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A Tale of Two Climate Policies: Political Economy of British Columbia's Carbon Tax and Clean Electricity Standard

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En 2007-2008, la Colombie-Britannique a adopté deux importantes politiques liées aux changements climatiques qui ont constitué des premières en Amérique du Nord : une taxe sur le carbone applicable à presque toute l'utilisation de combustibles fossiles et un standard de production d'électricité presque 100 % « propre ». Dans cet article, nous décrivons ces politiques et nous les analysons à l'aide des critères suivants : réduction des émissions de GES, efficacité économique, faisabilité administrative et adhésion des citoyens. Nos résultats montrent que, d'ici à 2020, le standard de production d'électricité propre devrait permettre de réduire les émissions annuelles de GES de quatre à six fois plus que la taxe sur le carbone, mais que le coût moyen d'une tonne d'émissions de CO₂ ainsi éliminées est beaucoup plus élevé que la taxe sur le carbone à son niveau actuel. Par ailleurs, il est intéressant de souligner que le standard de production d'électricité propre recueille une adhésion plus élevée et plus constante dans la population, ce qui pourrait être dû au fait que cette mesure est beaucoup moins « visible » que la taxe sur le carbone.

Mots clés : taxe sur le carbone, standard de production d'électricité propre, réduction des émissions de GES, efficacité économique, adhésion à des politiques, importance de l'effet d'une taxe

In 2007–08, British Columbia implemented two significant climate policies: the first broadly based carbon tax and the first almost 100-percent “clean” electricity standard in North America. We describe the key design characteristics of these policies and analyse them against the criteria of greenhouse gas (GHG) emissions reductions, economic efficiency, administrative feasibility, and public acceptance. We find that the clean electricity standard is estimated to reduce four to six times more emissions per year by 2020 than the carbon tax, but at an average cost per tonne of CO₂ reduced that is significantly higher than the carbon tax at its current level. Interestingly, the clean electricity standard achieves higher and steadier levels of public acceptance, which might be attributed to its lack of visibility, relative to the carbon tax.

Keywords: carbon tax, clean electricity standard, GHG emissions reductions, economic efficiency, policy acceptance, tax salience

INTRODUCTION

Many governments have established stringent targets to reduce greenhouse gas (GHG) emissions. However, effective climate policy-making has been extremely difficult for a number of reasons.

First, climate policies provide a form of global public good whose benefits are unconstrained by national boundaries but whose costs are concentrated in the countries or regions cutting the carbon dioxide (CO₂) emissions. Unless every country participates, a country that reduces emissions more than others will likely face greater costs than benefits, thus deterring its willingness to act unilaterally (Sandler 1996). To ensure collective and cooperative actions, effective global compliance and enforcement mechanisms are needed.

Second, climate policies cause costs in the present for benefits in the future, and while the costs of climate policies are visible, people find it difficult to visualize the future benefits of lower GHG concentrations and temperatures for certain countries and regions. Moreover, although the likelihood of significant negative outcomes beyond certain temperature thresholds is virtually certain, the complexity of the earth-atmosphere system causes multiple uncertainties about “specific” impacts of climate change mitigation on certain countries and regions (IPCC 2007).

Third, emerging research from psychology and behavioural economics suggests that many people exhibit significant distortions in how they interpret independent evidence from natural and social sciences, including climate science and climate-policy information, and that these distortions are driven by perceived self-interests (Caplan 2007; Thaler and Sunstein 2008). This can quickly lead to a significant gap between what policy analysts propose as optimal policy and the policy design with the greatest chance of garnering sufficient political support. In some cases, however, the most politically acceptable policy may be ineffective in achieving

its stated objective of reducing emissions. For these reasons, climate policies in most countries over the past three decades have been largely ineffective, especially due to their voluntary nature and/or inability to incorporate human biases and preferences with infrastructure- and technology-purchasing decisions (Jaccard 2012a).

However, there have been some modest successes. In the 1990s, a number of northern European countries implemented carbon taxes and supporting policies that caused some shift from fossil fuels to renewable energy. For example, between 1990 and 2006, Sweden’s carbon tax and other climate policies appear to have played a significant role in decreasing its emissions by 9 percent, while its GDP increased by 44 percent (Ministry of the Environment, Sweden 2008).

In Canada, the province of British Columbia undertook an aggressive climate-policy effort in 2007–08, with a target of reducing GHG emissions 33 percent by 2020, and 80 percent by 2050 (Government of British Columbia 2008). To this end, government introduced a carbon tax, a clean electricity regulation, a low-carbon fuel standard, and several other policies. Although it may be difficult to predict the ultimate impact of some of these, the carbon tax and the electricity standard are “firsts” in North America in terms of their coverage and ambition, the latter being the first almost 100-percent “clean” electricity standard in North America.

These two types of policies are widely recognized in climate policy literature as having features that can be highly effective, depending on the design details and degree of stringency selected by government. An economy-wide carbon tax, if rising to a sufficient level, is favoured by most economists because it should reduce emissions at the lowest possible total cost. Moreover, if carbon tax revenues are used to reduce other taxes that impede economic output, the policy may stimulate economic growth that offsets some or all of its negative impacts. But, because of its high visibility and a bias among

many members of the public against any policy that “appears” to increase taxes, it is seen as a difficult policy to implement (Harrison 2012).

A clean electricity standard (CES) requires that a certain percentage (or all) of new electricity is generated from zero-emission sources, such as hydro, solar, or wind. It is less favoured by economists if it is not matched by policies in other sectors that impose similar marginal costs on emissions. However, as a regulation, the policy can be highly effective for GHG reduction. And, by not favouring any specific technologies or energy forms (other than zero-emission), the policy allows electricity producers to achieve the zero-emission requirement as cheaply as possible. In comparison to the carbon tax, the clean electricity standard may have better political prospects to the extent that it is less likely to be perceived in a negative light by significant members of the public. Several Canadian provinces and 30 US states now have some form of CES (usually called a “renewable portfolio standard” and focused on renewables instead of zero-emission technologies and fuels), which suggests a higher level of political acceptance. In contrast, in the last four years since British Columbia’s carbon tax implementation, not a single provincial or state government in Canada or the United States has implemented, or is planning to implement a “serious” carbon tax.

Both of these policies were implemented in the 2007–08 period of intensive climate policy development in British Columbia, and both continue to stand out as the most aggressive climate policies in North America. In the intervening years, interest in climate policy has diminished; yet the climate threat only grows with time, creating a high likelihood that climate policy activity will intensify again at some point.

Since both policies have been in place for several years and provide interesting contrasts, they create an opportunity to compare their performances thus far across a spectrum of policy evaluation criteria, and to see what lessons might be drawn for future

climate policy initiatives. Our goals in this paper are to:

1. Describe the key design characteristics of British Columbia’s carbon tax and clean electricity standard; and
2. Analyze these two policies using multi-attribute policy evaluation criteria.

DESCRIPTION OF THE CARBON TAX AND THE CLEAN ELECTRICITY STANDARD

Carbon Tax

The BC carbon tax applies to 75 percent of British Columbia’s total GHG emissions, notably from fossil fuel use. The only exemptions are fuels used by planes and ships travelling to or from the province; fuels exported from British Columbia; and all non-fossil fuel GHG emissions, including emissions from industrial processes, landfills, and forestry and agricultural activities. Overall, 14 percent of British Columbia’s emissions are industrial-process emissions not covered by the carbon tax (Horne, Petropavlova, and Partington 2012).

The BC carbon tax was introduced at ten dollars per tonne of CO₂ and has been rising annually at a scheduled rate of five dollars per tonne to reach 30 dollars in 2012. It will not increase further unless specified by new legislation or regulation. At ten dollars, the carbon tax raises the price of gasoline by 2.34 cents per litre (c/L) and at 30 dollars, by 6.67 c/L. The tax collection mechanism uses the existing provisions of the Motor Fuel Tax Act applied to fuels in the province. Specifically, final-fuel consumers pay the tax to retailers, retailers pay the tax to wholesalers, and wholesalers pay the tax to the BC government.

The government designed the tax to be revenue-neutral, which implies that all carbon tax revenues are recycled through personal and corporate income tax reductions and low-income tax credits. However,

several revenue-investment streams, such as the northern and rural homeowner benefit, property tax cuts for schools, and payments to municipal governments for their efforts to reduce emissions, were introduced after implementation of the carbon tax to address complaints from these constituencies.

In the period July 2008–12, the carbon tax generated \$2,548 million, and the government estimates that its income tax cuts and tax credits generated returns of \$3,048 million to British Columbian individuals and corporations (BC Ministry of Finance 2010, 2011, 2012, 2013). In hindsight, to make the carbon tax precisely revenue-neutral, the income tax reductions and tax credits should have been smaller. The annual balance of carbon tax revenue and lost revenue from tax cuts and tax credits in future is uncertain, since it depends on the evolution of fuel consumption, among other things.

In the 2013 election, the main opposition party, the New Democratic Party (NDP), promised to extend the carbon tax to some industry emissions that are still untaxed, while the incumbent governing party, the Liberals, promised to freeze the carbon tax at its current level of \$30 to the year 2018. The Liberals won the election.

Clean Electricity Standard

British Columbia derives over 90 percent of its electricity from “clean” resources, specifically hydropower. The 2010 Clean Energy Act defines “clean or renewable resources” as “biomass, biogas, geothermal heat, hydro, solar, ocean, wind or any other prescribed resources” (Government of British Columbia 2010). This definition replaces the previous definition from the BC clean electricity guidelines that included cogeneration of heat and power, energy from landfill gas, and energy efficiency improvements as “clean” electricity sources (BC Ministry of Energy and Mines 2004, 2012).

Under the policy, independent power producers (IPPs) are exclusively responsible for new

electricity supply in British Columbia, except for large hydropower, which can only be developed by the publicly owned electric utility, BC Hydro. To ensure that the established clean energy objectives and British Columbia’s electricity needs are met, the Clean Energy Act requires BC Hydro to submit 20-year integrated resource plans to the BC government. In the draft of the 2012 Integrated Resource Plan, BC Hydro proposed to meet the clean electricity objective “on average” (BC Hydro 2012, 6-7). BC Hydro manages a competitive bidding process, resulting in long-term supply agreements with IPPs. In 2003, the government required IPPs to generate at least 50 percent of new electricity supply from clean sources. This clean electricity initiative was increased to 90 percent in the 2007 B.C. Energy Plan (BC Ministry of Energy, Mines and Petroleum Resources 2007), and to 93 percent in the 2010 Clean Energy Act. As noted, the BC clean electricity policy is similar to the renewable portfolio standards existing in many US states and several other countries—except for its broader prescription of zero-emission instead of renewable supply.

ANALYSIS OF THE POLICIES

To assess and compare these two climate policies, we applied criteria that include estimated GHG emission reductions, economic efficiency, administrative feasibility, and public acceptance. We first estimate the annual emission reductions of each policy compared to a business-as-usual scenario by 2020. We use 2008 as a reference year (when British Columbia’s Climate Action Plan was implemented) and ignore government policies or decisions made between 2008 and 2012. (We chose 2020 because it is the target year by which the province had aimed to reduce its GHG emissions 33 percent below 2007 levels.) For economic efficiency, we estimate the average cost per tonne of CO₂ reduced due to each policy in 2020.¹ For administrative feasibility, we assess the administrative complexity and costs associated with implementation and operation of each

policy. We use our personal judgment to rate the policies on a qualitative scale, which ranges from “high” (administrative feasibility or low level of complexity) to “medium” and “low.” Finally, the criterion of “public acceptance” relates to the extent to which a policy does not provoke public resistance and appears to enhance the chances of policy endurance. Based on the available surveys, we measure this criterion on a qualitative scale from a “high” level of acceptance to “medium” and “low” levels.

Carbon Tax

Using a hybrid energy-economy model, independent researchers for the BC government estimated that without any additional policies, the carbon tax could reduce British Columbia’s annual emissions in 2020 by three megatonnes (Mt) of CO₂ (Government of British Columbia 2008). In one hindsight estimate, Elgie (2012) noted that British Columbia’s overall per capita fuel use (subject to the carbon tax) fell 16.4 percent more than the rate at which fuel use fell on average in the rest of Canada, between 2008 and 2011. Rivers and Schaufele (2012) estimated that over the first four years, the carbon tax reduced British Columbia’s emissions by 3.04 Mt. They argued that this suggests a high sensitivity of fuel demand to the level of the tax, and they attributed this to its high “salience.” Tax salience implies that consumers are more responsive to tax-induced than to market-driven price changes because of the high visibility of taxes (Chetty, Looney, and Kroft 2009; Finkelstein 2009). According to Rivers and Schaufele (2012), British Columbia’s carbon tax has been four and one-half times more salient than an equivalent change in gasoline prices.

While high policy salience may ensure a significant impact on emissions, it may also imply significant negative political consequences. Evidence shows that those constituencies that are particularly sensitive to a highly visible policy that increases the cost of fuels (e.g., northern and rural communities, greenhouse growers) may influence political decisions and can achieve tax exemptions

or credits that ultimately undermine the primary policy goals. Hence, high salience may entail considerable trade-offs between significant emissions reductions and political acceptance.

In terms of economic efficiency, British Columbia’s carbon tax could be considered highly efficient for a number of reasons. First, the low initial tax rate and the five-year phase-in provided individuals and businesses with certainty about economic costs, and time to alter their fuel consumption and to plan investments. Second, the carbon tax imposes the same price for every unit of GHG emissions on almost all individuals and businesses, minimizing the total cost of emissions abatement to society. According to economists’ “equi-marginal principle,” each individual or business has an incentive to reduce emissions up to the point where any additional reductions are more expensive than paying the tax. Finally, to the extent that the revenue-recycling mechanism decreases growth-hindering taxes elsewhere in the economy, it provides a macro-economic benefit additional to its emissions-reducing effect.

For estimating the cost of reducing GHG emissions with a carbon tax, the tax revenues must be ignored. These are simply a transfer payment to government which, in this case, is immediately returned via tax cuts. Economists estimate abatement cost curves by simulating the abatement that occurs over several years due to a fixed carbon tax level. This exercise is complicated by the fact that British Columbia’s carbon tax was not fixed for its first five years. The cost of GHG emissions abatement at low carbon prices is controversial. Recent reports by the McKinsey consulting company for the United States estimated a negative average cost for carbon abatement for carbon rates up to 50 dollars per tonne of CO₂ (McKinsey & Company 2009). In other words, carbon tax rates between zero and 50 dollars would stimulate profitable investments (mostly in energy efficiency) that would offset abatement investments and actions that have a positive cost. However, many economists argue that

such results are only possible if researchers ignore hidden costs and risks of energy efficiency and other abatement investments. [Murphy and Jaccard \(2011\)](#) show how the integration of these factors into the McKinsey analysis leads to positive costs of GHG abatement. But, at low carbon tax levels, such as zero to 30 dollars per tonne, these average costs are small.

An additional complication occurs if one considers the macro-economic effect of using the carbon tax revenues to reduce corporate and personal income taxes, as in British Columbia. Goulder and Parry (1995) explained this double-dividend effect from recycled tax revenue and, more recently, [Peters and Melton \(2013\)](#) estimated its effect for the BC carbon tax. They concluded that, from a macro-economic perspective, the BC carbon tax at its current levels has had a net positive effect on the economy. In other words, to the year 2020, the macro-economic benefits of carbon tax recycling have exceeded the micro-economic abatement costs triggered by the tax.

To represent the diversity of cost (and benefit) estimates for the carbon tax, we provide a range for the average per tonne abated cost of the BC carbon tax. At the low end, we put the average cost at zero. At the high end, we follow cost curves produced by [Murphy and Jaccard \(2011\)](#) and other researchers using similar models (like the NEMS model of the US government) to estimate an average cost of five dollars per tonne, assuming that the carbon tax would stay constant at 30 dollars from 2012 to 2020, as initially modelled by the BC government and independent researchers at Simon Fraser University ([Government of British Columbia 2008](#); [Peters 2013](#)).

The carbon tax scores high on administrative feasibility because it only requires changing the tax rates of an existing tax. Thus, administrative costs to the government, companies, and final consumers are minimal.

Governments have recognized the need for climate policies for over two decades, and economists have convinced most climate policy advisors that a carbon tax in a market economy is the most economically efficient and effective policy. Yet there are still few jurisdictions in the world that seriously apply carbon taxes. [Kallbekken and Sælen \(2011\)](#) note that this is not surprising, given the salience of the tax in attracting opposition from key interest groups. This explanation is consistent with earlier arguments of [Olson \(1971\)](#), who noted how public policies are influenced especially by groups who face concentrated costs or who stand to gain concentrated benefits. Because the tax represents different combinations of losses (carbon tax) and gains (income tax cuts) to different people, it is perhaps important to also consider the tendency of people to value losses higher than otherwise equivalent gains, as noted by [Kahneman, Knetsch, and Thaler \(1991\)](#). This suggests that the carbon tax would be seen more negatively than it should be, considering that it is revenue-neutral.

When the carbon tax was first announced in February 2008, political support for the governing BC Liberal party was at 50 percent, and for the opposition NDP, at 30. The growing opposition to the carbon tax from multiple interest groups, as well as rapidly rising oil and gasoline prices, motivated the provincial NDP to launch an “axe the tax” campaign. The NDP claimed that the carbon tax put an additional burden on ordinary British Columbians; however, they kept quiet about the tax’s revenue-recycling mechanisms. By November 2008, political support for the Liberals had decreased to 43 percent while NDP support had risen to the same level as the Liberals. In other words, the attack on the carbon tax appears to have played a significant role in the elimination, in eight months, of a 20-point lead in the polls ([Harrison 2010, 2012](#); [Jaccard 2012b](#)).

Luckily for the government party, the global economic crisis shifted public concerns from environmental issues to the economy, an area where it polled

higher than the NDP (Harrison 2012), while international oil prices (and thus gasoline prices) started to fall. Consequently, the Liberals regained a small lead, in time to just barely win the May 2009 election and preserve the carbon tax for the time being.

Several public opinion polls by Environics have tracked public support for British Columbia's carbon tax over time. In November 2011, 57 percent of British Columbians supported the carbon tax, whereas in February 2008, the level of support had been at 54 percent and by July 2008, when the economy was the dominant public concern and the NDP was campaigning against the tax, the level of support had fallen to 40 percent.

While the BC carbon tax still retains public support in British Columbia, Borick, Lachapelle, and Rabe (2011) and Environics (2011) find that the majority of Canadians (74 percent), including British Columbians, prefer regulatory approaches over carbon taxes for climate policy. This preference could be attributed to a variety of factors suggested by the behavioural economics literature, including the high salience of taxes and an anti-tax bias (Caplan 2007).

The political challenges associated with British Columbia's carbon tax survival in 2008–09 might be one of the reasons why no other North American jurisdiction has implemented a true carbon tax (Harrison 2012). When first applied in Scandinavia, carbon taxes (for the most part) did not involve increases in energy prices for final consumers—carbon taxes either replaced existing energy security-motivated fuel taxes, or included multiple exemptions and differences in rates across sectors (Bruvoll and Larsen 2004; Sumner, Bird, and Smith 2009). And while gradual increases in carbon taxes have occurred in Sweden, Norway, Denmark, and a few other European countries, the global tendency has been to avoid the policy. Based on this evidence and experiences, both in British Columbia and elsewhere, we rank the carbon tax as “medium-low” in terms of public and political acceptance.²

Clean Electricity Standard

To estimate GHG emissions reductions due to the clean electricity standard (CES), we assessed the amount of emissions that would have been released from the cheapest alternatives to renewables if the policy had not been implemented.³ According to the 2007 BC Energy Plan, resources for electricity generation should be developed on a lowest-cost basis for final consumers. To meet this requirement and to ensure dispatchable electricity generation, GHG-emitting natural gas and coal plants are British Columbia's lowest cost options. For reasons of political acceptability, BC Hydro has not been able to develop more of the province's potential large-scale hydropower—for 25 years the government has refused to permit the Site C Dam on the Peace River, in spite of several major attempts to move ahead. For these reasons, during the last decade, BC Hydro had planned to build large natural gas plants on Vancouver Island and had contracted with private developers planning coal plants. Additional similar projects would have been likely in the absence of the clean electricity policy.

In its Integrated Electricity Plan (2000), BC Hydro's proposed combined cycle gas turbine (CCGT) plants of up to 660 megawatts (MW) on Vancouver Island would be supplied by a proposed new natural gas pipeline, the Georgia Strait Crossing. The CCGT plant at Duke Point, called the “Vancouver Island Generation Project,” would have had a capacity of 265 MW and would have generated 0.75 Mt CO₂ per year based on an estimated electricity production of 2,100 gigawatt hours (GWh) per year and a GHG intensity of 356 tonnes per GWh (Vancouver Island Energy Corporation 2003). If the Georgia Strait Crossing pipeline had been built and used to its full capacity, it could have powered two additional plants of a similar size that would have produced 1.87 Mt of CO₂ per year.

To meet the least-cost supply requirement from the 2002 BC Energy Plan, in July 2006, BC Hydro awarded contracts to two coal-fired power plant

proposals. AES Wapiti Energy Corporation proposed to build a 184 MW coal plant near Tumbler Ridge that would have produced 1,612 GWh of electricity per year; and Compliance Power Corporation proposed to develop a 56 MW wood residue and coal power generation plant near Princeton that would have produced 421 GWh of electricity per year. Together, the coal plants would have emitted up to 1.8 Mt CO₂ per year depending on the fuel mix (BC Sustainable Energy Association et al. 2006; BCTC 2007; Compliance Energy Corporation 2006).

Clearly, the impact of the clean electricity policy was dramatic. BC Hydro was forced to abandon its plans to contract for electricity from natural gas and coal, and instead issued requests for proposals from zero-emission IPPs developing small-scale hydropower and some other renewables projects, like wood waste and wind. Table 1 summarizes annual CO₂ emissions prevented in British Columbia by halting the natural gas project on Vancouver Island and the two coal plants at Tumbler Ridge and Princeton. British Columbia's clean electricity

policy helped to prevent up to 3.67 Mt CO₂ per year. This estimate is based on the assumption that the proposed natural gas plant(s) on Vancouver Island would have been built to match the full capacity of the Georgia Strait Crossing pipeline (660 MW).

According to BC Hydro's 2008 Long-Term Acquisition Plan, domestic demand for electricity is projected to reach about 70,000 GWh per year by 2020. Knowing electricity output and GHG emissions from the proposed natural gas and coal plants, we calculated the annual amount of GHG emissions in 2020 if we were to meet the additional electricity demand of 22,000 GWh per year solely by natural gas and coal generation (BC Hydro 2008). Our calculations are based on the reference case "high" and "low" natural gas price forecasts⁴ outlined in the BC Climate Action Plan (2008).⁵ Under the high gas price scenario, the price for natural gas in BC reaches \$12.10 per gigajoule (GJ) in 2020, and so more electricity generation comes from coal. Under the low gas price scenario, the natural gas price is \$4.70/GJ lower than in the high price case. Thus,

TABLE 1
CO₂ Emissions Prevented in British Columbia by Halting a Natural Gas Project and Two Coal Plants^a

#	Plant Name	Annual Output of Electricity (GWh/year)	Mt CO ₂ Prevented per Year
1	265 MW Vancouver Island Generation Project (VIGP) in Duke Point	2,100	0.75
	If the Georgia Strait Crossing pipeline was used to its full capacity of 660 MW	5,230	1.87
2	184 MW AES Wapiti Energy Corporation's coal plant in Tumbler Ridge	1,612	1.8
3	56 MW Compliance Power Corporation's coal/biomass plant in Princeton	421	
TOTAL		7,263	3.67

Notes: ^a Annual electricity and emissions output is based on the capacity factor assumptions from BC Hydro's report, *F2006 Open Call for Power* (2006), and Vancouver Island Energy Corporation's application (2003) for the Vancouver Island Generation Project (VIGP). MW=megawatt(s). GWh=gigawatt hour(s). Mt=megatonne(s).

Sources: Authors' calculations based on BC Sustainable Energy Association et al. (2006); BCTC (2007); Compliance Energy Corporation (2006); Vancouver Island Energy Corporation (2003).

in this scenario, more than 75 percent of electricity generation comes from natural gas and only 25 percent from coal, while this ratio is reversed under the high gas price scenario. Based on these assumptions, 10.8 Mt CO₂ per year would have been emitted by 2020 under the low gas price scenario, and 16.6 Mt under the high.

To estimate the cost of the clean electricity standard, we focus on the additional cost that the policy caused by prohibiting lower-cost coal and natural gas electricity generation. We thus compare the cost of providing all incremental electricity in British Columbia with coal and gas under the business-as-usual scenario versus the cost of providing the same amount of electricity with just renewables under the CES (Table 2). Since our perspective is looking forward from 2008, we replicate the price forecasts used at the time and use the same scenarios that BC Hydro and the BC government were using in terms of fuel prices and electricity demand. However, we incorporate additional information on: 1) the cost range for energy storage for non-dispatchable renewable supplies like micro-hydro and wind, and 2) uncertainty about the mix of natural gas and coal in power generation. The reductions in emissions due to the electricity policy are divided by the extra generation costs of renewables to calculate the average cost per tonne of CO₂ abated.

The cost of new electricity acquired under the CES includes BC Hydro's long-run marginal cost of acquiring firm energy from renewable resources, 11.8 cents per kilowatt hour (c/kWh), and the fixed cost of energy storage ranging from two c/kWh ("low cost storage" scenario) to five c/kWh ("high cost storage" scenario). We added the cost of storage to the long-run marginal cost because the small-scale renewables being developed thus far in the province are intermittent sources that require either dispatchable back-up capacity or storage. Two to five c/kWh is the most common range for the full cost of building brand new pumped hydro storage or back-up electricity storage identified in multiple sources (Poonpun and Jewell 2008). Thus,

the estimated cost of new electricity acquired from renewables is 13.8 c/kWh under the low cost storage scenario and 16.8 c/kWh under the high. The annual average cost of meeting additional electricity demand of 22,000 GWh by 2020 is therefore between \$3,036 and \$3,696 million.⁶

To estimate the cost of new electricity generation under the business-as-usual scenario, we calculated the cost of electricity acquired from state-of-the-art combined cycle natural gas and coal plants. The estimated cost of new electricity is 6.5 c/kWh under the low gas price, and 7 c/kWh under the high. The annual average cost of meeting additional demand of 22,000 GWh by 2020 is \$1,436 million under the low gas price scenario, and \$1,542 million under the high.

We determined the cost of the clean electricity policy (Cost of CES in Table 2) as the difference between the cost of new electricity acquired under the CES and the cost of new electricity acquired under the business-as-usual scenario. Under the low cost storage/low gas price scenario, it is estimated to be 7.3 c/kWh (13.8 – 6.5 = 7.3 c/kWh in the first row under the Cost of CES) or \$1,600 million per year (mil/year) in 2020 (\$3,036 – \$1,436 = \$1,600 mil/year in the second row under the Cost of CES). Under the low cost storage/high gas price scenario, the cost of CES is 6.8 c/kWh (13.8 – 7 = 6.8 c/kWh) or \$1,494 million (\$3,036 – \$1,542 = \$1,494 mil/year). Under the high cost storage/low gas price scenario, the cost is 10.3 c/kWh (16.8 – 6.5 = 10.3 c/kWh) or \$2,260 million per year in 2020 (\$3,696 – \$1,436 = \$2,260 mil/year). Finally, under the high cost storage/high gas price scenario, the cost of CES is estimated to be 9.8 c/kWh (16.8 – 7 = 9.8 c/kWh) or \$2,154 million (\$3,696 – \$1,542 = \$2,154 mil/year).

Therefore, the clean electricity standard reduces CO₂ emissions at an average cost of \$148 per tonne under the low cost storage/low gas price scenario (\$1,600 / 10.8 Mt CO₂ = \$148/tonne CO₂ in the last row of Table 2). Under the low cost storage/

TABLE 2
Cost of British Columbia's Clean Electricity Standard (CES)

<i>Cost of Incremental Electricity with Renewables (CES)</i>	
Cost per kWh	
• Low cost storage	13.8 c/kWh
• High cost storage	16.8 c/kWh
Annual average cost for additional demand of 22,000 GWh/year in 2020	
• Low cost storage	\$3,036 mil/year
• High cost storage	\$3,696 mil/year
<i>Cost of Incremental Electricity with Natural Gas and Coal (Business-as-Usual)</i>	
Cost per kWh	
• Low gas price	6.5 c/kWh
• High gas price	7 c/kWh
Annual average cost for additional demand of 22,000 GWh/year in 2020	
• Low gas price	\$1,436 mil/year
• High gas price	\$1,542 mil/year
<i>Cost of CES</i>	
Cost per kWh (cost per kWh under CES minus cost per kWh under business-as-usual)	
• Low cost storage/low gas price	7.3 c/kWh
• Low cost storage/high gas price	6.8 c/kWh
• High cost storage/low gas price	10.3 c/kWh
• High cost storage/high gas price	9.8 c/kWh
Annual average cost for additional demand of 22,000 GWh/year in 2020	
• Low cost storage/low gas price	\$1,600 mil/year
• Low cost storage/high gas price	\$1,494 mil/year
• High cost storage/low gas price	\$2,260 mil/year
• High cost storage/high gas price	\$2,154 mil/year
Additional GHG emissions in 2020 if the proposed coal and natural gas plants were built to meet additional demand of 22,000 GWh/year in 2020	
• Low gas price	10.8 Mt CO ₂ /year
• High gas price	16.6 Mt CO ₂ /year
Cost of CES per tonne of CO ₂	
• Low cost storage/low gas price	\$148/tonne CO ₂
• Low cost storage/high gas price	\$90/tonne CO ₂
• High cost storage/low gas price	\$210/tonne CO ₂
• High cost storage/high gas price	\$130/tonne CO ₂
Notes: kWh=kilowatt hour(s). GWh=gigawatt hour(s). c/kWh=cents per kilowatt hour. Mt=megatonne(s).	
Source: Authors' calculations.	

high gas price scenario, the cost is \$90 per tonne ($\$1,494 / 16.6 \text{ Mt CO}_2 = \$90/\text{tonne CO}_2$). Under the high cost storage/low gas price scenario, the cost is \$210 ($\$2,260 / 10.8 \text{ Mt CO}_2 = \$210/\text{tonne CO}_2$). Finally, under the high cost storage/high gas price scenario, the cost is \$130 per tonne ($\$2,154 / 16.6 \text{ Mt CO}_2 = \$130/\text{tonne CO}_2$).

In terms of administrative burden, the carbon tax is ideal. Since it simply changes the rate of the fuel taxes and income taxes that the government already collects, and the rate of tax credits that the government already distributes (rebates to low-income people of goods and services taxes), it causes no additional administration burden. The CES, on the other hand, appears to have a higher administrative burden because BC Hydro operates a competitive bidding process to develop long-term supply contracts with independent power producers. This burden in general is the result of the IPP supply policy, not the requirement that IPPs be engaged in producing zero-emission electricity. But to the extent that the CES policy favours a larger number of smaller producers (many micro-hydro and wind IPPs, instead of one or two IPPs developing large coal and natural gas plants), the CES policy does increase BC Hydro's administrative burden. Overall, we score the clean electricity standard at "medium" for administrative feasibility.

Borick, Lachapelle, and Rabe (2011) found that public support for regulatory policies in Canada, such as renewable electricity portfolios (69 percent) and vehicle fuel efficiency standards (60 percent), is greater than for market-based initiatives, including fossil fuel taxes (43 percent), gas taxes (36 percent), and cap-and-trade systems (51 percent).⁷ Interestingly, when asked about willingness to pay for greenhouse gas reduction, 28 percent of Canadians would pay one to 49 dollars per year, followed by zero dollars per year (21 percent). Knowing that the cost of British Columbia's clean electricity standard is clearly higher than that of the carbon tax, it appears that the level of public support for renewable

electricity portfolios does not align with people's willingness to pay for climate change mitigation. The lack of cost visibility, or awareness of the actual cost of regulations, may explain the relatively high levels of support for clean electricity and renewable portfolio standards. Thus, we score the clean electricity standard "high" for public acceptance.

However, it is important to remember that polling questions about policy support and willingness to pay could be framed around specific contexts that induce certain answers. To some extent, Horne, Petropavlova, and Partington (2012) tested this issue by asking BC stakeholder groups about their support for the clean electricity policy, if its approximate price was 100 dollars per tonne of CO₂. The number of stakeholders who would or would not support the policy was split equally. The majority of stakeholders opposing the policy felt they could support it, but not at the cost of 100 dollars per tonne, considering the absence of carbon pricing in other jurisdictions.

OVERALL ASSESSMENT AND CONCLUSION

Table 3 summarizes our assessment. To 2020, the clean electricity policy is projected to reduce emissions by 10.8 to 16.6 Mt CO₂ per year, which is 3.6 to 5.5 times more than the carbon tax policy. However, the clean electricity policy achieves these substantial reductions at an average cost of \$90 to \$210 per tonne of CO₂, a sharp contrast with the carbon tax's average cost of zero to five dollars per tonne. In hindsight, however, the effect of the carbon tax might be substantially larger than three Mt CO₂ per year in 2020, if it continues to have the salience effects identified by Rivers and Schaufele (2012). But hindsight also shows that natural gas prices have fallen substantially since 2007 and are now forecast to remain very low to 2020. If this happens, the actual cost of the clean electricity policy will be even higher than we have estimated using the information at the time it was implemented.

TABLE 3
Summary of the Evaluation of British Columbia's Carbon Tax and Clean Electricity Standard

	<i>Carbon Tax</i>	<i>Clean Electricity Standard</i>
Annual GHG emission reductions in 2020	3 Mt CO ₂	10.8 – 16.6 Mt CO ₂
Economic efficiency	\$0 – 5/tonne CO ₂	\$90 – 210/tonne CO ₂
Administrative feasibility	High	Medium
Public acceptance	Medium-low	High

Notes: GHG=greenhouse gas. For other abbreviations, please see [Tables 1 and 2](#).

Source: Authors' calculations.

Although the economic efficiency of the clean electricity regulation is much lower than that of the carbon tax, high levels of acceptance and administrative feasibility suggest that the policy may endure (BC Hydro 2012; Borick, Lachapelle, and Rabe 2011; Environics 2011). Steady and high levels of acceptance of the clean electricity standard could be attributed to its invisible costs.⁸ In contrast, public acceptance of the carbon tax may be sensitive to any changes to the rate, revenue streams, and low-income tax credits post 2012 (Horne 2011; Horne, Petropavlova, and Partington 2012). In future research, we intend to further explore the issue of policy-cost visibility and policy support. While high-tax salience seems to matter for policy “emissions impact,” it is likely also to matter for “political acceptability,” with these two working in opposite directions.

This comparative study illustrates the dilemma for climate policy-makers and advisors. While it might be easy for advocates of a particular policy to focus on a single criterion, such as economic efficiency or emissions reductions, this is not a luxury available to politicians. They must navigate the difficult trade-offs between economic, environmental, and political criteria when choosing among policy options. A carbon tax has significant benefits. Yet it is easy to understand why politicians who claim

to seek emissions reductions in North America have avoided this policy in the two decades since it was first seriously considered (around 1990) and then quickly implemented in a few Scandinavian countries. It is also easy to understand why these countries introduced carbon taxes as partial replacements for existing energy taxes or established multiple exemptions and differences in rates across sectors. In this regard, British Columbia's carbon tax stands as an anomaly that none have thus far been willing to emulate. In contrast, its electricity policy has strong similarities to policies in 30 US states and several European countries, although it is far more stringent than most. In the years ahead, there may well be pressures to undermine both policies (reducing the carbon tax, decreasing the percentage zero-emission requirement), and it will be interesting to see which policy performs better in such a case. In a world that seems less and less concerned with the threat of global warming, policy “endurance” may well become an additional policy evaluation criterion.

NOTES

¹ Comparing the economic efficiency of the two policies depends on assumptions about the response to prices and regulation and the costs of incremental increases in emissions abatement—both economy-wide

and within the electricity sector (in the case of the electricity-focused regulation).

² Australia recently implemented a modest carbon tax that applies to fuels used to produce electricity, but not to carbon fuels consumed directly by consumers (such as vehicle fuels and home heating fuels). It is still too early to tell if the Australian carbon tax will survive or if it will be applied more effectively, as in British Columbia.

³ Although British Columbia's CES was actually implemented and refined in three steps (50 percent clean electricity requirement in 2003, 90 percent in 2007, and 93 percent in 2010), we treat the policy as one step because we are interested in the emergence of CES as an important policy option, rather than its evolution over time by the same government. Thus, we calculate GHG reductions due to the CES as the amount of emissions that would have been released from coal and natural gas if the CES had not been implemented at all.

⁴ Under the "high" and "low" natural gas price scenarios, the price of coal also varies slightly. The coal price is \$2.40/GJ under the "high" gas price and \$1.70/GJ under the "low."

⁵ Although forecasts of future prices have changed considerably, we used the values that decision-makers were considering at the time of implementing the policies in order to make our results comparable and consistent with projections and goals outlined in British Columbia's Climate Action Plan (2008).

⁶ We calculated the cost of meeting additional electricity demand in 2020 using the current cost estimates for renewable electricity. The best sites are being exploited, which may lead to rising costs, while technological innovation may counter this enough to keep costs approximately stable, at least until 2020.

⁷ These levels of public support are found for climate policy implementation at both the federal and provincial levels.

⁸ There is now pressure to "relax" the CES because of all the expensive zero-emission electricity that would be required by processing plants planned for British Columbia's north coast as part of major projects to liquify and export natural gas. Recently, the government has actually redefined CO₂ emissions from burning natural gas at these plants as somehow not "emissions."

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