STATE AND PROVINCIAL EFFORTS TO PUT A PRICE ON GREENHOUSE GAS EMISSIONS, WITH IMPLICATIONS FOR ENERGY EFFICIENCY

Steven Nadel, James Gaede, and Brendan Haley

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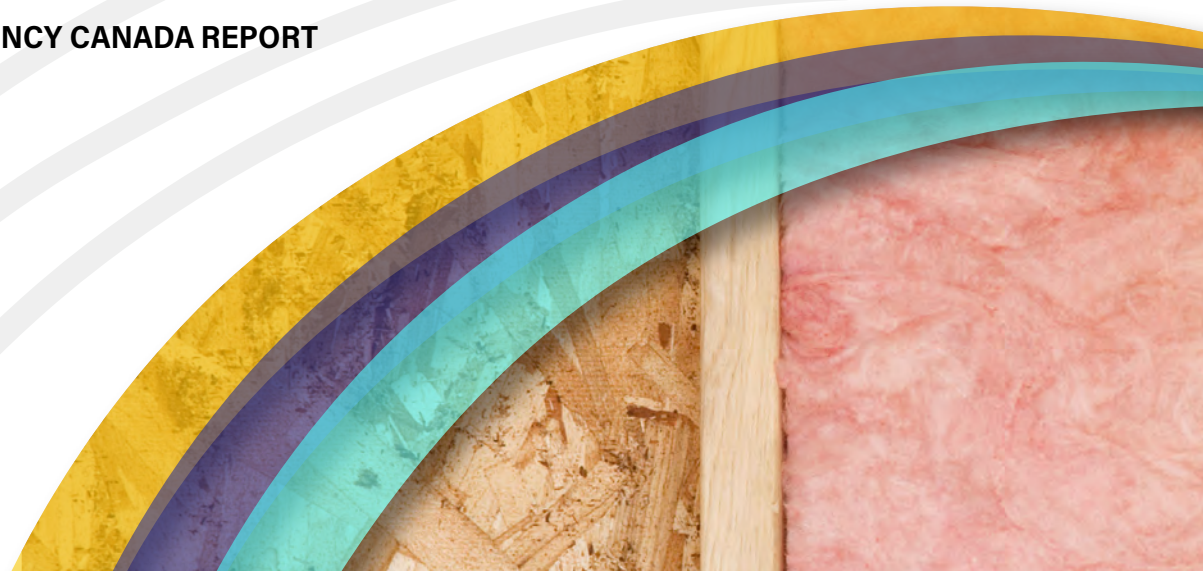

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Executive Summary

KEY TAKEAWAYS

- Efforts to put a price on greenhouse gas emissions are growing, with carbon prices now in effect in all Canadian provinces as well as 12 U.S. states.
- Several North American carbon-pricing programs have been in effect for more than a decade. Evaluations show they have reduced energy use and emissions while also providing other benefits, including perhaps helping local economies (and certainly not appreciably harming them).
- 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.
- While a price on carbon is an important strategy, to achieve long-term carbon-reduction goals, carbon pricing will need to be complemented by other approaches to reducing energy use and emissions.

REPORT SUMMARY

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 all of Canada (except Nova Scotia and Quebec) and Boulder, Colorado. Cap-and-trade programs are in effect in California, Quebec, Nova Scotia, and the 11 northeastern states that form the Regional Greenhouse Gas Initiative (RGGI). These states and provinces together comprise 37% of the U.S. and Canadian population, up from 31% two years ago. Several other states are now considering putting a price on emissions.

The British Columbia carbon tax has been in place for more than 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 over 10 years, and evaluators have found that it has reduced energy use and emissions while providing net positive benefits in the form of decreased emissions, lower customer bills, lower wholesale power prices, jobs gains, and boosts to local economies. 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 used to be in Alberta, where they funded Energy Efficiency Alberta, which was closed in September 2020 after a change in the provincial government.

On the basis of these findings, we recommend that other states and provinces study carbon-pricing options 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. In particular, efficiency investments should target underserved sectors, including disadvantaged communities. Without such reinvestment in energy efficiency, the benefits of a carbon price, while still positive, are not as extensive. And without investment in disadvantaged communities, the residents of those communities could pay more than they benefit.

While an important strategy for reducing greenhouse gas emissions, a price on carbon will need to be complemented by other approaches to reducing energy use and emissions, such as offering energy efficiency programs. As shown by international efforts and supported by the experience of California, current carbon-pricing programs alone have only a moderate impact on energy use and emissions, far less than the 80–100% 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 were to increase costs, then emitters will try to find the least costly ways to reduce emissions (see, for example, Gale 2013; 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 CO_2 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 GHG 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 GHG emissions and issues emissions permits, often referred to as allowances or certificates. Typically, one certificate allows the owner to emit one tonne of CO_2. Emitters operating under a cap can trade these certificates to other emitters that are under the same cap 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 approaches are generally implemented by government agencies, with the actual fee typically charged at the wholesale level to different energy sources on the basis of their carbon emissions per unit of energy (e.g., kilowatt-hour [kWh] of electricity or gallon of gasoline). These increases to wholesale energy costs are then generally passed on to energy consumers.

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 else being equal). Second, many of the jurisdictions examined for this report invest some of the funds collected in energy efficiency (or plan 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 (2020), currently 61 carbon-pricing initiatives are under way, as summarized in figure 1. These initiatives affect about 15% of annual global GHG emissions, and with the addition of carbon pricing in China in 2021, will affect more than 20% of global emissions.

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

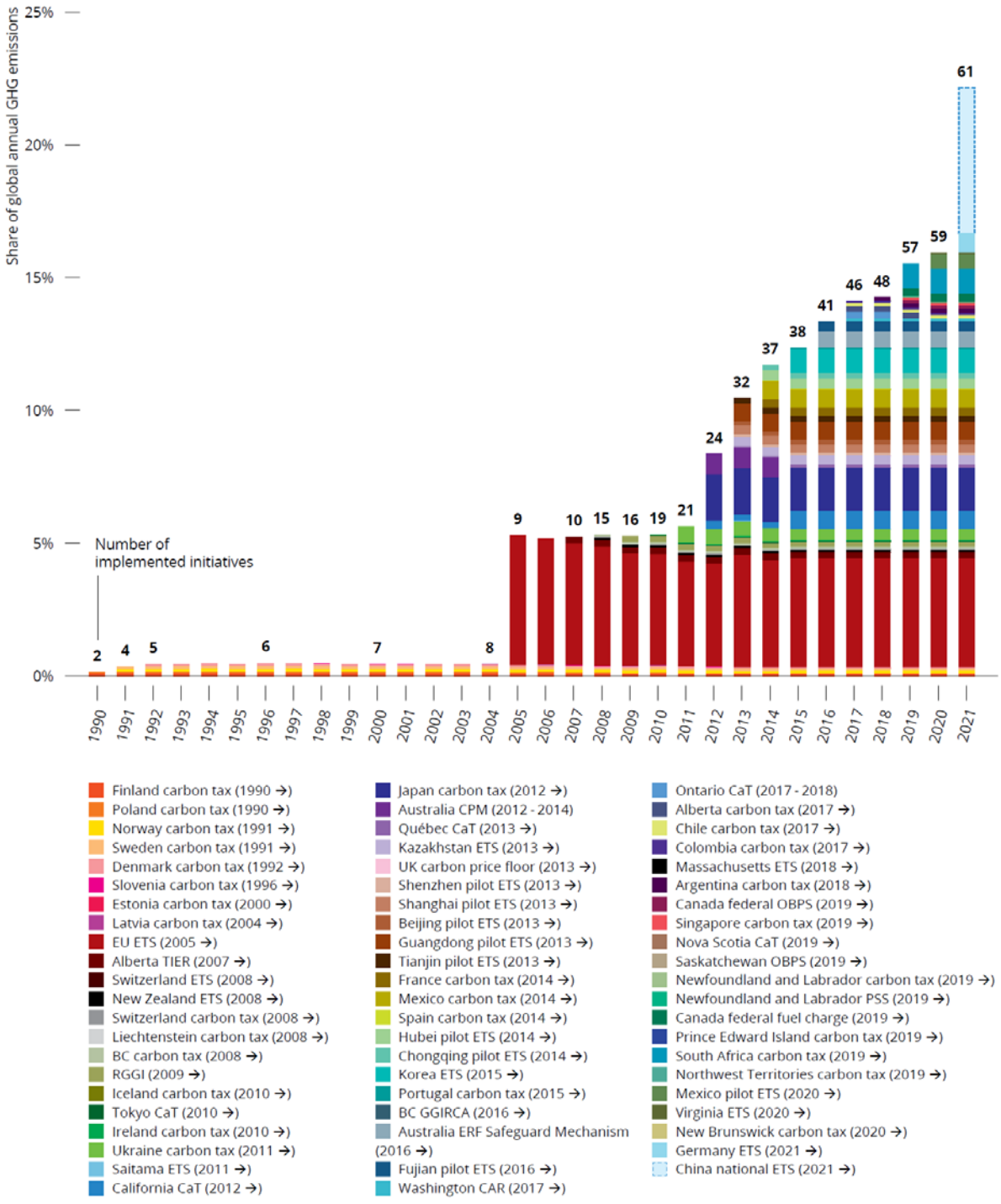

Figure 1. Regional, national, and subnational carbon-pricing initiatives. *Source:* World Bank 2020.

In the United States, putting a price on carbon can potentially span the country's left–right political divide, with carbon taxes endorsed by former Republican secretaries of state George Schultz and James Baker and former Democratic vice president Al Gore (Baker et al.

2017; Pearce 2017).[2] However, in the current U.S. national political climate, a federal price on carbon is not imminent. Instead, much of the activity around putting a price on carbon is occurring at the state or local level. Currently in the United States, carbon taxes are being implemented in the city of Boulder, Colorado, and cap-and-trade systems are in place in California and the Northeast.

FEDERAL CARBON-PRICING POLICY IN CANADA

Following the election of a Liberal Party federal government in 2015, the federal and provincial governments in Canada negotiated a Pan-Canadian Framework on Clean Growth and Climate Change (Environment and Climate Change Canada 2016), which was adopted in late 2016. The framework recognized the centrality of carbon pricing to Canada's efforts to combat climate change, that carbon pricing should be flexible and accommodating of initiatives already under way in some provinces, that it should be applied to a broad set of emission sources across the Canadian economy, and that the price must increase in a predictable and gradual way.

The federal government in 2018 then developed a carbon-price benchmark policy (the Greenhouse Gas Pollution Pricing Act), against which provincial initiatives are assessed for compliance. The federal benchmark allows for either a carbon tax or a cap-and-trade system, so long as it meets the specified targets for fuels coverage, emissions reductions, and/or price per tonne of CO_2 equivalent (CO_2e; starting at $20 (Canadian) per tonne, with $10 annual increases to $50 by 2022). If a province does not put in place such a system, or if the provincial system in place does not meet federal requirements, a federal fuel charge "backstop" was implemented in that province, starting January 1, 2019. Provincial governments placed on the federal backstop system do not receive any of the carbon-pricing revenues; instead, the federal government rebates approximately 90% of proceeds to households in these provinces. The remainder is used to support clean energy and energy efficiency projects in the jurisdiction where the revenue is generated (Parliament of Canada 2018).

The federal government's backstop also includes a separate output-based pricing system (OBPS) for select high-emitting and trade-exposed industrial sectors (including electricity generation). The federal OBPS requires that industry-average emissions standards be set, against which facilities are assessed for compliance. Facilities that fail to meet the targets can reach compliance by paying the federally set carbon price, by purchasing credits granted to facilities that exceed the emissions-reduction target, or by purchasing carbon offsets. Whereas the federal fuel charge applies to transport and heating fuels, the OBPS prices carbon from a broader set of sources (including industrial process emissions). Notably, the status of the federal OBPS does not mirror the status of the federal fuel charge (in terms of whether the system in place in a given province is administered by the federal or the provincial government).

In December 2020, the federal government released a new plan that reaffirmed the role of carbon pricing in Canada's broader actions to address climate change. The Healthy

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

Environment and a Healthy Economy plan positions carbon pricing as one of five key pillars to Canada's overall strategy and commits to continuing to raise the benchmark price by $15 (Canadian) per tonne CO_2e (tCO_2e) after 2022, reaching $170 per tCO_2e by 2030. The plan also calls for exploring the potential of implementing tax adjustments at the border (to create a level playing field for imports and exports) and a review of the standards used to assess provincial systems for compliance with the federal benchmark (Environment and Climate Change Canada 2020a).

All provinces and territories now have a carbon price in place, although with a mixture of systems across the provinces. Before the development of the federal carbon-pricing legislation, four provinces had carbon pricing in place: carbon taxes/levies in British Columbia and Alberta and cap-and-trade systems in Ontario and Quebec. The British Columbia and Quebec systems are still in place, while Alberta and Ontario are now placed under the federal backstop fuel charge (although they have developed their own industry pricing systems). Nova Scotia developed its own cap-and-trade program, and New Brunswick, Prince Edward Island, and Newfoundland and Labrador developed their own fuel charge systems (of these, New Brunswick and Prince Edward Island use the federal industry OBPS). The current status of administration (as of December 2020) is summarized in table 1.

Table 1. Current status (as of December 2020) of carbon-pricing regimes in Canada

Province/territory	System type	Fuel charge administration	Industry system administration
Alberta	Carbon tax	Federal	Provincial
British Columbia	Carbon tax	Provincial	
Manitoba	Carbon tax	Federal	Federal
New Brunswick	Carbon tax	Provincial	Federal
Newfoundland and Labrador	Carbon tax	Provincial	Provincial
Northwest Territories	Carbon tax	Territorial	Territorial
Nova Scotia	Cap-and-trade	Provincial	
Nunavut	Carbon tax	Federal	Federal
Ontario	Carbon tax	Federal	Federal
Prince Edward Island	Carbon tax	Provincial	Federal
Quebec	Cap-and-trade	Provincial	
Saskatchewan	Carbon tax	Federal	Provincial/federal
Yukon	Carbon tax	Federal	Federal

For British Columbia, Nova Scotia, and Quebec, the carbon price includes the industrial sector; they do not have a separate industrial program. In addition, both Ontario and New Brunswick have developed provincial industry OBPS systems that have been approved by the federal government, although they have yet to be implemented.

This paper will further outline 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. For some Canadian jurisdictions, we also look at how provincial systems evolved in response to federal initiatives. In addition, we review several pending proposals in the United States. 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 this report is a substantial update to a paper by the same name that we published in January 2019.

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 earlier, carbon fees are currently in effect in most Canadian provinces 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 northeastern United States, the California cap-and-trade program, and Canadian programs in Quebec and Nova Scotia. A summary of the various programs now in place is provided in table 2.

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 in the following, the Canadian federal government is imposing a carbon tax on provinces that do not have a provincial program. *Source:* ACEEE.

Table 2. 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 2020 (US$ per MT CO_2)[3]	Use of funds for energy efficiency (EE)
British Columbia	Carbon tax	2008	Fossil fuel energy	$30.55	Portion of revenues directed to industry programs
Alberta, Manitoba, Ontario, Saskatchewan	Federal carbon tax	2019 (2020 in Alberta)	Transport and heating fuels	$22.91	~10% of revenues directed to projects in MUSH[4] sector and small to medium-sized businesses In AB/SK, industry proceeds directed toward climate change/emissions-reduction projects
Nunavut, Yukon Territory	Federal carbon tax	2019	Transport and heating fuels (excl. aviation fuels)	$22.91	All revenues returned to territories
New Brunswick, Newfoundland and Labrador, Prince Edward Island, Northwest Territories	Provincial /territorial carbon tax	2019 (2020 for NB)	Transport and heating fuels (excl, furnace oil in NB, NL, and PEI; aviation fuels in NT)	$22.91	No active use of revenues to support energy efficiency, but some proceeds directed to climate fund
Boulder, Colorado	Carbon tax	2007	Electricity	$0.0003–0.0049 per kWh, varying by sector	Most funds spent on EE and renewable energy
RGGI involving nine northeastern states	Cap and trade	2009	CO_2 emissions from power sector	$5.65–7.41[a]	More than 50% of revenues invested in EE
California	Cap and trade	2013	CO_2 emissions from power and transportation sectors and natural gas use	$16.68–17.87[b]	Some funds allocated to EE
Quebec	Cap and trade	2013	Same as California	$16.68–17.87[c]	90% of revenues invested in strategies to reduce emissions, including EE

[3] MT = mega-tonne (1000 tonnes); Canadian–U.S. exchange of $0.76

[4] Municipalities, universities, schools, and hospitals

State or province	Type of program	Year program began	What is covered?	Price in 2020 (US$ per MT CO_2)[3]	Use of funds for energy efficiency (EE)
Nova Scotia	Cap and trade	2020	Large emitters, petroleum product suppliers, natural gas distributors, and electricity importers	$18.77 (Dec. 2020 auction)	Auction proceeds paid into a green fund

[a] RGGI 2020b. [b] CARB 2020b. [c] Quebec and California conduct a joint auction. *Source:* Based on information in tables A1 and A2 in Appendix A.

In the following, we provide a more detailed description of the various state and provincial programs. Appendix A contains details of the 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. The tax started at CAN$10 per tonne, gradually increasing to CAN$30 in 2012, where it stayed for several years.[5] It increased to CAN$35 in 2018 and was scheduled to increase CAN$5 each year until it reached CAN$50 per tonne in 2021. In September 2020, the province announced that further increases would be halted indefinitely due to the COVID-19 pandemic. The BC tax has a few exemptions, including fuel purchased on First Nations land and specific types of liquid fuel purchased by a qualifying farmer.

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). It was also designed to be revenue neutral, with funds originally used only to provide rebates to households and 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 2019 a Climate Action Tax Credit provided rebates to households of $154 per adult and $45.50 per child. In addition, the tax supports a Northern and Rural Homeowner Benefit of up to $200 per household (British Columbia 2020a; Lammam and Jackson 2017).

In 2018, the province began directing the incremental portion of the carbon tax above CAN$30 per tonne paid by industry to two CleanBC industry programs: the CleanBC Industrial Incentive, reducing carbon tax costs for facilities exceeding world emissions benchmarks, and the CleanBC Industry Fund, which invests revenue directly into emission reduction projects.

ROLE OF ENERGY EFFICIENCY

As noted, British Columbia now directs a portion of carbon tax revenues to two industrial support programs. The CleanBC Industry Fund directly supports projects. In 2019–2020, the

[5] As of November 23, 2020, a Canadian dollar was worth US$0.76.

fund invested $12.5 million, with 43% of funding involving projects described solely as "energy efficiency," while 74% of the funding involved projects including one or more of energy efficiency, process improvements, or waste heat recovery. Other projects involved fuel switching and methane capture. Examples of projects include the Copper Mountain Mine piloting an electric trolley system for haul trucks and the Quesnel River Pulp plants reconfiguring heat-exchange technology and installing a new pressurized scrubber to use less natural gas in the conversion of wood chips to mechanical pulp (British Columbia 2020b).

PROGRAM IMPACTS

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

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 (table 3). 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 3. 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

Source	Method	Results
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
Pretis (2019)	Difference-in-difference with synthetic controls	5% reduction in transportation emissions; no significant reduction in aggregate emissions
Xiang and Lawley (2019)	Regression; synthetic control modeling	7% per capita reduction in residential natural gas consumption
Bernard and Kichian (2019)	Time-series analysis with an error-correction model	Average annual reduction equivalent to ~1.3% of 2008 diesel emissions

The first study is a pretax projection. Murray and Rivers (2015) derived figures given for Gulati and Gholami.
Source: **Murray and Rivers 2015 for studies completed by 2015. Full citations are in that paper. The 2019 studies are included in the references section at the end of this report.**

Antweiler and Gulati (2016) used multistage regression models to compare British Columbia with other Canadian provinces on gasoline demand and vehicle purchase decisions. They controlled 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" (Antweiler and Gulati 2016, 1). Their savings estimates are lower than other estimates due to the effect of the tax on cross-border trips.

For buildings, Gulati and Gholami (2015) analyzed residential and commercial natural gas sales using an approach similar to that of Rivers and Schaufele (2012). 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 (2015) 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 GHG emissions in all sectors. These studies found GHG reductions of 5%, 8.5%, and 9% due to the carbon tax. Komanoff and Gordon (2015) compared the pre- and post-tax periods in British Columbia 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 gross domestic product (GDP), both British Columbia and Canada declined, with the difference between British Columbia and Canada being 9.2% for emissions per capita and 12.4% for emissions per dollar of GDP.

Some more recent studies show mixed results. Pretis (2019) found that, outside of a 5% reduction in transportation emissions, British Columbia's carbon tax had not yet resulted in a statistically significant reduction of aggregate emissions. Instead, Pretis found that facility closures and energy efficiency improvements in industry in provinces without carbon taxes had led to emissions reductions. By contrast, Xiang and Lawley (2019) found that British Columbia's carbon tax had reduced per capita residential natural gas consumption by approximately 7%, while Bernard and Kichian (2019) found that the tax had led to moderate reductions in per capita diesel use in the province. Figure 3 shows that, after an early divergence in gasoline and diesel demand in the transportation sector in British Columbia, demand for these fuels has increased in recent years at the same time that Canada-wide demand has been declining. We are not aware of any studies explaining why fuel demand has increased in British Columbia since 2011.

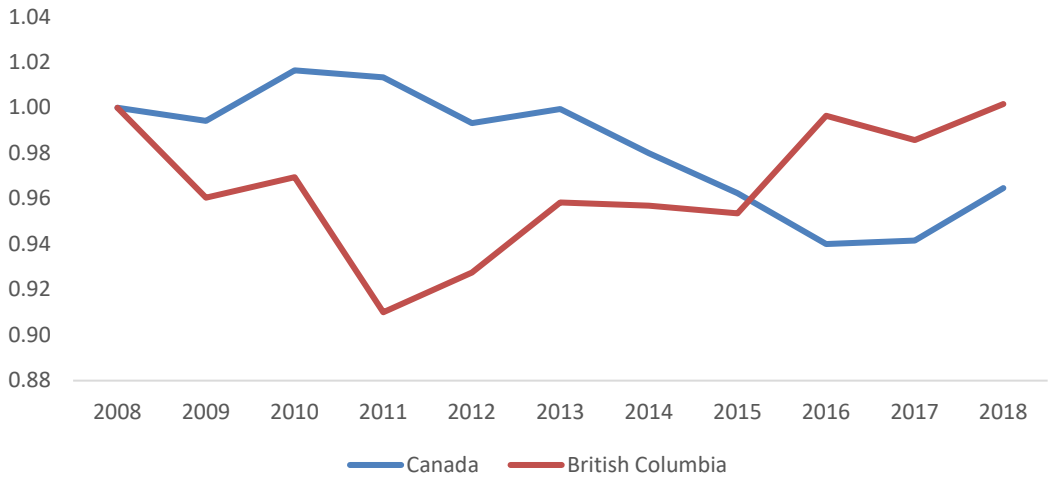

Figure 3. End-use demand for gasoline and diesel in the transportation sector, per capita (2008 = 1). Data from Statistics Canada's tables 25-10-0029-01 and 17-10-0005-01 (Statistics Canada 2020a; 2020b).

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" (Murray and Rivers 2015, 12).

In summary, the majority of available evaluations have found that the BC carbon tax has reduced GHG 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 British Columbia's economy.

Canadian Provinces and Territories with the Federal Carbon Tax

PROGRAM DESCRIPTION

As noted, the Canadian federal carbon-pricing system comprises two parts: a general carbon tax applied to combusted fossil fuels (e.g., gasoline, diesel, furnace oil) and an industry-specific OBPS that includes nonenergy use of fossil fuels. The general carbon tax is a regulatory charge applied to various liquid, gaseous, and solid fossil fuels and combustible wastes, equivalent to $20 (Canadian) per tCO_2e in 2019 and increasing by $10 per tCO_2e annually to $50 per tCO_2e in 2022. After 2022, the government is proposing to increase the tax by $15 per tCO_2e per year, reaching $170 per tCO_2e by 2030. The charges are paid by fuel producers or distributors for fuels produced or imported and sold domestically for certain nonindustrial end uses. Fuels used in commercial fishing and agriculture are exempt from the tax in the federal backstop system, as are those used by remote community power operators and in greenhouse operations.

The federal government rebates approximately 90% of the proceeds of the fuel tax directly to individuals in these provinces and reserves the other ~10% for the Climate Action Incentive Fund (CAIF). The CAIF supports projects and measures undertaken by small and medium-sized enterprises (the SME stream) and municipalities, universities, schools, and hospitals (the MUSH stream) in the provinces where the federal fuel tax is in place. Many, if not most, of these projects target energy efficiency improvements. According to the federal government, a total of $106 million was spent on the SME project stream and $60 million on the MUSH stream in 2019–2020 across Ontario, Saskatchewan, Manitoba, and New Brunswick (Environment and Climate Change Canada 2020b).[6]

The federal industrial OBPS establishes sectoral emission intensity standards for different industries and compliance periods within which covered facilities must meet those standards—either by reducing emissions, by purchasing and remitting compliance units, or by paying an excess emissions charge to the federal government (or a combination of these). Covered emissions include emissions from stationary fuel combustion as well as nonenergy uses such as industrial process emissions, onsite transport, venting and flaring emissions, and waste emissions. Facilities within a covered industry sector emitting more than 50 kilotonnes of CO_2e annually are required to participate, while facilities with lower emissions may apply to participate or opt in.

[6] Alberta is not included here as it was not yet on the federal backstop, whereas New Brunswick at this time was (but is no longer).

Details on the use of the OBPS proceeds have yet to be made public, but all proceeds collected are committed to be returned to the jurisdiction. The federal government amended the OBPS regulations in May 2020 to postpone the deadline for verification reporting and compensation from the first compliance period to October 1, 2020. In its December 2020 climate change plan, the federal government noted that it would look to use the OBPS to support emissions-reduction projects in industry starting in early 2021 (Environment and Climate Change Canada 2020a).

PROVINCIAL PROGRAM DETAILS

As of April 1, 2020, the federal carbon tax has been implemented in four Canadian provinces (Alberta, Manitoba, Ontario, and Saskatchewan) and two territories (Nunavut and Yukon). Of these jurisdictions, Alberta, Ontario, and Saskatchewan have developed their own industrial pricing systems (although Saskatchewan's is supplemented by the federal system for sectors not covered under the provincial plan, and Ontario's has yet to be implemented[7]). All four provinces, along with New Brunswick, have to date unsuccessfully challenged the federal carbon tax in court. Most recently, the provinces appealed the case to the Supreme Court, which adjourned in late September 2020 without making a decision on the constitutionality of the federal system.

In the following sections, we discuss the evolution of carbon pricing in the provinces that presently have the federal fuel charges in place, irrespective of whether they have developed their own industrial pricing system, as well as how—or whether—the proceeds from these systems have been used to support energy efficiency.

ALBERTA

Alberta was among the "first movers" for Canadian provinces implementing their own carbon prices, having originally established an emissions-intensity pricing system for large industrial emitters (>100 kilotonnes CO_2e per year) in 2007, set at CAN$15 per tCO_2e, under a conservative government (Haley, Gaede, and Correa 2019). The system was expanded to include a general carbon levy of CAN$20 per tCO_2e for transport and home heating fuels under a New Democratic Party government in 2017.[8] This system was assessed as meeting the federal benchmark in 2018; however, a provincial election brought to power a conservative government that eliminated the carbon levy in early 2019 (keeping in place the industry system, however). Consequently, the federal backstop fuel charges were not

[7] The implementation of Ontario's industry pricing system is pending the result of the Supreme Court case on the legality of the federal backstop system.

[8] For U.S. readers, Canada has three main national political parties: the right-leaning Conservative Party, the centrist Liberal Party, and the left-leaning New Democratic Party. Provincial political parties are separate organizations, even if they share the same name, and their relative political leanings may be different from the national parties'. For example, the British Columbia Liberal Party is typically considered the right-leaning party in that province. Alternatively, provincial parties may be similar in political leanings to national parties, but with different names—presently, the conservative party in Alberta is the United Conservative Party. Nevertheless, generally speaking, Canadian conservative parties are similar to the U.S. Republican Party, liberal parties to the U.S. Democratic Party, and New Democratic parties to U.S. liberal Democrats or the Democratic Socialists of America.

implemented in Alberta until January 1, 2020, a year after they went into effect in other provinces.

Alberta's industrial program, named the Carbon Competitiveness Incentive Regulation under the New Democratic Party government, was reworked and renamed the Technology Innovation and Emissions Reduction (TIER) regulation in January 2020. While the federal OBPS covers facilities with >50 kilotonnes of CO_2e annual emissions, the TIER is mandatory only for facilities with >100 kilotonnes of annual emissions. Facilities under this threshold may opt in if they compete with a facility regulated under TIER, and in doing so would thus be exempted from paying the federal carbon tax. According to the provincial government, the TIER regulation captures about 60% of Alberta's total emissions from all sectors (Alberta 2020).

The revenues from the now-defunct Alberta carbon-levy-funded Energy Efficiency Alberta, 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. Energy Efficiency Alberta developed and administered a variety of residential, commercial, and industrial energy efficiency programs between April 2017 and March 2020. The agency was closed in September 2020 following the cancellation of the provincial carbon levy. According to their final annual report, Energy Efficiency Alberta invested $292 million during this time to achieve an estimated $806 million in lifetime energy savings (Energy Efficiency Alberta 2020).

Figure 4 shows how Energy Efficiency Alberta's total spending was allocated among sectors.

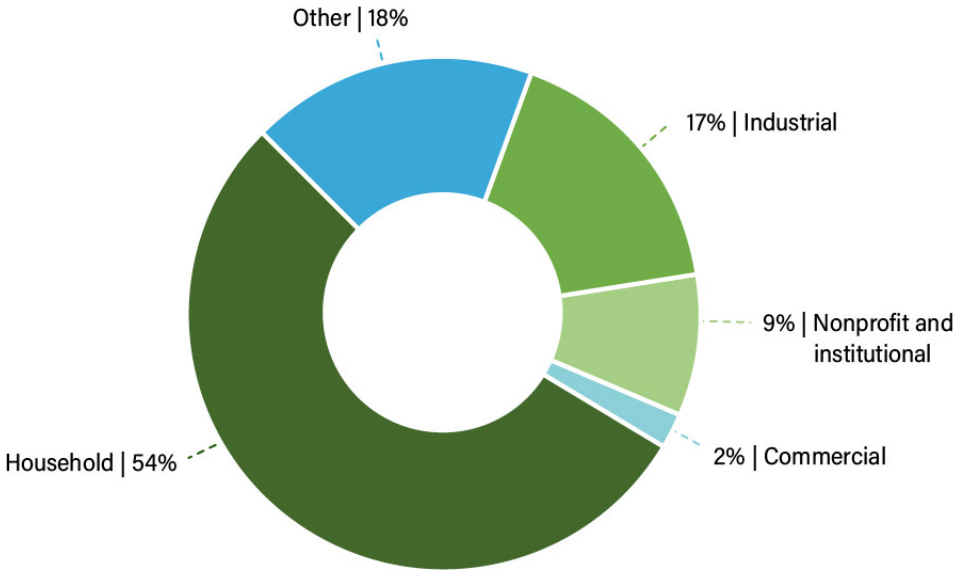

Figure 4. Allocation of Energy Efficiency Alberta 2017–2020 spending by sector. *Source:* Energy Efficiency Alberta 2020.

Proceeds from Alberta's TIER program go into the Technology Innovation and Emissions Reduction Fund. The regulation detailing the TIER program does not specify exactly how

this fund is to be used, but the province has committed to using it to support emissions-reduction programs for industry. In September 2020, the province announced it would spend the entire fund (~$750 million) on a variety of initiatives, with a special focus on carbon capture and storage (CBC News 2020). Industrial energy efficiency improvements and energy efficiency programs for business will also be supported with these funds, administered by an organization called Emissions Reduction Alberta, with some supplementation by federal government funding (Joannou 2020).[9]

In our search of 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 is unlikely to reflect all of the details of the expansion.

More recent work by researchers at the University of Alberta and the University of Calgary found that Alberta's industry carbon price, coupled with compensation agreements negotiated with coal companies in the wake of the province's coal phase-out regulation and poor market conditions resulting from low natural gas prices, has led to a significant reduction in coal-fired electricity generation in the province (Leach and Shaffer 2020). For its part, Energy Efficiency Alberta reported that their programs had delivered $806 million in lifetime savings for the province (through energy savings and emissions reductions) and avoided 6.8 MT of CO_2e emissions (Energy Efficiency Alberta 2020).

ONTARIO

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 Party 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 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

[9] The federal funds are from the low-carbon economy fund, which is not directly linked to carbon-pricing revenues.

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, v).

The Ontario government's cancellation of the cap-and-trade program placed the province on the federal backstop carbon tax. The province announced legislation for its own industrial system—the Emissions Performance Standards program—in mid-2019. The federal government assessed and accepted Ontario's industrial system in September 2020, despite noting in its acceptance that the Ontario system was "clearly weaker" than the federal OBPS (the federal government approved New Brunswick's industry system at the same time, with a similar message) (McIntosh 2020). The reason for this assessment was that federal government modeling indicated the proposed system would not lead to the degree of emissions reductions specified by the federal benchmark, largely because industry benchmarks are set at the facility level, not as a sector average (Edger and Turcotte 2019; Rabson 2020). Pending the result of the Supreme Court case, the federal OBPS remains in place.

Proceeds from the short-lived cap-and-trade market were directed to a special Green Ontario Fund, dedicated to supporting energy efficiency and electrification programs. These programs and the fund were dismantled following the cancellation of the cap-and-trade market in 2019, and no spending or savings figures have been made public.

MANITOBA

In 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 CAN$25 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). The province also took steps to develop its own industry OBPS (Manitoba 2018).

Manitoba planned to use the proceeds of the proposed provincial carbon tax to provide relief to households; support green projects, business competitiveness, and clean technologies; and invest in infrastructure for climate change adaptation purposes. The federal government found that the proposed system did not meet the requirements of the federal benchmark, however, and the federal carbon tax and OBPS were implemented in the province in 2019.

In early March 2020, the province announced that it would reintroduce its proposed flat tax and reduce a provincial sales tax to 6% starting July 1, but they postponed this decision later in the month in response to the COVID-19 pandemic (Woods 2020). It is unclear whether the federal government would continue to enforce the federal carbon tax increases beyond the provincial level if the province does eventually implement its tax.

SASKATCHEWAN

Saskatchewan is the fourth province that currently has the federal carbon tax system in place, although it developed its own industry OBPS. The Saskatchewan industry pricing system applies to large industrial facilities emitting more than 25 kilotonnes of CO_2e annually, but it does not include electricity generation or natural gas transmission pipelines,

as required by the federal benchmark. Consequently, the federal industrial OBPS supplements the provincial one by covering these sectors, applying to facilities with greater than 50 kilotonnes CO_2e emissions per year.

Proceeds from Saskatchewan's OBPS go to the Saskatchewan Technology Fund, which can be used by government to support emissions-reduction projects in regulated facilities. Payments to this fund from the first compliance period are not due to be deposited until 2021. It has no clear criteria for determining eligible projects; final assessment of projects rests with the Minister of Environment, to be informed by an advisory committee comprising representatives from the regulated sectors.

TERRITORIES

Finally, Yukon and Nunavut territories both willingly adopted the federal backstop system (fuel tax and industry pricing system), although aviation fuels are excluded for the territories. The federal government agreed to return all proceeds gathered from these jurisdictions to the territorial governments.

Canadian Provinces/Territories with Provincial Carbon Taxes

Not counting British Columbia, which is covered separately in the preceding discussion, presently three Canadian provinces and one territory have developed their own general carbon tax systems in response to the federal policy: Newfoundland and Labrador, Prince Edward Island, New Brunswick (which was on the federal system for 2019 but has since implemented its own tax), and Northwest Territories. Nova Scotia also developed its own system but opted for a cap-and-trade system instead of a tax and is thus covered in the cap-and-trade section that follows. Of these jurisdictions, Prince Edward Island is the only one not to develop its own industry OBPS (although New Brunswick's has yet to be implemented).

PROGRAM DESCRIPTIONS

To comply with the federal benchmark, these provincial systems largely mirror the federal fuel charge rates, with some important exceptions. These include the following:

- Aviation gasoline and turbo fuels are exempt in New Brunswick, Northwest Territories, and Newfoundland and Labrador.
- Kerosene is exempt in New Brunswick.
- Some light fuel oils (diesel, heating oil) are exempt in all three provinces if used in households.
- Propane is exempt in New Brunswick and Prince Edward Island if used for home heating.
- Diesel for off-grid electricity generation is exempted in Newfoundland and Labrador.

In addition, all three provinces lowered their fuel excise taxes to minimize the price increases of gasoline and diesel for transportation uses. Both New Brunswick and Newfoundland and Labrador also incorporated some exemptions into their industry pricing systems. In Newfoundland and Labrador, offshore and mineral exploration, and venting and fugitive emissions in the oil and gas sector, are not included. In New Brunswick, the

proposed method to establish the industry emission benchmark is based on a facility's emissions, not the industry as a whole. Consequently, an estimated 100% of industrial emissions in New Brunswick would be exempt in 2020, and 90% would still be exempt by 2030 (Poitras 2020b).

ROLE OF ENERGY EFFICIENCY

The use of proceeds from these carbon-pricing systems differs by province. In New Brunswick, roughly 55% of proceeds go to reducing the burden on the natural gas utility and to compensating for the lowering of the gas/diesel excise tax. The rest will go into a "climate fund" established by the province's Climate Change Act (Poitras 2020a; New Brunswick Legislative Assembly 2018). Compliance credits under New Brunswick's OBPS will also be purchased from this fund. Although the Climate Fund has yet to be used, it can be used for a variety of initiatives related to climate change. While energy efficiency is not explicitly mentioned in legislation, it was mentioned by the minister as an example of the type of project this fund could support (Brown 2020).

In Newfoundland and Labrador, proceeds are also used to offset reduced provincial fuel excise taxes. The province has committed to matching federal Low Carbon Economy Leadership Fund support, in the amount of $44.7 million (total funding of $89.4 million), which will be used to support efficiency, fuel switching, and industry process improvements; it is unclear which of these will use earmarked carbon-pricing revenues (Newfoundland and Labrador 2020).

In Prince Edward Island, carbon-pricing revenues were also used to offset the reduced provincial fuel taxes and to support a suite of measures to reduce costs for drivers and public transit users (including free driver's licenses and reduced or free vehicle registration costs) (Campbell 2019).

Northwest Territories expects to use roughly 25% of proceeds to support initiatives to reduce GHGs and rebate the rest to households. About 75% of industry payments on nonmotive diesel/heating fuel will be rebated to industry, and the remaining 25% will be held in individualized trust accounts to support facility GHG reduction efforts.

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 (U.S.) 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 (Boulder 2020). 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 59% of spending; renewable energy, electric vehicles, and market innovation account for another 28%. The remainder goes for strategy development, outreach, and evaluation. Currently, substantial funds support several city-run programs:

- EnergySmart energy advising services and rebates for businesses and residents
- Development of a building performance standard ordinance for buildings of 20,000 square feet or more
- Clean energy finance (commercial PACE loans)
- Consideration of commercial and residential net-zero energy codes
- SmartRegs energy efficiency requirements for rental properties
- Residential electrification pilot program and advising and rebates on residential heat pumps (Boulder 2020).

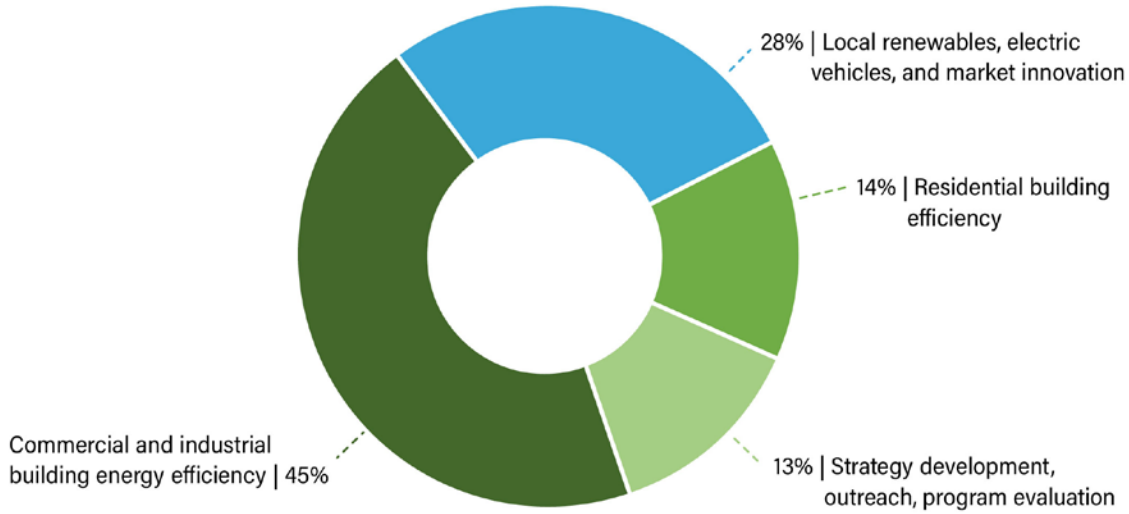

Figure 5. Average annual allocation of revenues from Boulder's carbon tax. *Source:* Boulder 2020.

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 (Boulder 2020). The city estimates that total annual emissions in 2016 were 1.6 million tonnes (Boulder 2019). Thus, the decade of cumulative program savings is 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

PROGRAM DESCRIPTION

The Regional Greenhouse Gas Initiative (RGGI) was the first mandatory cap-and-trade program for reducing GHG emissions in North America. In 2005, seven states committed to developing the program under the leadership of regional governors representing both major political parties; three other states joined in 2007. Currently composed of 11 northeastern and mid-Atlantic states, RGGI began its first compliance period in January 2009.[10] The program caps CO_2 emissions from the power sector with a goal of reducing emissions to 45% below 2005 levels by 2020, with an additional 30% reduction in the regional cap by 2030. 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 U.S. 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 (RGGI 2020a). 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 2021).[11] As shown in figure 6, auction clearing prices have stayed between $2 (U.S.) and about $8 per ton over the course of the program (these figures are in U.S. tons, not metric tonnes). RGGI states tightened the emissions cap starting 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). Compared with earlier periods, compliance period 3 (2015–2017) had a drop in the number of allowances sold while clearing prices were on average higher.[12] Total auction proceeds were slightly lower compared with the other two compliance periods (Hibbard et al. 2018).

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[10] As of December 2020, RGGI includes Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and Virginia. New Jersey participated in the first three years of the RGGI program but withdrew at the end of 2011 and rejoined at the beginning of 2020. Virginia has joined, with participation beginning January 2021. Pennsylvania is now in discussions to join RGGI.

[11] The Cost Containment Reserve provides additional allowances equal to 10% of the cap each year, with a trigger price of $10 (U.S.) per 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.

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

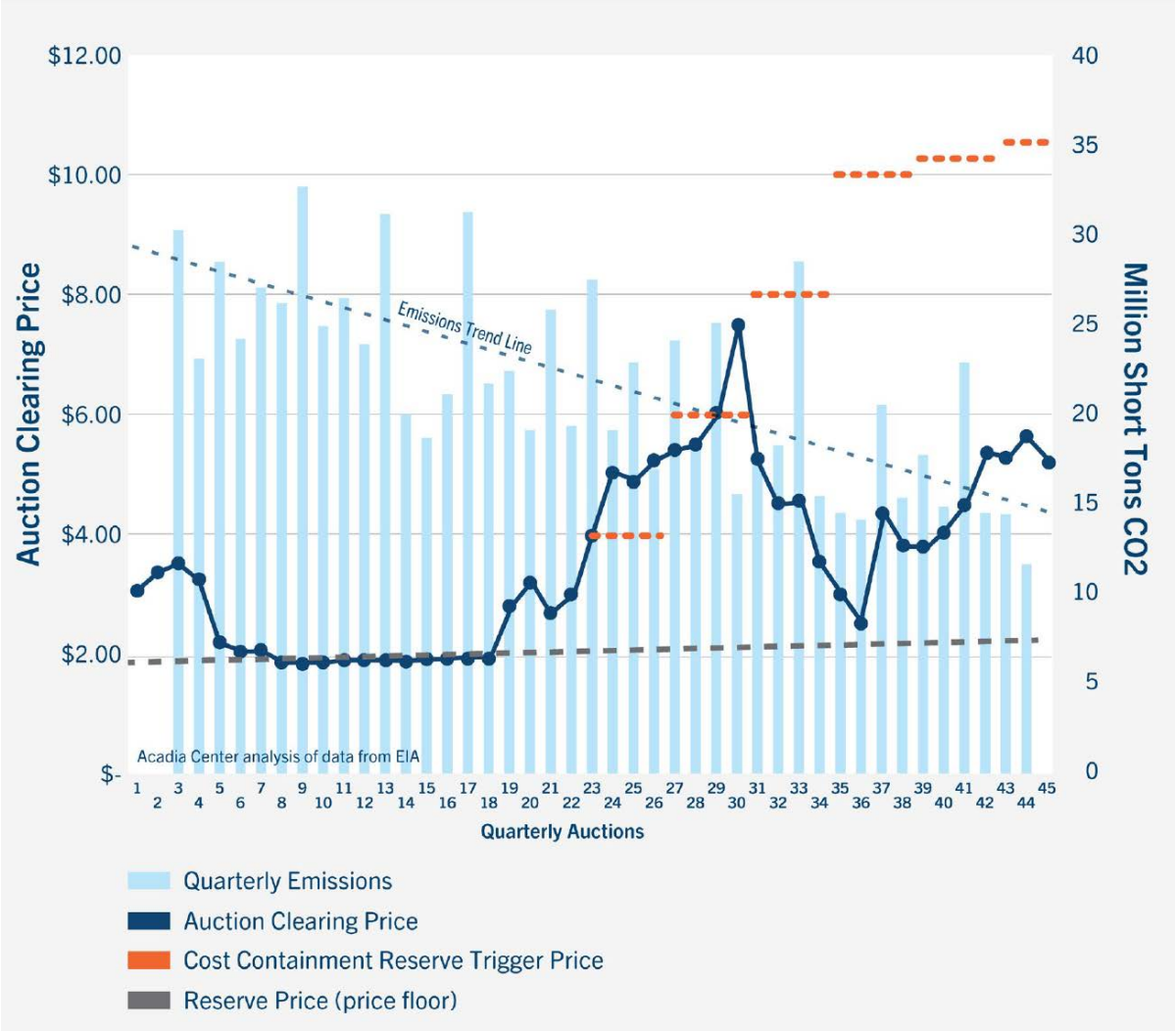

Figure 6. Summary of RGGI auction results, price controls, and CO_2 reductions. Emissions are per quarter (three months) and are in short tons (American tons), not metric tonnes. *Source:* Stutt 2019.

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 Pennsylvania, tentatively in 2022.

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. It comprises 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. We discuss this further under pending proposals.

Spending of RGGI proceeds is summarized in figure 7. Just over half the funds have gone to energy efficiency, with 18% to renewable energy investments and 13% to help pay energy bills, such as for low-income consumers.

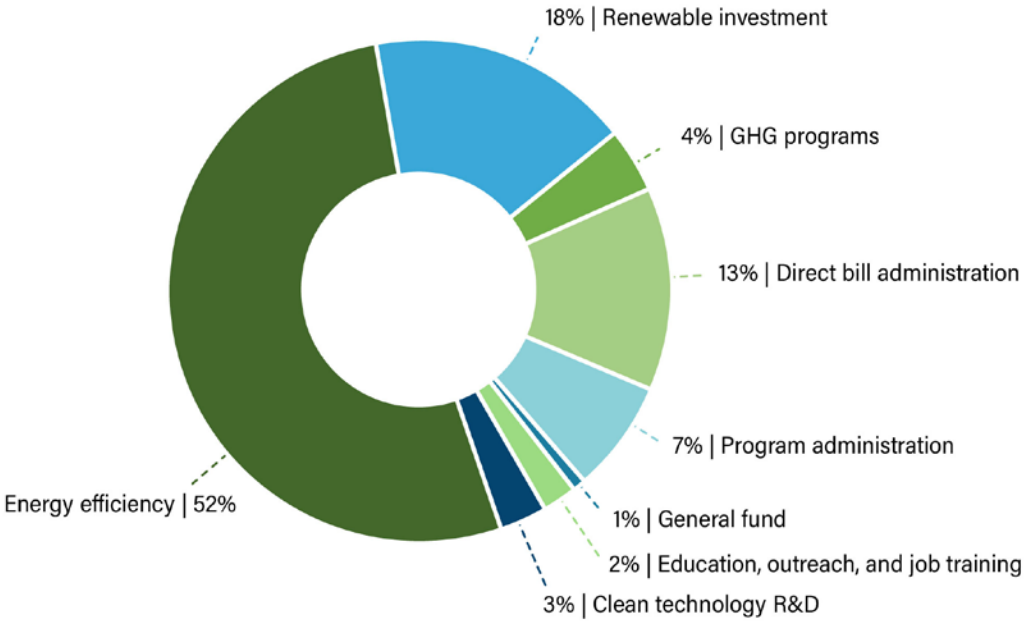

Figure 7. RGGI proceeds spending during compliance period 3 (2015–2017) for all RGGI states. *Source:* Hibbard et al. 2018.

PROGRAM IMPACT

After nearly 10 years of auctions and three compliance periods, RGGI states have hit each of their emissions-reduction targets. 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 tonnes to about 60 million tonnes (Hibbard et al. 2018). These reductions are due primarily 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 emissions 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). A more recent econometric analysis by Chan and Morrow (2019) found results consistent with Murray and Maniloff's. Specifically, Chan and Morrow found that CO_2 reductions at the average RGGI facility were roughly 20% greater than at the average non-RGGI facility; Murray and Maniloff found an RGGI effect on CO_2 emissions of 19–24%. Chan and Morrow also found that in addition to reducing CO_2, RGGI has reduced SO_2 emissions and damages in the region.

[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). Data for 2017 are not yet available.

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 (U.S.) 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 2018).

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 GHG 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 2015 the transportation sector and the use of natural gas outside the power sector were added to the program. Entities responsible for emissions of at least 25,000 tonnes per year are covered. The program now includes about 75% of GHG emissions in the state (IEMAC 2020).[14]

Some allowances are distributed for free, but most are auctioned. Free allowances are conditionally allocated 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. Allowances are auctioned quarterly by CARB, in conjunction with the Québec Ministry of the Environment and the Fight against Climate Change (California's and Quebec's programs are coordinated). Further information on allowance allocation can be found on the CARB website (CARB 2020a).

ROLE OF ENERGY EFFICIENCY

State law before 2017 required that auction revenues be used to reduce GHGs. 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. Since inception, auction revenues have raised $12.5 billion (U.S.) for the Greenhouse Gas Reduction Fund, and the legislature has appropriated $12.7 billion. Allocations are shown in figure 8 (California Climate Investments 2020). Of the funds allocated, 3% goes to agricultural efficiency and energy (e.g., the use of agricultural waste to produce energy) and 2% goes to low-income weatherization and solar. The investments in

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

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 (DOE 2020) and public transit (FTA 2010) are generally more efficient per passenger-mile than are private vehicles with internal combustion engines. 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 (CalEPA 2020).

Note also 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—$1.9 billion in 2019 counting both electric and gas utility expenditures (Berg et al. 2020).

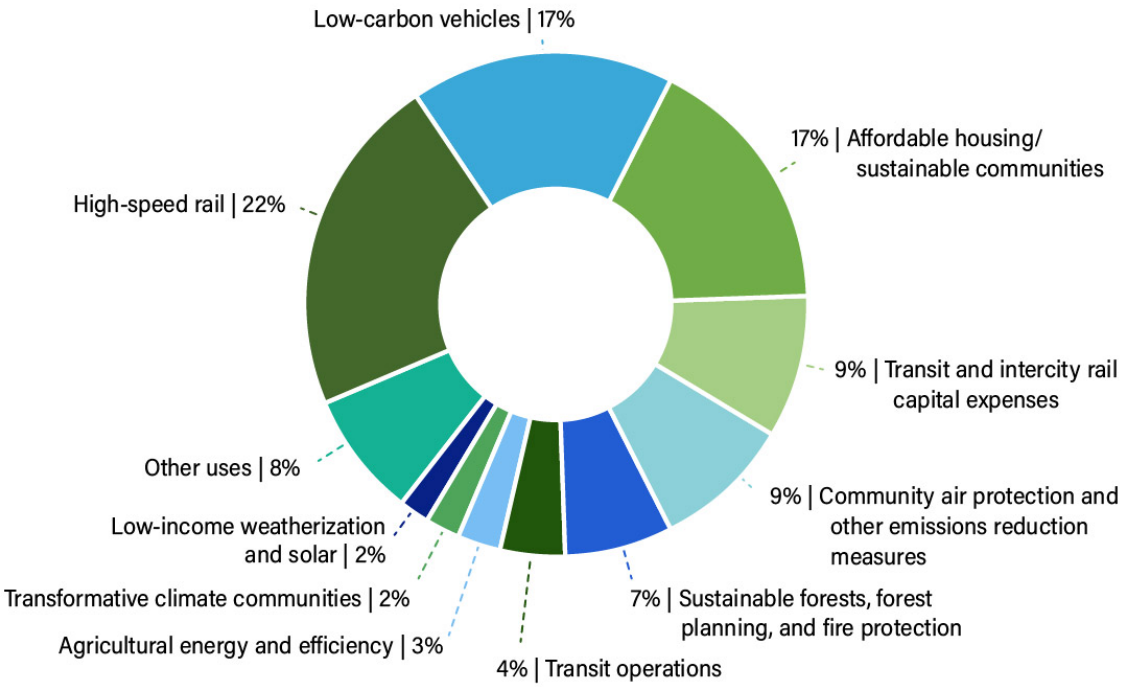

Figure 8. Cumulative allocations of California cap-and-trade revenues through 2019. *Source:* California Climate Investments 2020.

PROGRAM IMPACT

In 2018, CARB announced that in 2016 California had already met its 2020 emissions target, established under AB 32. The state also met its renewable energy target early: that 33% of electricity consumption in the state come from renewable sources by 2020. According to Barboza and Lange (2018), both early compliance with California's renewable electricity mandate and the weather helped drive reductions. 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).[15]

Borenstein et al. (2019) 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.

Cullenward and Victor (2020) went a step further and argued that California's reductions are driven primarily by other policies besides cap and trade and that cap and trade provides only a minority of the emissions reductions. Because only limited reductions are needed from cap and trade, allowance prices have been low. They noted that going forward, much greater reductions will be needed from cap and trade, and hence, they agree with Borenstein et al. (2019) that allowance prices could well increase. Similarly, the Independent Emissions Market Advisory Committee (IEMAC 2020, 2) noted that "anticipated emissions reductions attributable to the cap-and-trade program have risen from 20 percent in the 2008 Scoping Plan in 2020, to 38 percent cumulatively over the next decade through 2030 in the (third) Scoping Plan in 2017."

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 also passed laws to double energy efficiency savings by 2030 and aims to take a variety of steps, including modifying its building codes to require new construction in 2030 and beyond to be zero net energy (Jones et al. 2017). In 2020, California set requirements that a growing share of medium- and heavy-duty vehicle sales be zero emission (Shepardson and Groom 2020), and the Governor announced an effort to require that all new light-duty vehicle sales be zero emission by 2035 (California Office of the Governor 2020).

Interestingly, a 2016 study assessed equity issues under the California cap-and-trade program, finding that higher emitters of GHGs and fine particles (PM_{10})[16] 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). A more recent analysis by Hernandez-Cortes and Meng (2020) looked in detail at emissions before and after California's cap-and-trade program began. They embedded a pollution transport model within a program evaluation framework and found that while the gap in emissions between disadvantaged and other

[15] 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 ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard.

[16] Particulate matter with a diameter of 10 microns or less. Particulate matter is generally tracked for particles 10 microns and less and 2.5 microns and less. Generally, the smaller the particle, the deeper it can go in the lungs and the more harmful to human health.

communities was widening before 2013, it has since fallen by 21–30% across pollutants due to the policy.

While California met its 2020 target and has taken some steps to meet the 2030 target, the 2030 target is much more ambitious, and a variety of analysts have concluded that absent additional action, California will fall short of its 2030 goal. The price of allowances in auctions has remained low, driving only moderate emissions reductions to date (Becker 2020a, 2020b; Busch and Orvis 2020). Other analysts have noted rising transportation-sector emissions (Temple 2019), leniency toward the oil industry (Roberts 2018a), and the need to do more to reduce other industrial emissions, such as those from the cement industry (Busch and Orvis 2020). California has started a scheduled process to review and update its climate road map, a process due to be completed by fall 2022. As part of this process, a variety of changes to the cap-and-trade program will be considered, such as reducing the number of allowances and higher minimum allowance prices (Becker 2020a; IEMAC 2020).

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 has also considered integrating with California (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. It was 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 North American 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 GHG emissions to 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 LPRO 2017).

ROLE OF ENERGY EFFICIENCY

Auction proceeds are distributed across several government departments to further reduce emissions. The plan for 2013–2020 was to allocate 90% of funds 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 2018a). 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 2018a).

The three principal organizations using these funds are the Ministry of Sustainable Development, Environment and the Fight Against Climate Change, the Ministry of Transport, and Transition Energétique Québec (TEQ; Energy Transition Quebec), spending 33%, 30%, and 26% of the fund in 2019–2020, respectively (Conseil 2020).

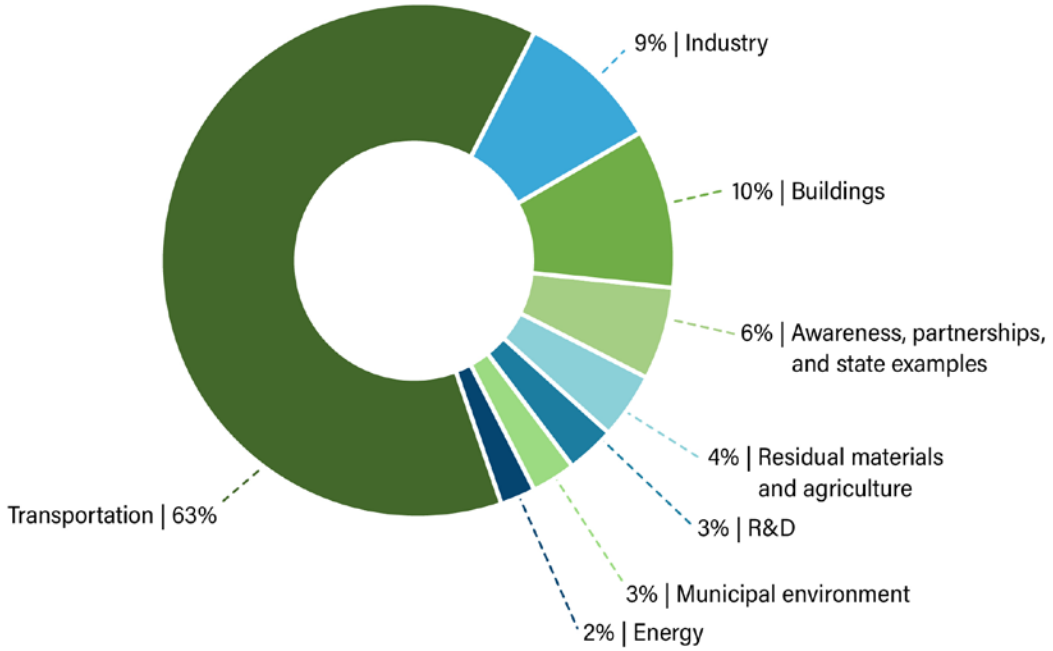

Figure 9. Planned allocation of Quebec cap-and-trade funds, 2013–2020. *Source:* Ministry of Sustainable Development, Environment and the Fight Against Climate Change 2017.

In November 2020, the government also released a new 2030 Plan for a Green Economy, which calls for increased auctioning of industrial emissions allowances. The plan emphasizes electrification of transportation and industry and a 50% GHG emission reduction target from building heating by 2030, which provides insight on the likely prioritization of cap-and-trade funds (Québec 2020).

The governance of auction proceeds has undergone recent changes as a component of the government's new plan. A new Electrification and Climate Change Fund, in accordance with a new law titled "An Act to ensure effective governance of the fight against climate change and to promote electrification", entered into force on November 1, 2020 (National Assembly of Québec 2020). This replaces the Green Fund, which was originally created in 2006 to finance programs related to climate change, waste management, and water governance and which received funds from the cap-and-trade auctions (Québec Ministère de l'Environnement et de la Lutte contre les Changements Climatiques 2020). The Green Fund has been overseen by a management council since 2017, but the new law abolishes this

council and gives the Ministry of Environment and the Fight Against Climate Change a horizontal mandate and enlarged governance powers. A consultative committee will also be created, and the auditor general and sustainable development commissioner are given new mandates to oversee and recommend changes concerning the use of revenues. These governance changes stem from controversies over the effective use of funds and from findings of incomplete information on the fund's performance (Richer 2020).

The new law also abolishes TEQ's status as an independent state corporation and places it under the Ministry of Energy and Natural Resources. TEQ developed a comprehensive master plan, which listed energy efficiency as a "priority energy source." This master plan remains and is listed as a complementary policy under the 2030 Green Economy Plan (Québec 2020).

PROGRAM IMPACT

The Quebec government provides periodic program reports to the legislature, but to date, no comprehensive or independent evaluation of GHG reductions achieved has been forthcoming. 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 Canadian province located northeast of Maine, with a population of 971,000. 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 GHG 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 used to achieve further reductions. Other elements include a green fund (discussed in the following), expanded energy efficiency and renewable energy funding, new federal infrastructure investment programs, and coal-to-clean-energy transitions (Nova Scotia Department of Environment 2018, 2019).

The cap-and-trade program covers about 20 firms, including those that directly emit more than 50 kilotonnes 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. No plan is presently in place to link trading with other provinces or U.S. states (Nova Scotia Department of Environment 2018, 2019). The system presents stricter limits than larger jurisdictions on how many allowances one entity can buy in cap-and-trade auctions to prevent monopoly concentration in the small jurisdiction.

Auctions occur twice a year, and the first auction took place in June 2020. A floor price of CAN$20 per tonne was established, and the settlement price was CAN$24 per tonne. A second auction took place in December 2020, with a settlement price of CAN$24.70.

ROLE OF ENERGY EFFICIENCY

Proceeds from this system will be deposited into a green fund. Section 112O of the provincial Environment Act states that this fund can be used to help reduce GHG emissions, mitigate social and economic impacts, or adapt to the impacts of climate change (Nova Scotia 2018). The first auction raised $15.4 million (Canadian), and the second auction is estimated to have raised $13.4 million ($28.7 million in 2020 in total). In February 2021, the government announced that nearly $18 million from the fund would be used to support youth internships, energy efficiency and renewable energy programs. This includes $5.5 million for residential solar panel rebates, $6.7 million for energy efficiency improvements in affordable housing projects, and $3.5 million for energy efficiency incentives for small businesses and non-profit organizations (Nova Scotia 2021).

PROGRAM IMPACT

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

Pending Proposals

As noted below, many Northeast states are planning to join the TCI. In addition, several U.S. states (including Hawaii, Massachusetts, Oregon, Rhode Island, and Washington) have or are actively considering fees on carbon emissions. In this section, we examine each of these proposals and briefly discuss related activity in several other states.

TRANSPORTATION CLIMATE INITIATIVE

The TCI is a regional collaboration of Northeast and mid-Atlantic states and the District of Columbia that seeks to reduce carbon emissions from the transportation sector, improve transportation, and develop the clean energy economy. In December 2020, three states (Connecticut, Massachusetts, and Rhode Island), as well as the District of Columbia, signed a memorandum of understanding (MOU) outlining the Transportation & Climate Initiative Program (TCI-P). At the same time, eight other states (Delaware, Maryland, New Jersey, New York, North Carolina, Pennsylvania, Vermont, and Virginia) joined the four MOU signatories in issuing a statement saying they would continue to work together on the development of the details of the regional program while also pursuing state-specific initiatives to reduce emissions and provide clean transportation solutions (TCI 2020b).

Under the TCI-P MOU (TCI 2020c), emissions from finished gasoline and on-road diesel would be capped in the participating states. Wholesale fuel suppliers would be the regulated entity and would need to obtain allowances at auction for the emissions associated with the fuels they distribute for sale in signatory jurisdictions. Each TCI-P jurisdiction will decide how to invest allowance proceeds in projects that would reduce transportation emissions and the health effects of these emissions. The program will run from 2022 through 2032.

Under the MOU, the parties committed to develop a model rule that will establish emission reporting requirements for regulated entities, beginning in 2022, and provide state-specific

caps for the 2023–2032 period that decrease CO_2 emissions by 30% over the period. Similarly to the RGGI, allowance auctions will be held by an administrative organization that is shared by all participating jurisdictions. The intent is for the model rule to also contain details regarding a cost containment reserve, an emissions containment reserve, and a minimum allowance price. The plan is to institute three-year compliance periods, allow for unlimited banking of allowances for future compliance periods, and provide compliance alternatives for regulated entities. The MOU also calls for each jurisdiction to establish an equity advisory body (or bodies) and "to invest […] no less than 35 percent of the proceeds to ensure that overburdened and underserved communities benefit equitably from clean transportation projects and programs" (TCI 2020c, 3).

As part of the policy development process, the states worked with consultants and research partners to conduct economic and health modeling. Preliminary modeling results indicate that the initiative will modestly increase GDP, income, and jobs and that health benefits will total hundreds of millions of dollars (TCI 2020a). It is hoped that the model rule will be developed in 2021 and that states will then formally adopt the policy so that emissions reporting can begin in 2022 and the first TCI-P compliance period will begin in 2023.

HAWAII

In 2017, the Hawaii legislature established a Climate Change Mitigation and Adaptation Commission to come up with a GHG reduction plan. 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). In 2020, several carbon tax bills were introduced and one passed the Senate, but the legislature adjourned due to COVID-19 just before a House hearing on the bill. However, the House had already declined to advance several House carbon tax bills. The Senate bill calls for a gradually increasing carbon tax but does not establish levels. The tax would be paid by fossil fuel distributors. Money from the tax would go to income-based tax credits and into six special funds such as energy security and environmental response (Finnerty 2020). Other funds are for energy development, agricultural development and food security, airports, and boating (Hawaii Legislature 2020). Details on the funds were to be inserted later, but energy efficiency might fit into the energy security or energy development fund.

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. This situation repeated in 2020, with the Senate passing a bill that includes a broad carbon tax and the House passing a more limited bill. Ultimately, conference negotiations between the House and Senate resulted in passage of a bill in early 2021 that is based on planning and does not include a carbon tax. This bill was vetoed by the governor, but legislative leaders pledged to quickly repass the bill, kicking off a process for the governor to ask for specific changes (Stout and Abel 2021). If agreement cannot be obtained, the legislature could

override the governor's veto. The carbon-pricing bill passed by the Senate left the details of a carbon price to an administrative process but would have required setting fees on transportation by January 1, 2022 (which could be through TCI); on commercial, industrial, and institutional buildings by January 1, 2025; and on residential buildings by January 1, 2030 (Cronin 2020).

OREGON

Oregon has been working with California and other nearby states and provinces to align carbon-pricing efforts. The governor and state legislative leaders 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 example, 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 GHG emissions (Profita 2018).

Bills were reported out of committees in both the House and Senate, but it was a short legislative session in 2018, with not enough time to consider the bill on the House or Senate floor. In addition, 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).

In 2019 and 2020, revised bills were introduced, and hearings were held throughout the state. Many amendments were introduced to address issues raised and gain support. However, each year, Republican opponents of the bill left the capital to deprive the legislature of a quorum and prevent passage of a bill. Following the end of the 2020 session, the governor issued an executive order calling on 16 state agencies to implement policies in their jurisdiction that will reduce GHG emissions by 45% in 2035 and 80% in 2050 relative to 1990 emissions (VanderHart 2019; Goble 2020). In the fall of 2020, key legislators said that they would let this executive order set policy and were not planning to bring up cap-and-trade legislation in 2021 (Monahan 2020).

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 included funds for such a study (Faulkner 2018). Carbon tax legislation continues to be introduced but has not moved forward, pending the study.

Funding for the study was provided out of RGGI proceeds in 2019; the study is scheduled to be published in early 2021.

WASHINGTON

The state of Washington seriously considered 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) (Washington Office of the Secretary of State 2016). 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 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 AP 2018). The last version of the bill included a carbon tax of $12 (U.S.) per ton of CO_2, increasing by $1.80 per year until it reached a price of $30. 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 (U.S.) 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, 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 resilience to

climate change, and 5% to healthy community investments to prepare for climate change challenges. Included across the various funds were allocations to assist low-income residents and fossil fuel workers affected by the transition, to fund projects endorsed by the governing body of federally recognized tribes, and to benefit designated pollution and health action areas (Washington Initiative Measure No. 1631 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 a coal plant that was about to shut down. Roberts (2018b) discusses the two citizens' initiative campaigns in more detail.

In 2019, the governor and legislature switched tactics, and instead of a carbon tax they pursued a series of five regulatory bills that (1) eliminate coal-fired power by 2025 and move to 100% clean electricity by 2045, (2) expand electric vehicle incentives, (3) establish new energy efficiency standards for commercial buildings, (4) establish new efficiency standards for appliances, and (5) restrict the use of hydrofluorocarbons, which are GHGs used for refrigeration and air-conditioning (Santos 2019).

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 then elected a new governor who is opposed to a carbon tax.

In **Maryland**, a carbon tax bill was introduced in the legislature with nearly half of House members as co-sponsors. A major contributor was that the state needed more money for education, and a substantial amount of revenue from the bill was allocated to education. Two days of hearings were held, but the session ended due to COVID-19 before a vote could be held. Support in the Senate was more limited (Ashley-Williams 2020).

New York is another state where carbon tax legislation was proposed but has not moved in the legislature (Mahoney 2018). New York is also considering including a carbon price in the New York Independent System Operator (NYISO) market for electricity. To start, NYISO is developing an emissions reporting program (Kuser 2018a, 2018b). A proposal is now taking shape under which the state would establish a carbon price that would be incorporated into the wholesale price of electricity in the NYISO market. About half of the revenue would be distributed back to consumers, and the other half would be allocated for low-carbon and carbon-free resources (Dewey 2020).

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). For the 2020

legislative session, the legislature's Climate Solutions Caucus did not put a carbon tax on its list of priorities (Epp 2019).

Findings from Other Countries

While the focus of this paper is on state and provincial programs in North America, other countries provide some useful lessons. For example, an earlier American Council for an Energy-Efficient Economy (ACEEE) paper (Nadel 2016) looked at experiences with carbon taxes around the world. This earlier paper described 19 carbon taxes in place in various countries, 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 GHG emissions.

Overall, this earlier study found that these taxes have contributed to reductions in energy use and CO_2 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; 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, 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.

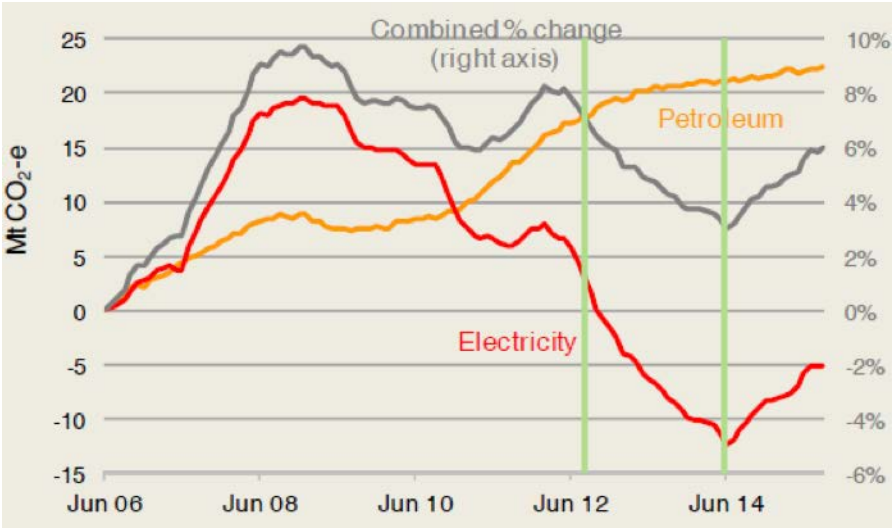

Figure 10. Change in CO_2 emissions in Australia from the electricity and petroleum sectors and both sectors together, 2006–2014. The left-hand scale is in tonnes, the right-hand scale in percentages, both relative to June 2006 emissions (pretax). The green vertical lines show when the carbon tax began and ended. *Source:* Saddler, Tinch, and Johnston 2015.

The Nadel (2016) paper concluded that while studies to date are limited, 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 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.

Finally, they note that both the World Bank and the Institute for Climate Economics (I4CE) publish annual reports on carbon pricing. For example, World Bank (2020) notes that some jurisdictions are broadening their carbon-pricing coverage to increase their carbon ambition, that carbon prices are increasing in many jurisdictions but remain substantially lower than is needed to achieve Paris Agreement targets, and that Canadian provincial efforts played a significant role in expanding the number of carbon-pricing initiatives internationally in 2019.

The I4CE report (Postic and Fetet 2020) notes that of the carbon prices in place, more than 75% of covered emissions are at a price below US$10 per tonne. They estimate that carbon pricing generated about US$48 billion in revenue, split about equally between carbon prices and carbon quotas (e.g., cap and trade). Spending is roughly split between general budgets and specific environmental or development projects.

Much more information is provided in these annual reports.

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 of 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, for example, 10% higher, then the value of energy savings from energy efficiency investments increases by 10%, all else being equal). For example, Resources for the Future projects that a $20 per tonne carbon tax would increase the average national price of gasoline 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 show realized energy use reductions of several percentage points.

Funds from a carbon price can be invested in energy efficiency; such investments can achieve large benefits. In all of the jurisdictions we profile, some of the funds collected are invested in energy efficiency, or such investments are planned to begin in the future. In a cap-and-trade program, several mechanisms are available 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 2018). 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, revenues in Quebec and California are being spent on building energy efficiency, as well as public transit and electric vehicles. The Canadian federal carbon-pricing system invests 10% of fuel charge revenues principally on energy efficiency in markets such as schools and small/medium-sized businesses. Jurisdictions that originally had all revenues used for tax credits or given away as free allowances in auctions are now starting to collect more revenue and spend some of this revenue on clean energy projects. This includes British Columbia industrial efficiency efforts and potential for further auctioning of allowances in Quebec.

Funds from a carbon price can be targeted at underserved sectors. In California, 35% of spending must benefit disadvantaged communities. TCI has a similar requirement. And as noted in the preceding paragraph, Canada is focusing energy efficiency funds at schools and small/medium businesses.

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 allocated mostly 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 specific fund that supports initiatives across a variety of ministries and organizations.

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 GHG emissions and have positive economic impacts in the jurisdictions we profile.

ACEEE tracks progress on efficiency policies and programs in all U.S. states and the top 25 energy-consuming countries, and Efficiency Canada tracks progress across the provinces. Among U.S. states, in 2020, six states participating in RGGI ranked in the top 10 nationwide, and California ranked first (Berg et al. 2020). The correlation between carbon pricing and state rank is probably due to two complementary effects: (1) carbon pricing provides additional revenues to spend on energy efficiency, and (2) states that are supportive of energy efficiency are also more likely to be concerned about climate change and willing to take action on carbon pricing. In Canada, British Columbia and Quebec (the provinces with the longest-standing carbon prices) ranked one and two, respectively, in both the 2019 and 2020 provincial scorecards. Nova Scotia ranked third in 2020, driven by strong efficiency program performance, suggesting this is a fruitful avenue for further investment of carbon-pricing proceeds (Haley, Gaede, and Correa 2019; Gaede, Haley, and Chauvin 2020). 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

Together, the states and province with carbon pricing in effect account for 37.3% of the population of the U.S. and Canada, including all of Canada and 30.1% of the U.S. population. The total for the two countries is up from 30.6% in early 2019.[17]

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, the Canadian federal system, and Boulder, Colorado, 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.

[17] ACEEE calculations based on official 2019 population estimates in the two countries.

OBSERVATIONS

From the information in the preceding discussion and the tables in Appendix A, several patterns emerge, which 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 GHG emissions without a serious impact on the provincial economy. Energy Efficiency Alberta, once supported by the provincial carbon levy, also contributed to energy savings and GHG reductions in Alberta. Washington was also planning to use substantial revenues for energy efficiency efforts.

Likewise, cap and trade has been in place in the northeastern 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, yet Canada's new climate plan includes a significant increase in the price after a system with modest increases was established. 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) and in the December 2020 auction were toward the high end of this range (RGGI 2020b). For California and Quebec, allowance prices were about $17–18 (U.S.) per tonne in 2020, significantly above the price floor of about US$10 per tonne. For the carbon taxes, current fees range from about CAN$25 to CAN$40 (about US$19–26), but the Canadian taxes are scheduled to increase to CAN$50/US$38 by 2022 and to CAN$170/US$129 by 2030.

All of the programs that apply to industry or agriculture have been sensitive to 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, or (as under the Canadian federal industrial benchmark system) given additional compliance options. 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.

Carbon-pricing programs have been adopted under various political parties in both countries. In Canada, early initiatives to put a price on carbon were advanced by both conservative and liberal parties, although in the wake of the federal Liberal Party national system, political support for carbon prices has fractured somewhat, with several Conservative Party–governed provinces opposing the federal system in court. In the United

States, Democrats often lead, but moderate Republican governors gave critical support in California and New York (the largest state in RGGI).[18]

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. And in some states, state laws prohibit local carbon or energy taxes.

Many of the jurisdictions have established or are establishing some type of green fund to spend revenues on measures and programs that will reduce GHG 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, California, Nova Scotia). 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 (e.g., 90% of Canadian federal carbon tax proceeds are returned to households). 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 a middle ground between these extremes would be more appealing to voters.

Canada's new plan to raise the carbon price to $170 per tonne by 2030 aims to ensure that the majority of households receive more income as a result of the policy through household rebates, which will be provided on a quarterly basis (instead of annually) under the new climate plan. The distributional implications of a higher carbon price will also be determined by access to carbon-reducing services, such as public transit and building energy efficiency programs, especially in rural and low-income communities. Canada does not have a federal low-income efficiency program like the U.S. Weatherization Assistance Program. A dedicated policy aimed at reducing energy poverty and improving low-income access to the comfort and health benefits of energy efficiency could be particularly important to ensure carbon pricing is politically acceptable and gives everyone the opportunity to reduce their emissions.

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 multiple appraisals of measures are taken in the RGGI states. For other programs that

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

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, their GHG 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 GHG reduction programs and policies. And as new carbon-pricing programs build a track record, they should be evaluated as well. Furthermore, in British Columbia, the most recent evaluations are a few years old and use data only up to 2016. 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.

Canada presents an example of how carbon pricing can integrate provincial and federal efforts—initial provincial leadership followed by the federal government creating a minimum standard but maintaining provincial flexibility to design their own systems for pricing and use of revenues. However, specific provincial cases also demonstrate how volatile carbon-pricing politics can affect energy efficiency program efforts. Alberta's energy efficiency programs were almost completely funded by a provincial carbon tax. When that policy changed with the election of a new government, the province's energy efficiency programs were canceled and the Energy Efficiency Alberta agency was closed down. It is a similar story with the end of Ontario's cap-and-trade system, which was to deliver funds for a new "Green Ontario Fund" that was quickly scrapped with the election of a new government. However, Ontario energy efficiency programs are still administered by natural gas utilities and the electricity system operator. While Quebec uses cap-and-trade proceeds to support building and industrial energy efficiency and electrification efforts, it also has a long history of electricity and natural gas utility energy efficiency program offerings and a long-standing fuel charge to fund government programs. Similarly, Nova Scotia has a history of demand-side management and energy efficiency dating back to 2008, and the new carbon-pricing revenues will augment this existing policy structure. Thus, provinces with multiple funding sources may not be as vulnerable to political changes that affect how carbon-pricing revenues are spent, and provinces with significant carbon-pricing revenues can build new programs on top of existing utility and government efficiency efforts.

Another interesting question concerns how the availability of carbon-pricing revenues can augment and complement utility programs that have thus far provided the bulk of efficiency program spending in North America. Carbon-pricing revenues have the potential to act as zero sum from an efficiency programs perspective if political decision makers use the revenues to offset funding for cost-effective energy efficiency typically provided by ratepayers. This was briefly considered in the 2016 Ontario climate change action plan and was critiqued by the province's environmental commissioner (Ontario 2016; Saxe 2016). While considering the interaction between utility and carbon-pricing revenue streams, Haley et al. 2020 listed political autonomy, evidence-based budgets and targets, and performance-based accountability as strengths that are often found in well-functioning utility programs that should be emulated in the governance of carbon-pricing revenues. They also note that the availability of carbon-pricing revenues also provides the opportunity to fill gaps that can occur in utility programs, including integration across fuels and promotion of beneficial electrification, stronger support for market transformation, and innovative financing initiatives. This has been the case in the RGGI states, where cap-and-

trade revenues are often used to complement utility programs, such as helping to pay for efficiency improvements in buildings with oil heat.

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 U.S. 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., GHG 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 GHG 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 establish new programs, as we see in Quebec, British Columbia, and throughout the Canadian federal carbon-pricing system. 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 special report of the United Nations International Panel on Climate Change (IPCC 2018), climate change will have a dramatic impact on the global environment and global economies, particularly if governments do not take rapid action to reduce emissions. 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 GHG emissions.

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

Table A1. Key attributes of pre-2019 state and provincial carbon tax and fee programs

Element	British Columbia	Alberta (repealed in 2019)	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 GHGs when burned; separate program for large (>100,000 MT per year) industrial emitters	Electricity	Sale and use of fossil fuels within the state; for electricity, based on emissions to generate the electricity
2020 Fee per MT CO_2	CAN$40	CAN$30	~$0.0003–0.0049 per kWh, varying by sector	US$12 starting in 2019
Escalation	Started at $10 and gradually increased; will rise $5 per year until reaching $50	Started at $15, then increased to $20 in 2017 and $30 in 2018; future increases were to be based on Canadian federal requirement	None planned	Increases $1.80 per year until reaching $30
What is exempted?	Fuel purchased on First Nations land by First Nations 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 Nations 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 (repealed in 2019)	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. The portion of the carbon tax above $30 per tonne paid by industry goes to support emissions-reduction projects in the industrial sector, including energy efficiency improvements.	Over three years, CAN$662 million allocated to EE, $1.3 billion allocated to public transit; EE Alberta was a government agency that ran 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 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 one-seat majority. As of 2019, this majority increases by several seats.

Sources: British Columbia 2020a; Alberta 2018a, 2018b, 2018c; Boulder 2020; Bhatt and Ryan 2017; Washington Legislature 2018; www.carbontax.org.

Table A2. Key attributes of 2019 and 2020 provincial carbon tax and fee programs

Element	Newfoundland and Labrador	Prince Edward Island	Northwest Territories	New Brunswick	Canadian Federal (covers other provinces and territories)
When it began	2019	2019	2019	2020	2019
What is covered?	Transport and heating fuels	Transport and heating fuels	Transport and heating fuels	Transport and heating fuels	Transport and heating fuels
2020 Fee per MT CO_2	CAN$30	CAN$30	CAN$30	CAN$30	CAN$30
Escalation	Started at $20 and increasing $10 per year until $50 in 2022	Started at $20 and increasing $10 per year until $50 in 2022	Started at $20 and increasing $10 per year until $50 in 2022	Started at $20 and increasing $10 per year until $50 in 2022	Started at $20 and increasing $10 per year until $50 in 2022
What is exempted?	Diesel/heating oil used for home heating, off-grid diesel generation, aviation fuel, First Nations on reserves, interprovincial marine, municipalities, fuels used for offshore petroleum exploration	Marked fuels for farmers, fishers, aquaculturists; First Nations on reserves; home heating oil, propane (2019 and 2020)	Aviation fuels for internal flights, diesel and natural gas for electric generation, fishing	Diesel/heating oil for home heating, First Nations on reserves, farming and fishing	Commercial fishing and agriculture; First Nations on reserves; in the territories, aviation fuels (for domestic flights), diesel/natural gas for electricity generation in remote communities, and gasoline/diesel used for fishing

Element	Newfoundland and Labrador	Prince Edward Island	Northwest Territories	New Brunswick	Canadian Federal (covers other provinces and territories)
What are funds used for?	Offset excise tax reductions	Offset excise tax reductions, support for drivers and public transit users	25% to actions to reduce GHGs, rebate the rest to households; 75% of industry payments rebated to industry, the rest held in individualized trust accounts to support facility GHG reduction	~11% to offset natural gas price increases, 43% to a climate fund, remainder to offset reduced excise taxes	90% of proceeds returned to households via tax rebate (CAIF); remainder used for federal support of energy efficiency projects in SME, MUSH, and rebates to SMEs/nonprofits
Role of energy efficiency	To be determined	None	The government directs ~25% of revenues to support emissions-reduction projects in line with its climate change and energy plans, which includes energy efficiency.	To be determined	10% of proceeds supports energy efficiency projects for SMEs and MUSH sector in province from which revenues were received.
Other notes	Lowered gasoline excise tax to reduce impact of carbon tax; increase to $30 per MT delayed to November 2020 because of COVID-19 and a severe snowstorm in early 2020	Lowered existing fuel taxes to reduce impact of carbon tax		The province lowered fuel excise taxes in proportion to carbon tax increases, rebates 100% of revenue from natural gas home heating to the utility to keep consumer price static.	

Sources: Newfoundland and Labrador 2018; Prince Edward Island Department of Finance 2018; Northwest Territories Department of Finance 2019; New Brunswick Finance and Treasury Board 2020; Canada Revenue Agency 2020

Table A3. 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 per 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 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

Element	RGGI	California	Quebec	Nova Scotia
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	An offset system yet to be developed, as of January 2021 Legislation includes ability to create an offset system; a study of offset potential concluded in 2020.
Temporal flexibility	Unlimited banking, but factors into states' future budgets; compliance evaluated on a three-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 $10 per 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 per ton in 2012, rising 5% per year plus inflation; reserve allowances provide a soft price ceiling	Similar to California; in addition, issued some early reduction credits in 2013	Price auction bid price of CAN$20 per tonne in 2020, with annual increase of 5% + inflation Reserve allowances available for purchase, helping to establish a soft price ceiling; 3% of emission allowances reserved in 2020
Compliance and oversight	Covers fossil fuel generators ≥ 25 MW (currently 168 facilities)	Cap and trade 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, NJ, MD, DE; VA and PA joining	California and Quebec are linked. At one point, so was Ontario.		Not linked with other systems

Element	RGGI	California	Quebec	Nova Scotia
Implementation, evaluation, and revisions	Auction administered by RGGI, Inc. and independent market monitoring by Potomac Economics; program reviews in 2012 and 2017	Implemented by 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; government periodically reports results to the legislature	Implemented by Nova Scotia Environment, a department of the provincial government
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 5% of revenues invested in low-income weatherization and agricultural efficiency; just over 50% of revenues 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	Allowance auction proceeds placed in Green Fund to be used for measures to reduce GHG emission, mitigate social and economic impacts, and adapt to climate change Distribution of funds across priorities not available at time of writing
Other notes		2017 changes include substantial attention to environmental justice issues.	2030 targets added in 2015	

Sources: EDF 2015, 2018; Hibbard et al. 2018; RGGI 2017; Québec 2018b; ICAP 2021; Oregon Legislative Policy and Research Office 2017; Nova Scotia 2019.