

CANADIAN  
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# ECONOMIC AND ENVIRONMENTAL IMPACTS OF TRANSITIONING TO A CLEANER ELECTRICITY GRID IN WESTERN CANADA



## Executive Summary

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With the Pan-Canadian Framework on Clean Growth and Climate Change, Canada has set an ambitious goal to reduce greenhouse gas (GHG) emissions to mitigate global climate change while sustaining economic growth. Guided by the Pan-Canadian Framework, Canadian provinces are acting through the implementation of programs and regulations to reduce GHG emissions in respective economies. Central to the GHG emissions reduction plan is reducing GHG emissions from the electric power sectors of Canadian provinces. A multitude of policies and programs are being implemented to reduce GHG emissions from electricity generation.

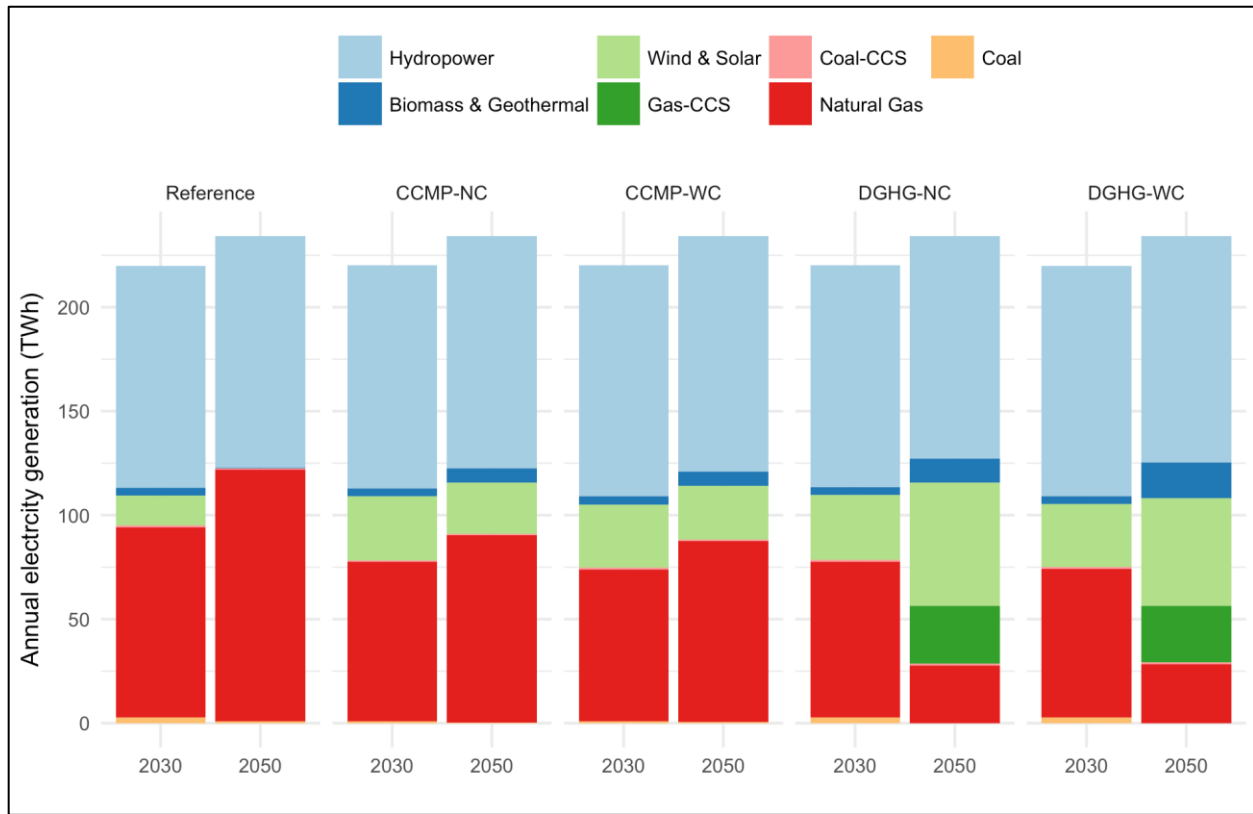
The purpose of this CERI study is to assess economic impacts and GHG emissions under alternative pathways of transforming the electricity grid in the four western provinces: British Columbia, Alberta, Saskatchewan, and Manitoba. The alternative pathways are primarily characterized by energy and climate change policies that are already adopted or could potentially be adopted by the provincial and federal governments. In this study, the pathways are developed into five scenarios. These scenarios consist of a reference scenario (Reference), two carbon pricing scenarios (CCMP-NC and CCMP-WC), and two carbon emissions cap scenarios (DGHG-NC and DGHG-WC). Two scenarios in each of the latter two categories have the same policy targets but differ by whether provinces coordinate with each other by increasing electricity trade (CCMP-WC and DGHG-WC) or no higher level of coordination among provinces is sought (CCMP-NC and DGHG-NC). Higher coordination scenarios assume doubling of current intertie capacities.

This study focuses on the period 2020-2055. CERI has developed an electric power system investment planning and economic dispatch simulation model to conduct the underlying analysis in this report.

Figure E.1 shows the combined electric power generation mix of the four western provinces under each scenario in five-year periods starting in 2030 and 2050. As can be seen from the figure, in most cases the dominant power generation options in the western grid are hydropower (in British Columbia and Manitoba) and the natural gas-fired technologies (in Alberta and Saskatchewan). Under the Reference scenario, the share of electricity produced by natural gas-fired technologies in Alberta rises to 99% by 2050. This is due to the variable nature of renewable electricity generation and low natural gas prices. Despite the dominance of natural gas, both the total GHG emissions and emissions intensities will be lower than 2005 levels in Alberta and Saskatchewan due to the retirement of coal-fired generation.

Under all scenarios, power generation in Manitoba and BC will be dominated by hydropower. Some natural gas-fired generating units get added to these two provinces to compensate for variations in seasonal hydropower supply.

Figure E.1: Electricity Generation in Western Canada in 2030 and 2050



Under the CCMP-NC & CCMP-WC scenarios (carbon pricing scenarios) the generation mix of Alberta and Saskatchewan notably changes. The share of renewable energy in Alberta's generation mix increases from 16% in 2020 to 30% in 2030 and after. In Saskatchewan, the renewable share increases from 17% in 2020 to 26-35% after 2030. The increase in renewable share is driven mainly by renewable energy targets as opposed to the credits provided by the carbon pricing systems. Nonetheless, renewables receive incentives under the carbon pricing system. The dominant renewable energy technology in Alberta is wind power. By 2050-2055, solar PV and geothermal energy start competing with wind for the 30% renewable energy target set by Alberta.

The two emissions cap scenarios (DGHG-NC and DGHG-WC) lead to transformative changes in the electricity generation mix in Alberta and Saskatchewan after 2045. The deep GHG emissions cap of 80% drives conventional natural gas-fired generation away from the generation mix. Up to 2040, the capacity and generation mix in the two provinces remains close to those under the carbon pricing scenarios but changes significantly after that.

In both Alberta and Saskatchewan, a large amount of renewable energy gets added to the generation mix under the carbon cap scenarios. By 2050, as the carbon cap becomes more stringent, the power system in Alberta will require a low carbon flexible generation source. Consequently, natural gas combined cycle units with carbon capture and storage and geothermal

energy enter the generation mix. Under these scenarios, the share of electricity from renewable sources and CCS units reached over 75% in both Alberta and Saskatchewan by 2050.

Table E.1 presents some key metrics pertaining to the four provincial electric power systems under each scenario. As can be seen from Table E.1, compared to the Reference scenario, the average cost of electricity is higher when different climate change policies are enforced (i.e., carbon pricing, renewable targets, and carbon caps). There are few exceptions. Under carbon pricing scenarios, credits received by hydropower in BC and Manitoba lowers the average cost of electricity in those two provinces. The highest cost increase compared to the Reference scenario is observed under the carbon cap scenarios.

**Table E.1: Summary of Scenario Results**

	Province	Reference		CCMP-NC		CCMP-WC		DGHG-NC		DGHG-WC	
		2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Emissions intensity (gCO <sub>2</sub> e/kWh)	AB	345	397	279	288	278	290	281	108	282	119
	BC	7	13	7	18	9	10	7	4	9	1
	MB	9	21	9	20	8	12	6	2	0	3
	SK	368	351	262	278	248	265	316	115	301	97
Relative GHG emissions (% of 2005 GHG emissions from electricity generation)	AB	57%	73%	46%	52%	43%	52%	47%	20%	44%	21%
	BC	38%	72%	38%	98%	53%	55%	38%	20%	53%	6%
	MB	93%	221%	91%	211%	82%	128%	62%	20%	5%	26%
	SK	59%	63%	42%	52%	41%	52%	50%	20%	50%	19%
Average cost of electricity for residential customers (cents/kWh)	AB	12.0	12.8	12.4	13.9	12.4	14.0	12.7	16.3	12.7	16.2
	BC	13.0	11.6	11.1	9.8	11.0	9.6	13.0	11.6	12.8	11.7
	MB	11.4	10.8	9.5	9.0	9.2	8.8	11.5	11.3	11.1	10.5
	SK	11.5	12.4	11.9	12.8	12.0	12.7	12.3	15.0	12.4	15.1

In the higher coordination scenarios, provinces increase the intertie capacities to increase electricity trade. The intended benefit is reducing the overall cost by sharing resources and providing system balancing services. In the carbon cap scenarios, when provinces have higher coordination, a combined carbon cap is set for the whole western region. The intention here is to achieve higher emissions reductions where it is cheaper to do so. In scenarios where provinces have higher coordination, the total cost is lower compared to the scenario with the same policy goals. As such, the value of coordination for carbon pricing scenarios is CAD\$1,691 million. For the carbon cap scenarios, the value of coordination is estimated to be CAD\$1,812 million. The effectiveness of coordination to reduce overall cost is constrained by the amount of investment needed to enhance the intertie capacities.

Both sets of policy scenarios (carbon pricing scenarios and carbon cap scenarios) can achieve the intended goal of reducing GHG emissions while not significantly increasing the average cost of

electricity. In addition to the main results summarized here, the report also provides insights into renewable energy regimes and impacts of operating a power system with the higher amount of variable generating sources.