ESTIMATED GENERATION COSTS WITHIN A SASKATCHEWAN CONTEXT

The attached table, which was developed in 2009 for the Legislative Assembly of Saskatchewan Standing Committee on Crown and Central Agencies Inquiry into Saskatchewan's Energy Needs, provides a snapshot of the estimated generation costs at that time. The costs are typical overnight capital costs in Saskatchewan, excluding transmission and system integration costs. Please refer to the table notes for further clarification.

Since this table is somewhat dated, the following are some qualifications:

1. **Coal - Compliant capture ready coal is no longer an option, as Federal Greenhouse Gas Regulations introduced in September 2012 set a maximum carbon dioxide (CO_2) emission intensity which cannot be achieved without CO_2 capture. It is believed that the capital cost in 2013 dollars to retrofit existing coal units with clean-as-gas capability (partial CO_2 capture) or 90% CO_2 capture may be near the top end of the range shown in the table. The cost of a greenfield coal option (i.e. new power plant site development) would be significantly higher.**

2. **Nuclear - The overnight capital cost range shown in the table was based on large nuclear power plants. However, SaskPower is not considering large-scale nuclear power generation, but instead is investigating the economic and technical feasibility of small modular reactors (SMRs) that could be available to the grid around 2025. Current publically available estimates of overnight capital cost for power from SMRs range from $5,000 to $6,500 per kilowatt (kW) installed ($2013).**

3. **Gas Turbine - The capital cost range provided in the table is generally consistent with today's market.**

4. **Combined Cycle - The capital cost range provided in the table is generally consistent with today's market.**

5. **Cogeneration - The capital cost range provided in the table is generally consistent with today's market.**

6. **Wind (large, 150 MW or more) - The capital cost range provided in the table is generally consistent with today's market.**

7. **Wind (small and micro) - Not looked at extensively, so no further information available to comment.**

8. **Hydro - Although hydro costs are very site specific, recent cost estimates for the hydro options under review by SaskPower have exceeded the cost range shown in the table. This suggests that the cost of hydro generation is likely higher.**

9. **Biomass - SaskPower has not looked at this option extensively, but based on the capital cost of $150 million needed to develop the 36-MW Meadow Lake Energy Center ($4,166/kW) the cost range shown in the table appears to be reasonable.**

10. **Solar Photovoltaics - Costs as low as $3,000 per kW for the 100-MW solar farm component of the utility-scale Grand Renewable Energy Project in Ontario have been recently reported. In general, the capital cost of photovoltaic panels has been dropping in recent years.**

Option		Useful life (yrs)	Typical overnight installed capital cost ($/kW) in 2009$	Busbar 1st year power cost (cents/kWh) in 2010$
Coal	Compliant capture ready	40 to 55	4,300 to 5,700	7 to 10
	Clean as gas		6,300 to 8,600	8 to 12
	90% CO_2 capture		7,200 to 10,000	8 to 13
Nuclear		60	5,000 to 7,200	8 to 10
Natural Gas	Gas turbine	25	1,000 to 1,500	Not applicable
	Combined cycle	25	1,500 to 2,400	8 to 13
	Cogeneration	25	1,500 to 2,400	7 to 12
Import		Highly variable — based on availability, market conditions and transmission		
Polygeneration		Highly variable — project specific		
Wind	Large 150 MW or more	20	2,000 to 3,000	6 to 10
	Small 1 MW to 10 MW		3,600 to 4,700	12 to 22
	Micro 10 kW or less		4,000 to 10,000	27 to 57
Hydro 30 MW or more		50 or more	3,000 to 6,000	5 to 10
Biomass		20	3,000 to 6,600	6 to 11
Solar photovoltaics		20	7,000 to 13,000	43 to 180

NOTES

A. The "overnight" installed capital cost is the cost to build the power plant as if the project was completed overnight. The cost does not include interest which is incurred during construction or escalation of materials, labour or equipment expense.

B. The capital costs are "typical" in nature for new power plants and not based on detailed site specific analysis of costs.

C. No transmission or other system integration costs have been included in the capital or busbar power costs.

D. Hydro plant costs and energy production are site specific; the actual installed costs vary widely based on the amount of civil works and mitigation required. The costs do not include flow through benefits for First Nations partners or other potential stakeholders.

E. The "busbar" power cost, or expense of producing electricity to the point it leaves the plant, is based upon future year power costs escalating at 2% annually.

F. The busbar power costs have not considered all the costs or uncertainties of a detailed project decision (e.g. fuel risk, operating risk, line losses, system integration and backup costs).

G. The busbar power costs include the impact of a cost of carbon on GHG emissions and sales revenue for CO_2 captured in some cases. The upper range generation prices for emitting options include a $25/tonne charge on all CO_2 emitted as a means of trying to level the comparisons.

H. The busbar power cost for nuclear includes an allowance for decommissioning and interim fuel storage.

I. The busbar power cost for a simple cycle option is not applicable to this comparison of options as this option typically has low capacity factors due to its peaking operation.

J. Coal, nuclear and biomass option busbar power costs are based on baseload operation (e.g. high capacity factors).

K. The combined cycle option busbar power cost is based on mid-range to baseload operation (capacity factor 50% to 90%).

L. Wind, solar and hydro option busbar power costs are based on capacity factors applicable for the resource.

M. Estimates based on SaskPower build financial assumptions.

N. These costs were updated on October 6, 2009.