

## Western Canada Coal Plant Repowering Economics Addendum

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This document is an addendum to the reports published in GHGT13. This shows the results for western Canada.

### 1) Results for Western Canada:

The economic model used to evaluate the Lingan cases has been modified to use three different assumptions which approximate the results for western Canada. The coal cost is reduced to \$1.41/GJ, a biomass case was added with a cost of \$6.20/GJ and the natural gas price forecast is reduced to \$3.38/GJ in 2020. Unlike Nova Scotia, a carbon tax is assumed. It is assumed to be \$20/t in 2016, \$30/t from 2017 to 2020 and increasing to \$40/t in 2021 and \$50/t in 2022. It is assumed that the tax is paid on the difference between the emission intensity of the plant and a performance standard estimated to be .4 t/MWh multiplied by the energy produced from the power plant. In cases where the emission intensity of the plant is below .4 t/MWh a carbon credit is generated. It has been assumed but not confirmed that the capital and operating costs for Nova Scotia will be similar to those for Alberta.

The following briefly describes the cases studied in the order they appear in the tables and charts below.

NGCC: A GE 7F.05 gas turbine (GT) produces 320 MW net in combined cycle mode.

Lingan: Comprised of units 3&4 producing 308 MW net on bituminous coal.

MCFC: A molten carbonate fuel cell is used to capture CO<sub>2</sub> and produce power from natural gas. The capital costs have been increased to account for the recent increase in foreign exchange.

Biomass: 58% biomass is co-fired with 42% coal. Whole tree biomass was used for Nova Scotia and Wood Pellets produced in Alberta was used.

Case 1a: PCC case using commercially available amine where both steam turbines are modified to supply LP steam required by the PCC unit.

Case 1b: PCC case with advanced amine where both steam turbines are modified to supply LP steam required by the PCC unit.

Case 1c: PCC case with advanced amine where a small natural gas fired GT and HRSG are used to supply steam required by the PCC unit.

Case 1d: PCC case with advanced amine where a large natural gas fired GT and HRSG are used to supply steam required by the PCC unit.

Case 1e: PCC case with advanced amine where a natural gas boiler and steam turbine are used to supply steam and power required by the PCC unit.

Case 2: One boiler is dismantled and replaced by a new gas turbine and HRSG connected to the remaining steam turbines.

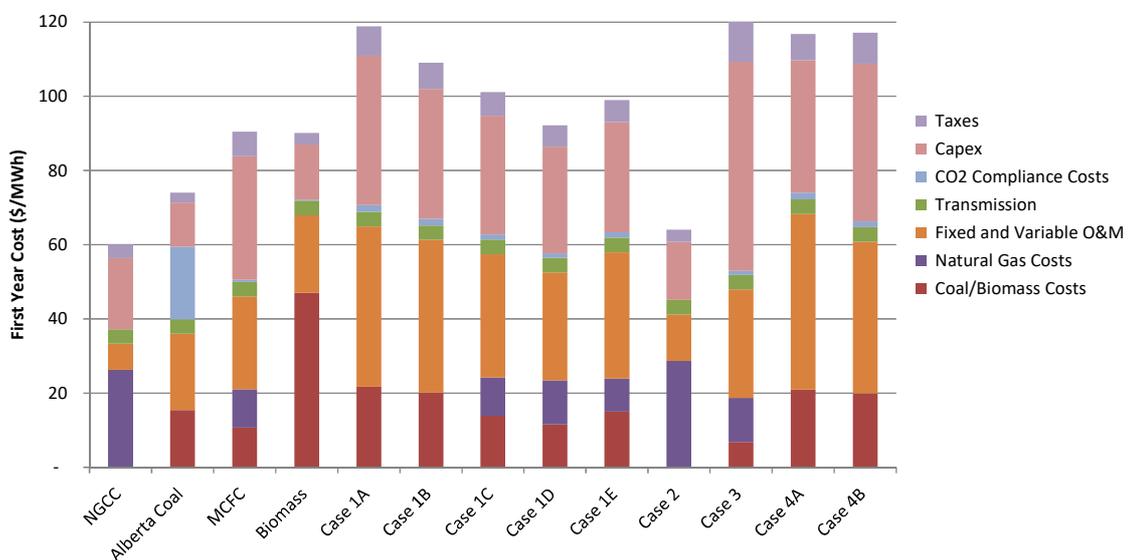
Case 3: SOFC with CCS supplies heat to one coal plant to reduce coal consumption and supply clean power.

Case 4a: Lingan unit 1 supplies steam and power required for PCC on the two other units.

Case 4b: A coal fired fluidized bed combustion (FBC) unit is used to supply steam and power required by the PCC unit.

The relative ranking of the cases is the same as in Nova Scotia except for the NGCC, Alberta Coal, Biomass case and Case 3. The Biomass case has a higher relative price since biomass is a significantly more expensive fuel than coal in Alberta. Case 3 is relatively high because it has such a high capex and O&M cost. The decrease in fuel costs had little impact on this case. The NGCC case and Case 2 have the lowest first year costs. Case 2, the Repowering can likely be optimized even further. Case 1D still has the lowest first year costs of the PCC cases. The Molten Carbonate Fuel Cell or MCFC case has a first year cost comparable to Case 1D. This case was constructed based on values taken from the earlier MCFC study.

**Figure 1:** First Year Cost of Power for Alberta



The first year cost for many of the coal fired cases below are similar to those for the natural gas fired cases between \$8 and \$10/GJ. Case 1B the advanced amine PCC case looks more attractive than the repowering Case 2 once the gas price exceeds about \$9.00/GJ. Case 2 has a lower first year cost than Case 1D when the gas price exceeds about \$8.50/GJ. The first year cost for case 1B is comparable to the NGCC at about \$10.00/GJ. The Biomass case has a higher first year cost than the NGCC case and Case 2. Case 2 has a similar first year cost of power to the Biomass case at \$6.50/GJ. The NGCC case has as a similar first year cost of power to the Biomass case at about \$10.00/GJ. It should be noted that there may be lower cost forms of biomass available. Biomass would have to drop below \$2.50/GJ to be more economical than Case 2 and \$2.00/GJ to be more economical than the NGCC case.

**Figure 2:** Impact of Natural Gas Price on First Year Cost of Power for Alberta

