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BCUC INQUIRY RESPECTING SITE C A-22

Sent via eFile

Re: British Columbia Hydro and Power Authority – British Columbia Utilities Commission Inquiry Respecting Site C – Project No. 1598922

On August 2, 2017, the British Columbia Utilities Commission (BCUC, Commission) was requested by the Lieutenant Governor in Council (LGIC), under section 5(1) of the *Utilities Commission Act* (UCA), to advise the LGIC respecting British Columbia Hydro and Power Authority's (BC Hydro) Site C project in accordance with the terms of Order in Council (OIC) No. 244.

Section 3(b)(iv) of the OIC terms of reference directs the Commission to respond to the following question:

> Given the energy objectives set out in the Clean Energy Act, what, if any, other portfolio of commercially feasible generating projects and demand-side management initiatives could provide similar benefits (including firming; shaping; storage; grid reliability; and maintenance or reduction of 2016/17 greenhouse gas emission levels) to ratepayers at similar or lower unit energy cost as the Site C project?

Section 3(c) of the OIC terms of reference further directs the Commission to use the forecast of peak capacity demand and energy demand submitted in July 2016 as part of BC Hydro's Revenue Requirements Application in responding to this question.

At the request of the Panel, Commission staff have prepared three illustrative Alternative Portfolios (one for each of BC Hydro's July 2016 load forecasts) based on information submitted in the Site C Inquiry. These Alternative Portfolios are provided in an Excel spreadsheet titled Alternative Portfolio Spreadsheet (see document A-22-1). The spreadsheet has been prepared using the spreadsheet provided by BC Hydro in response to Panel Question No. 2 of submission F1-4 (Attachment 3 to Question No. 2). The Net Present Value (NPV) of the revenue requirements associated with the Alternative Portfolios is provided in the attached spreadsheet.

The Panel invites comments from BC Hydro and other parties on these Alternative Portfolios of generating projects and demand-side management (DSM) initiatives; in particular:

- The underlying assumptions regarding the Alternative Portfolios (see the Key Assumptions table for descriptions of all key assumptions); and
- The calculations, inputs and assumptions used in the Alternative Portfolio Spreadsheet.

Comments can be uploaded via the BCUC's Site C Inquiry website at www.sitecinquiry.com on or before Wednesday, October 18, 2017 at 11:59 p.m.

Given that the comment period on the Preliminary Report closes today, October 11, 2017, going forward, the Panel will only accept submissions that are within the specific scope set out in this letter.

In reviewing the cost of the illustrative Alternative Portfolios it is important to note the following:

- The illustrative Alternative Portfolios have been prepared for the purpose of soliciting feedback only. No findings have been made by the Panel regarding the assumptions used in the model or the general approach used.
- The illustrative Alternative Portfolios are designed to replace only Site C energy and capacity used for domestic consumption (specifically, they do not include generation built for the purpose of export). To the extent that they result in generation that is surplus to BC Hydro's requirements (for example, as a result of ramping up DSM energy savings), it is assumed that this surplus energy is exported and the value of these exports is treated as a credit to the cost of the illustrative Alternative Portfolio.

The following pages describe: (i) summary results of the Alternative Portfolios; (ii) a general overview of the spreadsheet; and (iii) key assumptions made in the spreadsheet.

Results summary

A summary of results of the Alternative Portfolio are shown below:

Summary Results of the Illustrative Alternative Portfolios (2018$)			
	High Load Forecast	**Medium Load Forecast**	**Low Load Forecast**
Alternative Portfolio composition	• 588 MW of wind projects starting in F2025, 297MW in F2026 • DSM initiatives (energy efficiency, optional time of use (TOU) rate, capacity focused DSM, industrial curtailment) • 150 MW of batteries in F2025[1]	• 591 MW of wind projects starting between F2028 and F2031 • DSM initiatives (energy efficiency, optional TOU rate, capacity focused DSM, industrial curtailment) • 400 MW of batteries starting between F2025 and F2026[2]	• 444 MW of wind projects starting between F2039 and F2041 • DSM initiatives (energy efficiency, optional TOU rate, capacity focused DSM, industrial curtailment)[3]
Net Present Value (NPV) of portfolio cost less export revenues[4]	$3,411 million[5]	$2,889 million[6]	$1,851 million[7]

[1] A-22-1 submission (Alternative Portfolio), Tab ' High LF – portfolio', with costs in Tab 'High LF - $'
[2] Ibid, Tab ' Med LF – portfolio', with costs in Tab 'Med LF - $'
[3] Ibid, Tab ' Low LF – portfolio', with costs in Tab 'Low LF - $'
[4] Discount rate of 4% real, 6% nominal; export revenues valued at CAD $25MWh (at plant gate location).
[5] A-22-1 submission (Alternative Portfolio), Tab 'High LF – NPV', cell I 5
[6] Ibid, Tab 'Med LF – NPV', cell I 5
[7] Ibid., Tab 'Low LF – NPV', cell I 5

Summary of tabs in the attached spreadsheet

The following table provides a general description of each of the tabs in the Alternative Portfolio Excel spreadsheet. These descriptions are linked to the Key Assumptions table regarding key data sources and inputs.

Summary of Alternative Portfolio Spreadsheet	
Tab Name	**Tab Overview**
Energy & capacity gap	The purpose of this tab is to identify the size of BC Hydro's energy and capacity load resource balance after planned resources without Site C, under BC Hydro's three 2016 load forecast scenarios. The starting point is the "energy and capacity load resource balance after planned resources" from BC Hydro's F2017 to F2019 Revenue Requirement Application (RRA). The Site C energy and capacity is then subtracted from the surplus/deficit. Where there is no resulting deficit, there is no gap to fill. Where there is a deficit, the size of the gap to fill is the lower of Site C energy/capacity or the load forecast gap. This approach is also described in the Key Assumptions table (nos. 4 and 5). The F2017–F2019 RRA low load forecast ends in F2036. For the purpose of the low load forecast, a ramp up of 800 GWh/year for energy and 200 MW/year for capacity has been assumed.
Low, Medium and High Load Forecast (LF) - portfolio	The purpose of the Low LF – portfolio, Medium LF – portfolio and High LF – portfolio tabs is to layer in supply and demand-side resource volumes to fill the energy and capacity gaps. The gap is shown in black and new resources shown in blue. <u>Energy gap after planned resources</u> As DSM resources ramp up over time and wind farms are layered-in in blocks, there is the potential for energy from the Alternative Portfolios to exceed the energy gap. If this occurs during a time that BC Hydro is in an energy surplus position, it is assumed that energy is exported and the surplus energy is shown in green. If this occurs during a time that BC Hydro is in an energy shortage position, it is assumed that energy is used to offset other BC Hydro energy purchases and the exported and the surplus energy is shown in black. Energy DSM and wind energy input assumptions are documented in the Key Assumptions table (nos. 11 to 14). <u>Capacity gap after planned resources</u> The capacity gap relates to BC Hydro's ability to meet peak demand. Energy focused DSM has associated capacity savings, and BC Hydro assumes an effective load carrying capacity of wind projects of 26% of the nameplate capacity. These capacity resources are therefore layered in first to fill the gap. Energy DSM and wind energy capacity assumptions are documented in the Key Assumptions table (nos. 11 to 14). Capacity focused DSM options (capacity DSM programs, optional TOU rate, industrial curtailment) and batteries are then used to fill in remaining gaps. Input assumptions are documented in the Key Assumptions table (nos. 15 and 16).

Low, Medium and High LF – portfolio costs	The purpose of these tabs is to translate the GWh/MW volumes from the portfolio worksheets into BC Hydro costs (from a cash flow perspective). The left-hand side of the worksheet (supporting data) summarises the key cost information, noting the type of investment (DSM, wind, etc.), investment year and cost. Cost input data for these resources are documented in the assumptions table (nos. 11 to 16). Revenues from export sales These tabs calculate revenue from export sales by applying the forecast value of export revenues in $/MW to the energy volumes identified in green in the previous worksheet. This is treated as a credit to the cost of the portfolio. Assumptions regarding the value of export energy are documented in the Key Assumptions table (no. 6). No value is assumed for additional capacity surplus to BC Hydro's needs (no. 7), so no equivalent capacity adjustment is made. Energy adjustment This adjustment recognises that, in years where BC Hydro is in an energy shortage situation, if the Alternative Portfolio generates more energy than Site C, the excess energy will be used to meet BC Hydro's load (i.e. it will not be exported). An adjustment is made to the cost of the alternative portfolio in those years to recognise the value of this benefit. The worksheet calculates Site C energy as a percentage of portfolio energy (less exports), and applies this percentage to the cost of the alternative portfolio. For example, if the Alternative Portfolio generates 5,564 GWh compared to a "gap to fill" of 5,286 GWh during a year where BC Hydro is in an energy shortage position, only 95% of the cost of the Alternative Portfolio for that year will be included in NPV of the Alternative Portfolio. This adjustment is shown in purple in the worksheet, and is discussed in the Key Assumptions table (no. 8). Capacity credit While no value is assumed for portfolio capacity that is surplus to BC Hydro's requirements, it is assumed that if BC Hydro is in a capacity shortage position, a benefit will be derived from an alternative portfolio with a higher level of capacity than Site C. This adjustment identifies any capacity provided in addition to Site C during years when BC Hydro is in a capacity shortage situation, and assumes a value of $50/kW-year for this benefit (no. 9). This is applied as a credit to the portfolio cost.
Low, Medium and High LF – NPV	The purpose of these tabs is to translate the cash flow estimates from the previous worksheet into a revenue requirement view. For example, while the Low LF – portfolio costs worksheet shows wind capital costs in the year they occur, this worksheet calculates the associated depreciation and financing costs. This worksheet also calculates a NPV of the alternative portfolio, with key financial assumptions shown in the top left-hand corner. Input assumptions for this worksheet are described in the Key Assumptions table (nos. 1 and 2).

Key assumptions

The following table shows the key assumptions made in developing the Alternative Portfolios.

	Portfolio Assumption
1. Discount rate	The discount rate proposed by BC Hydro for Site C (6% nominal, 3.9% real) has been assumed.[8]
2. Financing costs, taxes	The financing costs of the Alternative Portfolio are assumed to be the same as BC Hydro's financing cost for Site C (100% debt financing at a cost of 3.43%).[9] Grants in lieu of taxes and school taxes (GIL/ST) were assumed to be the same as that used by BC Hydro for Site C.[10]
3. Alternative Portfolio options	Three portfolios were developed in total, one for each BC Hydro 2016 load forecast.
4. Size of the Alternative Portfolio	The Alternative Portfolio has been sized to replace Site C energy and capacity used for domestic consumption. Specifically, the Alternative Portfolio does not include generation built for the purpose of export. The starting point is the "energy and capacity load resource balance after planned resources" from BC Hydro's F2017–F2019 RRA.[11] The Site C energy and capacity is then subtracted from the surplus/deficit.[12] Where there is no resulting deficit, there is no gap to fill. Where there is a deficit, the size of the gap to fill is the lower of Site C energy/capacity[13] or the load forecast gap. The F2017–F2019 RRA low load forecast ends in F2036. For the purpose of the low load forecast, a ramp up of 800 GWh/year for energy and 200MW/year for capacity has been assumed.
5. Location of the Alternative Portfolio	The Alternative Portfolio reflects a "plant gate" cost, and the location for wind build has been set to be similar to Site C (Peace region) to minimize the risk of additional network reinforcements relative to Site C.
6. Energy surplus to BC Hydro need	In any year, if the energy of the Alternative Portfolio exceeds that of the gap to fill, and to the extent that it is surplus to BC Hydro's requirements, the energy is assumed to be exported at a plant gate export price of 2018 $25/MWh. This is based on: • a forward market F2025 price of Mid-C power of US 30/MWh;[14] • translated to CAD $ at an exchange rate of 1 CAD $ = USD 0.7979 (CAD $37.60);[15]

[8] F1-1 submission, Appendix K, p. 3.
[9] F1-4 submission, BCUC 2, Attachment 3, Tab 'Assumption Summary; Exhibit A-13, p. 86.
[10] F1-4 submission, Question 2, Attachment 3.
[11] A-22-1 submission (Alternative Portfolio), Tab 'Energy & Capacity gap';BC Hydro F2017 to F2019 Revenue Requirement Application, Exhibit B-1-1, pp. 3-31, 3-32. The "Surplus / (Deficit)" line correspond to the Medium Load Forecast, the "Small Gap Surplus / (Deficit)" corresponds to the Low Load Forecast and the "Large Gap Surplus / (Deficit)" corresponds to the High Load Forecast.
[12] F1-1 submission, Appendix K, pp. 7–8.
[13] Ibid.
[14] F35-6 submission, p. 2.
[15] F1-1 submission, Appendix K, p. 3.

	• less losses (1.9%) and wheeling costs ($6.3/MWh) to the US/Canada border (CAD $30.59);[16] • less 11% incremental transmission losses to Site C plant gate location (CAD $27.22);[17] and • adjusted down to CAD $25 to reflect (i) risk premiums inherent in forward market prices; (ii) risk of limited available transmission capacity reducing BC Hydro's ability to access the Mid-C market, and (iii) risk of future downward pressure on Mid-C prices from renewables (such as solar, wind) with low or no incremental generation costs.
7. Capacity surplus to BC Hydro need	In any year, if the capacity of the Alternative Portfolio exceeds that of the gap to fill, and to the extent that it is surplus to BC Hydro's requirements, the surplus capacity is assumed to have no additional value to BC Hydro (i.e., an export price of CAD $0/kW-year).[18]
8. Energy exceeding Site C	In any year, if the energy of the Alternative Portfolio exceeds that of the gap to fill and is used to meet BC Hydro's domestic load requirements, the cost of the Alternative Portfolio will be reduced proportionally. For example, if the Alternative Portfolio generates 5,564 GWh compared to a gap to fill of 5,286 GWh, only 95% of the cost of the Alternative Portfolio for that year will be included in NPV of the Alternative Portfolio.
9. Capacity exceeding Site C	In any year, if the capacity of the Alternative Portfolio exceeds that of the gap to fill and is used to meet BC Hydro's domestic load requirements, the Alternative Portfolio will be credited with the assumed value of this additional capacity of $50/kW-year. This is referred to as capacity credit in the analysis.[19]
10. Energy and capacity Options	The energy and capacity options included in the illustrative Portfolio Alternatives are: wind, energy efficiency DSM programs, capacity focused DSM programs, optional TOU rate, industrial curtailment rate, and batteries. It is acknowledged that there may be additional options that could reduce the cost of the Alternative Portfolios, such as codes and standards, Independent Power Producer (IPP) contract renewals, upgrade of existing BC Hydro assets, geothermal, solar, biomass, etc.[20]
11. Energy efficiency DSM	This energy efficiency option represents BC Hydro's Integrated Resource Plan (IRP) DSM Incremental to RRA DSM option.[21] Energy volumes have been grossed up by 11%

[16] F1-8 submission, BCUC 22.1.
[17] BC Hydro submits that wind transmission losses are $9/MWh on a levelized firm energy price of $83/MWh (F1-1 submission, Appendix L, pp. 19, 20).
[18] F18-3 submission, p. 22, F35-2 submission, p. 9.
[19] F35-5 submission, p. 15; Estimated based on post F2030 $/kW cost of batteries from NERL. 2016. *Exploring the Potential Competitiveness of Utility-Scale Photovoltaics plus Batteries with Concentrating Solar Power 2015-2030*'. https://www.nrel.gov/docs/fy16osti/66592.pdf, (page 18, figure 18, median line), assuming a 10 year battery life.
[20] For example, BC Hydro estimates the plant gate cost of utility solar to be $48/MWh in 2025 and $44/MWh in 2035 (F1-8 submission, BCUC 68.4), and that 200 GWh/year of sawmill waste biomass energy could be available in West Kootenay at a cost of $25/MWh (F1-11 submission, BCUC 67).
[21] F1-5 submission, BCUC 64, Attachment 1.

	for avoided real power losses to be comparable to wind plant gate supply side options.[22] For the purpose of comparison to Site C costs, societal costs/benefits of energy efficiency DSM have not been included. However, it is assumed that energy efficiency DSM programs in this portfolio would pass the total resource cost test (i.e. BC energy savings exceed BC costs). The cost of energy efficiency DSM has therefore been included at the utility cost to BC Hydro (i.e., it includes the cost to BC Hydro of an incentive to encourage customers to install efficient lightbulbs, rather than the cost of the lightbulbs before the incentive). Costs are deferred and amortized over 15 years.
12. Wind – project characteristics	Wind project characteristics (load, annual energy, installed capacity) were taken from BC Hydro's portfolio results.[23] Effective load carrying capacity and plant life for each project was taken from BC Hydro's resource options spreadsheet. [24]
13. Wind – capital and O&M cost	Wind capital and operating costs are taken from the National Renewable Energy Laboratory (NERL) 2017 Annual Technology Baseline.[25] NREL costs were increased by 10% in light of cost differences between BC Hydro's 2015 capital costs in BC Hydro's resource options spreadsheet and NREL 2015 estimates for wind investments of similar capacity factor. Costs were converted to Canadian dollars and historical inflation estimates for F2015 to F2018 were taken from BC Hydro's resource options spreadsheet.[26] Wind farms are assumed to be refurbished at the end of 25 years at a cost 30% less than the cost of a new wind farm.[27]
14. Wind – wind integration	Wind integration costs were assumed to be $2.5/MWh, taking into account concerns raised with BC Hydro's $5.00/MWh estimate.[28]
15. Capacity DSM	Costs and cumulative capacity savings for optional TOU rates and capacity focused DSM programs were estimated from the graphs on page 3-21 of BC Hydro's 2012 draft IRP. For the Industrial Load Curtailment volumes/costs were assumed to be 100 MW at $75/kW-year based on BC Hydro's industrial load curtailment pilot, available at 1MW increments.[29] Costs are deferred and amortized over 15 years.

[22] Wind transmission losses are $9/MWh on a levelized firm energy price of $83/MWh (F1-1 submission, Appendix L, pp. 19, 20).
[23] F1-1 submission, Appendix Q, page 8.
[24] F1-4 submission, Attachment BCUC_1_001_00_ATT_01.xlsm, UEC_UCC tab (select wind project from cell K9, dependable capacity is shown in cell D23.
[25] F35-5 submission, p. 15; NREL (National Renewable Energy Laboratory). 2017. *2017 Annual Technology Baseline*. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/analysis/data_tech_baseline.html , land based wind tab, TRG4 mid (weighted average net capacity factor of 43.5%).
[26] F1-4 submission, Attachment BCUC_1_001_00_ATT_01.xlsm, resource options tab, cell BD1.
[27] F18-3 submission, p. 30.
[28] F1-1 submission, p. 63; F18-3 submission, pp. 14- 17.
[29] F28-2 submission, Tab 5 (Helios Centre, April 2014), pp. 7-10; F106-1 submission, pp. 87–90, https://www.bchydro.com/content/dam/hydro/medialib/internet/documents/planning_regulatory/iep_ltap/2012q2/draft_2012_irp_chapter1.pdf , p. 3-21.

16. Batteries	Battery costs were estimated from a graph (figure 18, median line) in an August 2016 NERL report "Exploring the Potential Competitiveness of Utility-Scale Photovoltaics plus Batteries with Concentrating Solar Power 2015-2030."[30] Costs were converted to Canadian dollars, and historical inflation estimates for F2015 to F2018 were taken from BC Hydro's resource options spreadsheet. [31] A 10-year battery life was assumed.
17. Exchange rate	Exchange rate of $1 CAD = 0.7979 USD.[32]
18. Firming	It is assumed that, through the inclusion of capacity demand-side options and batteries, the Alternative Portfolio has a similar level of firmness as Site C.
19. Shaping, storage	The Site C reservoir does not have sufficient storage volumes to provide seasonal shaping of generation. The Alternative Portfolio also does not provide seasonal shaping of generation.[33]
20. Grid reliability	It is assumed that the Alternative Portfolio results in similar levels of grid reliability compared to Site C as a result of (i) the inclusion of wind integration costs and (ii) by siting Alternative Portfolio resources at the end-user location (for DSM) or at the Site C location (for wind). Regarding the provision of ancillary services to support the grid (regulation and frequency response, spinning and supplemental reserves), it is assumed that BC Hydro already has sufficient generation assets capable of providing ancillary services to meet North American Electric Reliability Corporation and the Western Electricity Coordinating Council reliability requirements.[34] The Alternative Portfolio does not build for export into a potential ancillary services market.
21. Greenhouse gas emissions	It is assumed that the Alternative Portfolio has similar levels of greenhouse gas emissions compared to Site C.

Sincerely,

Original signed by:

Patrick Wruck
Commission Secretary

SW/kbb

[30] F35-5 submission, p. 15; NERL. 2016. *Exploring the Potential Competitiveness of Utility-Scale Photovoltaics plus Batteries with Concentrating Solar Power 2015-2030*'. https://www.nrel.gov/docs/fy16osti/66592.pdf, page 18, figure 18, medium line.
[31] F1-4 submission, Attachment BCUC_1_001_00_ATT_01.xlsm, resource options tab, cell BD1.
[32] F1-1 submission, Appendix K, p. 3.
[33] F35-5 submission, p. 24; F1-1 submission, Appendix F, p. 2.
[34] F35-2 submission, p. 9; http://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/WRA%202016_2017_final.pdf, p. 22.