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BCUC INQUIRY RESPECTING SITE C

F 33-3

October 16, 2017

Mr. Patrick Wruck
Commission Secretary
B.C. Utilities Commission
Sixth Floor, 900 Howe Street
Vancouver, BC Canada V6Z 2N3

Re: BCUC Site C Inquiry – Project No. 1598922

**CLEAN BALANCE POWER INC. COMMENT TO BCUC RELATING TO BCUC SUBMISSIONS A-22
AND A-22-1**

John Johnson – Principal and Director, Clean Balance Power Inc.

Dear Mr. Wruck:

Clean Balance Power (CBP) is pleased to offer comments on the assumptions related to the BCUC Alternative Portfolios as proposed in Submissions A-22 and A-22-1.

CBP will limit its comments to assumptions related to the capacity elements of the BCUC Alternative Portfolios. For simplicity, CBP will focus only on the Alternative Portfolio required to meet the Medium Load Forecast (MLF).

The “Med LF – portfolio” tab shows that 300 MW of batteries will be required in 2025 and another 100 MW of batteries in 2026 to meet the system capacity requirements not addressed by DSM and Industrial Load Curtailment initiatives. Battery life is estimated at 10 years.

CBP will comment on two aspects of the assumptions related to batteries:

1. Quantum of Battery Capacity Required to Replace Other BC Hydro Capacity Initiatives
2. Cost of Battery Energy Storage Systems in the NREL Report

1. Quantum of Battery Capacity Required to Replace Other BC Hydro Capacity Initiatives

Utility planners often simply refer to MW's of capacity required in the planning process. However, to prescribe and compare alternative technologies that can address a given capacity shortfall, it is necessary to know the number of hours for which the system will need this capacity. The MWh of energy per 'cycle' required from a capacity product is quite specific and is primarily a function of the load profile it is designed to accommodate.

This becomes particularly relevant when assessing battery energy storage systems which are commonly sold in kWh (i.e. as energy) but have a kW capacity element (capacity is called power in the battery industry). For simplicity we assume a Charge-Rate¹ (C-Rate) of 1.

BC Hydro's assumption for its Industrial Load Curtailment pilot project was 16 hours per day, 6 days per week for 2 consecutive weeks, offered 3 times per year². Similarly, in response to BCUC IR No. 1.1.0,³ BC Hydro indicated it assumed the pumped hydro project in its Alternative Portfolio would run during the heavy load hours, or 16 hours per day, in the high-use months of November to February. We therefore conclude that if capacity in the BC Hydro planning model is to be replaced, it must be done so on a 'MW to MW' basis, meaning each MW must be available in 16 hour increments.

This has major implications for the amount and cost of batteries required to replace 300 MW in BCUC Alternative Portfolio. If we assume that the 300 MW of battery capacity in the BCUC Alternative is required to replace 300 MW of capacity capable of delivering 300 MWh of capacity for 16 hours per day, then 4,800 MWh of battery energy must be acquired. Stated somewhat differently, the 300 MW of battery capacity prescribed in the BCUC "Med LF – Portfolio" tab would only provide 300 MW for 1 hour, or 300 MWh of energy. In fact, 16 times that amount is required.

The 16 hour generating cycle presents an additional challenge because only 8 hours per day are available for charging. One option might be to increase the C-Rate to 2, so the system could recharge at 600 MW for 8 hours, but this would add unnecessary cost. It would be more economic to have two 150 MW facilities, each with a C-Rate of 1, capable of charging 2,400 MWh in the same 8-hour period and generating two blocks of 2,400 MWh over two subsequent 8-hour periods.

¹ Different cell-chemistries and battery management systems offer different Charge-Rates which govern how quickly a battery system can be charged and discharged. For instance, a 1 MWh battery system with a C-Rate of 10, could offer 10 MW of power for a duration of 6 minutes. Generally, higher C-rate systems are provided at a higher cost and vice-versa.

² BC Hydro 2017-2019 Revenue Requirements Project No. 3698869

³ September 18, 2017 Response by BC Hydro to BCUC IR 1.1.0

2. Cost of Battery Energy Storage Systems from the NREL Report

The NREL report separates the battery energy storage system cost projections into the Battery Pack⁴ estimates (see Figure 17) and Balance of System (BOS)⁵ costs. Battery Packs are generally sold in kWh and battery system BOS is sold in kW. In the NREL report, nominal BOS costs are pro-rated across the kWh of the Pack to express the entire system in kWh. Of course systems with more energy (longer hours of generation) have lower unit BOS costs when expressed as kWh. Figure 19 of the NREL report represents these combined costs on a per-kWh basis for 3 different durations (3, 6 and 9 hours).

On page 8 of BCUC submission A-22, it is stated that battery costs were estimated from Figure 18 of the NREL report. This appears erroneous as Figure 18 represents only the BOS cost. The more relevant data is contained in Figure 19 described above. CBP would recommend extrapolating the cost per kWh in 2025 from the 9-hour cost curves (i.e. the closest to 8 hours) from Figure 19 which appear to average close to US\$370/kWh (C\$464/kWh).

For reasons explained in Section (1) above, to achieve the same 300 MWs of capacity over 16 hours per day provided by Industrial Load Capacity or Pumped Storage Capacity in the BC Hydro Alternative Portfolio a 300 MW battery system would need to generate 4,800 MWh of energy over 16 hours. If the cost extrapolated from Figure 19 is C\$464/kWh in 2025 as explained above, then the future expected cost for 4,800 MWh in 2025 would be **roughly \$2.227 billion, more \$2 billion higher than \$163 million shown in cell E12 of the BCUC Excel tab “Mid-LF – portfolio cost”**. The cost of another 100 MW equivalent in 2026 would be one-third of this amount.

Based on anecdotal evidence, CBP considers the BOS costs – current and forecast - in the NREL report to very high and may not accurately represent BOS costs for large-scale grid battery systems. But even if the cost of 4,800 MWh of storage were assessed using only the estimated 2025 average Pack cost of US\$175/kWh (extrapolated from Figure 17 of the NREL report), the capital cost of an equivalent of 300 MW of batteries is still C\$1.05 billion.

Conclusion

CBP respectfully submits that the analysis above simply confirms that battery storage is not an appropriate technology to address large, 16-hour per day clean energy capacity deficits within the BC Hydro system. This is quite different than concluding that battery storage is more expensive or more risky than Site C. In fact, **battery storage would be very cost-effective relative to either Site C, pumped hydro or Load Curtailment in addressing short duration load spikes within the system** (i.e. less than 2 hours). Moreover, permitting risk, inflation risk and construction cost risk would be extremely low relative to Site C.

⁴ The cell, the battery module and the battery management system

⁵ The biggest BOS cost is the inverter, but BOS could also include the cost of air conditioning, lighting, buildings, electrical panels, transformers, land acquisition and interconnection

Optimal capacity alternatives to Site C can only be determined by a more granular understanding of the quantum, profile and location of load and generation spikes within the BC Hydro system. **At this time, without this information, CBP can only simplistically opine that Site C represents is a very expensive, energy-rich capacity alternative to address system imbalances which are most likely predominant in the Lower Mainland between the hours of 6:00 am and 10:00 am and 4:00 pm and 8:00 pm, 6 days per week.**

It is highly unlikely that all MW's of capacity need 16 hours of energy storage to keep the BC Hydro system in balance. CBP would consider a more optimal strategy to replace 300 MW of capacity in the BCUC Alternative Portfolio would take the form of 100 MW's of battery capacity with up to 4 hours of generation per cycle⁶ installed prior to 2025 throughout the BC Hydro system where it is needed, followed in 2026 by 200 MWs of pumped hydro capacity (up to 16 hours of generation per cycle) located in the Lower Mainland.

Based on unit battery costs from the NREL study, the 100 MW's of battery capacity would cost roughly \$185 million⁷ in 2025 and, based on work undertaken by Knight Piesold for CBP in 2017, inflated by 2% per year, the 2026 cost of a 200 MW of pumped hydro capacity in the Lower Mainland would be approximately \$420 million⁸. **The combined total future estimated cost of this alternative capacity product would be roughly \$605 million.**

Kindest regards,

John Johnson
Principal and Director
Clean Balance Power Inc.

⁶ Technically the same system could be cycled twice per day to get 8 hours per day of storage

⁷ The extrapolated 2025 NREL cost of \$464/kWh multiplied by 400 kWh of energy = \$185.6 million

⁸ \$1.75 million/MW X 200 MW X 1.02⁹ (inflated at 2%/yr)= \$418.3 million;