# STUDY OVERVIEW: ECONOMIC AND ENVIRONMENTAL IMPACTS OF TRANSITIONING TO A CLEANER ELECTRICITY GRID IN WESTERN CANADA

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## BACKGROUND & STUDY SCOPE

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 framework, Canadian provinces are acting through the implementation of programs and regulations to reduce GHG emissions in respective economies. Central to the emissions reduction plan is reducing emissions from electric power sectors in Canada. A multitude of policies and programs are being implemented to reduce emissions from electricity generation.

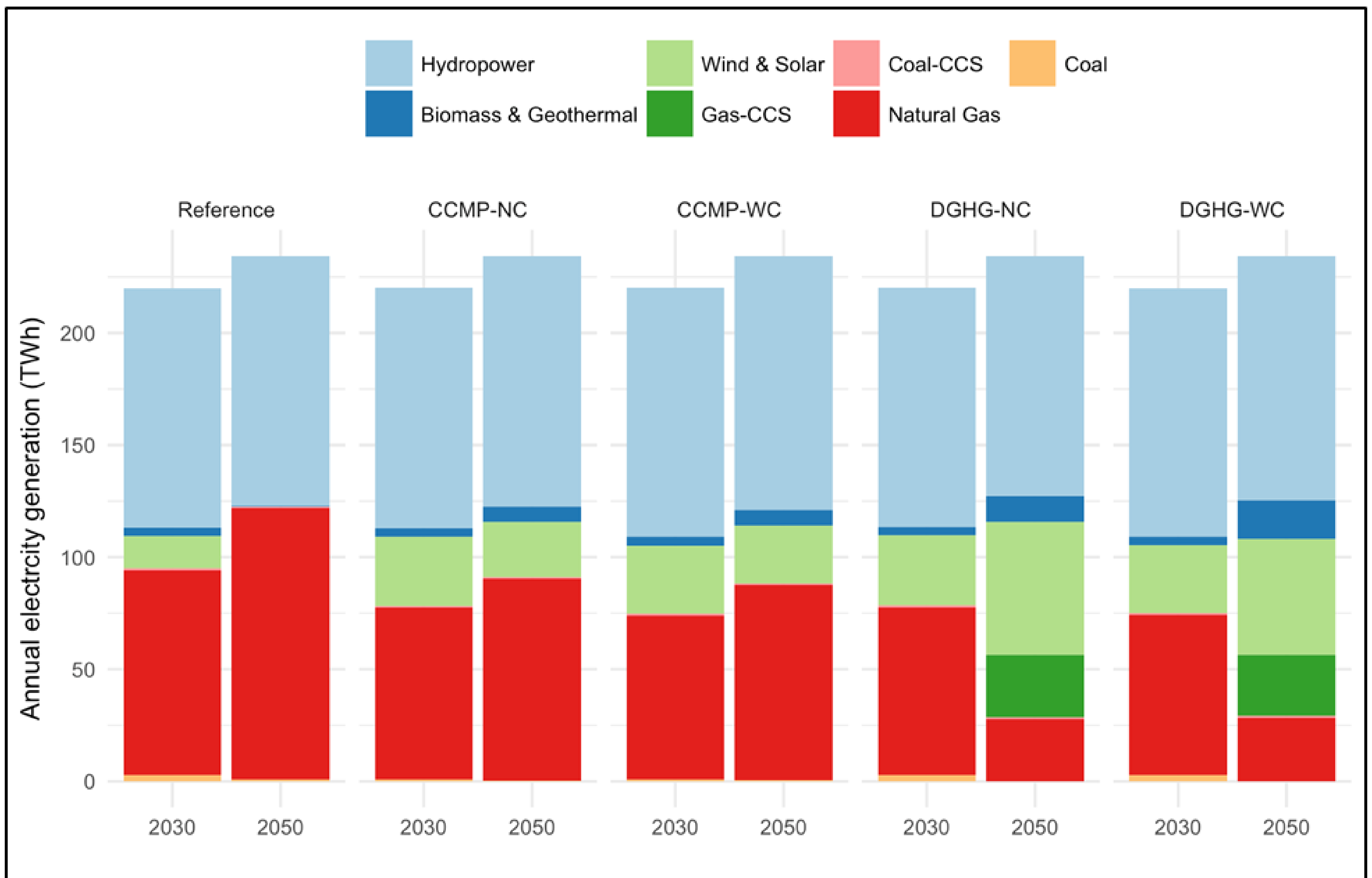
This study assesses the economic impacts and GHG emissions under alternative pathways of transforming the electricity grid in BC, AB, SK and MB, in particular an expansion of the coordination of the provincial grids through increased interties. Pathways are primarily characterized by energy and climate change policies that are already adopted or could potentially be adopted by provincial and federal governments.

In this study, focused on the period 2020-2055, we examine five scenarios: a reference scenario (Reference), two carbon pricing scenarios (CCMP-NC and CCMP-WC), and two carbon emissions cap scenarios (DGHG-NC and DGHG-WC). The scenarios explore the different economic impacts of enhanced coordination (WC) compared to no additional coordination (NC). CERI developed an electric power system investment planning and economic dispatch simulation model to conduct the underlying analysis in this study.

## STUDY FINDINGS

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. In most cases the dominant power generation options in the western grid are hydropower (in BC and MB) and natural gas-fired generation (in AB and SK). Under the Reference scenario, the share of electricity produced by natural gas-fired generation in AB rises to 99% by 2050. This is due to the variable nature of renewable electricity generation and low natural gas prices. This result indicates that even with dropping costs for renewable generation, the additional services provided through firm power options is an important decision factor for grid planners.

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




As such, increased penetration of renewables needs policy support. 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 MB 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.

Under the two carbon pricing scenarios, the generation mix of AB and SK notably changes. The share of renewable energy in AB's generation mix increases from 16% in 2020 to 30% in 2030 and after. In SK, 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 AB is wind power. By 2050-2055, solar PV and geothermal energy start competing with wind for the 30% renewable energy target set by AB.

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## STUDY FINDINGS

The two emissions cap scenarios lead to transformative changes in the electricity generation mix in AB and SK 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 AB and SK, 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 AB will require a low carbon flexible generation source. Consequently, natural gas combined cycle units with carbon capture and storage (CCS) 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 AB and SK by 2050.

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

In the higher coordination scenarios (WC), 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 and no additional coordination. 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.

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

| | | Reference | | CCMP-NC | | CCMP-WC | | DGHG-NC | | DGHG-WC | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Province | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| Emissions intensity (gCO2e/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 |