Cap-and-trade programs that are in effect include the Regional Greenhouse Gas Initiative (RGGI) in the northeast United States, the California program, and Canadian programs in Quebec and Nova Scotia. A summary of the various programs now in place is provided in table 1.

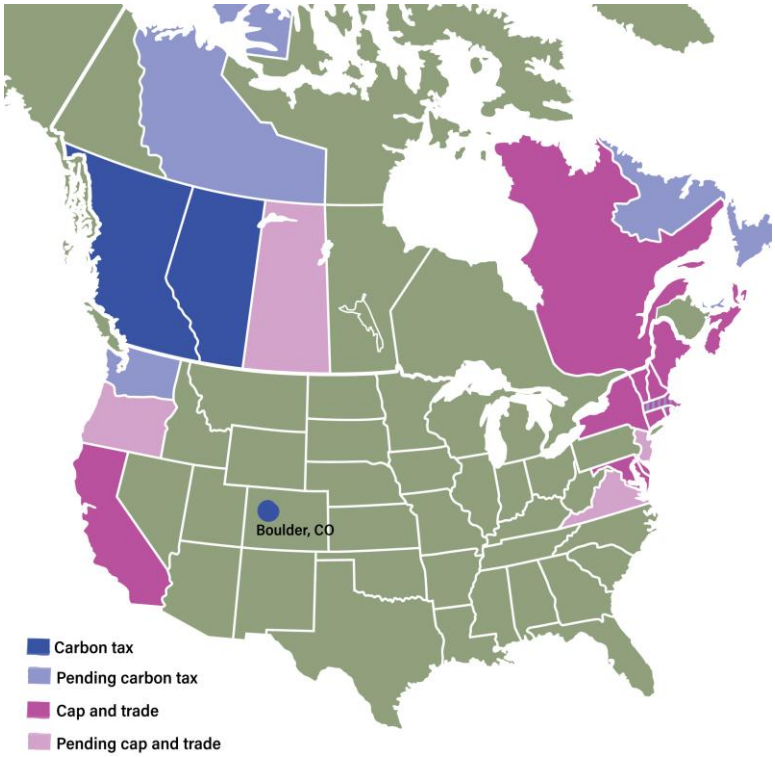

Figure 2. States and provinces with current and pending carbon taxes and cap-and-trade programs. Hawaii is also considering a carbon tax. As discussed below, the Canadian federal government is imposing a carbon tax on provinces that are not shaded. *Source:* ACEEE.

Table 1. Current state and provincial carbon taxes and cap-and-trade programs

State or province	Type of program	Year program began	What is covered?	Price in 2018 (US $/MT CO_2)	Use of funds for energy efficiency (EE)
British Columbia	Carbon tax	2008	Fossil fuel energy	$27	Will soon start investing some revenues in a green fund that includes EE
Alberta	Carbon tax	2007 for large industry, 2017 for others	Fossil fuel energy	$23	Some funds allocated to EE, such as the Efficiency Alberta set of programs
Boulder, CO	Carbon tax	2007	Electricity	$0.0003–0.0049/kWh, varying by sector	Most funds spent on EE and renewable energy
Regional Greenhouse Gas Initiative involving nine northeastern states	Cap and trade	2009	CO_2 emissions from power sector	$4.18–4.96	More than 50% of revenues invested in EE

State or province	Type of program	Year program began	What is covered?	Price in 2018 (US $/MT CO_2)	Use of funds for energy efficiency (EE)
California	Cap and trade	2013	CO_2 emissions from power and transportation sectors and natural gas use	~$15[a]	Some funds allocated to EE
Quebec	Cap and trade	2013	Same as California	~$15[b]	90% of revenues invested in strategies to reduce emissions, including EE
Nova Scotia	Cap and trade	2019	~80% of GHG emissions—large emitters, petroleum product suppliers, natural gas distributors, and electricity importers	TBD	Revenue goes to green fund that includes EE

[a] calcarbondash.org. [b] Quebec and California conduct a joint auction. *Source:* Based on information in tables A1 and A2 in Appendix A to this paper.

Below we provide a more detailed description of the various state and provincial programs. Appendix A contains details of the various programs in tabular form.

CARBON TAXES

British Columbia

PROGRAM DESCRIPTION

British Columbia (BC), on Canada's west coast just north of Washington State, instituted a carbon tax on fuel use in 2008. The tax was developed when a center-right coalition governed the province, but it was recently expanded by a government led by the New Democratic Party (a social democratic party). The tax started at $15 (Canadian) per tonne, gradually increasing to $30, where it stayed for several years.[3] It increased to $35 in 2018 and is scheduled to increase $5 each year until it reaches $50 per tonne in 2021. There are a few exemptions to the BC tax, including fuel purchased on First Nations land and specific types of liquid fuel purchased by a qualifying farmer.

The BC carbon tax was designed to be revenue neutral, with funds used to provide rebates to households and also to reduce business and personal tax rates. However some analyses found the original tax to be revenue negative (Lee 2010). Using funds from the tax, in 2018 a Climate Action Tax Credit provided rebates to households of $135 per adult and $40 per child. In addition, there is a Northern and Rural Homeowner Benefit of up to $200 per household (British Columbia 2018; Lammam and Jackson 2017).

[3] As of November 15, 2018, a Canadian dollar was worth $0.76 US.

The tax was designed to be one element in a broader climate policy. Other elements include energy efficiency programs and a clean electricity standard (Demerse 2015).

ROLE OF ENERGY EFFICIENCY

Going forward, as the tax rate increases and more revenue is collected, some funds will be used for targeted efforts to maintain industry competitiveness and for green initiatives, including energy efficiency (British Columbia 2018). Further details are not yet available.

PROGRAM IMPACTS

Much has been written evaluating the British Columbia carbon tax, most recently by Murray and Rivers (2015) and Komanoff and Gordon (2015). These studies have found it to be effective at reducing energy consumption and emissions. In BC most electricity comes from zero-carbon hydroelectric power, so the carbon tax has little effect on electricity use in the province. Studies have focused largely on gasoline and diesel use for transportation, although some have looked at the overall economy, and one study (discussed below) examined natural gas use in buildings.

Changes in use of vehicle fuels can be observed in per capita consumption in BC relative to the rest of Canada. While fuel use declined in both BC and Canada overall in 2009 (during the Great Recession), the two have diverged since then, as figure 3 shows.

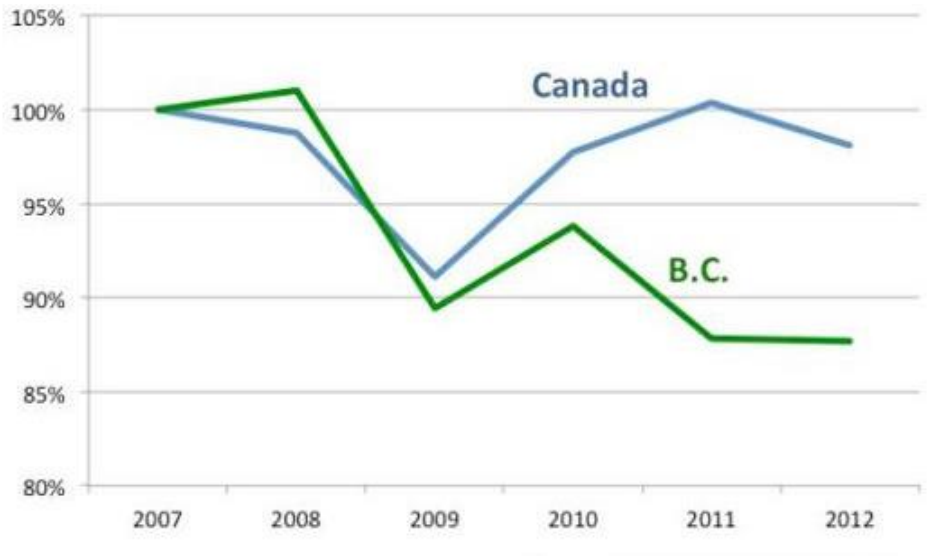

Figure 3. Comparison of petroleum consumption in British Columbia and in Canada as a whole, 2007–2012.
Source: Durning and Bauman 2014.

For petroleum fuels, probably the most comprehensive study was by Rivers and Schaufele (2012), who conducted an econometric analysis comparing BC gasoline use with that of other provinces, controlling for other covariates that could affect gasoline sales, such as income, prices, the business cycle, and public-transit investments. Their analysis suggested that the BC carbon tax caused a reduction of 11–17% in gasoline sales. They noted that this effect was much larger than would be expected if consumers responded to the carbon tax in the same way that they responded to other changes in gasoline price. Murray and Rivers (2015) summarized this and other studies on the BC carbon tax, as table 2 shows. In the case

of transportation fuels, in addition to the 11–17% reduction found by Rivers and Schaufele, they cite studies finding reductions of 18.8% and 7%.

Table 2. Results of evaluations of British Columbia's carbon tax

Source	Method	Results
British Columbia (2008)	Numerical simulation model with technological detail	5% reduction in GHG emissions
Beck et al. (2015)	Computable general equilibrium model	8.5% reduction in GHG emissions
Elgie and McClay (2013)	Difference-in-difference with no additional controls	18.8% reduction in per capita sales of petroleum fuels subject to the tax
Elgie and McClay (2013)	Difference-in-difference with no additional controls	9% reduction in per capita GHG emissions (data to 2011 only)
Rivers and Schaufele (2012)	Difference-in-difference with controls	11–17% reduction in per capita gasoline sales
Gulati and Gholami (2015)	Difference-in-difference with controls	15% reduction in residential natural gas demand; 67% reduction in commercial natural gas demand
Bernard, Guenther, and Kichian (2014)	Time series analysis	7% reduction in per capita gasoline sales

The first study is a pretax projection. Murray and Rivers derived figures given for Gulati and Gholami.
Source: Murray and Rivers 2015. Full citations are in that paper.

A more recent study, by Antweiler and Gulati (2016), used multistage regression models to compare BC to other Canadian provinces on gasoline demand and vehicle purchase decisions, controlling for a variety of factors including cross-border trips to the United States, where gasoline taxes are lower and many goods are cheaper. Their preferred model "suggests that without BC's carbon tax, fuel demand per capita would be 7% higher, and the average vehicle's fuel efficiency would be 4% lower." Their savings estimates are lower than other estimates due to the effect of the tax on cross-border trips during a period when currency exchange rates were skewed.

For buildings, Gulati and Gholami (2015) analyzed residential and commercial natural gas sales using a similar approach to that of Rivers and Schaufele. They found that following the imposition of the carbon tax, both residential and commercial consumption declined. The commercial decline is statistically significant; the residential decline is not. Murray and Rivers (2015) applied the carbon tax coefficients Gulati and Gholami developed, noting that

the carbon tax appears to have reduced commercial natural gas consumption by a much larger amount than would be expected on the basis of the normal response to changing prices, and therefore these results should be viewed with caution.

Table 2 also shows the results of several studies looking at the effects of the carbon tax on provincial greenhouse gas emissions in all sectors. These studies found greenhouse gas reductions due to the carbon tax of 5%, 8.5%, and 9%. More recently, Komanoff and Gordon (2015) compared the pre- and post-tax periods in BC and the rest of Canada, finding that BC emissions (excluding the electric sector) declined 6.1% while emissions in the rest of Canada rose 3.5%, a difference of 9.6%. For emissions per capita and emissions per dollar of GDP, both BC and Canada declined, with the difference between BC and Canada being 9.2% for emissions per capita and 12.4% for emissions per dollar of GDP.

Murray and Rivers (2015) also summarized a variety of studies looking at the impact of the BC carbon tax on economic activity. While a full discussion of economic impacts is beyond the scope of this paper, it is useful to note the authors' conclusion: "In summary, empirical evidence on the effects of the BC carbon tax on economic performance—though based on a somewhat limited number of studies—suggests little net impact in either direction. There is some evidence of negative effects in emissions-intensive sectors, such as cement, but the positive impacts in other sectors appear to compensate for those effects."

In summary, available evaluations find that the BC carbon tax has reduced greenhouse gas emissions and reduced use of gasoline and other petroleum fuels, as well as natural gas use in the residential and commercial sectors, all while having little net impact on BC's economy.

Alberta

PROGRAM DESCRIPTION

The province of Alberta straddles the Rocky Mountains. Its capital is Calgary. The Alberta carbon tax was developed by the Conservative Party but recently was expanded by the New Democratic Party.[4] The Alberta carbon levy began in 2007 for large emitters, with a tax of $15 (Canadian) per tonne of CO_2 emissions above a facility's baseline. In 2017 the levy was expanded to households and transportation fuels and increased to $20 per tonne, rising to $30 in 2018. The industrial portion of the program was restructured then as well, as discussed further below. The current levy applies to motor fuels, heating fuels, and industrial fuel consumption. It does not apply to electricity. Farm liquid fuels are exempted, as are fuels used on First Nation land, biofuels, and industrial feedstocks (fuels used as a raw material rather than burned).

As of 2017, large facilities (primarily those with emissions of more than 100,000 tonnes per year) are covered by a companion program called the Carbon Competitiveness Incentive Regulation. This program charges the same carbon tax that is applied to other sectors but provides credits based on benchmark emissions for a given industry, with the benchmarks

[4] For US readers, the Canadian Conservative Party is somewhat similar to the US Republican Party, but perhaps not quite as conservative. The Canadian Liberal Party is generally similar to the US Democratic Party, while the New Democratic Party is analogous to liberal Democrats.

gradually tightening (Alberta 2018b). Firms receive the same credit per unit product, regardless of their emissions per unit product. Thus low emitters can actually make money on the combination of the levy and the credit while for high emitters, the credit will not fully offset the levy (Tombe 2015). In addition, several forms of relief are provided for facilities with high compliance costs (defined as costs greater than 3% of facility sales or 10% of facility profit). Potential relief includes additional compliance flexibility, priority for Industrial Energy Efficiency program grant funding, and the possibility of additional free allocations (Alberta 2018c). For Alberta's large oil and gas industry, natural gas consumed on site is exempted from the fee until 2023 (Tombe 2015).

An analysis of the 2017 levy estimated that it increases annual energy bills for the average household by $300 for a typical low-income household, $500 for the median household, and $600 for a high-income household (Tombe 2015). For low- and medium-income households, quarterly rebate payments are provided to offset these higher costs; in 2018 the rebates are $300 annually for the first adult in a household, $150 for a spouse or equivalent, and $45 for each child. Additionally, in 2017 the small-business tax was reduced from 3% to 2% of net income to offset much of the impact of the carbon levy on small businesses (Alberta 2018a).

Nearly half of the funds collected from the levy are used for the household rebates and small-business tax reductions discussed above. Other funds are used to support public transit, innovation research, energy efficiency programs ($662 million allocated over three years), infrastructure projects, and indigenous communities (Alberta 2018a).

Alberta has an election coming in the spring of 2019, and polls indicate that the opposition, the United Conservative Party (UCP), is ahead of the current government (which is run by the New Democratic Party). If elected, the UCP has pledged to dramatically reduce but not eliminate the carbon levy (Flavelle and Wingrove 2018).

ROLE OF ENERGY EFFICIENCY

Energy Efficiency Alberta (EEA) is a government agency established in late 2016 to "deliver energy-efficiency awareness, programming and industry development for Albertans as part of Alberta's Climate Leadership Plan." The broader plan includes the price on carbon emissions discussed above, with a portion of revenues used to fund EEA. In the 2018/2019 fiscal year, the agency has a budget of $149 million (Canadian), funded mostly by the carbon levy with additional funds from the federal government (Energy Efficiency Alberta 2018). In its first year, EEA established six programs:

- Residential No-Charge Energy Savings Program
- Residential Retail Products Program—online rebates, instant savings, and home improvement rebates
- Business, Nonprofit, and Institutional Energy Savings Program
- Residential and Commercial Solar Program
- Custom Energy Solutions
- Indigenous Green Loan Guarantee

Figure 4 shows how EEA's 2018–19 budget is allocated among programs.

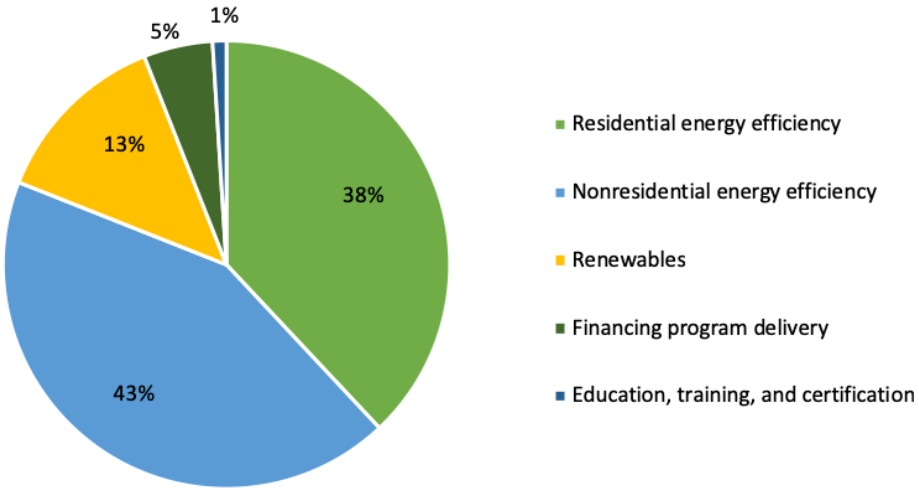

Figure 4. Planned Energy Efficiency Alberta 2018–19 spending by program area.
Source: Energy Efficiency Alberta 2018.

In addition to EEA, much of the industrial revenue from the carbon levy goes to an organization called Emissions Reduction Alberta, which "is investing in a diverse portfolio of transformative, sustainable technologies that reduce emissions."[5] Efficient industrial processes are one area of focus (Haley 2016).

PROGRAM IMPACTS

In our search through the literature, we found two studies that attempt to measure impacts. Ali (2015) looked at the impact of the initial industrial carbon levy, using the neighboring province of Saskatchewan as a control. This study found that the emissions intensity (emissions per unit GDP) of Alberta and Saskatchewan were similar before the Alberta levy, but afterward they diverged, with emissions intensity lower in Alberta in the oil and gas, electricity and heat, transportation, and residential buildings sectors. These differences were statistically significant with 95% confidence. This study concluded that the carbon levy probably contributed to these differences but that other factors may have also been involved.

Another study, by Canada's Ecofiscal Commission, estimates 7% emissions reductions in Alberta from carbon pricing relative to a no-policy case (Beugin et al. 2017). This estimate is derived from several other studies the authors reference, but how they arrived at this 7% estimate is unclear. One of the referenced studies was a report to the Alberta government recommending expansion of the initial carbon tax. Thus this 7% estimate is probably for something more extensive than the initial industrial tax, but since it predates the actual expansion, it therefore is unlikely to reflect all of the details of the expansion.

[5] www.eralberta.ca.

Boulder, Colorado

PROGRAM DESCRIPTION

The city of Boulder adopted a carbon energy tax in a 2007 referendum and extended it in 2015 in another referendum. The tax is authorized through March 31, 2023. The tax applies only to electricity and is assessed per kWh consumed (about half a cent per kWh for residential customers, much less for commercial and industrial users). The tax is collected by the local electric company as part of the electric bill. Boulder officials estimate that the annual tax averages $21 per residential electric customer, $94 per commercial customer, and $9,600 per industrial customer. Power generated by wind turbines is exempted. This tax generates about $1.8 million per year (City of Boulder 2018). While this is not a comprehensive carbon tax, since it applies only to electricity, we include it in this paper because it is labeled a carbon tax and revenues are used to address climate change.

ROLE OF ENERGY EFFICIENCY

Funds collected are used to implement the Boulder Climate Action Plan, which supports public education, investments in public transit, energy audits, and rebates for energy efficiency improvements to homes and businesses (Bhatt and Ryan 2017). The average annual allocation of funds is illustrated in figure 5. Energy efficiency accounts for 63% of spending; renewable energy, electric vehicles, and market innovation account for another 25%. The remainder goes for strategy development, outreach, and evaluation. Currently, substantial funds support several city-run programs:

- EnergySmart energy advising services and rebates for residents;
- SmartRegs energy efficiency requirements for rental properties;
- Pilot programs that spur market innovation and local renewable energy generation;
- Programs and policies designed to improve energy efficiency in commercial properties (City of Boulder 2018).

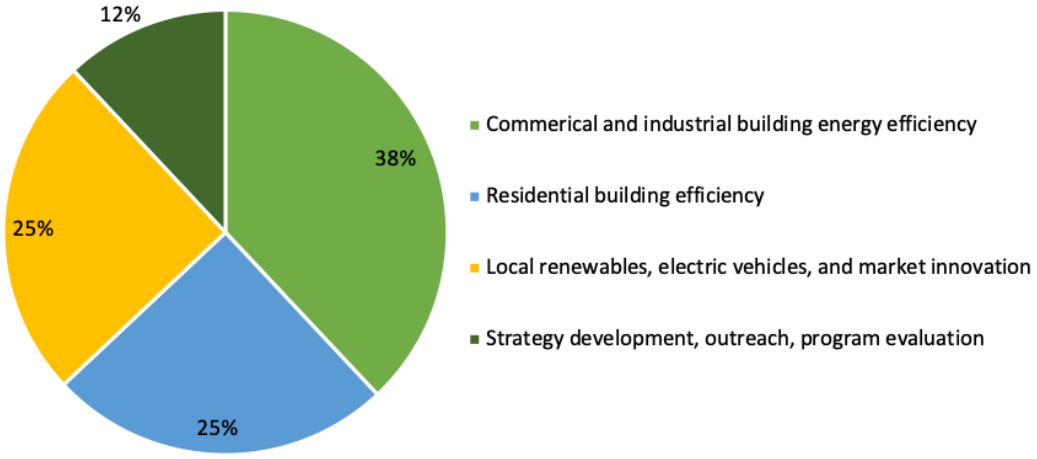

Figure 5. Average annual allocation of revenues from Boulder's carbon tax. *Source:* City of Boulder 2018.

PROGRAM IMPACT

Boulder officials estimate that programs funded under the carbon tax have avoided about 250,000–750,000 cumulative tonnes of emissions since 2007 (City of Boulder 2019). The city

estimates that total annual emissions in 2016 were 1.6 million tonnes.[6] Thus the decade of cumulative program savings are about 16–47% of annual emissions and on the order of 1–4% of cumulative emissions over the 12-year period.

CAP-AND-TRADE PROGRAMS

Regional Greenhouse Gas Initiative (RGGI)

PROGRAM DESCRIPTION

The Regional Greenhouse Gas Initiative (RGGI) was the first mandatory cap-and-trade program for reducing greenhouse gas emissions in North America. In 2005 seven states committed to develop the program under the leadership of regional governors representing both major political parties; three other states joined in 2007. Currently composed of nine northeastern and mid-Atlantic states, RGGI began its first compliance period in January 2009.[7] The program caps CO_2 emissions from the power sector with a goal of reducing emissions 45% below 2005 levels by 2020, with an additional 30% reduction in the regional cap by 2030.[8] Electric-generating units burning fossil fuels and having the capacity to generate 25 megawatts or more are required to reduce emissions or acquire allowances to cover each US ton of CO_2 emitted.

RGGI distributes most of the allowances through quarterly regional auctions open to all qualified participants, resulting in a single clearing price. The remaining allowances are used primarily for state set-aside accounts.[9] Each state is committed to spending 25% of allowance proceeds for consumer benefit, including investment in energy efficiency programs, a requirement that all states exceed (EDF 2015).

Allowance prices have varied over the course of the program. However RGGI states adopted three program features to help minimize allowance price volatility: the Cost Containment Reserve, a provision that adds allowances to the market if prices rise past a certain level; the Emissions Containment Reserve, triggering removal of allowances when prices fall below the prescribed level; and an absolute minimum price in the auction below which no allowances will be issued (RGGI 2018a).[10] As shown in figure 6, auction clearing prices have stayed between $2 and about $8 per ton over the course of the program (these figures are in US tons, not metric tonnes). RGGI states tightened the emissions cap starting

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[6] bouldercolorado.gov/climate/boulders-community-greenhouse-gas-inventory.

[7] As of September 2018, RGGI includes Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. New Jersey participated in the first three years of the RGGI program but withdrew at the end of 2011. New Jersey and Virginia are now in discussions to join or link to RGGI.

[8] Projected reductions between 2020 and 2030 amount to 2.275 million tonnes per year. These additional reductions were determined as part of the second program review, held in 2017.

[9] www.rggi.org/allowance-tracking/allowance-distribution.

[10] The Cost Containment Reserve provides additional allowances equal to 10% of the cap each year, with a trigger price of $10/allowance in 2017, rising to $13 in 2021. The minimum reserve price was $2.05 in 2015, increasing by 2.5% annually. In 2021, the Emissions Containment Reserve will have states withhold approximately 10% of the allowances if prices fall below $6.

in 2014, further tightening it by 2.5% per year thereafter for compliance period 3 (which began with the 27th quarterly auction in March 2015). There was a drop in the number of allowances sold for compliance period 3 (2015–2017) compared with earlier periods, while clearing prices were on average higher.[11] Total auction proceeds were slightly lower compared with the other two compliance periods (Hibbard et al. 2018).

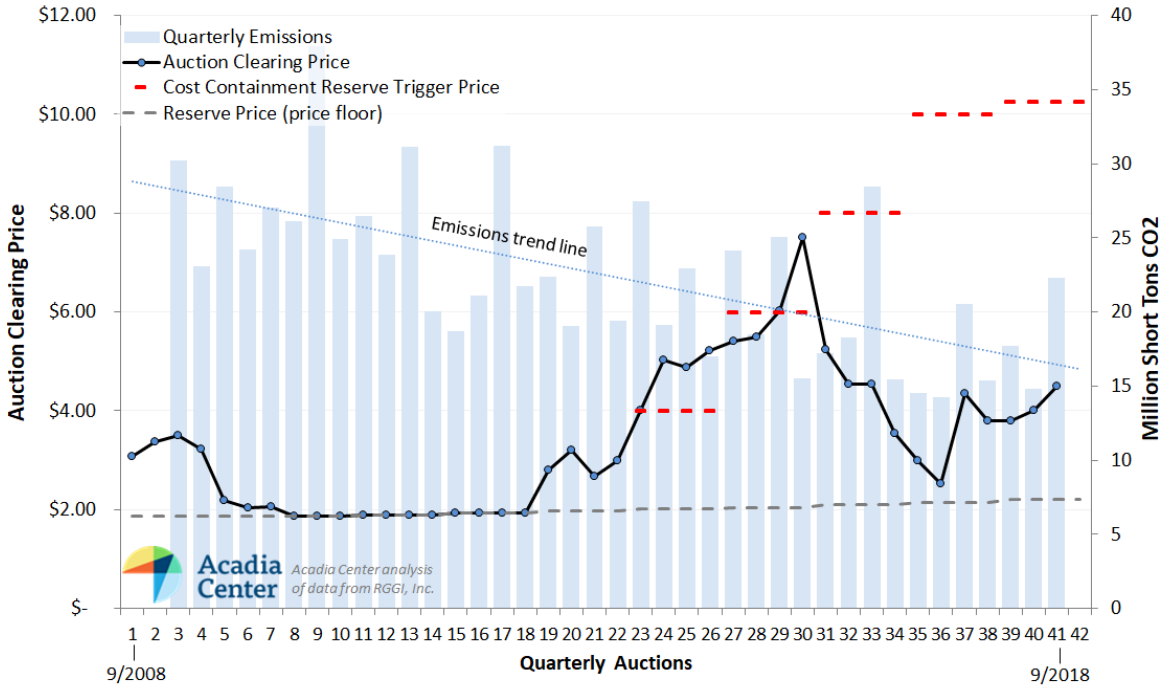

Figure 6. Summary of RGGI auction results, price controls, and CO_2 reductions. Emissions are per quarter (three months) and are in American tons, not metric tonnes. *Source:* Jordan Stutt, carbon programs director, Acadia Center, pers. comm., November 12, 2018.

RGGI states have enacted program adjustments since the program review in 2017, instituting steady annual reductions in the amount of emissions allowances available and increasing the trigger prices for the Cost Containment Reserve. The program is anticipated to grow with the likely reentry of New Jersey (which dropped out in 2011) and the addition of Virginia to the emissions market in 2020.

As electric sector emissions continue to fall, states involved in RGGI have recognized the need to reduce emissions from the transportation sector, which surpassed power sector emissions nationwide in 2016 (EIA 2017). The Transportation and Climate Initiative (TCI) is a regional collaboration established in 2010 and made up of 13 northeastern and mid-Atlantic jurisdictions (many in or planning to enter RGGI, plus a few others) that seek to reduce carbon emissions in the transportation sector. Representatives from each jurisdiction participated in workgroups focused on regional priorities. In December 2018, nine of these states announced an agreement to develop a cap-and-trade program for transportation

[11] The emissions cap declines by 3% per year beginning in 2021.

emissions. Their goal was to complete the policy design process within one year, after which each jurisdiction would decide whether to adopt and implement the policy (TCI 2018).[12]

ROLE OF ENERGY EFFICIENCY

Auctioning of allowances over the course of the program from 2009 through 2017 has resulted in nearly $3 billion in revenue. Over the past three compliance periods, participating states have invested more than half of those proceeds into energy efficiency programs (Hibbard et al. 2011, 2015, 2018). An analysis by RGGI, Inc. concluded that energy efficiency accounted for 58% of cumulative investments through 2016 (RGGI 2018b). Figure 7 shows investments of auction proceeds from compliance period 3 (2015–2017), with RGGI states dedicating 52% ($572 million) of proceeds for energy efficiency programs, 18% for renewable energy programs, and 13% for direct bill assistance.

States invest much of the revenue in utility energy efficiency programs, state green banks, and/or programs run by state energy offices offering incentives, technical support, and financing. The investments reach a variety of customer types, including businesses, municipalities, and residential and low-income communities (RGGI 2018b). Proceeds are augmented by investments made as a result of complementary policies in RGGI states, including energy efficiency resource standards (mandatory energy savings targets for utilities), building energy codes, and state government-led initiatives. Six of the nine states participating in RGGI ranked in the top 10 of ACEEE's annual nationwide energy efficiency ranking (Berg et al. 2018). These policies magnify the GHG reductions and economic benefits realized through the cap-and-trade program.

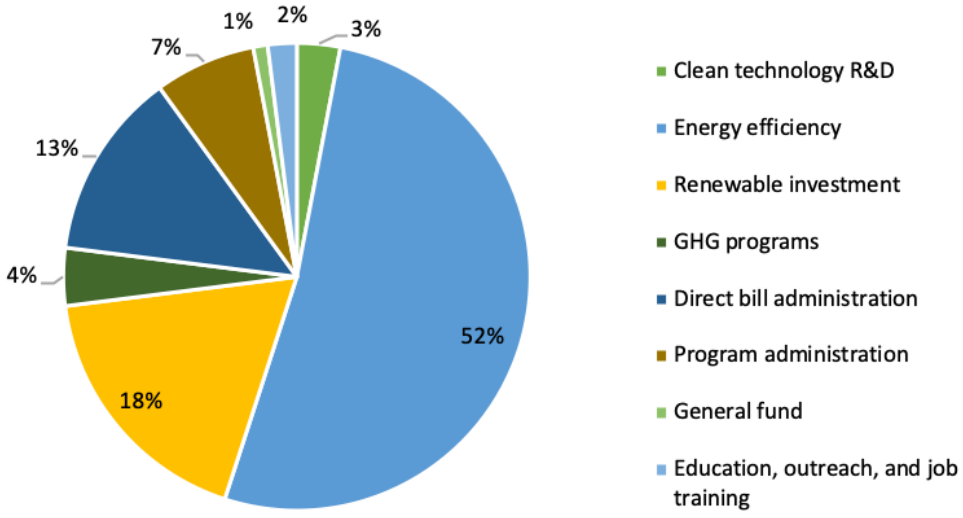

Figure 7. RGGI proceeds spending during compliance period 3 (2015–2017) for all RGGI states.
Source: Hibbard et al. 2018.

[12] Participating jurisdictions include Connecticut, Delaware, the District of Columbia, Maryland, Massachusetts, New Jersey, Pennsylvania, Rhode Island, Vermont, and Virginia. In addition, Maine, New Hampshire, and New York participated in the discussions but were not among the states committing to a cap-and-trade program.

PROGRAM IMPACT

After nearly 10 years of auctions and three compliance periods, RGGI states have hit each emissions reduction target. The impacts of RGGI investments have resulted in net positive benefits in the form of decreased emissions, lower customer bills, lower wholesale power prices, jobs gains, and boosts to local economies (Hibbard et al. 2018). Since 2005, when development of the program began, CO_2 emissions from plants subject to RGGI have declined from about 160 million metric tonnes to about 60 million tonnes (Hibbard et al. 2018). These reductions are primarily due to a shift to lower-emitting generating sources, but energy efficiency also played a role, helping to reduce total electricity consumption over the 2005–2016 period despite substantial economic growth.[13] While complementary policies, such as adoption of energy efficiency resource standards and renewable portfolio standards, have contributed to emission reductions in the region, an econometric analysis from 2015 demonstrated that the RGGI program accounted for nearly half of the region's emissions reductions (Murray and Maniloff 2015).

Three studies of the economic impacts over each compliance period determined that the program resulted in net positive economic outcomes, due in large part to the RGGI states' decision to auction allowances and reinvest the proceeds to meet state policy objectives (Hibbard et al. 2011, 2015, 2018). The 2018 study found that the net economic value of the program to the region was about $1.4 billion over the 2015–2017 period (in 2018 dollars, using a 3% real discount rate), supporting 14,500 job-years (a job-year is a full-time job for a year). Direct consumer benefits during this period were about $220 million considering the impact of reduced energy use, minus the impact of allowance prices on the price of electricity. In addition, RGGI, Inc. developed reports reviewing the impacts of the use of auction proceeds (RGGI 2016, 2017). In 2016, the lifetime effects of RGGI investments were estimated to return $822.8 million in bill savings to more than 176,000 households and 2,430 businesses. They will save an estimated 4.5 million MWh of electricity, avoiding the release of 3.3 million short tons of CO_2 (RGGI 2018b).

California

PROGRAM DESCRIPTION

The California legislature adopted the Global Warming Solutions Act in 2006 (AB 32). At the time the state had a Republican governor and a Democratic majority in the legislature. AB 32 authorized the California Air Resources Board (CARB) to establish a cap-and-trade program for greenhouse gas emissions based on emissions reduction targets in the bill (Taylor 2017). CARB developed the program over several years; implementation began in 2013. The program initially covered emissions in the power sector, but in 2017 the transportation sector and the use of natural gas outside the power sector were added to the

[13] A simple calculation based on total electricity sales in the nine RGGI states shows a 6% decline in electricity consumption over this period (data from www.eia.gov/electricity/data/state). Data for 2017 are not yet available.

program. Entities responsible for emissions of at least 25,000 tonnes per year are covered. The program now includes about 85% of greenhouse gas emissions in the state (EDF 2018).[14]

Some allowances are distributed for free, but most are auctioned. Free allowances are given to utilities, but they must in turn consign these allowances to the auction, with the proceeds used to benefit ratepayers. Free allowances—about 15% of the total—are also distributed to the industrial sector to combat leakage of industrial production to other states and countries. Transportation allowances are auctioned. Further information on allowance allocation can be found on the CARB website.[15]

ROLE OF ENERGY EFFICIENCY

State law prior to 2017 required that auction revenues be used to reduce greenhouse gases. In 2017 the state extended the trading program to 2030 and freed the program from an obligation to use all funds for program-related purposes, thereby allowing some funds to be directed to general use. From 2013–2017, more than $3.6 billion of auction revenues were appropriated by the legislature for program-related purposes; allocations are shown in figure 8 (Taylor 2017). Of the funds allocated, 4% goes to agricultural efficiency and energy (e.g., the use of agricultural waste to produce energy) and 5% goes to low-income weatherization and solar. The investments in low-carbon vehicles (e.g., electric and hydrogen vehicles) and public transportation (high-speed rail, transit, and intercity rail) are substantial. They will generally reduce energy use and boost efficiency since electric vehicles and public transit are generally more efficient per passenger-mile than private vehicles with internal combustion engines.[16] Across all of these categories, California laws and regulations require that 35% of spending benefit disadvantaged communities and that 25% be spent in those communities.[17]

It should also be noted that while only a limited share of auction revenue goes to building and industrial efficiency, the state's utilities spend considerable efficiency funds in these sectors—nearly $1.7 billion in 2017 counting both electric and gas utility expenditures (Berg et al. 2018).

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[14] This percentage likely excludes the impact of forest fires on emissions.

[15] www.arb.ca.gov/cc/capandtrade/allowanceallocation/allowanceallocation.htm.

[16] en.wikipedia.org/wiki/Energy_efficiency_in_transport.

[17] calepa.ca.gov/envjustice/ghginvest.

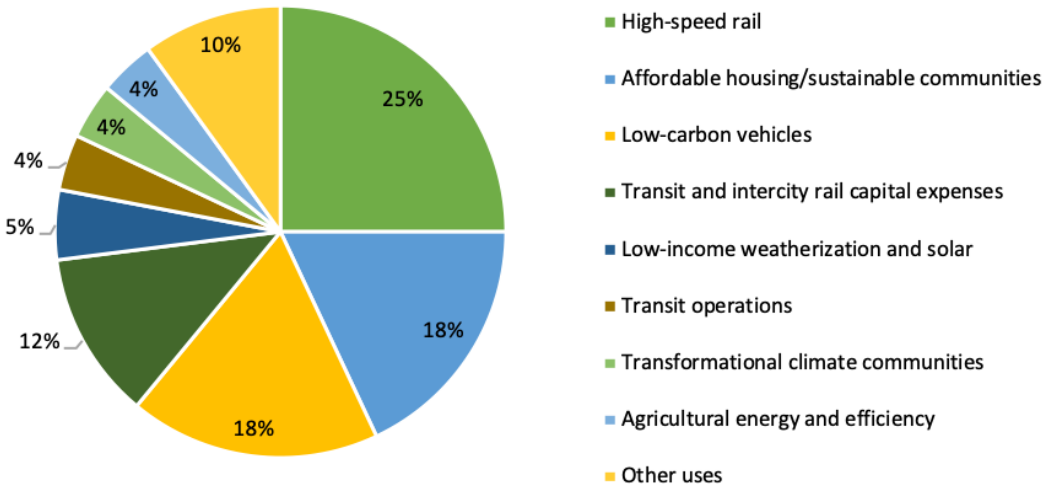

Figure 8. Allocations of California cap-and-trade revenues, 2013–2017. *Source:* Taylor 2017.

PROGRAM IMPACT

In 2018, CARB announced that in 2016 California had already met its 2020 emissions target. According to Barboza and Lange (2018), both early compliance with California's renewable electricity mandate and the weather helped drive reductions. California requires that 33% of electricity generation in the state come from renewable resources by 2020. And in 2016, rainfall was high, increasing production from hydroelectric dams and reducing imports of coal-generated power (Barboza and Lange 2018). CARB officials also credited the cap-and-trade program and the state's low-carbon fuel standard (Barboza and Lange 2018).[18] These impacts may be larger in the future. Borenstein et al. (2018) found that while the emissions allowance market has been soft in the past, resulting in allowance prices near the price floor, modeling that looks forward to 2030 indicates the likelihood of higher allowance prices that could help drive emissions reductions.

Interestingly, a 2016 study assessed equity issues under the California cap-and-trade program, finding that the higher emitters of greenhouse gases and fine particles (PM_{10})[19] are more likely to be located in communities with above-average portions of residents of color and residents living in poverty (Cushing et al. 2016). This report and related research helped lead the California legislature to modify the program in 2016 to give priority to direct emissions reductions from these facilities (Carlson 2016).

Going forward, the emissions cap in California will continue to decline—the 2030 cap is 40% below the 2020 cap (Gustin 2017). Various complementary policies will also reduce emissions. For example, recent California laws require 60% of electricity to come from renewable energy sources by 2030 and to be carbon free by 2045 (Shoot 2018). California has

[18] The low-carbon fuel standard calls for producers of petroleum-based fuels to reduce the carbon intensity of their products by 10% by 2020. For further information, see www.energy.ca.gov/low_carbon_fuel_standard.

[19] Particulate matter with a diameter of 10 microns or less.

also passed laws to double energy efficiency savings by 2030, and aims to modify its building codes to require zero net energy construction by 2030.[20]

California has also been working with other states and provinces to encourage an integrated multistate/province cap-and-trade program. In the next section we discuss the Quebec cap-and-trade program, which is integrated with California's. Oregon is also planning to integrate, with legislation to be considered in 2019 (discussed later in this paper).

Quebec

PROGRAM DESCRIPTION

Quebec is Canada's second-most populous province. Its largest city is Montreal. Quebec has a cap-and-trade program very similar to California's, adopted in 2011 under a Liberal Party government and begun in 2013. Both the California and Quebec programs are based on discussions held by a group of states and provinces called the Western Climate Initiative. California and Quebec have harmonized enough that they now conduct joint auctions of emissions allowances, with purchased allowances good in both jurisdictions.

In Quebec, the cap-and-trade program is run by the Ministry of Sustainable Development, Environment and the Fight against Climate Change. Quebec's program targets reducing 2030 greenhouse gas emissions by 37.5% below 1990 levels. Nearly all of the particulars of the program (e.g., covered gases, price floor, allowed use of offsets) are the same in Quebec and California; the few differences include which emitters are given free allowances and some offset specifics (Kroft and Drance 2015; Oregon Legislative Policy and Research Office 2017).

ROLE OF ENERGY EFFICIENCY

Auction proceeds go into a green fund. For 2013–2020, 90% of funds have been allocated to investments to reduce emissions, including efficiency programs, with 8% dedicated to adaptation and 2% to administration. Figure 9 illustrates planned uses of the revenues over the 2013–2020 period. The majority, 63%, is going to transportation, which accounts for the largest share of emissions in the province. Of the transportation funds, the majority is being devoted to public transportation and alternatives to vehicles with only one passenger, but substantial funds are also going to electric vehicles (passenger cars, taxis, and buses) and to projects to reduce energy use and emissions in transporting goods (Québec 2018).

Quebec also devotes nearly 20% of its funds to buildings and industry, including revisions to the construction code for new buildings (e.g., efficiency improvements and the use of wood as a low-carbon building material), insulation and heating system efficiency measures for homes, use of solar energy, and assessments and training for industrial customers including on process efficiency optimization and use of residual biomass fuels (Québec 2018).

[20] www.energy.ca.gov/sb350/doubling_efficiency_savings. www.cpuc.ca.gov/General.aspx?id=4125.

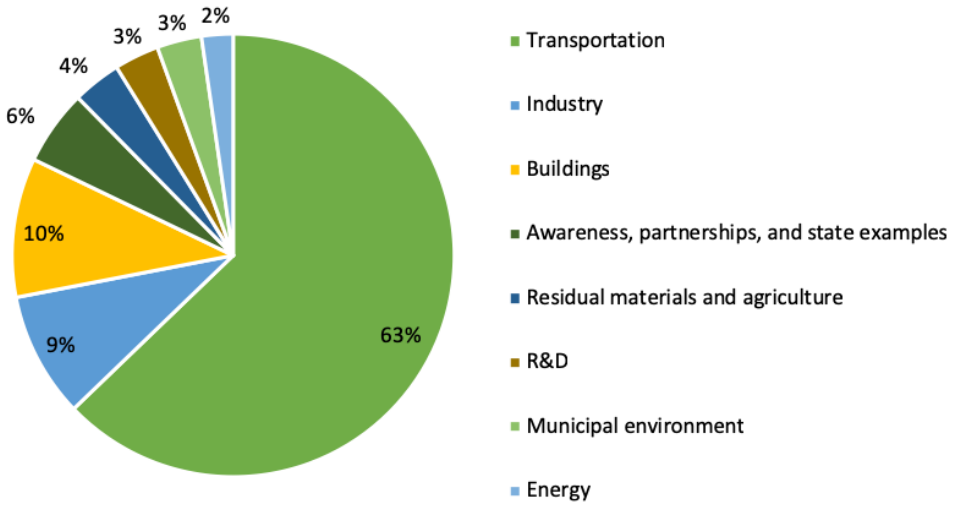

Figure 9. Planned allocation of Quebec cap-and-trade funds, 2013–2020. *Source:* Ministry of Sustainable Development, Environment and the Fight Against Climate Change 2017.

In 2017 Quebec established a new state corporation, Transition Énergétique Québec (TEQ), to coordinate many efforts in the province (Haley 2018a). TEQ is funded by cap-and-trade revenues, a charge on energy distributors, and an energy transition fund. In mid-2018 TEQ released a detailed plan that involves TEQ's own programs as well as programs coordinated with government ministries and electric and gas distributors. The plan takes an integrated approach, for example noting how incentive programs smooth the way for strong regulations. The plan is now being reviewed by Quebec regulators.

Energy efficiency is a "priority energy source" under the plan, and specific efficiency steps are outlined for each sector. For example, the residential plan includes building code changes, appliance regulations, a building labeling system, voluntary contractor certification, and a prohibition against installing heating oil systems in grid-connected houses as of 2028. For the commercial sector, the plan calls for a voluntary and ultimately mandatory building energy data program, a voluntary building code targeting net zero construction, waste heat recovery efforts, and the promotion of green leases. For industry the plan includes promotion of the International Standards Organization 50001 Energy Management System and the possible inclusion of an energy efficiency clause in environmental regulations. And for transportation, the plan includes a "feebate" program to reward the purchase of efficient vehicles and penalize the purchase of inefficient ones, efforts to optimize supply chain logistics, a "green transport" program for companies, and programs to promote sustainable mobility solutions (Haley 2018a).

PROGRAM IMPACT

The Quebec government provides periodic program reports to the legislature, but to date there has been no comprehensive or independent evaluation. Canada's Ecofiscal Commission projects a 15% emissions reduction in 2020 due to the cap-and-trade program (Beugin et al. 2017), but this estimate appears to fully credit the cap, with no credit given to any other programs and policies that help to lower emissions.

Nova Scotia

PROGRAM DESCRIPTION

Nova Scotia is a small Canadian province located northeast of Maine. Its capital is Halifax. Nova Scotia recently finalized a cap-and-trade program under the leadership of its Liberal Party government. The program, designed to meet the federal requirement for carbon pricing, began on January 1, 2019, and is one element of a plan to reduce greenhouse gas emissions 45–50% below 2005 levels by 2030. As of 2016, emissions were about 30% below this baseline; the cap-and-trade program is one element to achieve further reductions. Other elements include a green fund (discussed below), expanded energy efficiency and renewable energy funding, new federal infrastructure investment programs, and coal-to-clean-energy transitions (Nova Scotia 2018a, 2018b).

The cap-and-trade program covers about 20 firms, including those that directly emit more than 50,000 tonnes of carbon per year (including electric generators), petroleum product suppliers, natural gas distributors, and electricity importers. Most of the available emissions allowances will be distributed for free, accounting for 75–90% of business-as-usual emissions, depending on the sector. Additional allowances may be purchased at auction, and a small share of allowances will be put in a reserve to allow for new entrants, provide a soft price ceiling (reserve allowances can be purchased at a set price), and provide a buffer for uncertainty. Trading is allowed among the participating firms. There are presently no plans to link trading with other provinces or US states (Nova Scotia 2018a, 2018b).

The Nova Scotia government estimates that the cap-and-trade program will cost households about $50–70 per year due to slightly higher prices for electricity, gasoline, natural gas, and heating oil (Nova Scotia 2018b).

Nova Scotia plans to establish a green fund using auction revenues and perhaps other funding sources. The fund will "help mitigate impacts, create programs and leverage federal and private sector investments." It will start operation in 2020, with details to be developed in 2019 (Nova Scotia 2018b).

ROLE OF ENERGY EFFICIENCY

As noted in the section above, the government plans to expand energy efficiency programs as part of efforts to meet 2030 targets. Green fund dollars may help with these efforts.

PROGRAM IMPACT

Since the cap-and-trade program is just beginning, it is too early to assess its impact.

Ontario

PROGRAM DESCRIPTION

Ontario, Canada's most populous province, implemented a cap-and-trade program (aligned with California's and Quebec's) in 2017, but with the election of a new Conservative government, the program was canceled in July 2018 (Ontario 2018). The program did not amass much of a track record before it was canceled, but an analysis of the program found that the caps established under the program were sufficient to meet Ontario's emissions target of a 15% reduction from 1990 levels by 2020. This study also found that "until the carbon price reaches levels that could prompt significant technological progression by

industry," the emissions reductions needed to fit under the cap "will depend on the implementation of complementary policies set out in the climate change action plan to support sustainable reductions in all sectors of the economy" (But 2016).

Other Carbon Fees in Canada

Canada's federal and provincial governments have worked together to develop plans to put a price on greenhouse gas emissions. In 2017 the federal government and most of the provinces reached agreement on a plan allowing individual provinces to establish their own carbon taxes, cap-and-trade programs, or a combination. Provinces that do not do so will be covered by a federal carbon tax. The federal government, under Liberal Party leadership, is now developing implementing legislation. The current federal proposal is for a carbon tax to begin at $20 (Canadian) per tonne in 2019 and then ramp up $10 per year to $50 in 2022 (Canada 2018a). Under the agreement, provinces that develop their own programs must have a carbon price equivalent to at least $50 per tonne by 2022.

As discussed above, British Columbia, Alberta, Quebec, and Nova Scotia all have programs. The new Ontario government, which is run by the Progressive Conservative Party, is pledging to fight the federal carbon tax, as is the province of Saskatchewan. This issue will be resolved either by the courts or in the next Canadian election, scheduled for October 2019. Manitoba prepared a detailed carbon tax proposal that we describe in the pending proposals section, below. However in October 2018 the provincial government decided not to move forward, stating that the province was getting too little credit from the federal government for its green economy, credit that would allow it to meet climate targets with a smaller carbon tax than the federal government insisted on (Froese 2018). The Northwest Territories are developing a carbon tax, as is discussed in the next section of this report.

In October 2018 there was a flurry of activity in Canada. The federal government and two small Atlantic Coast provinces (Newfoundland and Prince Edward Island) announced agreement on carbon pricing, as discussed in the next section. Also in October, the federal government announced that the four remaining provinces (Manitoba, New Brunswick, Ontario, and Saskatchewan) and two remaining territories (Nunavut and Yukon) would be covered by a federal carbon tax, with most of the revenue collected rebated to consumers in those provinces. The government estimates that the rebates will be greater than the tax for 70% of consumers. The reverse will be true for the remaining 30%, who are likely to be wealthier than average and to own larger homes and vehicles (Tasker 2018; Canada 2018b).

Pending Proposals

Several US states and Canadian provinces are actively considering fees on carbon emissions, including Washington, Massachusetts, Oregon, Rhode Island, Manitoba, Newfoundland, Prince Edward Island, the Northwest Territories, and Saskatchewan. Here we examine these proposals and also briefly discuss related activity in several other states.

WASHINGTON

The state of Washington has been seriously considering some type of carbon tax for several years. In 2016 a citizens' initiative that would have established a revenue-neutral carbon tax collected enough signatures to make it onto the ballot, but it was defeated (41% support, 59% opposition).[21] The proposal included a fee of $25 per ton starting in 2018, with the revenue used to reduce sales taxes, provide rebates for working families, and fund a tax

[21] results.vote.wa.gov/results/20161108/State-Measures-Initiative-Measure-No-732-concerns-taxes.html.

break for manufacturers. The environmental community split on the initiative, with many environmental groups opposing it because all of the revenue would be devoted to tax cuts and none to investments in clean energy or other environmental programs. Another problem was that while the initiative was intended to be revenue neutral, the state budget office concluded that proceeds would fall short of the promised tax breaks by about $225 million per year, leading Governor Jay Inslee, a Democrat, to oppose the initiative (Lavelle 2016).

In 2018, the governor and several members of the legislature developed a carbon tax bill that went through several iterations. It ultimately died at the end of the 60-day legislative session after the governor and other supporters concluded that the bill, with no Republican support, was one or two votes short of passing the state Senate (Seattle Times staff and the Associated Press 2018). The last version of the bill included a carbon tax of $12 per ton of carbon dioxide, increasing by $1.80 per year until a price of $30 was reached. Exemptions included agricultural uses, Indian tribes and individuals, lumber transportation, and manufacturing by energy-intensive trade-exposed industries (i.e., those that must compete with jurisdictions that have no carbon pricing). Revenue would be spent on a Clean Energy Investment Fund; an Energy Transformation Fund for projects that reduce carbon emissions, to be appropriated by the legislature; rural transportation electrification projects; transition assistance for low-income households and displaced workers; education programs related to the clean energy economy; a Water and Natural Resource Resilience Account; and a Rural Economic Development Account (Washington Legislature 2018).

In November 2018, another citizens' initiative came up for a vote but was also defeated (44% support, 56% opposition). This initiative was developed by environmental groups but carefully negotiated with a broad coalition that included labor, local Indian tribes, and environmental justice groups. The initiative would have established a carbon fee of $15 beginning in 2020, increasing $2 per year until the state's 2035 GHG reduction goal was met and emissions were on a trajectory likely to meet the state's 2050 goal. The initiative included exemptions generally similar to those in the legislative bill discussed above, but also exempted a coal-fired power plant that will close in 2025 under a previous agreement. The bill carefully allocated the revenue, with 70% going to clean air and clean energy investments, 25% to clean water and healthy forest investments to increase resiliency to climate change, and 5% to healthy community investments to prepare for climate change challenges. Across the various funds there were allocations to assist low-income residents and fossil fuel workers affected by transition, to fund projects endorsed by the governing body of federally recognized tribes, and to benefit designated pollution and health action areas (Protect Washington Act 2018).

The initiative had strong opposition, led by the Western Petroleum Marketers Association, and about $31 million was spent to defeat it. Among other issues, critics focused on the economic impacts and on how the proposal exempted certain large emitters, such as the coal plant that is about to shut down. Roberts (2018) discusses the two citizens' initiative campaigns in more detail.

In the 2018 election, the Democratic Party increased its majority in the state Senate, and a carbon tax may again be considered by the legislature (Bernton 2018).

MASSACHUSETTS

In the spring of 2018 the Massachusetts Senate unanimously passed an energy and climate bill that included a provision establishing a revenue-neutral carbon fee (called a market-based mechanism) on fossil fuel use in the transportation, commercial, industrial, and residential building sectors. Thus it would extend beyond RGGI, which covers only the electric power sector (Climate XChange 2018).

The House passed an energy bill without the carbon fee provision, and the provision was dropped during conference negotiations. Reportedly the House was concerned about a constitutional requirement that revenue measures originate in the House (Ebell 2018).

The bill passed by the Senate left the details to an administrative process but would have required the fees to start not later than the end of 2020 for transportation, the end of 2021 for the commercial and industrial sectors, and the end of 2022 for residential buildings. Guidance was provided to "maximize the ability of the commonwealth to achieve [its] greenhouse gas emissions limits," to minimize impacts on low-income households, and to mitigate impacts on manufacturers and other employers facing "serious negative impacts." "Revenue neutral" was not defined but appeared to include rebates as well as climate-related spending (Climate XChange 2018).

A bill along these lines is likely to come before the legislature again in 2019.

OREGON

Oregon has been working with California and other nearby states and provinces to align carbon pricing efforts. State policymakers have decided to pursue a cap-and-trade program that can be integrated with California's much larger market.

In 2018 detailed legislation was introduced to set up a "cap and invest" program that would cover emissions from about 100 of Oregon's largest emitters, those producing more than 25,000 tonnes per year. This includes a variety of large manufacturers, paper mills, fuel distributors, and utilities. Under the bill, program details would be developed over a three-year administrative proceeding, with the program actually beginning in 2023. The cap would gradually decline, meaning that covered entities would need to reduce emissions or purchase credits or offsets from others (forestry projects, for instance, could earn offset credits for the CO_2 taken up by trees). The revenue from auctions would be invested in a variety of initiatives—such as projects to expand public transit, solar power, electric vehicles, and home energy efficiency upgrades—to help reduce the state's overall greenhouse gas emissions (Profita 2018).

Bills were reported out of committees in both the House and Senate, but it was a short legislative session in 2018, and there was not enough time to consider the bill on the House or Senate floor. Also, legislative leaders estimated they were a few votes short of what was needed for passage. Instead, they established a legislative committee (chaired by the House speaker and the Senate president) to discuss and refine bill details in preparation for a longer legislative session in 2019, when lawmakers expect a bill to pass (Danko 2018).

HAWAII

In 2017 the Hawaii legislature established a Climate Change Mitigation and Adaptation Commission to come up with a greenhouse gas reduction plan. House Bill 1991, introduced in the legislature in 2018, would set a carbon tax of $10 per tonne in 2019, gradually rising to $40 per tonne in 2025 (Hawaii Legislature 2018). Also in 2018, a bill was enacted to commit to a zero-emission, carbon-neutral economy by 2045. In late 2018, the Climate Change Commission released draft recommendations that call on the legislature to establish a carbon fee program, with details still to be developed (Lavelle 2018).

RHODE ISLAND

In Rhode Island, a carbon tax bill was introduced in 2017 and again in 2018. Among other features, it included a provision that the tax would take effect only when Massachusetts and at least one other nearby state enacted similar taxes. Of the revenues collected, 40% would be allocated for dividends to every state resident; 30% to provide dividends to employers on a per-employee basis; and 28% for energy efficiency, energy conservation, renewable energy programs, and climate resilience (Ahlquist 2018). The carbon tax bill was not enacted; instead, in 2017, a bill passed calling for a study to examine a statewide carbon pricing program. However neither the 2018 nor the 2019 state budgets include funds for such a study. The governor has said she would help to raise study funds "philanthropically" (Faulkner 2018).

MANITOBA

Manitoba is located in Canada's Great Plains, with its capital in Winnipeg. Manitoba policymakers spent much of 2017 and 2018 developing a "Made in Manitoba" climate plan under Conservative Party leadership. The plan included a flat carbon tax of $25 (Canadian) per tonne of emissions on fossil fuels such as transportation and heating fuels. Under this proposal, agriculture producers, commercial fishers and trappers, mining companies, and the forestry industry would be exempt (Kives 2018). A separate program was being developed to price carbon from large industrial emitters (more than 50,000 tonnes per year), somewhat similar to the Alberta program for large emitters discussed above (Manitoba 2018).

Under the Made in Manitoba plan, the province expected to raise $143 million in the first fiscal year, which would go to tax reductions, a conservation trust to protect natural areas, and a green fund to help mitigate the effects of climate change. Energy efficiency was part of the green fund (Kives 2018; Geary 2018; Crabb 2018).

However, in October 2018, the provincial government decided not to move forward with the carbon tax, blaming lack of flexibility on the Canadian federal government's part to accept the flat $25 per tonne tax instead of an escalating tax that would eventually reach $50 per tonne. Manitoba still plans to implement other aspects of its climate plan and is hoping to show its mitigation efforts will achieve the same policy goals (Froese 2018). While this proposal has been withdrawn for now, we include it in this paper because it was fully developed and conceivably could come back in play as the political and judicial conflict between the Canadian government and its provinces plays out.

NEWFOUNDLAND AND PRINCE EDWARD ISLAND

In October 2018, the Canadian federal government and these two provinces (both on the Atlantic coast north of Maine) announced an agreement to mutually impose carbon taxes on transportation fuels, beginning in April 2019, while reducing fuel taxes by a similar amount. The provinces will also implement performance-based systems for industry, with Newfoundland implementing its own and Prince Edward Island participating in a federal system. Neither province will cover heating fuels (CBC 2018; Campbell 2018; Canada 2018b).

NORTHWEST TERRITORIES

The Northwest Territories, located in Canada's western Artic, is planning to implement a carbon tax beginning in July 2019. The tax will start at $20 (Canadian) per tonne and increase annually until reaching $50 per tonne in 2022. It will cover most energy use but exempt aviation fuels. Much of the revenue will be rebated to consumers and businesses, including heating fuel rebates to prevent heating cost increases, rebates to the electric utility to prevent electricity rate increases, and partial rebates to large businesses. Some revenues will be in invested in initiatives that reduce emissions and address climate change, primarily renewable energy projects. Energy efficiency is not explicitly mentioned (Northwest Territories 2018).

SASKATCHEWAN

Saskatchewan, a province on the Canadian prairie that shares a border with western North Dakota and eastern Montana, is planning to implement a performance-based emissions standard for more than 40 large industrial customers that together produce about 11% of greenhouse gas emissions in the province. This is a modest program that could be considered a form of cap and trade. The program covers companies that emit more than 25,000 tonnes per year. Specific reduction targets of 5–15% will apply, varying by industry. According to a recent article, "There is no widespread carbon price in the plan, but heavy emitters can choose from addition costed compliance options like buying offset credits, earning best performance credits and paying into a technology fund. Specifics on how exactly these performance standards will work will be finalized through the remainder of the year" (Baxter 2018).

OTHER PROPOSALS

Carbon taxes have been proposed in several other states, although none have moved out of a legislative committee.

In **Alaska**, the governor convened a Climate Action for Alaska Leadership Team in the fall of 2017. The team's report included a recommendation to consider a carbon tax, not just on consumption in the state but also on fuel exports (Brugger 2018a). The idea was quickly opposed by Alaska's oil industry (Brugger 2018b). This proposal is unlikely to be enacted because the state recently elected a new governor who is opposed to a carbon tax.

New York is another state where carbon tax legislation was proposed in 2018. The bill would tax fuel distributors and utility companies "at a rate and schedule to be determined by the Department of Environmental Conservation." Under the bill, the state would

distribute 60% of the revenue generated by the tax to low-income people via tax credits and send the remainder to efforts aimed at bringing about "100 percent clean energy in the state" (Mahoney 2018).

New York is also considering including a carbon price in the New York Independent System Operator (NYISO) market for electricity, but the earliest such a price would begin is 2021. In the meantime, NYISO is developing an emissions reporting program (Kuser 2018a, 2018b).

In **Vermont**, several carbon tax proposals have been put forward, and the state's Carbon Action Coalition proposed a study of the idea. However Governor Phil Scott has opposed a tax and even the study of a tax, and no action has been taken (Polhamus 2018). On the other hand, in the 2018 elections the Democrats increased their majorities in the legislature and can now potentially override a veto by the governor (Lavelle 2018).

In the **District of Columbia**, legislation is advancing to enact a number of energy efficiency and renewable energy policies to reduce greenhouse gas emissions. The legislation includes a provision authorizing carbon pricing of transportation emissions if a similar policy is adopted in the adjacent states of Maryland and Virginia (Lavelle 2018).

Findings from Other Countries

While the focus of this paper is on state and provincial programs in North America, there are some useful lessons from elsewhere in the world. For example, an earlier ACEEE paper (Nadel 2016) looked at experience with carbon taxes around the world. This earlier paper described 19 carbon taxes in place around the world, examined data on energy use and carbon emissions for eight countries where the taxes had been in place for at least two years, and reviewed a variety of evaluations on the carbon taxes in place in Australia, British Columbia, Denmark, the Netherlands, Norway, Sweden, and the United Kingdom. The median tax in this study was $18 per tonne and applied to 45% of greenhouse gas emissions.

Overall, this earlier study found that these taxes have contributed to reductions in energy use and carbon dioxide emissions, with the average or median reduction ranging from 0.1% to 1.3% for each year the tax has been in place. Many countries provide special treatment for industrial emissions. In some cases these special treatments result in industrial emissions reductions, and in other cases they effectively allow industrial emissions to be unchanged. The details of how the industrial sector is treated are important for achieving emissions reductions.

One particularly interesting result is in Australia, where a carbon tax took effect in July 2012 but was repealed in July 2014 upon a change in government. The impact of these shifts can be seen in figure 10, below, which shows that emissions from the electricity sector declined when the tax took effect and increased as soon as the tax was repealed. Petroleum emissions were not affected as petroleum was untaxed.

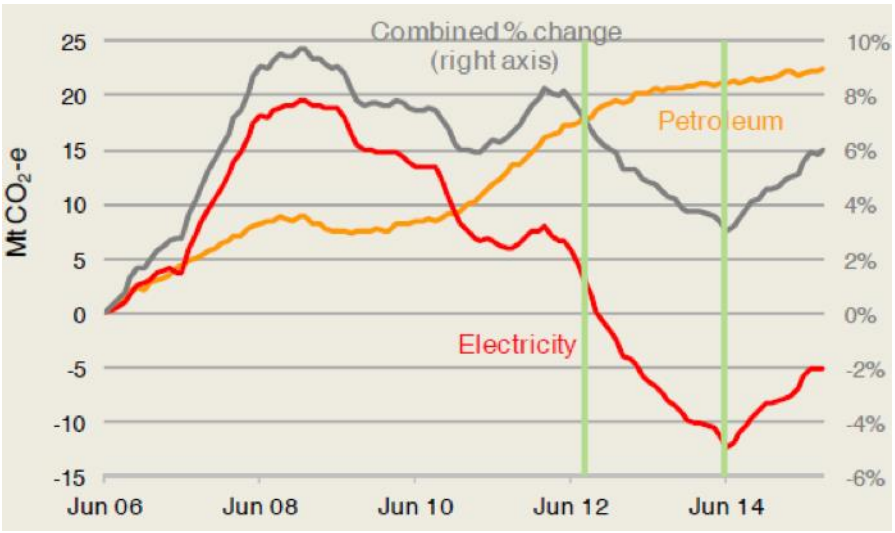

Figure 10. Change in CO_2 emissions in Australia from the electricity and petroleum sectors and both sectors together, 2006–14. The left-hand scale is in tonnes, the right-hand scale in percentages, both relative to June 2006 emissions (pretax). The green vertical lines show when the carbon tax began and ended. *Source*: The Australia Institute 2015.

The Nadel (2016) paper concluded that while studies to date are limited, it is notable that every study examined found that carbon taxes reduce energy use and emissions relative to periods and/or countries without carbon taxes. Still, the impacts have been modest so far. At the tax levels that have been politically feasible to date, carbon taxes alone are unlikely to solve the climate change problem (e.g., if a 0.7% per year emissions reduction were achieved—the midpoint of the 0.1–1.3% range discussed above—it would take more than 100 years to reach an 80% emissions-reduction target. The paper noted that carbon taxes can be combined with other strategies to spur larger emissions reductions, providing specific examples from Australia, Denmark, Ireland, and the Netherlands.

Another interesting international finding is contained in a paper by Carl and Fedor (2016), who examined how carbon revenues are being spent throughout the world. They found that globally, carbon taxes, fees, and levy revenues are about three times cap-and-trade revenues. For cap and trade, globally, about 70% of revenue is being spent on "green" programs such as energy efficiency and renewable energy, and that 9% is directly returned to taxpayers or individual consumers. For carbon taxes, fees, and levies, about 15% globally is being used for green spending, 44% is returned to taxpayers via tax cuts or rebates, and 28% is going to government general funds.

Implications for Energy Efficiency

The programs and policies we have discussed offer several takeaways regarding the incorporation of energy efficiency into carbon taxes or cap-and-trade programs. We describe four of them in this section.

A carbon price improves the economics for energy efficiency investments. Carbon taxes and cap-and-trade programs raise energy prices, improving the economics of energy efficiency (if the price of energy is, say, 10% higher, then the value of energy savings from energy efficiency investments increase by 10%, all other things being equal). For example, Resources for the

Future projects that a $20 per tonne carbon tax would increase average national gasoline prices by 9%, oil for heating by 11–18%, natural gas by 25%, and coal by 132% relative to 2015 prices (Hafstead and Picciano 2017). As discussed above, evaluations of the British Columbia carbon tax show realized reductions of 5–15% in affected energy uses. Likewise, many of the country-level examples discussed above show realized energy use reductions of several percentage points.

Funds from a carbon price can be invested in energy efficiency. In all of the jurisdictions we profile, some of the funds collected are invested in energy efficiency, or there are plans to begin such investments in the future. In a cap-and-trade program, there are several mechanisms to incentivize energy efficiency. A revenue-raising auction can produce proceeds to reinvest in energy efficiency to further reduce emissions, as seen in the RGGI states, with energy efficiency accounting for 58% of cumulative investments through 2016 (RGGI 2018b). For RGGI, evaluations show that investing auction revenue in energy efficiency produces the largest net positive benefits to customers and the economy compared with other uses of the proceeds (Hibbard et al. 2018). Likewise, substantial revenues in Quebec are being spent on energy efficiency, as are a portion of revenues in Alberta and California. In addition, British Columbia and Nova Scotia are planning substantial energy efficiency expenditures. Alberta and British Columbia are interesting in that originally their carbon taxes were revenue neutral, but more recently some funds have been (or will be) spent on other initiatives such as energy efficiency programs. Several states and provinces are also using carbon pricing revenue to invest in transportation, including public transit and electric vehicles. This is the case in California and Quebec.

A variety of mechanisms can be used to invest in efficiency programs. In the RGGI states, much of the funds are invested in utility energy efficiency programs or programs run by state energy offices. Third-party providers also play a role. For example, in Vermont the funds are mostly allocated to Efficiency Vermont, an organization that operates efficiency programs throughout the state under the supervision of the state utility commission. Investments from RGGI reach a variety of customer types, including businesses, municipalities, residential users, and low-income communities.

In California, the cap-and-trade funds are allocated by the legislature, and these funds are directed primarily to state agencies and local jurisdictions or their designees. In Quebec, cap-and-trade revenues are directed to a green fund governed by a board of directors comprising independent members and representatives of government departments. The green fund then makes distributions to a variety of parties, primarily government agencies. Funds also go to Transition Énergétique Québec. All funds are meant to support measures needed to achieve additional emissions reductions, including energy efficiency.

In Alberta, investments in energy efficiency are made through a newly established government agency, Energy Efficiency Alberta. Programs funded through carbon tax revenues help residential and business customers make energy-saving improvements.

Complementary policies can further energy efficiency progress. The emissions reductions and economic benefits of energy efficiency can be amplified by implementing efficiency policies alongside a carbon tax or cap-and-trade program. Policies that establish utility energy

savings goals or improve the stringency of building energy codes can help a state or province make significant progress toward meeting its GHG reduction goals.

In California, the majority of efficiency investments are made by utilities using funds from rates rather than from the cap-and-trade program. California also has a variety of policies (e.g., state building codes, appliance standards, and renewable fuel standards) that result in substantial energy savings and emissions reductions.

RGGI states, British Columbia, Quebec, and Nova Scotia also have complementary energy efficiency programs and policies, such as utility energy savings programs financed through rates, building codes, and product efficiency standards.

In states with cap-and-trade programs, energy efficiency helps to reduce emissions, thereby reducing the demand for emissions allowances. In RGGI states, California, and Quebec, emissions allowance prices are relatively low, likely due in part to the influence of energy efficiency on the demand for allowances.

More broadly, ACEEE estimates that electricity efficiency programs and policies in the United States avoided the need to build the equivalent of 313 large power plants from 1990 to 2015, reducing annual CO_2 emissions by 490 million tons in 2015 (Molina, Kiker, and Nowak 2016). Savings from energy efficiency policies reduce greenhouse gas emissions and have positive economic impacts in the jurisdictions we profile.

ACEEE tracks progress on efficiency policies and programs in all US states and the top 25 energy-consuming countries. Among US states, in 2018, six states participating in RGGI ranked in the top 10 nationwide, and California ranked second (Berg et al. 2018). Among the 25 countries with the highest energy consumption, Canada and the United States tied at 10th overall in 2018 (Castro-Alvarez et al. 2018).

Discussion

To aid in comparison of the various carbon taxes and cap-and-trade programs, we prepared two tables that can be found in Appendix A. Table A1 looks at current carbon taxes in British Columbia, Alberta, and Boulder as well as the very detailed legislative proposal in Washington State. Table A2 looks at current cap-and-trade programs in the RGGI states, California, Quebec, and Nova Scotia. We do not include Ontario because its cap-and-trade program was repealed and because it had many similarities to California's and Quebec's.

OBSERVATIONS

From the information in the preceding discussion and the tables in Appendix A, several patterns emerge that we discuss in the following paragraphs.

The BC carbon tax has been in place for a decade, and multiple evaluations have found that it is reducing greenhouse gas emissions without a serious impact on the provincial economy. Alberta started with large emitters and recently expanded its program to other sectors. These provinces' programs were set up to return revenues as rebates or tax cuts, but both now plan to dedicate some revenues to energy efficiency and other green investments. With the establishment of Energy Efficiency Alberta, energy efficiency is already playing a

substantial role in Alberta's carbon tax program. Washington is also planning to use substantial revenues for energy efficiency efforts.

Likewise, cap and trade has been in place in the northeast United States, California, and Quebec for multiple years and has contributed to emissions reductions and economic benefits in those states and provinces, with other, complementary policies also playing a big role. In these states and provinces, a substantial share of cap-and-trade revenue has generally been used to fund energy efficiency programs, helping to reduce energy use and energy bills.

Many of the state and provincial programs apply to most fossil fuel use, including use in the power, transportation, industrial, and buildings sectors. Some programs have less coverage (e.g., RGGI applies only to the power sector), while others started with narrower coverage and have since expanded (e.g., California, Quebec, and Alberta).

The fees on emissions have been relatively modest for all the programs so far. For RGGI, the auction clearing prices have ranged from $2 to about $8 per American ton ($1.94 to about $7.26 per tonne) over the 10-year program (Acadia Center 2017). For California and Quebec, allowance prices have been a little above the price floor of about $10 (US) per tonne. For the carbon taxes, current fees range from $25 to $35 Canadian (about $19–26 US), but some are scheduled to increase to $50/38 (Canadian/US) by 2022. The Washington State proposals likewise start low ($12–15) and then increase each year.

For all of the programs that apply to industry or agriculture (Alberta, BC, California, and Quebec), there has been sensitivity on how to treat these sectors under the various carbon pricing programs, especially industries that must compete with jurisdictions that have no carbon pricing. Sometimes these affected industries are fully or partially exempted (e.g., exemptions for agricultural fuels and the planned exemption for these trade-exposed industries in Manitoba). In California, Quebec, and Nova Scotia, these industries often receive free allowances, although Quebec is planning to institute emissions criteria to qualify for free allowances. Often special programs are implemented for these industries, as in Alberta and British Columbia; Saskatchewan and Nova Scotia are now planning the same. Likewise, in the western parts of Canada and the United States, many emissions on Native American lands are exempted.

Carbon pricing programs have been adopted under various political parties in both countries. In Canada, conservative parties led initial efforts in Alberta, BC, Manitoba, and Saskatchewan, while liberal parties led in Quebec and Nova Scotia. Interestingly, the conservative-led efforts have all been carbon taxes while the liberal-led efforts have been cap and trade. The Canadian New Democratic Party has not so far initiated the establishment of carbon pricing, but it has increased and expanded the carbon tax in BC and Alberta. In the United States, Democrats often lead, but moderate Republican governors gave critical support in California and New York (the largest state in RGGI).[22]

[22] Former California governor Arnold Schwarzenegger and former New York governor George Pataki.

So far there is only one limited local carbon tax—on electricity in Boulder, Colorado. We are not aware of interest in similar programs in other cities. Carbon pricing can be complex and may be beyond the capabilities of most local governments.

All of the jurisdictions have established or are establishing some type of green fund to spend revenues on measures and programs that will reduce greenhouse gas emissions (e.g., energy efficiency programs), help with adaptation to climate change, and/or advance natural resource conservation. Job training and other programs for fossil fuel workers are also common. "Green" spending is particularly robust in many of the cap-and-trade states (RGGI, Quebec, and California) but is also beginning in some of the carbon tax states (Alberta and BC). Nearly all jurisdictions use some of the revenue to moderate or eliminate the impact of the taxes and costs on low- and moderate-income families. Some jurisdictions with carbon taxes use most of the revenue, or a substantial portion, on tax reductions or rebates (British Columbia, Alberta, Nova Scotia, and the Manitoba proposal). In Washington State, voters rejected a carbon tax with all revenue directed to tax reductions and no green spending, and a carbon fee with only spending and no tax reductions. Perhaps there is a middle ground between these extremes that voters might find more appealing.

AREAS FOR FURTHER WORK

State and provincial carbon prices are being implemented or discussed in many jurisdictions. Continued tracking of these initiatives would be useful, including additional analyses of successful and unsuccessful approaches to navigating the many issues involved in pricing carbon.

State and provincial prices on carbon are well established in a few jurisdictions, and it would be useful to have further evaluations of how well they are working and areas for improvement. As discussed above, the British Columbia carbon tax has been well evaluated, and there are also multiple appraisals of measures taken in the RGGI states. For other programs that have been in place a few years (e.g., California and Quebec), a comprehensive independent evaluation of the impact of their cap-and-trade programs on energy use, greenhouse gas emissions, and their economies would be useful. To the extent possible, such assessments should seek to separate out the impact of higher energy prices caused by carbon pricing, programs implemented using carbon-pricing revenues, and other, complementary greenhouse gas reduction programs and policies. And as new carbon-pricing programs build a track record (e.g., Alberta), they should be evaluated as well. Furthermore, in British Columbia the latest evaluations are a few years old, and with the carbon tax recently increased, newer appraisals would be useful to explore the impact of the higher carbon tax and to investigate whether the impacts might fade as consumers get used to the tax.

In Canada, where carbon pricing is much more extensive than in the United States, an emerging issue is whether to fund energy efficiency programs largely through a carbon price (as Alberta and Quebec are doing) or directly through utility rates (as happens in many US states and in several Canadian provinces, such as BC and Nova Scotia). Haley (2018b) raises this issue, but more work on the pros, cons, and best practices for the different approaches would be useful.

Conclusions and Recommendations

Interest in putting a price on carbon is growing, with the World Bank showing increasing numbers of programs worldwide. In North America, several Canadian provinces recently adopted or expanded programs, RGGI states are exploring market-based policies to reduce transportation emissions, and programs are under active consideration in several other US states.

Our research indicates that

- Either a carbon tax or cap and trade can be effective to reduce energy use and carbon emissions without harming the local economy. This is particularly shown by the success of the British Columbia carbon tax and the RGGI cap-and-trade program but is also supported by experience in Alberta, Boulder, California, and Quebec.
- These carbon-pricing policies are more effective at achieving emissions and economic benefits if a share of revenue is used to fund energy efficiency programs and other mitigation strategies to reduce emissions, as shown in particular by the RGGI experience. In addition, all of the jurisdictions with current programs show the importance of using some revenues to cushion the impacts on low- and moderate-income households and trade-exposed industries.
- In addition to carbon pricing and revenue recycling, the experiences in British Columbia, California, RGGI, and countries outside North America show that complementary policies, such as establishing energy efficiency savings targets, are useful for meeting long-term emissions targets (e.g., greenhouse gas emissions reductions of 80% or more).
- More policy research evaluating current and emerging programs is needed, to identify successful strategies and understand where improvements or new approaches are required.

On the basis of these findings, we recommend that other states and provinces seriously study and ultimately adopt a price on greenhouse gas emissions that builds on the lessons from these leaders. Jurisdictions should invest a portion of revenues in energy efficiency, looking to supplement funding for well-established programs, as RGGI is doing, or to establishing new programs, as Alberta is doing through the establishment of Energy Efficiency Alberta. Energy efficiency investments along these lines have been shown to drive substantial energy savings, emissions reductions, and economic benefits. Without such reinvestment, the benefits of a carbon pricing initiative are not as extensive.

As shown by the recently released special report of the United Nations International Panel on Climate Change (IPCC 2018), climate change will have dramatic impact on the global environment and global economies, particularly if governments do not take rapid action to reduce emissions. Recent studies on North America have reached similar conclusions (e.g., USGCRP 2017). States and provinces can play an important role in addressing these problems by enacting policies to reduce energy use and emissions, including a price on greenhouse gas emissions.

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Appendix A. Details of Carbon Tax and Cap-and-Trade Programs

Table A1. Key attributes of state and provincial carbon tax and fee programs

Element	British Columbia	Alberta	Boulder	Washington Senate bill (2nd revision)
When it began	2008	2007 for large industry/2017 for others	2007	Pending
What is covered?	Energy sold and consumed in the province from fossil fuel combustion	Transportation and heating fuels that emit greenhouse gases when burned; separate program for large (>100,000 MT/yr) industrial emitters	Electricity	Sale and use of fossil fuels within the state; for electricity, based on emissions to generate the electricity
2018 Fee/MT CO_2	$35 Canadian	$30 Canadian	~$0.0003–0.0049/kWh, varying by sector	$12 US starting in 2019
Escalation	Started at $10 and gradually increased; will rise $5/year until reaching $50 in 2021	Started at $15, then increased to $20 in 2017 and $30 in 2018. Future increases will be based on Canadian federal requirement.	None planned	Increases $1.80/year until reaching $30
What is exempted?	Fuel purchased on First Nations land by First Nation individuals and bands, specially marked fuel purchased by a qualifying farmer, locomotive fuel purchased by inter-jurisdictional rail service	Specially marked fuels used on farms, fuel purchased on First Nations land by First Nation individuals and bands, biofuels, industrial feedstocks, interjurisdictional flights, natural gas consumed onsite by oil and gas producers (through 2022)	Wind power	Agricultural uses, Indian tribes and individuals per current law, lumber transportation, manufacturing by energy-intensive trade-exposed industries

Element	British Columbia	Alberta	Boulder	Washington Senate bill (2nd revision)
What are funds used for?	Cuts to other taxes, including tax credits for low-income households and northern and rural homeowners; planning to develop clean-growth incentive program for large industrial emitters and new green initiatives	Tax rebates to low- and middle-income households; small-business tax rate cut and Capital Investment Tax Credit; rebates to large trade-exposed industries; climate leadership initiatives to transition away from coal-generated electricity, support energy efficiency projects, support initiatives in indigenous communities, enable greater public use of transit, and support innovation and technology development	Implementation of Boulder Climate Action Plan, including investments in public education, public transit, energy audits, and rebates for energy efficiency improvements to homes and businesses	Clean Energy Investment Fund; Energy Transformation Fund for projects that reduce carbon emissions as appropriated by the legislature, rural transportation electrification projects, transition assistance for low-income households and displaced workers, education programs related to the clean energy economy, Water and Natural Resource Resilience Account, and Rural Economic Development Account
Role of energy efficiency	Studies show that tax has resulted in some EE savings. EE will be part of new green fund.	Over 3 years, $662 million (Canadian) allocated to EE, $1.3 billion allocated to public transit. EE Alberta is a government agency that runs EE programs throughout the province.	63% of funds invested in EE programs run by the city government	EE is part of the Clean Energy Investment Fund that will be established
Other notes	Primarily applies to transportation and direct use of natural gas, as most electricity is renewable	For large industry. Since 2018 it is essentially a fee-plus-rebate program with fees paid by all and rebates earned by firms with emissions better than industry-specific benchmarks that gradually tighten.		Package was a few votes short of enactment in the state Senate, where Democrats had a 1-seat majority. As of 2019, this majority increases by several seats.

Sources: British Columbia 2018; Alberta 2018a, 2018b, 2018c; City of Boulder 2018; Bhatt and Ryan 2017; Washington Legislature 2018; www.carbontax.org.

Table A2. Key attributes of state and provincial cap-and-trade programs

Element	RGGI	California	Quebec	Nova Scotia
When it began	2009	2013	2013	2019
Current scope	Power sector emissions of CO_2	Six GHGs in the power and industrial sectors plus natural gas and transportation fuels; covers about 85% of GHG emissions	Very similar to California. Covers CO_2 emissions except for emissions from combustion of biomass. Covered industrial and electricity sectors initially; fossil fuel distributors added in 2015.	Large facilities (>50,000 tonnes CO_2/year), petroleum product suppliers, natural gas distributors, and electricity importers; covers about 80% of GHG emissions
Cap	45% below 2005 levels by 2020; additional 30% reduction in regional cap between 2020 and 2030	40% below 1990 levels by 2030	20% below 1990 levels by 2020; 37.5% below 1990 levels by 2030	650,000-tonne reduction over 2019–2022; part of longer-term effort to reduce emissions 45–50% below 2005 levels by 2030
Allowances distribution	90% of allowances are offered through quarterly regional auctions open to all qualified participants, resulting in a single clearing price. 25% of allowance proceeds must be spent for consumer benefit (includes EE); all states exceed this requirement.	Some distributed for free, some distributed in auction. Industry 90% free; utilities free but must auction off to benefit ratepayers; transportation in auction.	Some distributed for free, some distributed in auction. Some free allowances to 10 specific industries, but over time these industries must meet tighter emissions limits to earn free allowances. Power generators with pre-2008 pricing contracts are eligible for free allowances for contracted sales.	75–90% of allowances distributed for free, depending on sector; additional allowances can be bought at auction; 3% of allowances each year in a reserve
Offsets	Up to 3.3% of a power plant's compliance obligation for each control period. Five eligible project categories, including EE.	Up to 8% of compliance obligations can be met with offsets but will decline in 2021	Similar to California on 8% cap and planned decline.	Allowed; details to be developed in 2019

Element	RGGI	California	Quebec	Nova Scotia
Temporal flexibility	Unlimited banking, but factors into states' future budgets. Compliance evaluated on a 3-year basis.	Unlimited banking; borrowing only in extreme circumstances	Unlimited banking	500,000 cap on how many allowances a covered party can hold; borrowing not permitted
Price predictability and cost containment	Cost Containment Reserve equal to 10% of the cap each year; trigger price is $10/ton in 2017, rising to $13 in 2021. Minimum reserve price of $2.05 in 2015, increasing by 2.5% annually. In 2021, Emissions Containment Reserve will have states withhold allowance if prices fall below $6.	Price floor of $10/ton in 2012, rising 5%/year plus inflation. Reserve allowances provide a soft price ceiling.	Similar to California. In addition, issued some early reduction credits in 2013.	Reserve allowances available for purchase, helping to establish a soft price ceiling
Compliance and oversight	Covers fossil fuel generators ≥ 25 MW (currently 168 facilities)	C&T covers entities emitting > 25,000 MT; mandatory reporting for entities emitting > 10,000 MT	Similar to California	See current scope, above
Linkages	Currently covers New England, NY, MD, DE; NJ and VA joining	California and Quebec are linked. Until recently, so was Ontario.		Not linked with other systems
Implementation, evaluation, and revisions	Auction administered by RGGI, Inc. and independent market monitoring by Potomac Economics. Program reviews in 2012 and 2017.	Implemented by California Air Resources Board (CARB). Review about every two years; legislature extended and modified program in 2017.	Implemented by Ministry of Sustainable Development, the Environment and the Fight Against Climate Change. The government periodically reports results to the legislature.	Implemented by Nova Scotia Environment, a department of the provincial government

Element	RGGI	California	Quebec	Nova Scotia
Role of energy efficiency	2015–2017 compliance years resulted in 52% of proceeds invested in EE programs across RGGI states. *RGGI Investments Proceeds* (2017) report details EE investments in 2015 by state.	About 9% of revenues are invested in low-income weatherization and agricultural efficiency; nearly 60% of revenues are invested in public transit and alternative vehicles, saving energy relative to conventional vehicles	90% of revenues invested in strategies to reduce emissions including energy efficiency; about 10% invested in buildings and 10% in industry, 64% in transportation	Planning to expand energy efficiency programs using cap-and-trade auction revenues and perhaps other sources
Other notes		2017 changes include substantial attention to environmental justice issues	2030 targets added in 2015	

Sources: EDF 2018; EDF 2015; Hibbard et al. 2018; RGGI, Inc. 2017; Quebec 2014; ICAP 2018; Oregon Legislative Policy and Research Office 2017; Nova Scotia 2018b.