What if BC & Alberta were to Cooperate on Green Power?

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INTRODUCTION

At 11.4 t CO_2e per person per year, the coal and natural gas (NG)-dominated electrical grid of Alberta (AB) is responsible for ca. 100 times more greenhouse gas (GHG) emissions than the hydro-dominated grid in British Columbia (BC) [1][2] (Fig. 1).

BC has large undeveloped hydro resources (est. at 32 GW with potential for 119+ TWhr/yr [3][4]) that could provide AB with C free power and deliver other benefits, including:

- ❑ Reduce the life cycle GHG emissions associated with other AB industries, including oil sands;
- ❑ Reduce adverse health impacts associated with coal power;
- ❑ Protect AB power costs from increases in NGas price;
- ❑ Provide energy storage for intermittent wind generation
- ❑ **Create an opportunity for interprovincial cooperation around energy that could include energy corridors to bring power into the province while carrying oil and gas resources to international markets.**

To explore alternatives, we modeled three scenarios for AB's electricity future to 2060:

(A) Coal: Maintain 2012 generation mix;

(B) NGas: Transition to NG as per AESO LTO 2012 update;

(C) LowC: Imported BC hydro coupled with more AB wind & solar.

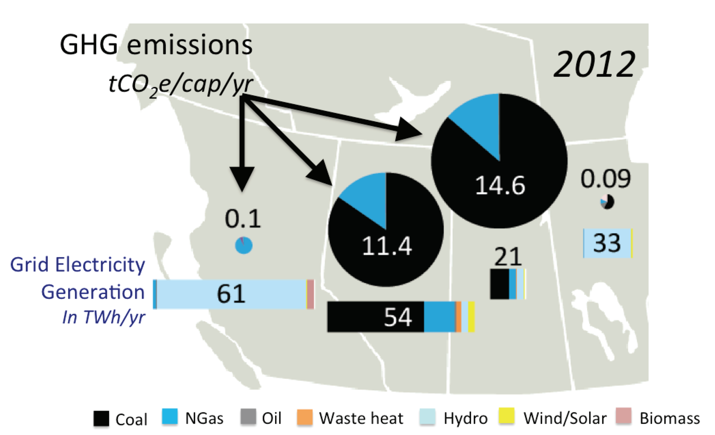


Fig. 1. Grid Generation and associated per capita emissions in W Canada

METHODS

A model of the electricity supply and demand for the AB Grid (excluding oil sand CHP) was built in Microsoft Excel using the following principles & assumptions:

- ❑ All scenarios must be resilient
- ❑ Once built, a power plant runs for its intended life;
- ❑ The economic & population growth of AB is coupled to the oil sands growth, as extrapolated from AB Treasury Bd, AESO & CAPP data as shown in Fig. 2 [5][6][7];
- ❑ By 2020 & beyond, all oil sands power for all scenarios was assumed to be provided by off-grid power from Ngas CHP;
- ❑ Total Grid demand extrapolated from AESO values to 2060
- ❑ Assumes 9% ROI +Capacity Factors, Capital (CAPEX), Operational (OPEX) and fuel costs as per Table 1.
- ❑ Calculated Levelized cost assuming C levy with portion of proceeds invested in offsetting CAPEX for LowC scenario.

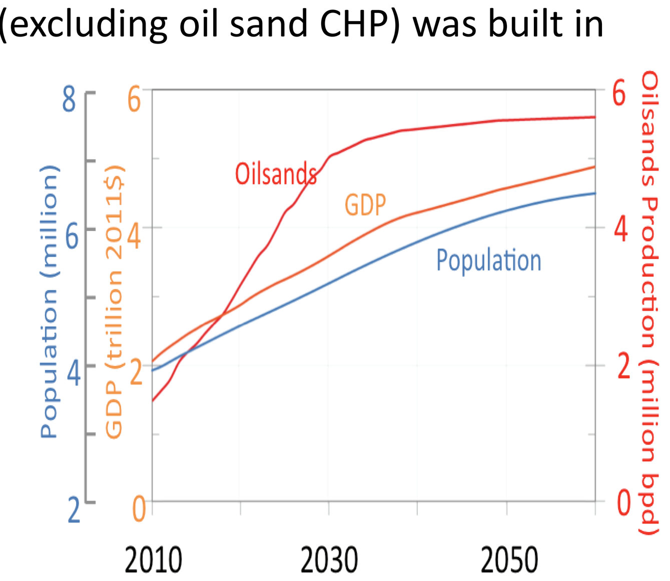


Fig. 2: Pop'n, GDP &oil sands growth

Table 1: Parameters for Cost Analysis (from [6],[8],[9],[10],[11])

Power Source	Avg CF (%)	Ref. build size (MW)	Build time (yrs)	Lifetime (yrs)	Capital Expense ($/kW)	Operational Expense			Heat Rate (GJ/MWh)	Emission (kgCO2e/MWh)
						Fixed ($/kW)	Variable ($/kWh)	Fuel ($/GJ)		
Coal	55%	450	4	50	3,850	33	6.3	1.5	9.4	987
NG-CC	71%	300	3	30	1,435	15.5	3.7	Variable	7.2	367
NG-SC	30%	100	3	25	1,150	14	4.3	Variable	9.8	500
Hydro	30%	100	10	100	5,055	0	12	0	0	0
Wind	32%	150	2	25	2,300	50	2	0	0	0
Biomass	60%	100	2	30	4,038	104	5.16	3[3]	12	0
Solar	22%	100	2	25	2,000	24.2	0	0	0	0
Hydro import	45%	100	10	100	5,055	0	12	0	0	0
HVDC line	45%	>400	6	50	600	0.5	0	0	0	0

RESULTS

A. Generation Mix in the Three Scenarios:

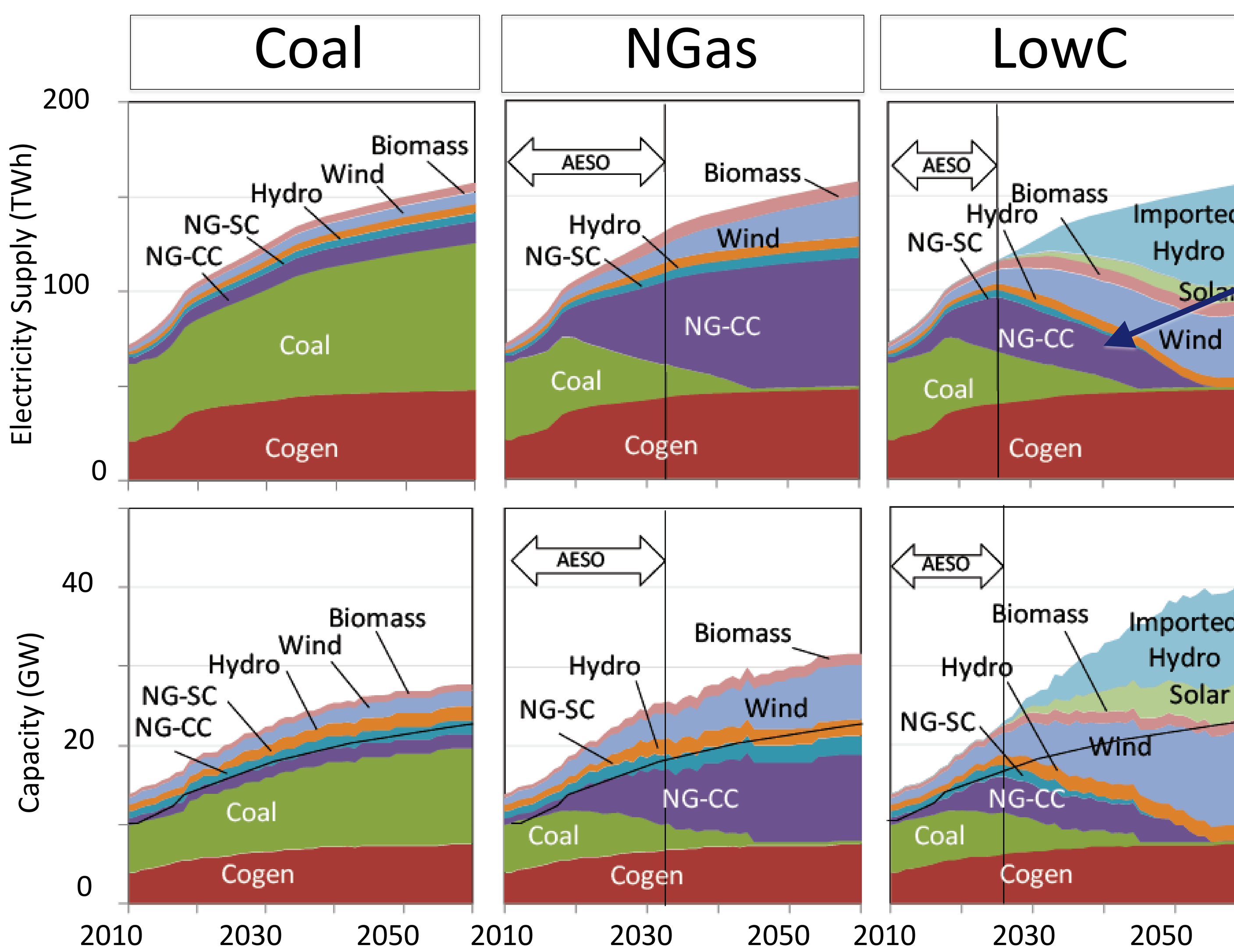
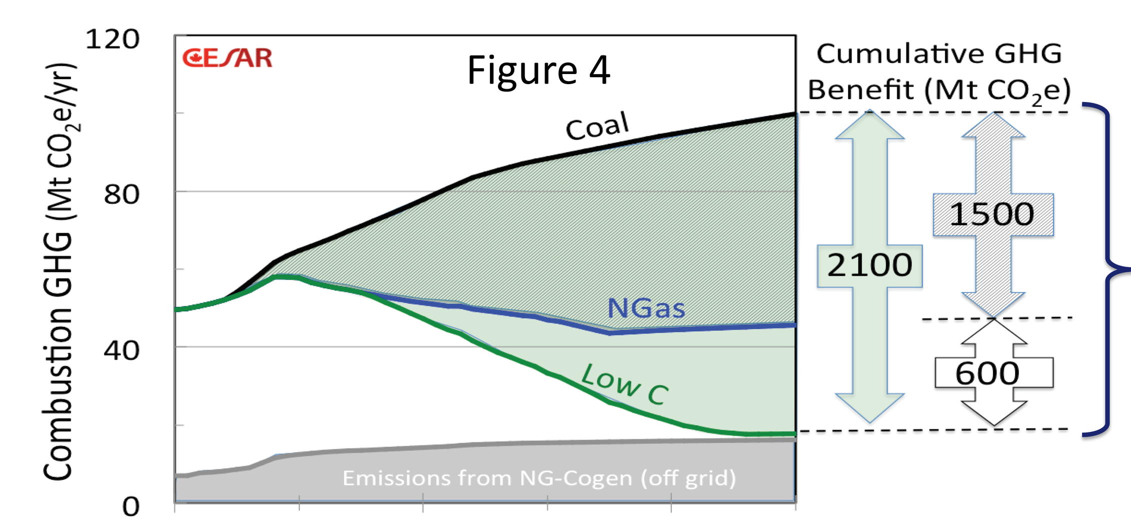


Figure 3: Generation and Capacity for the three scenarios

NOTE

- In LowC Scenario, NG is a transitional fuel (to late 2020's) when new imported hydro can be brought online.
- The lower capacity factors and intermittency of renewables requires more capacity build.

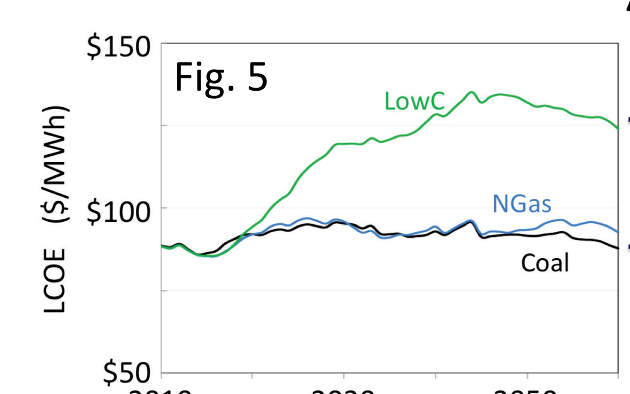
B. GHG Emissions:



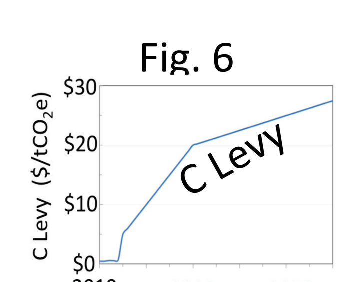
- LowC delivers major reductions in GHG emissions of 25-80 Mt/yr

C. Levelized Cost of Electricity

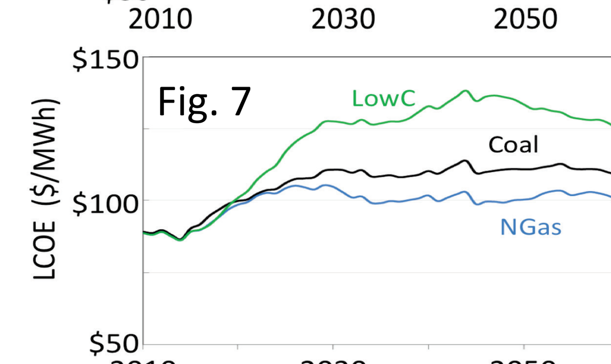
✗ No C Levy;
✗ No C investment



- With no C Levy, the expensive CAPEX for hydro elevates LowC power cost by ~25-30%.

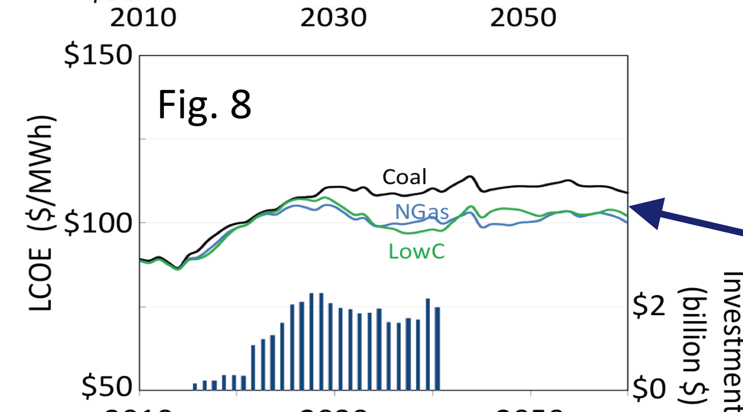


✓ C Levy;
✗ No C investment



- With a ramping C levy (Fig 6), the premium cost for the LowC Scenario reduces to ~10%

✓ C Levy
✓ + C Investment



- By investing a portion (~$37B) of the C levy to offset the high CAPEX for hydro, electricity price in LowC is competitive.

DISCUSSION / CONCLUSION

A shift to the NGas Scenario from the Coal Scenario delivers the largest GHG emission reductions for the lowest cost. However, the NGas Scenario would still have a significant GHG footprint, especially if upstream NG emissions are included. Moreover, there are risks associated with future price volatility for NG fired electricity.

Another option (i.e. the LowC Scenario) is to envisage NG as a transitional fuel on the road to a longer term solution involving cooperation between BC and AB to develop BC's large untapped hydro resources for export to AB.

The high CAPEX and long build time for hydropower makes it an expensive option until the capital costs are paid off. Then hydropower becomes a very cost-effective electricity source.

A combination of a ramped C levy (from $5/t CO_2e in 2015 to $28/t CO_2e in 2060) and an investment into offsetting CAPEX for renewables (Fig. 5-8) made electricity in the LowC scenario cost competitive.

Given the large GHG emission reductions, the cost for this scenario declined with time and was as low as $17/t$CO_2e$ by 2060 (Fig. 9).

While the decades required to achieve cost-effective emission reductions from the LowC Scenario would be a deterrent for deployment, if this scenario increased interprovincial cooperation for the creation of energy corridors (power, oil & gas), it could be a beneficial investment for both AB and BC.

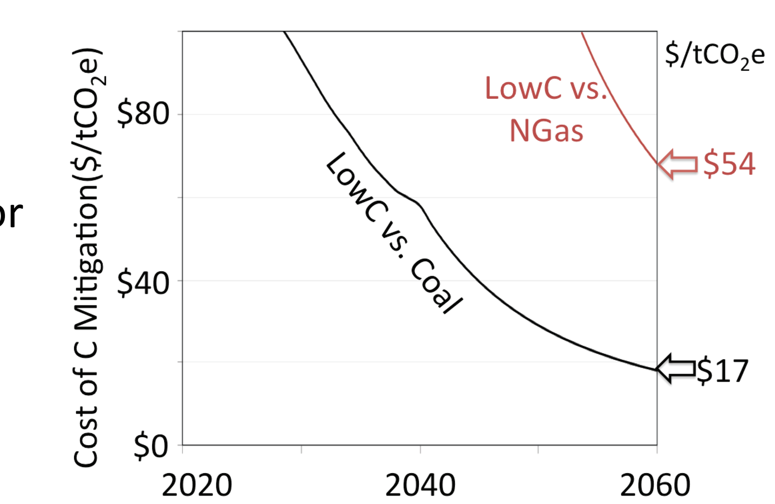


Fig. 9: C Cost for the LowC Scenario

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