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Scoping Study of the Potential Linkage of New Brunswick and Nova Scotia to the Western Climate Initiative

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A Study Commissioned by
The Conservation Council of New Brunswick
Ecology Action Centre
Équiterre
Environmental Defence

30 May 2017

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Executive Summary

Should New Brunswick and Nova Scotia consider emission trading systems linked with Quebec, California and Ontario under the auspices of the Western Climate Initiative (WCI)? The Government of New Brunswick is currently considering various climate mitigation options to comply with the federal carbon pricing benchmark outlined in the Pan-Canadian Framework on Clean Growth and Climate Change. In late 2016, Nova Scotia announced it would establish its own cap-and-trade system though not linked with any other jurisdiction. In this paper, we consider the prospect of climate finance flowing into NB & NS in order to reduce emissions in these two Maritime provinces through the establishment of cap-and-trade systems that are linked to the WCI. Emissions trading under the WCI could see Quebec and Ontario firms buy emission allowances from their counterparts in NB & NS.

Both Maritime provinces have committed to reducing emissions 10% below 1990 levels by 2020. Looking ahead, NB has committed to reducing its emissions to 35% below 1990 levels by 2030, considerably beyond its implicit share of emission reductions under the Pan-Canadian Framework. NS has not presented a 2030 target; however, under the Pan-Canadian Framework, Nova Scotia is likely to be expected to reduce emissions to 19.5% reduction below 1990 emission levels. Looking to 2050, NB has committed to a reduction of 72% below 1990 levels and NS to a target 80% below, though not all of these long-term commitments are codified in legislation. The 2020 emission reduction targets of Quebec and Ontario are somewhat more ambitious than NS & NB targets, although California only seeks to reduce emissions to 1990 levels by 2020. With regards to 2030 emission reduction targets, California, Quebec and Ontario have all ratcheted up ambition to between 37% to 40% reductions below 1990 levels. All three WCI jurisdictions have adopted 2050 emission reductions targets ranging from 80% to 95%.

NB & NS have seen considerable improvement in their emission profiles over recent years. Indeed, relative to 1990 emission levels, NS has showed the greatest relative improvement of the five jurisdictions considered in this report by having reduced emissions to nearly 17% below 1990 levels, which surpasses its 2020 target. For its part, NB reduced emissions by 11% as of 2014, which already exceeds its 2020 emission reduction target, though the province has set itself a more ambitious 2030 target than NS. In terms of emissions per capita and emissions per GDP, there is considerable distance between NB & NS and the next most polluting jurisdiction considered, Ontario.

How have prices on the WCI evolved over time? Currently, the WCI floor price is $18.5 per tonne CO2e but is set to rise annually by 5% plus the rate of inflation. While it remains uncertain if a WCI joint carbon market will extend post-2020, we estimate that the price floor would reach $34 by 2030 if the annual increase were maintained at 5%. Except for a speculative period starting in California in 2011 and ending by late 2013, primary and secondary market prices have hugged the carbon price floor. Are prices in the WCI too low to drive emissions reductions? The answer may be that current prices on the WCI carbon market are not intended to be the main driver of emission reductions—rather regulations are doing most of the heavy lifting. For example, the striking feature of California's climate strategy has been that the state expects to secure 70-80% of its emissions reduction through complementary policies, with the cap-and-trade system serving as a backstop measure to make the system more robust and link its different components. If regulations are effective or if they prove more effective than anticipated, there will be few residual emissions remaining for the carbon market to mop up and interjurisdictional market prices are likely to be shaped by the price floor. However, change may be afoot. Under California's recently proposed Senate Bill 775, the carbon floor price would rise to approximately $92 by 2030, which we show is comparable to an extension of current Canadian federal carbon pricing.

Given the important role that regulations and so-called complimentary policies currently play in the WCI through their interaction with carbon prices, it is useful to consider energy policy in both NB & NS where important regulations have been introduced to boost renewable energy consumption as well as improve energy efficiency. Consequently, we offer a summary of existing policies in the electric power sector, which is the most important source of emissions in both NB & NS. Moving forward, we see a turn towards greater renewable energy imports as an important part of future electricity provision in both Maritime provinces. But our review also suggests that there is considerable potential for further development of renewable energy in NB & NS including hydroelectric, solar, wind and tidal resources. Review of available information on the costs of such renewable energy technologies suggests that they could compete with existing electric power generating capacity as well as imports when carbon pricing is considered. While importing hydroelectricity from Quebec and Labrador is a rational option for increasing renewable energy consumption in NB & NS, by relying on imports, the two Maritime provinces may be foregoing the development of a low-carbon energy in-province and reducing the supply of renewable energy resources for other states and provinces in the region.

The question regarding linking to the WCI is, can NB & NS decarbonize their economies at a cost that is competitive vis-à-vis other WCI partners, especially California where economic models now suggest Quebec and Ontario are seeking to reduce their emissions. What might it cost to further decarbonize NB & NS? Building on our analysis of provincial energy policy in conjunction with review of available marginal abatement cost curves of existing WCI partners suggests that there are grounds to believe that the costs of reducing emissions in these two Maritime provinces will be competitive with California at the current rate of increase of the WCI price floor. While detailed analysis of the implications of California's proposed Senate Bill 775 are beyond the scope of this paper, it is likely that any further rise in the WCI's carbon price floor will increase the prospects of seeing carbon finance flow from Quebec and Ontario to the Maritimes rather than California. But in the spirit of cooperation, we urge California to enter into discussion about the prospect raising the carbon price floor with other WCI partners, as such a move has far ranging implications.

While more detailed studies will be required to determine if the opportunity of carbon finance inflows into NB & NS is real and outweighs the risks we have identified, given the considerable opportunity this represents for these two Maritime provinces such an exploration would be worthwhile. We urge for greater research, dialogue and outreach about the possibility of NB & NS linking emissions trading systems with the WCI.

1. Introduction

Should New Brunswick and Nova Scotia consider emission trading systems linked with Quebec, California and Ontario? Under the auspices of the Western Climate Initiative (WCI), emissions trading systems in Quebec and California came into effect in 2013 and have been linked since 2014, with Ontario set to join in 2018 (Houle et al., 2015; Purdon et al., 2014). The Government of New Brunswick is currently considering various climate mitigation options to comply with the federal carbon pricing benchmark outlined in the Pan-Canadian Framework on Clean Growth and Climate Change (Government of Canada, 2016). In late 2016, Nova Scotia announced it would establish its own cap-and-trade system though not linked with any other jurisdiction (GoNS, 2017). In this paper, we review the opportunities and risks associated with the prospect of climate finance flowing into NB & NS in order to reduce emissions in these Maritime provinces through the establishment of cap-and-trade systems that are linked to the WCI. Emissions trading under the WCI could see Quebec and Ontario firms buy emission allowances from their counterparts in NB & NS.

There are potential advantages to joining the WCI for NB & NS. While there has been considerable improvement in energy efficiency in NB & NS over the past decade, there are reasons to believe that further emission reductions can be achieved in these two Maritime provinces in a more cost-effective manner than in Central Canada. But there are risks, the most important of which is that other sources of low-cost emission reductions could be brought into the WCI, including Mexico's potential involvement (ICAP, 2017b: 9-10), as well as California's interest in international offsets (CARB, 2015). If such potential new supply of low-cost emissions reductions is not carefully coordinated with greater emission reduction effort across all partner jurisdictions, these potential developments might reduce carbon prices and render the relative advantage of NB & NS less attractive. Of course, any low-cost international allowances and offset credits would also be available to NB & NS should they join the WCI. But recent developments in California, notably the recently proposed Senate Bill No. 775 (2017), hereafter SB775, suggest some appetite in California to raise prices on its carbon market, with important ramifications for all partners.

Before going further, it is important to highlight that a key distinguishing feature of the WCI carbon market is that it is highly regulated. In contrast to the European Union's Emissions Trading System (EU-ETS), the WCI has imposed a carbon floor price that is intended to offer a certain degree of price stability. Under the WCI, California and Quebec agreed to a common carbon floor price that is set to rise annually by 5% plus the rate of inflation (IETA, 2012a; b). This is important given the significance that regulations play among WCI partners, particularly in California with its low-carbon fuel standard and other so-called complimentary policies. Contrary to the "carbon market" label, regulations currently play the dominant role in California and Quebec's plans to reduce emission. In California, emissions trading itself intended to achieve only 20% of total reductions counted towards the state's 2020 target (CARB, 2008a: 17). The California Air Resources Board (CARB) has recently recommended a similar plan for reaching the state's 2030 target, where the carbon market is only anticipated to drive 28% of emission reductions (CARB, 2017: 41). When regulations are responsible for the majority of emission reductions, they tend to compete with carbon pricing and dampen market price signals (Fischer and Preonas, 2010). While some economists might object, such policy design might be seen as an astute political move as the market price for carbon may be lower than actual program costs (see Jaccard et al., 2016; Victor, 2011: 66-68). The upshot is that market prices for carbon are unlikely to be the main driver of emission reductions in the WCI, meaning that the negotiated carbon price floor becomes is better viewed as an inter-jurisdictional measure for burden-sharing between WCI partners.

With such an understanding of the effect of regulations on carbon pricing amongst WCI partners, a key question is whether the current rate of increase of the WCI price floor promises to favour the flow of climate finance into NB & NS in order to reduce emissions and how this might be affected by a price rise? Without detailed economic modeling of the costs of reducing emissions in NB & NS, it is difficult to offer a definitive answer to this question. At current the current rate of increase, the WCI carbon price floor will be approximately $34 per tCO2e by 2030 while under California's proposed price increase under SB775 they would reach approximately $92 per tCO2e by 2030—a trajectory itself which we will show is comparable to current Canadian federal carbon pricing. However, given that estimates that a carbon price of $200 would be necessary for Canada to reach its 2030 emission reduction commitment under the recent Paris Agreement stand at $200 per tCO2e (Jaccard et al., 2016: 25), the attractiveness of emissions trading is likely still to remain. Based on our review of trends in WCI carbon market prices, various future carbon floor prices and currently available marginal abatement cost curves of existing WCI partners in addition to review of emissions and energy profiles of NB & NS, there are grounds to believe that the costs of reducing emissions in these two Maritime provinces will be competitive with California at the current rate of increase of the WCI price floor while any further rise will increase the prospects of seeing carbon finance flow from Quebec and Ontario to the Maritimes rather than California. But as important as carbon pricing may be, their interaction with provincial renewable energy standards and demand-side management programmes in NB & NS would need to be clarified. Also important is how the potential entry of new international partners and carbon offsets might be managed in order to avoid the over-supply of cheaper emissions reductions that could undercut the carbon price floor. In order to clarify the risks and opportunities involved, we would urge for greater research, dialogue and outreach about the possibility of NB & NS linking emissions trading systems with the WCI.

2. Why the WCI and Emissions Trading?

Established in 2007, the WCI is a voluntary coalition of US states and Canadian provinces that have developed a common set of guidelines to facilitate mutual cooperation in order to reduce their collective emissions to 15% below 2005 levels by 2020 (WCI, 2010). By setting targets and timetables on emission reductions, the WCI bears many similarities to the EU-ETS as well as the Kyoto Protocol. However, the key difference is that the WCI is a non-binding voluntary agreement designed by participating jurisdictions for their mutual benefit. Political authority for such cooperation remains firmly with the individual jurisdictions involved. Neither California, Québec nor Ontario are compelled by a higher authority to establish a cap-and-trade system—each has done so voluntarily because of the expected advantages of cooperation while the non-binding nature of the WCI allows jurisdictions to maintain their autonomy. Yet the WCI framework is more comprehensive and stringent than other subnational efforts to reduce emissions in North America. For instance, the caps of jurisdictions party to the WCI are quite comprehensive and cover a number of economic sectors instead of only power generation, as is the case with the Regional Greenhouse Gas Initiative (RGGI) amongst northeastern US states.

Why choose emissions trading? There are two basic reasons. The one that has grabbed the most attention is the economic rationale that emissions trading places a price on carbon, harnessing the market to drive efficient emissions reductions in a particular jurisdiction or between linked jurisdictions (Hepburn, 2006; Ragan et al., 2015). Often emissions trading is presented as an alternative carbon pricing strategy to a carbon tax, which differ in subtle but important ways in how they handle uncertainty (Weitzman, 1974). But another, less well appreciated but politically salient reason is that emission trading across different jurisdictions allows a common price on carbon to emerge from the bottom-up, letting jurisdictions share the burden of reducing emissions. This is important because, given different economic contexts, the cost of reducing emissions varies considerably across Canadian provinces as well as across US states (CARB, 2008b; Rivers, 2010; Wei and Rose, 2008). Alternatively, a global carbon tax could play a similar role in catalyzing cooperation amongst states and other parties (Cramton et al., 2017). But such a global carbon price would apparently need to be imposed by some international body (see Weitzman, 2015), which appears at odds with the bottom-up character of the current climate change regime where climate clubs are at best emerging piecemeal. At least in theory, emissions trading allows for different parties to reach a price that reduces emissions in the most cost-effective manner amongst them, even in the absence of a central authority. Such cost savings might substantial, over-coming concerns about price volatility and related economic shocks being transmitted between linked jurisdictions—though much depends on the linked parties involved (Doda and Taschini, Forthcoming 2017). While many critiques of carbon markets suggest that they reduce only costs without reducing the absolute amount of emissions (Böhm and Dhabi, 2009; Bumpus and Liverman, 2008), there is emerging evidence that reducing costs may increase ambition. A quick review of experience to date with emissions trading between California and Quebec, compared to British Columbia, brings these issues into relief.

All else being equal, it is relatively more expensive to squeeze emission reductions out of Quebec's economy which, because of its considerable hydroelectric energy resource, is relatively cleaner than California (Purdon et al., 2014; Purdon and Sinclair-Desgagné, 2015). By buying emission allowances from California, Quebec can reduce emissions at considerably lower cost. A similar logic explains Ontario's interest in linking its emissions trading system to that of Quebec and California. Economic models suggest that the cost of reaching Ontario's 2020 emissions reduction target drops from $157 to $18 per tCO2e (nominal dollars) when Ontario firms are allowed to buy allowances on the linked market (Sawyer et al., 2016: 14). California is key to these costs savings, which anchors the WCI as the largest partner. While there are concerns about California's cap-and-trade system (Cullenward and Coghlan, 2016; Green, 2017)—which we address in more detail below—preliminary results suggest that since emissions trading began in late 2012, emissions under the cap have been going down (Morehouse and Camuzeaux, 2016). It will be important to verify these results moving forward.

Contrast experience to date with the WCI to the situation in British Columbia. While the $30 carbon tax, which was introduced in 2008, has slowed the growth of BC's emissions, it has never been sufficiently high to drive emissions towards the province's 2020 emission reduction target of 33% below 2007 levels—approximately 20% below 1990 levels (Houle et al., 2015). Rather, based on the most recent federal government data, emissions in BC have declined only about 3% since 2007 from 62.7 MtCO2e to 60.9 MtCO2e in 2015 while its 2020 target would be 41.4 MtCO2e (ECCC, 2017). More recently, BC's emissions are expected to continue to rise even under a $50 carbon tax to align with the Pan-Canadian Framework because of expansion of BC's shale gas sector (Wolinetz, 2016). The province will miss its own 2020 emission reduction target and has so far declined to set one for 2030 (Bailey, 2016), though things could change under a NDP-Green Party minority government that has emerged from the recent provincial elections. At the same time, in 2015, BC formally withdrew from emissions trading, despite being partner to the WCI, which means that it is currently unable to benefit from low-cost emission reduction opportunities elsewhere. In contrast to BC, California, Quebec and Ontario have been ratcheting up emission reduction ambitions for 2020 and 2030, which we discuss in more detail below.

3. Cap & Trade Design Principles of the WCI and NB & NS

To better understand climate and energy policies in NB, NS and the three WCI jurisdictions, we first discuss basic elements of their emission reduction targets below (Table 1). We use a 1990 baseline throughout our discussion as this remains the most common frame of reference. It is also helpful to compare commitments made under the WCI to that which Canada made under the 2015 Paris Agreement, where the federal government pledged to reduce Canada's emissions by 30% below 2005 levels (Government of Canada, 2015). When converted to our common 1990 baseline, Canada's commitment under the Paris Agreement amounts to a reduction of approximately 15% below 1990 emissions. We note again that

Jaccard et al. (2016: 25) estimated that in order to reach Canada's Paris commitment, the price on carbon would need to reach approximately $200 per tCO2e in by 2030 (2016 dollars). While it is important to keep this cost of meeting Canada's Paris commitment in mind, we return to Jaccard below in our discussion of market prices and implicit regulatory prices.

Returning to emission reduction targets, both Maritime provinces have committed to reducing emissions 10% below 1990 levels by 2020. Looking ahead, NB has committed to reduce its emissions to 35% below 1990 levels by 2030, considerably beyond its implicit share of emission reductions under the Pan-Canadian Framework. NS actually has not presented a 2030 target; however, under the Pan-Canadian Framework, Nova Scotia will be expected to reduce emissions to 30% below 2005 levels by 2030 (GoNS, 2017: 5). If NS only keeps to the federal target, this represents a 19.5% reduction below 1990 emission levels. Looking to 2050, NB has committed to a reduction of 72% below 1990 levels and NS to a target 80% below, though not all of these long-term commitments are codified in legislation.

The 2020 emission reduction targets of Quebec and Ontario are somewhat more ambitious than NS & NB targets, although California only seeks to reduce emissions to 1990 levels by 2020. Nonetheless, it is also interesting to observe that the WCI target of 15% below 2005 emission level is 657 MtCO2e, which is roughly equivalent the combined 2020 reduction target for California, Quebec and Ontario of 658 MtCO2e set out in each jurisdiction's domestic legislation. With regards to 2030 emission reduction targets, California, Quebec and Ontario have all ratcheted up ambition to between 37% to 40% reductions below 1990 levels. We can see that the ambition in Quebec, California and Ontario is considerably greater than Canada's federal government. While all three WCI jurisdictions have formally adopted 2030 emission reduction targets, it needs to be borne in mind that the Quebec-California-Ontario market is officially mandated only through to 2020. Nonetheless, in early 2017, CARB tabled a Scoping Plan where it weighed various options and recommended again that the State of California pursue a strategy of combining emissions trading with smart regulations (CARB, 2017). We note that given SB775, CARB's proposal is likely to see certain modifications. Finally, we note that all three jurisdictions have adopted 2050 emission reductions targets ranging from 80% to 95%.

While the three existing WCI jurisdictions have harmonized their climate policies, Nova Scotia's cap and trade system is coarser (Table 2). First, while all power generators are included, the threshold for including large final emitters has been set at 100,000 ktCO2e in contrast to 25,000 ktCO2e in Quebec, California and Ontario. Second, there are substantially fewer entities under the cap in Nova Scotia than the other WCI jurisdictions, likely to due in part to the threshold above. Less than 20 entities will be subject to the cap in Nova Scotia compared to over 700 in the rest of the WCI after Ontario's entry in early 2018, suggesting fewer opportunities for trading in the Maritime province. Third, Nova Scotia intends to use only offsets generated in the province, while the other three jurisdictions will accept offsets from projects anywhere in North America, though limiting offset use to 8% of their respective caps. Finally, we note that the proposed NS emissions trading system is described as a key element in the province's contribution to Canada's commitment under the Paris Agreement (GoNS, 2017: 5), though details are yet to emerge. As indicated earlier, NB's government is still deliberating on which course of action to take.

Table 1: Comparison of Emissions Targets and Emissions

Issue	California	Quebec	Ontario	NB	NS
Emission Targets*					
2020 Emissions Target	1990 levels	20% below 1990	15% below 1990	10% below 1990	10% below 1990
2030 Emissions Target	40% below 1990	37.5% below 1990	37% below 1990	35% below 1990	19.5% below 1990[δ]
2050 Emissions Target	80% below 1990	80%-95% below 1990	80% below 1990	72% below 1990[β]	80% below 1990
2014 Gross Emissions relative to 1990 (%)	+2.1%	-10.1%	-7.1%	-11%	-16.7%
Emissions**					
1990 Gross Emissions (MtCO2e)	433	89.0	181.3	16.3	19.8
2005 Gross Emissions (MtCO2e)	480	88.9	204.4	20.3	23.2
2013 Gross Emissions (MtCO2e)	444	82.3	170.8	15.0	18.4
2014 Gross Emissions (MtCO2e)	442	80.0	168.5	14.5	16.5
2015 Gross Emissions (MtCO2e)	NA[Ω]	80.1	166.2	14.1	16.2
BAU Emissions Projections***					
2020 Emissions Projection (MtCO2e)	596	127	244	25.8	26.4
2030 Emissions Projection (MtCO2e)	392	NA	NA	NA	NA
Emissions Targets					
2020 Gross Emissions Target (MtCO2e)	433	71.2	154	14.7	17.8
2030 Gross Emissions Target (MtCO2e)	260	55.6	114	10.6	15.9
Current Emissions Gap					
2020 Emissions Gap (MtCO2e) (2014 emissions minus 2020 emissions target, MtCO2e)	9.0	8.8	14.5	-0.2	-1.3
2030 Emissions Gap (MtCO2e) (2014 emissions minus 2030 emissions target, MtCO2e)	182	24.4	54.3	3.9	0.5

**Sources: ECO (2016); (Environmental Goals and Sustainable Prosperity Act, 2007); ICAP (2017a; 2017c); (Nova Scotia, 2009); Government of New Brunswick (2016).*

***Sources: CARB (2007; 2016); ECCC (2017). Gross emissions do not include carbon sinks associated with the land-use, land-use change and forests (LULUCF)*

**** Sources: (CARB, 2008a: 74); (CARB, 2017 37); (Rivers, 2010: 52).*

δ Based on a target of 30% below 2005 levels, as per the Pan-Canadian Framework (Government of Canada, 2016).

β Based on target of 80% below 2001 levels (Government of New Brunswick, 2016: 4).

Ω California's 2015 gross emissions measure to be released in June 2017.

Table 2: Comparison of Basic Elements of Cap & Trade Systems

Issue	California	Quebec	Ontario	NS
Scope of Capped Emissions				
- Capped emissions 2017*	370 MtCO2e	61.2 MtCO2e	142.3 MtCO2e	TBD
- Percentage of 2014 gross emissions	83.7%	76.5%	84.5%	TBD
- Inclusion Threshold for Covered Entities**	25,000 tCO2e/yr	25,000 tCO2e/yr	25,000 tCO2e/yr	All power producers, industry of 100,000 tCO2e/yr and petroleum product suppliers that place more than 200 L of fuel/yr
- Inclusion Threshold for Covered Entities**	Includes imported electricity and distributors of liquid fuels	Includes imported electricity and distributors of liquid fuels	Includes imported electricity and distributors of liquid fuels	Includes imported electricity and distributors of liquid fuels
- Number of establishments covered**	450	132	148	Fewer than 20
Use of Offsets***				
Domestic Offsets	8%	8%	8%	NA
International Offsets	Limited to Canada, US and Mexico	Limited to Canada, US and Mexico	Limited to Canada, US and Mexico	Limited to Nova Scotia

*Sources: Annual Allowance Budgets for Calendar Years 2013-2020 (2012); Determination of Annual Caps on Greenhouse Gas Emission Units Relating to the Cap-and-Trade System for Greenhouse Gas Emission Allowances for the 2013-2020 Period (2012); The Cap and Trade Program (2016)
** ECO (2016); GoNS (2017); ICAP (2017a; 2017c)
*** GoNS (2017); WCI (2010)

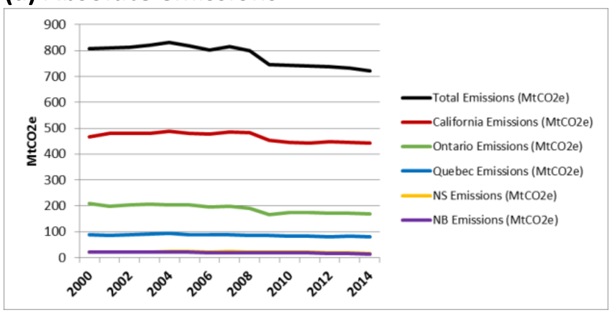
4. Emissions Trends

In this section we present a brief overview of emissions trends amongst NB & NS as well as the three other WCI partner jurisdictions. Figure 1 presents emissions in absolute terms across all five jurisdictions (Figure 1a), as well as emissions per capita (Figure 1c) and emissions per GDP (Figure 1d). Of course, the carbon footprints of NB & NS are considerably smaller than the other WCI jurisdictions involved, for which reason we provide a zoom in on their absolute emissions in Figure1b. These trends suggest there has been movement towards greater, cost-effective emission reductions in the two Maritime provinces than in other jurisdictions.

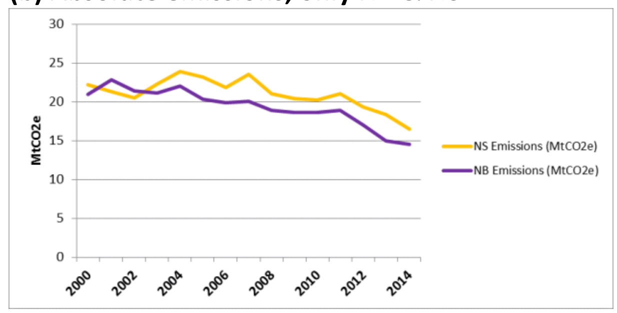
In terms of emissions per capita and emissions per GDP, there is considerable distance between NB & NS and the next most polluting jurisdiction, Ontario. It is also important to observe that for all three key measures of emissions NB & NS have shown considerable progress. Indeed, relative to 1990 emission levels, NS has showed the greatest relative improvement of the five jurisdictions considered in this report by having reduced emissions to nearly 17% below 1990 levels, which surpasses its 2020 target and has nearly attained its implicit commitment under the Paris Agreement (Table 1). For its part, NB reduced emissions by 11% as of 2014, which already exceeds its 2020 emission reduction target, though the province has set itself a more ambitious 2030 target than NS. To reach their implicit 2030 emissions reduction targets (assuming NS implements a target comparable to the current federal target), NB & NS would need to further reduce their collective emissions by 4.4 MtCO2e.

Figure 1: Emissions trends in NB & NS and WCI Partners, 2000-2014

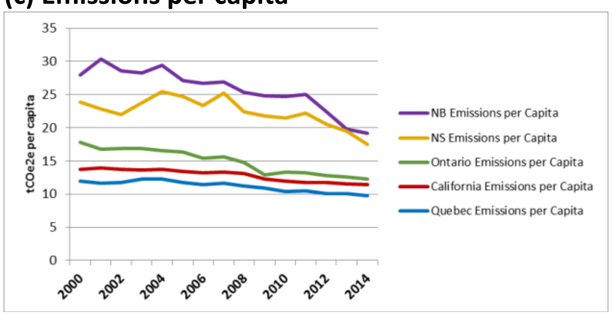
(a) Absolute emissions



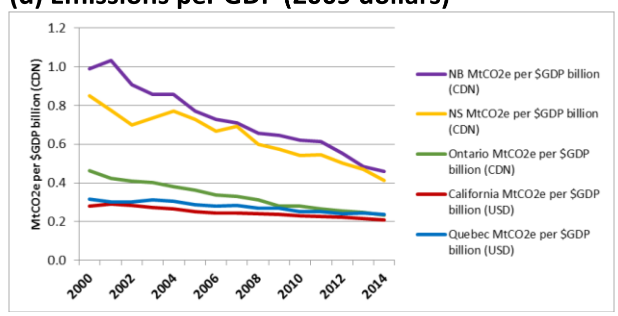
(b) Absolute emissions, only NB & NS



(c) Emissions per capita



(d) Emissions per GDP (2009 dollars)



Sources: Data on emissions derived from CARB (2007; 2016); ECCC (2017). Gross emissions do not include carbon sinks associated with the land-use, land-use change and forests (LULUCF). Data on population and GDP obtained from StatsCan and StatsAmerica. Historical and current (monthly) exchange rates derived from Bank of Canada.

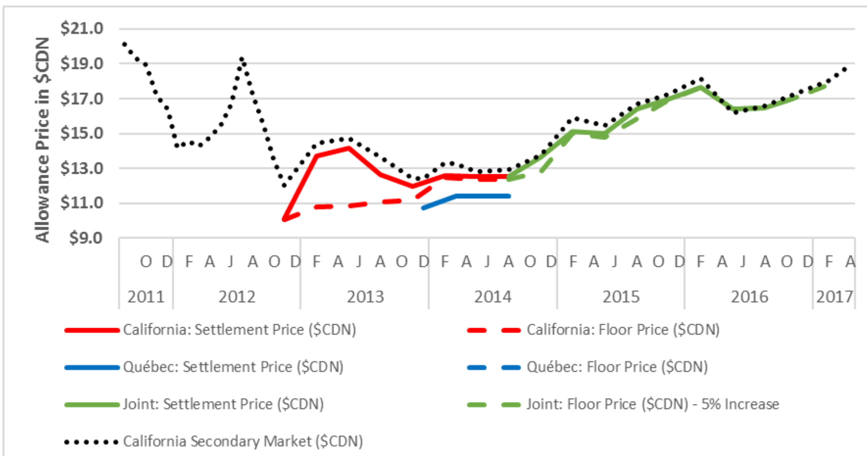
5. Trends in WCI Carbon Market Prices

How have prices on the WCI evolved over time? Figure 2 below distinguished between three prices on the WCI carbon market: the auction settlement price (also known as the primary market), the secondary market price, and the carbon floor price. The auction settlement price is the actual price paid for allowances at quarterly auctions. The secondary market is the price at which allowances are trading between firms, which is now largely set by firms in California where most transactions are taking place. The carbon price floor is the minimum price that firms must bid at auction.

Currently, the floor price is $18.5 per tonne CO2e(CARB and MDDELCC, 2017: 4). But as indicated earlier, the carbon price floor is set to rise annually by 5% plus the rate of inflation. This annual increase in the carbon floor price was agreed between California and Quebec and subsequently codified into each jurisdiction's legislation (Format for Auction of California GHG Allowances, 2012:(c); IETA, 2012a; b). In its regulations, Ontario has agreed to this price floor set by California and Quebec (The Cap and Trade Program, 2016: para.71). While it remains uncertain if a joint carbon market will extend post-2020, we estimate that the price floor would reach $34 by 2030 if the annual increase were maintained at 5% (prices in 2016 dollars).

While in theory, the three prices might diverge, except for a speculative period starting in California in 2011 and ending by late 2013, primary and secondary market prices have hugged the carbon price floor. Alarmingly, in 2016, prices on the secondary market, which is most developed in California, dipped below the floor price. Explanations for this diverge, with some observers claiming the dip is evidence of oversupply and leakage from the California carbon market (Cullenward and Coghlan, 2016), while others point to on-going legal and political uncertainty facing California's carbon market (Diodati and Purdon, 2016). It is beyond the scope of this paper to provide a definitive answer to questions about potential leakage on California's carbon market, which revolve around accounting protocols for imported electricity from neighboring states themselves not subject to carbon pricing. However, it is worth noting that an April 7 decision by the California Court of Appeals removed considerable legal uncertainty about California's carbon market (Zwick, 2017), which saw prices on the secondary market rise nearly 4% from $18.6 ($13.8 USD) to $19.3 ($14.3 USD) upon the court decision (CaliforniaCarbon.Info, 2017). After numerous undersubscribed allowance auctions in 2016 and February 2017, the most recent May 2017 joint California-Quebec auction results were fully subscribed and the auction price of $18.8 ($13.8 USD) was slightly above the price floor of $18.5 ($13.6 USD) (CARB and MDDELCC, 2017) while secondary market prices have held at $19.1 ($14.2 USD) (CaliforniaCarbon.Info, 2017). Nonetheless, even $19.3 is still not very far from the carbon price floor. Are prices in the WCI too low to drive emissions reductions?

Figure 2. Prices on WCI Primary (Auction) and Secondary Markets, 2011-2017



Sources: Data on California secondary market prices derived from "ICE End of Day Reports". Data on auction price floor and settlement prices derived from quarterly auction reports of CARB and MDDELCC. Historical and current (monthly) exchange rates derived from Bank of Canada.

The answer may be that prices on the WCI carbon market are not intended to be the main driver of emission reductions—rather regulations are doing most of the heavy lifting. For example, the striking feature of California's climate strategy has been that the state expects to secure 70-80% of its emissions reduction through complementary policies (CARB, 2008a: 17; 2017: 41), with the cap-and-trade system serving as a backstop measure to make the system more robust and link its different components (Purdon et al., 2014: 31-32). It is well known in climate policy circles that regulations designed to spur emissions reductions in economic sectors also under the cap have the effect of reducing demand for allowances and, consequently, drive down the market price for carbon (Fischer and Preonas, 2010). Economists tend to object to this practice as it blunts the carbon price signal which, in theory, needs to rise in order to efficiently reduce emissions (Stavins, 2014). The cost of emissions reductions achieved by regulation is often less transparent, allowing politicians to impose costly strategies unwittingly on their constituents. As Victor concludes, this facet of regulation makes it politically attractive: "political forces strongly favor policy choices that are exactly reverse the advice of expert economists who favor markets over regulations and prices over quantities" (Victor, 2011: 68).

In Canada, even one of the country's leading climate change economists recently acknowledged what political scientists have long suspected: that the high, but only implicit prices embodied in carbon regulations avoids some of the political dilemmas encountered by more explicit carbon pricing instruments (Jaccard, 2016). Jaccard, for example, points approvingly to California's vehicle emission standards. More explicitly, he argues that greater use of smart regulations in conjunction with carbon pricing might achieve Canada's 2030 commitment under the Paris Agreement at an explicit carbon price of $40 (whether on the markets or through a carbon tax) in contrast to an implicit carbon price of $200 for the full program (Jaccard et al., 2016: 16, all prices in 2016 dollars). While we tend to agree that a combination of regulations and carbon pricing could have political advantages, we also acknowledge that more research in this area would be necessary. Undoubtedly some efficiency gains associated with a pure price mechanism might be lost in regulatory approaches, though so-called smart regulations might mitigate such concerns.

The upshot of experience to date with the Quebec-California carbon market is that the carbon floor price is of key importance. If regulations are effective or if they prove more effective than anticipated, there will be few residual emissions remaining for the carbon market to mop up and interjurisdictional market prices are likely to remain low and shaped by the price floor.

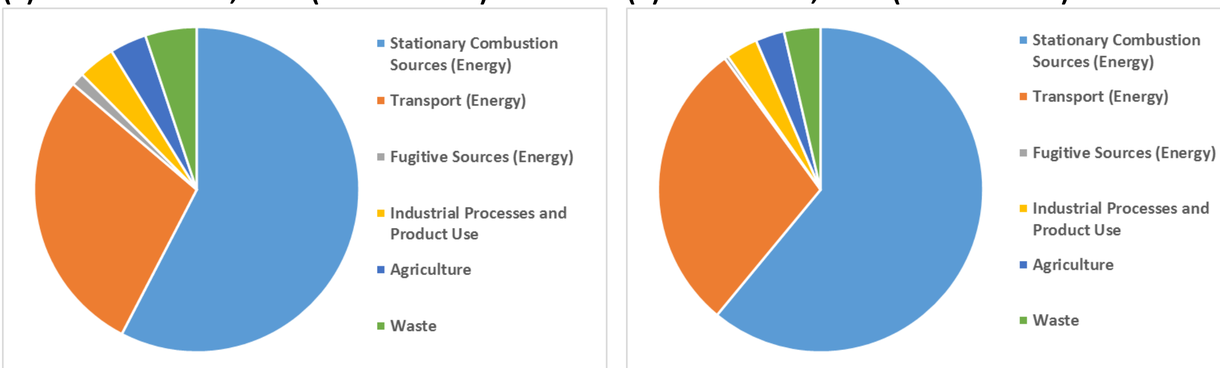
6. NB & NS Emissions and Energy Profiles

Given the important role that regulations and so-called complimentary policies currently play in the WCI through their interaction with carbon prices, it is useful to consider energy policy in both NB & NS where important regulations have been introduced to boost renewable energy consumption as well as improve energy efficiency. Ideally, economic modeling would consider the interaction between these regulations and carbon pricing in order to calibrate carbon prices necessary to reach provincial and, perhaps, WCI-related emission reduction goals. Unfortunately, such modeling is beyond the scope of the present study. Consequently, we offer a summary of existing policies in the electric power sector, which is the most important source of emissions in both NB & NS (Figure 3).

Our emphasis on electric power generation is not intended to exclude the importance of reducing emissions in other sectors. Indeed, despite the size of the power generation sector, there are other important sectors contributing to emissions in both NB & NS, particularly transport (Figure 3). It would be important to include additional sectors as well in any climate change policy. Generally, the broader the scope of carbon pricing and regulatory effort, the lower the per unit carbon price will be as more sectors of the economy are involved in the emissions reduction effort. If only the electric power generation sector were to be involved, it would need to face a higher carbon price to compensate for lacklustre efforts elsewhere.

Figure 3. Emissions by sector in New Brunswick and Nova Scotia

(a) New Brunswick, 2015 (14.1 MtCO2e) **(b) Nova Scotia, 2015 (16.2 MtCO2e)**



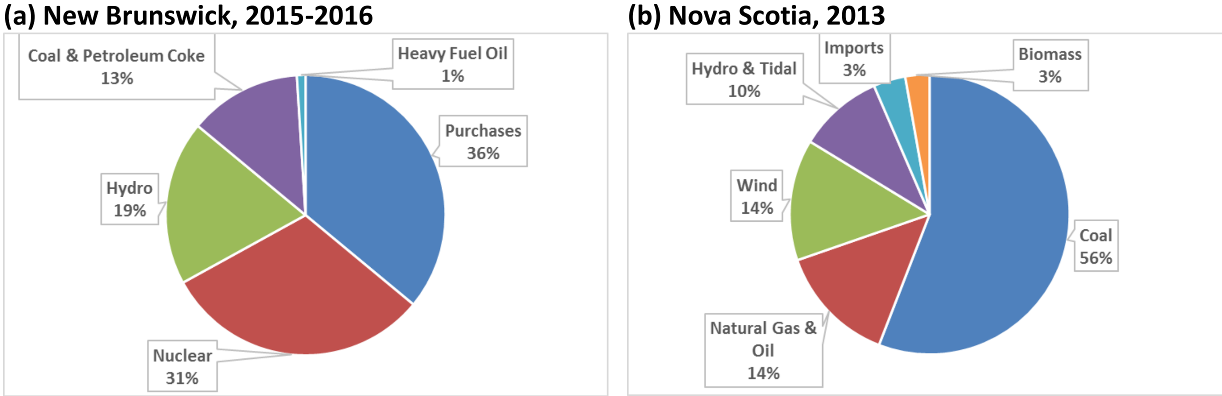
Source: ECCC (2017) *Source: ECCC (2017)*

6.1. Electric Power Policy in NB & NS

In this section, we discuss both policies to increase renewable energy consumption as well as to reduce demand for electric power through energy efficiency programmes. First, both NB & NS have adopted renewable energy standards. NB's Renewable Energy Portfolio Standard (REPS) will ensure that a minimum of 40% of electricity sold in-province comes from renewable resources by 2020. Importantly, this might be derived from renewable energy from outside the province, including large-scale hydro imports. Similarly, NS adopted a Renewable Energy Standard (RES) that requires at least 40% of net power sales to be sourced from renewable electricity (Nova Scotia Department of Energy, 2017b). The saliency of these renewable energy standards will be most pronounced in NS where the energy sector has been dominated by coal-fired thermal power generation (Figure 4). While coal was traditionally mined in Cape Breton, virtually all of this coal is now imported due to the closure of local mines and changes in emission regulations (Nova Scotia Government, 2015a). However, as we discuss in more detail below, NS will be able to import significant amounts of hydroelectric power from Labrador that will make coal phase-out less painful. As for New Brunswick, NB Power reported it actually reached 42% of its in-province electricity sales from renewables in 2015/2016, thereby actually exceeding the RPS requirements (NB Power, 2016). This is largely due to NB's current reliance on imported hydroelectricity from Quebec. In contrast, NS's current transmission connections with neighboring jurisdictions are relatively poor, as only one 300 MW connection of non-firm capacity to New Brunswick is now available.

Finally, we also note that both provinces have considerable wind energy capacity. As of 2016, NB had 294 MW of installed capacity (included in "Purchases" in Figure 1a as it is produced privately) while NS leads the Maritime provinces with 597 MW of installed capacity (Canadian Wind Energy Association, 2017).

Figure 4. Current electricity provision from various sources in New Brunswick (in province only) and Nova Scotia (including imports)



Note: data adapted from NB Power (2016: 136). *Note: data adapted from Nova Scotia Power (2016).*

But renewable energy standards are not the only energy policy that will affect emissions in NB & NS. Future electricity demand in New Brunswick is expected to decline due in large measure to a demand-side management (DMS) program known as reduce and shift demand (RASD) program, which is expected to free up of 600 MW capacity by 2038. There are also efficiencies that the industrial sector will be inclined to adopt that also reduce the province's electricity consumption. In addition, NB Power has contracted a private firm to develop smart grid options for the province (NB Power, 2014). Finally, NB's Climate Change Action Plan commits the province to phasing out the generation of coal-fired electricity by 2030 "if adequate support can be found to minimize impacts on energy costs and the local economy" (Government of New Brunswick, 2016: 12).

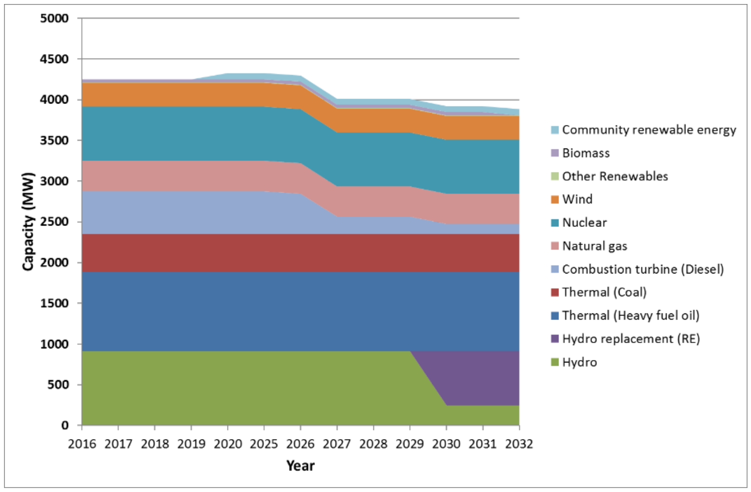
Nova Scotia has also developed a demand-side management program, that is to save an estimated 135 GWh per year (Nova Scotia Power, 2015). A key player in this effort is Efficiency Nova Scotia (ENS), Canada's first energy efficiency utility which is helping 225,000 program participants complete energy efficiency projects (Efficiency NS, 2017). ENS is designated to provide Nova Scotia Power with "reasonably available, cost-effective" energy efficiency programming, with cost-savings to be passed along to customers through power rates (Ibid.). Nonetheless, NS Power is concerned that the early retirement of fossil fuels might pose certain risks, stating that "If DSM programs do not deliver energy and peak reductions as forecasted, early steam fleet retirement scenarios will call for new capacity to be built in order to maintain system reliability" (NS Power, 2014: 78).

6.2. Planned Future Electricity Supply

What is planned for future supply in NB & NS? In both provinces, we see a turn towards greater renewable energy imports as an important part of future electricity provision.

Planned generating capacity for New Brunswick through 2032 is presented Figure 6. A major planned development involves the replacement of the Mactaquac Hydroelectric Station, which will no longer be functional in its current state after 2030. We note however that, recently, NB Power indicated that it wishes to keep the dam in service until 2068 or, otherwise, see it replaced by renewable energy (White, 2016). Small-scale community renewable projects are planned to generate 75 MW of renewable energy by 2020 (reNEWS, 2015). While not unimportant, we estimate that this corresponds to less than 2% of the total installed generating capacity. Since neither of these in-province renewable energy planned developments is of significant scale, we are led to the conclusion that NB will continue to rely on imported renewable energy to meet its 40% RESP. While currently NB imports electricity from Quebec, it may also come to import electricity from Labrador via Nova Scotia—which we discuss below.

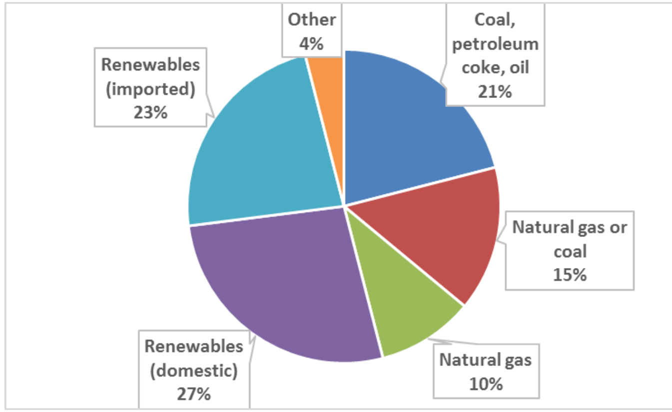
Figure 5. Planned development in electricity generation capacity in NB through 2032



Source: NB Power (2015)

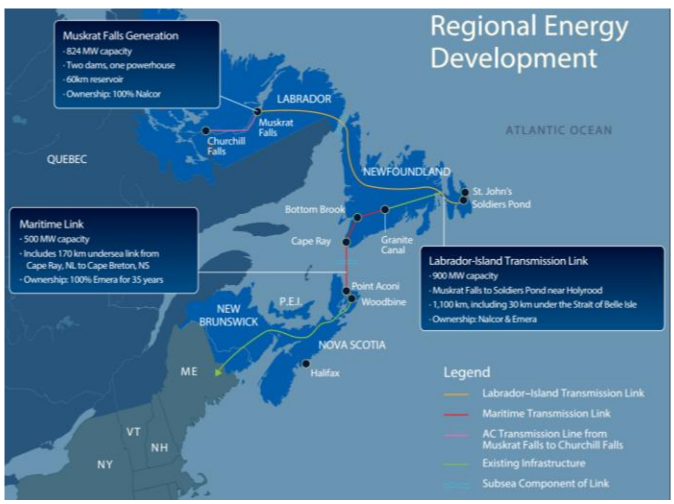
Though there is less detail on Nova Scotia's future energy plans, the available evidence also suggests greater reliance on imported hydroelectric power. Figure 5 shows the expected power mix for 2020 in Nova Scotia. Of key importance is Labrador's 824 MW capacity Muskrat Falls hydro power station, currently under construction, which is to set enter NS through the so-called Maritime Link (see Figure 7). NS Power expects to purchase annually 20% of the power generated from Muskrat Falls (NS Power, 2014: 33), constituting nearly a quarter of NS electricity by 2020. But Muskrat Falls is also significant in terms of new balancing power which will allow for the development of intermittent sources of renewable energy. Other renewable energy sources are also being explored. While tidal power is currently marginal, NS is aiming to install 16-22 MW by the early 2020s (Nova Scotia Government, 2015b: 10), although the cost of this energy source remains very high (Nova Scotia Department of Energy, 2017a: 22). It should be noted that coal is expected to continue to play a significant role in the future in Nova Scotia's energy mix until at least 2042, as the federal government's timeline to shut down coal plants does not apply in Nova Scotia due to an equivalency agreement negotiated between Halifax and Ottawa (Nova Scotia Government, 2015a; b)—a situation which continues to evolve. Overall, NS is well on its way to achieving its renewable energy standard. Coupled with an increase in wind and other NS-based renewables, including tidal power, the government has declared that "no major sources of electricity will be needed until nearly 2030" in order to reach its RES (Nova Scotia Government, 2015b: 18).

Figure 6. Expected Nova Scotia energy sources for electricity generation in 2020



Source: Nova Scotia Government (2015a: 7)

Figure 7. Muskrat Falls and Maritime Link Regional Hydroelectric Development Project



Source: Emera (2014)

6.3. Potential for Greater In-Province Renewable Energy Deployment

While NB & NS appear well on their way to meeting their mid-term renewable energy targets, is there room to improve? Our review suggests that there is considerable potential for further development of renewable energy in NB & NS (Table 3). Wind energy shows greatest potential in NB. One study concluded that the development of 3000 to 4000 MW wind power capacity is possible towards 2025 in NB (Ea Energy Analyses, 2008: 5). At the time of this study, high fossil fuel costs were believed to constitute a strong incentive to invest in low-carbon electricity (recall that in 2008 oil was fetching nearly $156 USD per barrel in 2016 dollars). However, based on a sensitivity analysis, the authors concluded that carbon pricing and RPS would be the main drivers of wind energy development even at a global oil price as low as $67 USD per barrel. Furthermore, a study by Gagnon (2008) estimated the total technical potential for NB stands at 40,000 MW. To maximize the value of wind power, "high level of cooperation" with neighboring energy markets will be necessary in order to balance power at reasonable cost (Ea Energy Analyses, 2008: 5).

But there are other underdeveloped renewable energy technologies available for NB. The province has important solar energy potential. Solar resource maps indicate that the highest annual average irradiance reached in the province is 3.7 $kWh/m^2/day$ (GoNB, 2012). This is competitive compared with 2.8 $kWh/m^2/day$ for Germany, the world leader in installed solar capacity. Unfortunately, we have been unable to identify literature estimating the potential solar PV capacity for the province. NB also has significant tidal energy potential, estimated at 5.5 TWh per year in power generation corresponding to a capacity of 636 MW (Triton Consultants Ltd, 2006: 15). Total power generation could exceed 23.5 TWh per year if tidal power in the Bay of Fundy were developed in collaboration with Nova Scotia (NB Power, 2014). Finally, there is also potential to develop additional large-scale hydro power in NB. In the near term, NB Power has identified 100 MW technically available capacity adjacent to the current Grand Falls dam (NB Power, 2017). Extension of the hydroelectric dam at High Narrows was also deemed feasible, with a maximal capacity of 60 MW. Finally, a 2012 map of hydroelectric potential indicates that a potential of 352 MW at 695 sites distributed around the province (GoNB, 2012).

There is also considerable potential for further development of renewable electricity generation in Nova Scotia. Nova Scotia's Electricity Plan 2015-2040 affirms that Nova Scotia's future electricity will primarily be derived from hydro (including the Maritime Link), natural gas, wind, solar and tidal (Nova Scotia Government, 2015b). In terms of wind energy potential, a 2008 study mentioned earlier concluded that it is possible to develop 2000 to 2500 MW of capacity in the province by 2025 (Ea Energy Analyses, 2008: 5). Technical potential for hydroelectric capacity was estimated at 8,900 MW (TEFP, 2016: 95). While it was not possible to find a specific figure for the technical potential of solar PV in Nova Scotia, solar maps hint at an annual average irradiance of 3.3-3.6 $kWh/m^2/day$ (Groszko, 2014: 14). As suggested earlier, Nova Scotia shows considerable potential for the development of tidal energy. The Marine Renewable Energy Strategy has asserted that costs could come down to $0.42 per kWh for in-stream tidal power by 2020 if supportive policies and successful technological innovations were achieved (Nova Scotia Department of Energy, 2017a: 22). Research is continuing regarding tidal energy, with a provincial goal of installing 300 MW by 2028 (Nova Scotia Government, 2015a).

Costs will be the determining factor for ramping up renewable energy in NB & NS. Figure 6 provides of estimated Levelized Cost of Electricity (LCOE) per MWh for traditional and new renewable energy sources for New Brunswick as reported by NB Power (NB Power, 2014: 101-105, Annex 3). The LCOE is defined as the "minimum price at which energy must be sold for an energy project to break even over the life of the project" (NB Power, 2014: 101-105, Annex 3). As cost information such as LCOE estimates are lacking for Nova Scotia, we assume that costs are like New Brunswick. It should be borne in mind that comparing LCOE across different energy technologies is not straightforward. Cost overruns for nuclear power are notoriously common (Sovacool et al., 2014), while electricity produced from natural gas and diesel plants is complicated by that fact that these plants are generally only used under conditions of peak demand. Similarly, the competitiveness of renewables depends on regional fossil fuel and power prices while, and as intermittent technology, renewables may require new balancing power.

While bearing these complications in mind, Figure 6 suggests that, in addition to large hydro and imported electricity, new renewable energy technologies could compete with existing electric power generating capacity. Such trends are increasingly being observed around the world: onshore wind is already competitive with traditional fossil fuel energy sources (even without incentives), while solar PV is projected to become so by 2025 (Stark et al., 2015: vi). It is important to note that the costs of these two renewable energy sources have been declining rapidly. From 2010 to 2015, global average costs for solar

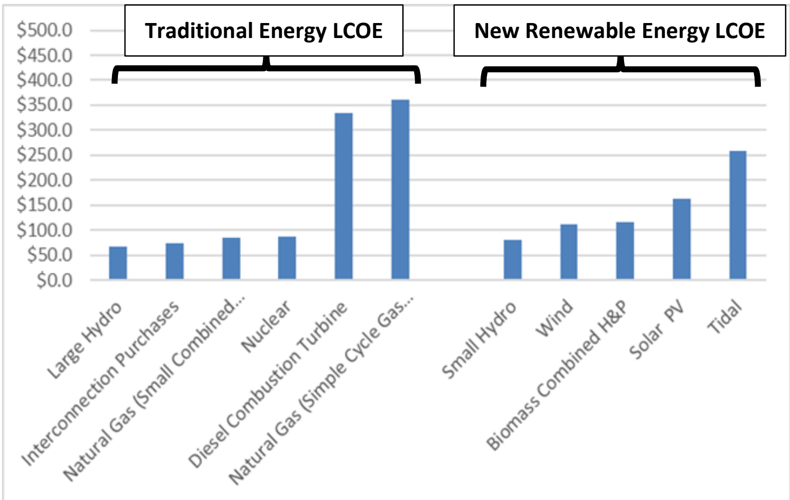
PV decreased by two-thirds, while costs for onshore wind fell by one-third (Stark et al., 2015). According to the International Energy Agency (IEA), the decreasing cost trends of utility-scale solar PV is expected to decrease another 25% from 2015 to 2020 (IEA, 2016). The key question for NB & NS will be whether new in-province renewable energy is competitive with imported hydroelectricity from Quebec and Labrador. While importing hydroelectricity from Quebec and Labrador is a rational option for increasing RE consumption in NB & NS, by relying on imports, the two Maritime provinces may be foregoing the development of a low-carbon energy in-province and reducing the supply of renewable energy resources for other states and provinces in the region.

Table 3. Potential for further development of renewable energy in NB & NS

Energy Source	Potential	Reference
New Brunswick		
Wind (large farm)	3,000 – 4,000 MW by 2025 and 40,000 MW technical potential	(Ea Energy Analyses, 2008), (Gagnon, 2008)
Solar PV (large farm)	Resource map available	(GoNB, 2012)
Tidal	636 MW*	(Triton Consultants Ltd, 2006)
Biomass	463 MW	(Bouchard, 2012; Shannon, 2015)
Hydro	352 MW	(GoNB, 2012)
Nova Scotia		
Wind (large farm)	2000-2500 MW towards 2025	(Ea Energy Analyses, 2008), Wind Atlas (Nova Scotia Department of Energy, 2008)
Solar PV (large farm)	Resource maps available	(Green Power Labs, 2017)
Tidal	60 000MW, 2 500MW without significant impact on marine environment	(Nova Scotia Department of Energy, 2017a)
Biomass	NA	
Hydro	8 900MW**	(TEFP, 2016: 95)

Note: Asterix (*) indicates that this potential does not consider environmental, technological, climate nor economic factors. It is given in terms of mean power which considers daytime variation in the production. The generated yearly power is then obtained by multiplying by the number of hours in a year (Triton Consultants Ltd, 2006). Double asterix (**) indicates technical potential.

Figure 8. Levelized cost of electricity for various sources of energy generation (2013 dollars per MWH)



Note: LCOE derived from NB Power (2014: Appendix 3).

7. Carbon Pricing and Decarbonization

Our discussion thus far has indicated that NB & NS have been able to achieve considerable decarbonization through renewable energy and energy efficiency policies currently being implemented. Indeed, both NB & NS have already exceeded their 2020 emission reduction targets with NS nearly 17% below 1990 levels though NB, at approximately -11%, still has a long way to go to reach its more stringent 2030 target of 35% below 1990 levels. We have also seen that significant additional renewable energy potential exists in NB & NS. While imported renewable energy from Quebec and Labrador will remain important for further decarbonization, there is also opportunity to ramp up renewable energy in-province. And of course, transport and other sectors of the economy of NB & NS might also be involved in future decarbonization efforts to a larger degree. The question regarding linking to the WCI is, can NB & NS decarbonize their economies at a cost that is competitive vis-à-vis other WCI partners, especially California where economic models now suggest Quebec and Ontario are seeking to reduce their emissions (CARB, 2012; Sawyer et al., 2016; WCI Economic Modeling Team, 2012). It is currently cheaper to reduce emissions by buying emissions allowances in California than it is Quebec and Ontario. What might it cost to further decarbonize NB & NS?

7.1. The Modeling Gap

Unfortunately, we cannot offer a firm answer to this question. Understanding the impact of carbon pricing on emissions in NB & NS into the future is a complex undertaking requiring detailed modeling and public consultation (Geels et al., 2016). While certain climate and energy modeling efforts have been undertaken in Canada over the years, a number of limitations frustrate their application to emissions trading between California, Quebec, Ontario, New Brunswick and Nova Scotia. Most importantly, the majority of recent modeling efforts looking ahead to 2030 have taken a national approach, including *The Deep Decarbonization Pathways Project* (Sawyer and Bataille, 2016) and *The Trottier Energy Futures Project* (Trottier Family Foundation, 2016). But under Canadian federalism, provinces possess significant constitutional powers over matters related to natural resources and the environment within their borders (Morton, 1996). This is not to say that the federal government is unimportant or has little role to play but there has been insufficient publicly-available and up-to-date climate and energy modeling across

Canadian provinces. Publicly available, provincial-level modeling efforts have been undertaken for 2010 and 2020 (Bataille et al., 2002; Rivers, 2010), which tends to put them out of date for planning purposes. We note that 2030 provincial analyses certainly exist (see Bohringer et al., 2015), but comprehensive results do not yet appear to be in the public domain.

But a second challenge presents itself for understanding the implications of joining the WCI for NB & NS. Many of the provincial-level studies cited above aggregate the four provinces of Atlantic Canada into a single region. This is problematic given that emissions in Newfoundland and Labrador have seen some of the most significant growth of any province in Canada. Given growth in the oil sector in Newfoundland and Labrador in recent years, emissions are expected to grow 123% above 1990 levels in a 2020 business-as-usual scenario, in comparison to more modest growth in NB & NS, 59% and 33%, respectively (Rivers, 2010: 52). In addition, NB & NS have shown different levels of ambition for reducing emissions, which makes results of such regional modeling output less useful for policy planning. It is difficult to draw firm conclusions about the opportunities and risks for NB & NS linking to the WCI from review of modeling output for Atlantic Canada.

Last, there has been very little modeling done to consider emissions trading across Canadian provinces and with US states including California. It is true that modeling of emissions trading between the US and Canada has been undertaken. A modeling effort by Sawyer and Fischer (2010) has indicated that—all else being equal—it is marginally less expensive to reduce emissions south of the border. However, except for Wei and Rose (2008), most economic modeling of subfederal emissions trading has been done explicitly with regard to California and Quebec (CARB, 2012; WCI Economic Modeling Team, 2012) and, more recently, California, Quebec and Ontario (Sawyer et al., 2016). How might a carbon price emerge across the WCI as additional states and provinces join one by one?

7.2. Reasons for Optimism about Linking to the WCI

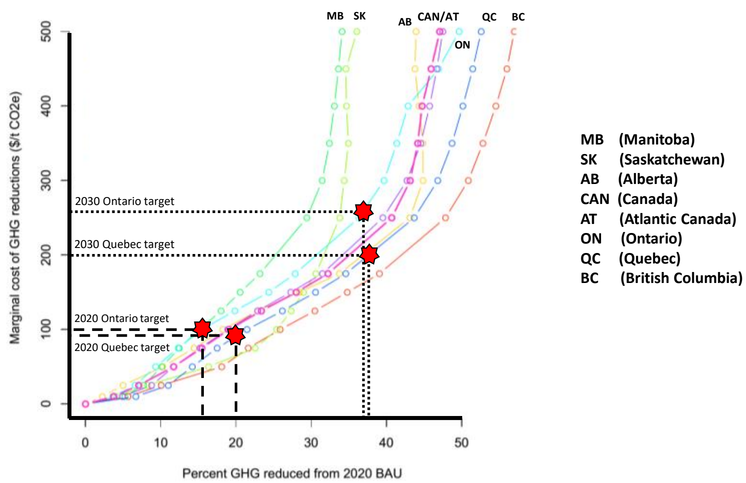
Despite the lack of sufficient modeling insight, based on existing evidence, we posit that it is likely that the costs of reducing emissions in NB & NS is competitive with California at current market prices. Consider the marginal abatement cost curves across Canadian provinces/regions and US states in Figures 9 & 10 below. Of course it should be borne in mind that the results in the two figures are not directly comparable, given they were developed by different modeling teams each with their own set of assumptions (Rivers, 2010; Wei and Rose, 2008). Furthermore, both are limited to 2020 and not oriented towards a mid-term 2030 target that would be more appropriate for current planning purposes.

Nonetheless, Figure 9 indicates that reducing emission in Atlantic Canada is slightly less expensive than in Ontario, though slightly more expensive than in Quebec. Based on what we know of the economies of Quebec, Ontario, New Brunswick and Nova Scotia, we venture that it is quite possible that reducing emissions in the two maritime provinces is cheaper than in Central Canada. Quebec has extensive hydroelectric capacity—much of the surplus of which is exported—which means that reducing emissions further is relatively more costly compared to jurisdictions still relying on fossil fuels. However, with surplus electricity, considerable opportunities to reduce emissions in the transport sector would appear feasible in Quebec (Bahn et al., 2013). Prior to joining the WCI, Ontario had taken considerable action to reduce emissions by completely phasing out coal-fired power plants as early as 2014 (Cundiff, 2015) while nearly 60% of the province's electricity is derived from nuclear power (CNS, 2017). More up-to-date modeling would be necessary to confirm our assessment, but there would appear to be greater opportunity for low-cost decarbonisation in NB & NS than in Central Canada.

The question then becomes, is it cheaper to reduce emissions in NB & NS than in California? Figure 10 presents marginal abatement cost curves for 2020 amongst California, Quebec and a number of other former WCI members, most who have since withdrawn from the initiative (Wei and Rose, 2008). It indicates that the cost of reducing emission in Quebec is also slightly higher than in California. These results align with other modeling efforts of the California-Quebec carbon market as discussed above. However, we are aware of no modeling of emissions trading between WCI partners that looks ahead to 2030. Nonetheless, we might envision a few scenarios about future WCI carbon prices.

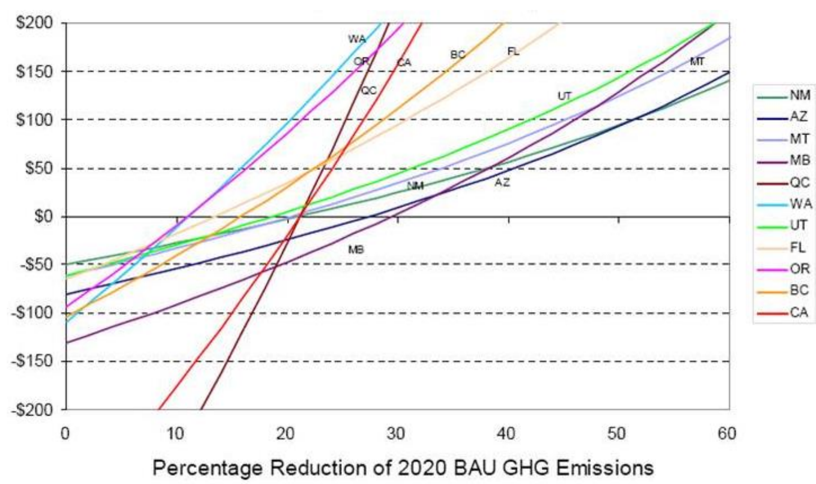
First, the strategy proposed by CARB post-2020 proposes that regulations continue to be an important feature in California's post-2020 climate change strategy, responsible for as much as 72% of the state's reductions (CARB, 2017: 41). Under this scenario, it is likely that regulations continue to do most of the heavy lifting while the carbon market mops up the residual emission reductions. The implication for interjurisdictional emissions trading is that WCI carbon prices will continue to hug the price floor which, at current scheduled increases, will grow to an estimated $34 by 2030 (in 2016 dollars). If the long-term costs of reducing emissions in NB & NS is below $34, there is a good chance that WCI carbon finance from Quebec and Ontario would flow into the two maritime provinces rather than California.

Figure 9: Marginal Abatement Cost Curves for Canadian provinces/regions, 2020



Source: Rivers (2010: 54). Note that marginal abatement cost curves in Canada and Atlantic Canada are very close in the figure above, for which reason their label is separated by a "/".

Figure 10: Marginal Abatement Cost Curves for Various States and Provinces, 2020



Source: Wei and Rose (2008: 6). Note that QC is Quebec and CA is California

But is WCI's carbon price floor set in stone? It needs to be borne in mind that despite designation as a "market-based instrument", the WCI carbon market is very much shaped by government intervention. In this light, it is interesting to note that Quebec originally proposed a price floor starting at $15/tCO2e in 2012 and rising 7% per year, though this was modified to facilitate linking with California (IETA, 2012b). At the price floor originally proposed by Quebec, we estimate the 2020 floor price would have been $34 in 2020 and $68 by 2030 (all in 2016 dollars). This is a considerable difference from the current situation. The recently proposed SB775 would start at $26 ($20 USD) in 2020 and reaching $92 ($70 USD) by 2030 (all Canadian values estimated in 2016 dollars)—of course depending on exchange rates.[i] It is too soon to offer a thorough analysis of SB775, but the strategy behind this proposed reform would appear to be to make the costs of California's climate mitigation policy more transparent and reliable by shifting more of the emission reduction effort from regulation to a carbon price signal. While attractive in economic terms, as we have suggested before—and as the experience of BC's carbon tax tends to support—making the costs of climate policy transparent may have the negative side-effect of rendering them less politically palatable. It cannot be assumed that SB775 will sail through the legislative process, given the non-negligible opposition to climate policy evidence by California's recent court case—which itself may continue to the US Supreme Court. Nor should we assume that Quebec and Ontario will accept a unilateral hike in WCI carbon prices without more deliberation. Nonetheless, there is a political window during which to discuss raising the WCI carbon floor price.

Figure 11 presents results of various hypothetical increases in the WCI carbon floor price in graphical form along with the Canadian federal government's carbon floor price. From the perspective of NB & NS, it is likely that any such increase in the WCI carbon price floor will be favourable to the objective of seeing carbon finance flow from Quebec and Ontario to the Maritimes rather than to California. In effect, an increase in the carbon price floor will render reductions in California less competitive relative to reductions elsewhere in the WCI. While more emission reductions would likely be undertaken in Quebec and Ontario themselves, a raised price floor will also increase the attractiveness of NB & NS vis-à-vis California as jurisdictions for reducing emissions. It might also address criticism that Quebec and Ontario are simply buying their way out of their emission reduction commitments under the WCI and paying to modernize the energy sector of California rather than at home (Mousseau, 2017). We note in Table 1 above that Quebec's emissions actually increased by 0.1 MtCO2e between 2014 and 2015, though they are down from 2013 when Quebec initiated the cap-and-trade program. With only limited experience with emissions trading, more time is necessary to evaluate Quebec's emissions in light of its linkage to California through the WCI.

But even the proposed 2030 carbon floor price under SB755 may still be attractive from a Canadian perspective. Even an estimated $92 ($70 USD) price floor is still considerably lower than the estimated $200 per tCO2e cost of reducing emissions in Canada in order to reach its Paris commitment. However, the SB775 carbon price floor is higher than in the scenario suggested by Jaccard where a $40 explicit carbon price operated in parallel to Canadian regulations (Jaccard et al., 2016). Also interesting, Figure 11 indicates that the carbon price floor proposed under California's SB775 is similar to the current price trajectory of the Pan-Canadian Framework. Is there an effort by certain California legislators to harmonize California prices with the Canadian government's federal pricing strategy? While our conclusions here are only preliminary and would need to be confirmed through more detailed modeling, an increase in the carbon price floor could offer political advantages for Canadian WCI partners by ensuring more emissions reductions are achieved in Canada, especially in provinces such as NB & NS.

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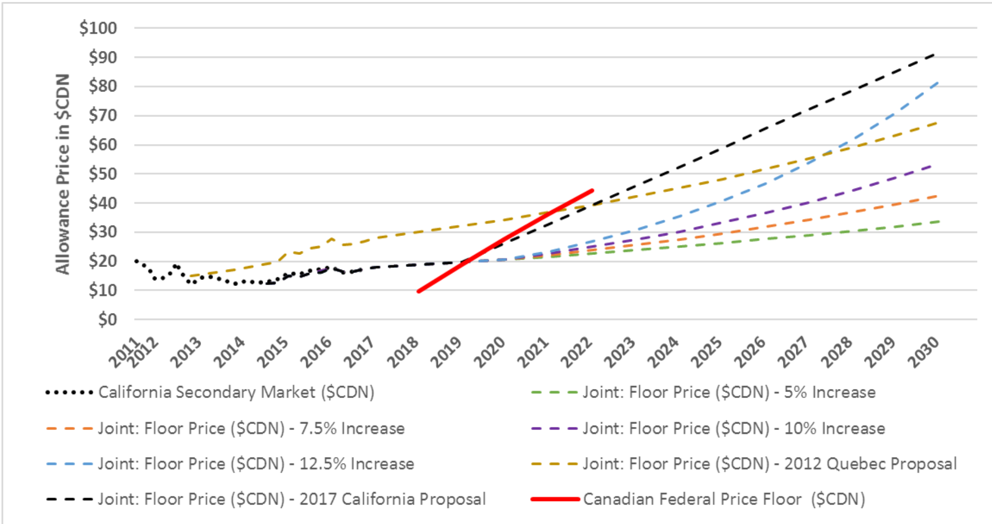
[i] We modeled the SB577 carbon floor price through 2030 based on a current exchange rate of 1 USD = 1.31 CDN.

Figure 11. Hypothetical scenarios of evolution of WCI carbon price floor (2016 dollars)



Note: The Pan-Canadian Framework describes carbon prices from 2018-2022 only in nominal terms (Government of Canada, 2016: 49); these were adjusted to account for an estimated 2% annual inflation in the figure above. Historical and current (monthly) exchange rates through 2017 derived from Bank of Canada; for projections after 2017 exchange rate was set at 1 USD = 1.31 CDN (an extension of current rates).

7.3. Reasons for Concern about Linking to the WCI

While there does appear to be an opportunity for carbon finance to flow into NB & NS under current WCI carbon floor prices, and recognizing that there is potential interest in raising the carbon price floor further, there are risks that WCI carbon prices trend downwards. One concern is that other sources of low-cost emission reductions could be brought into the WCI, including Mexico's potential involvement (ICAP, 2017b: 9-10), as well as California's interest in international offsets (CARB, 2015). If such potential new supply of low-cost emissions reductions is not carefully coordinated with greater emission reduction effort across all partner jurisdictions, these potential developments might reduce carbon prices and render the relative advantage of NB & NS less attractive.

While Quebec and Ontario have signed an agreement with Mexico to develop joint carbon markets (McCarthy, 2016), California's 2017 Scoping Plan Update makes no mention of Mexico. When discussing additional linkages in the context of the WCI, it is important to note that the program has rules governing this process (WCI, 2010: DD-44-45). This includes requirements of a binding and annually declining aggregate total emissions cap, a set of administrative elements, enforcement measures as well as capability "of transferring between linked jurisdictions all information necessary to monitor market trends on a regional basis" (Ibid.). It will be interesting to see how discussion unfolds about whether Mexico is capable of meeting these requirements. We note in passing that both NB and, especially, NS would likely have to ratchet up their 2030 target to meet the WCI's linking requirements as well.

As for international offsets, CARB has indicated that an international offset program for reducing emissions from deforestation in the Brazilian state of Acre is "ready to be considered for linkage" (CARB, 2017: 29). Such offset programs differ from emissions trading systems in fundamental ways, most notably in that they operate as baseline-and-credit systems. Questions of effectiveness and "environmental integrity" have dogged similar efforts, most notably the Clean Development Mechanism (CDM) of the Kyoto Protocol which sought to engage developing countries on climate change mitigation (Cames et al., 2016; Wara, 2008). It is beyond the scope of the current paper to comment on international offsets except to observe that under low carbon prices that characterized the first commitment period of the Kyoto Protocol, CDM projects were most effective under a rather limited set of economic and political conditions (Purdon, 2015). Higher carbon prices could make the transition to low-carbon development easier to observe for regulators and also more attractive for state and non-state actors to implement. Finally, we close this section by pointing out that neither Quebec nor Ontario appear to be currently considering international carbon offsets.

8. Conclusion

Our review of the opportunities and risks for NB & NS to establish and link emissions trading systems with California, Quebec and Ontario under the auspices of the WCI has shown that there are many moving parts. Much of the complexity lies with California. No sooner had the state seemed to turn a page on outstanding legal questions regarding its emissions trading scheme in April 2017 than a new senate bill proposed significant revisions to CARB's plan of combining carbon pricing and regulations for reducing emissions. There are also ongoing critiques about inter-state emissions leakage confronting California that would benefit from further objective review. As California emerges as an anchor for North America and global climate change efforts, scrutiny of its policies and strategies will only increase.

At the same time, a number of limitations confront Canadian analysts interested in the prospect of seeing carbon finance flow via the WCI to NB & NS or any other province to further decarbonize their economies. Much of this is tied to insufficient provincial-level modeling capacity, which is particularly pronounced for provinces of Atlantic Canada who are often lumped together in most modeling efforts. Adding to this challenge, most Canadian modeling efforts have focused on Canada-wide climate policy and have not considered linkages with the US nor California. Finally, the important role of regulations in climate change policy has only recently emerged, with only a handful of modeling exercises considering them. We agree that politics are likely to make regulatory approaches quite attractive in the foreseeable future, which has important implications for carbon pricing. However, we caution that climate policy is not simply a question of building better models. Building climate and energy models alive to the political challenges inherent in efforts to address climate change requires greater collaboration between economists, engineers, political scientists as well as the broader public and civil society (Geels et al., 2016).

The current study sought to circumvent these modeling gaps by plunging into the details of climate and energy policy in NB & NS. We have demonstrated that there has already been considerable progress in reducing emissions in these two provinces and that opportunities for further reductions exist through expansion of in-province renewable energy generation and demand management efforts. But our analysis was limited to the electricity sector. While important as currently the largest source of emissions, we did not consider opportunities in other important sectors including transport and buildings. Finally, while we discussed the potential role of international carbon offsets in the WCI, we did not discuss the opportunities for offsets in the two Maritime provinces. There is still much to be learned. Overall, it is reasonable to conclude that at an appropriate cost, carbon finance flowing from other WCI jurisdictions could drive these greater emissions reductions in NB & NS. But is the cost of reducing emissions in NB & NS competitive?

Despite the caveats above, there are grounds to believe that NB & NS can compete with California in offering Quebec and Ontario low-cost emission reductions and, as a result, stand to see carbon finance inflows upon joining the WCI. While much of the currently planned decarbonization in the two Maritime provinces is afforded by importing hydroelectricity from Quebec and Labrador, we have also seen that significant additional renewable energy potential exists in NB & NS themselves. And while the technical elements of our current study have focused on the power sector, the inclusion of the transport sector and other sectors of the economy of NB & NS promise to lower costs of reducing emissions while expanding effort. There does appear to be room for more ambitious emission reduction efforts in these two Maritime provinces, which would appear to be necessary in order to become effective partners to the WCI. At current prices on the WCI carbon market, reducing emissions in NB & NS appear competitive with California and this would likely increase if the rate of increase of the carbon price floor were accelerated. While more detailed studies will be required to determine if the opportunity of carbon finance inflows into NB & NS is real and outweighs the risks we have identified, given the considerable opportunity this represents for these two Maritime provinces such an exploration would be worthwhile.

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10. About IQCarbone

The Institut québécois du carbone/Quebec Carbon Institute (IQCarbone) is a non-profit organization whose vision is to become an important source of information and research on Quebec and global climate change policy. To this end, the Institute offers original and innovative research distinguished by its quality and academic rigor. The Institute aspires to become one of the largest groups of specialists, experts and academics working on climate change policy in Quebec.

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