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IN THE MATTER OF THE YUKON ENERGY CORPORATION APPLICATION FOR AN ENERGY PROJECT CERTIFICATE AND AN ENERGY OPERATION CERTIFICATE FOR THE PROPOSED BATTERY ENERGY STORAGE SYSTEM PROJECT

Heard before the

YUKON UTILITIES BOARD

May 4 - 6, 2021

WRITTEN SUBMISSION OF JOHN MAISSAN

Submission introductory comments

In the preparation of this written submission the transcript is referenced by page and line numbers and whenever possible. This reference will appear in brackets as Tr for transcript, p for page number, and Lx-y for line numbers. For example, a reference to the transcript at page 428 lines 17 to 19 would appear as (Tr p428 L17-19). The Yukon Utilities Board is referred to as "the Board". Interrogatory responses (IR) will be referenced by their identifying numbers.

In this submission I address the six points in part 3 the Board's Terms of Reference as specifically requested by the Board Chair, Mr. Buchan, in his opening comments in the virtual hearing. I have also addressed some other issues that in my opinion required or deserved comment. My silence in this submission on matters raised by any other party in this proceeding are not to be interpreted as agreement with, or disagreement with, the other party or parties' positions. I leave these matters to the Board to address based on all the information on the record.

Section A The public need for the Battery Energy Storage System (BESS) Project…

1. Yukon Integrated System (YIS or "the grid") load growth

Yukon's peak non-industrial electrical load has been growing in recent years (YEC 2021 GRA pages 2-1 to 2-4, and Tr p230 L14 to p232 L6). There are three grid-connected mines operating driving the economy and housing is in short supply while home construction is continuing at a rapid pace. Virtually all new homes are heated by electricity rather than fossil fuels, thus the peak non-industrial electrical loads that the N-1 criterion requires that the grid must be able to supply will continue to increase steadily (Application page 28 Figure 4-1 and Table 4-1).

Adding to the pace of both peak and energy electrical load growth will be the policies of all levels of government as they begin to tackle climate change by further discouraging the use of fossil fuels (in transportation and home heating for example) and promoting lower greenhouse gas (GHG) emitting forms of energy, electricity in particular (YUB-YEC-1-1 (f) and (g)).

The forecasted electrical energy requirement for 2021 is 542 GWh (JM-YEC-1-15(b) Attachment 1). At long-term average water availability for hydro power generation the grid would require year-round thermal generation (JM-YEC-1-15(b) Attachment 1). It is apparent that electrical energy and peak load requirements will continue to require significant thermal generation (including rented diesels) for at least the next few years, and likely beyond. While Yukon Energy is increasing its renewable energy and capacity supplies, it is not until the proposed Moon Lake pumped hydro storage project comes to fruition about a decade from now that the grid would be able to meet the N-1 planning criterion without rented diesel generators. The Moon Lake project development has

not yet been started as it is said to require federal funding before work can proceed (JM-YEC-1-29).

From my perspective it is unlikely that the present industrial customers will drop away in the short term as commodity prices (precious metals and copper) are strong. If the industrial customers were to drop away over time, say 5 to 10 years, the non-industrial loads by that time will require substantially more peak load and energy than they do at present, and the benefits of the BESS may well be larger than projected now, just as the benefits of the BESS will be higher in wet years that provide above long-term average hydro energy (Application page 12).

2. N-1 Capacity Reserve Criterion

Yukon Energy has been renting 1.8 MW modular mobile diesel generators for a number of years, including 17 rentals for the winter of 2020-2021 – 15 to meet the N-I criterion and 2 spares to cover unavailability of units (YUB-YEC-1-19(c)). The BESS project has been designed to provide 7.2 MW of dependable capacity which displaces the need for 4 rented diesel units. During an N-1 event the BESS can provide 7.2 MW of dependable capacity during the daytime and be recharged completely at night when electrical loads are about 20 MW lower than the daytime peak (Application pages 7 - 9). This cycle can be repeated day after day through an N-1 event.

One of the YUB Board members asked a series of questions in cross-examination (Tr p324 L5 to Tr p333 L8) that appeared to reveal some confusion as to how a BESS can provide dependable capacity as effectively as diesel generators can. Yukon Energy's Figure 3-2 on page 8 of the Application is one key to understanding this. To provide a unit of dependable capacity, a generating unit does not need to be running at that capacity all the time, it just needs to be able to keep the peak grid load lower by that unit of capacity. The peak load on the grid happens over a relatively short period of time, usually 1 or 2 hours in the early evening. And rather smaller amounts of dependable capacity are needed for the remainder of the daytime. At night when the grid loads drop 20 to 25 MW below the peak load, the dependable capacity is not required at all. In the case of this BESS project, the "shape" of the typical peak load day (Figure 3-2 in the Application) was used to calculate the energy required to keep the peak load 7.2 MW below what would have been the peak load without the BESS. It is also used to ensure that the BESS can be recharged with that amount of energy during the night when the load is more than 7.2 MW below the peak. The energy storage capacity and charging capacity of the BESS have been selected to meet these requirements (among other considerations). This cycle of the BESS providing 7.2 MW of dependable capacity supply in the daytime and recharging at night can be repeated day after day (TR p350 L25 to p351 L7). In this respect it is completely equivalent to a 7.2 MW diesel generator.

3. Operating reserve

The hydro generators on the grid provide an operating reserve by running at less than full optimum capacity. This means that thermal generation (diesel or LNG) needs to make up the difference whenever the electrical load surpasses the reduced output of the hydro generators. The BESS can provide that operating reserve just be being connected to the grid and being available (Tr p48 L19 to p49 L18). This better utilizes the available hydro resources and reduces the amount of thermal generation required thereby saving both cost and GHG emissions.

4. Diesel and LNG Peak shifting

Whenever the electrical load surpasses the hydro supply capacity available, thermal generation is used. If this is anticipated to be a short period of time, then diesel generators are started but for longer periods LNG generation is selected (Tr p38 L6 to p40 L21). Whenever diesel generation is running the BESS could be displacing the peak diesel usage and replacing it with lower-cost LNG or even lower-cost hydro. Similarly, when peak LNG generation is displaced by available lower-cost hydro there is a saving realized. Surplus intermittent renewable energy sources such as solar or wind power, when available, could also be used to charge the BESS (JM-YEC-1-16).

5. Grid reliability

When a hydro generator trips off-line and the load is too large for the available generation the grid frequency drops and an outage ensues (Application page 13). The extent of the outage might be limited, or the entire grid might go down if the generator that trips was a larger one carrying a fairly large load, the 20 MW Whitehorse #4 for example. The BESS can ramp up to 20 MW output in 150 to 200 milliseconds, so it could pick up the load that the tripped generator was carrying and prevent an outage. This is an increase in grid reliability. In the Yukon Energy 2017-2018 GRA proceeding we discussed a week in the summer of 2017 in which there were 5 grid outages (YEC 2017-2018 GRA John Maissan-YEC-1-31). These significantly impacted a large number of customers.

6. Load loss stabilization

The opposite of having a generator trip off-line is for a transmission or distribution line trip off-line due to a fault. In this circumstance there is too much generation on the grid for the load and this would result in an increase in frequency and might further result in a generator tripping off-line etc. and probably an outage to otherwise unaffected customers. In this circumstance the BESS can absorb power very quickly by charging. Again, the result is likely to be better reliability (and better power quality) for customers.

7. Blackstart and outage restoration capability

In the circumstance when the entire grid goes down the BESS is an instant-on battery which can be used to re-energize generating plants allowing the generating units to start up. During the process of restoring power to the entire grid the BESS can help "pick up" larger chunks of load (up to 20 MW) than the diesel and hydro generators can on their own (Application page 13). This will reduce the outage time experienced by the grid's customers.

8. Ancillary services and reactive power support

The ancillary service of frequency stabilization described in the Application (page 10) that the BESS can provide will help provide a more stable frequency as more intermittent solar and wind energy is connected to the grid (JM-YEC-1-16(a) and JM-YEC-1-31(a)). The Yukon government's Our Clean Future" policy document provides for up to 40 GWh per year of such renewable energy from the Independent Power Producer (IPP) Standing Offer Program (SOP). As well, it is anticipated that up to 4.6 GWh annually of microgeneration energy will be connected to the grid by 2024 (JM-YEC-1-29(a)). A Yukon Energy IR response (JM-YEC-1-16) suggests that the BESS could also stabilize the connection of a 20 MW wind farm.

Reactive power support is another benefit that the BESS will provide that improves the power quality from a customer perspective.

9. Summary of Section A

The discussion in part 1 one outlines convincing evidence that the projected non-industrial peak electrical loads and grid energy requirements, which drive the need for, and the benefits of the BESS, are here to stay for an indeterminant length of time. As discussed in parts 2 through 8, there are a number of needs and benefits that the proposed BESS can and will serve.

The N-1 capacity reserve and the operating reserve are only two attributes which are counted on to significantly contribute to the financial benefits of the BESS. There are significant other benefits, which are not counted for the purposes of conservatism. See further discussion in Section C.

In summary:

1. ***There is a public need for the project.***
2. ***The reliability of electric service to industrial and non-industrial customers alike will increase.***
3. ***The electric load forecasts support the BESS project's benefits.***
4. ***All customers will experience rate benefits compared to alternatives.***

Section B The capability of existing and committed generation and transmission …

10. Ability of existing and committed generation and transmission

The existing YIS is providing a level of service that Yukoners are used to and generally comfortable with in the present circumstances. However, I believe that it is also true that there is a generally increasing level concern with Yukon Energy's ability in future to continue to provide that level of reliability, especially in winter. This concern centers on the number of diesel generators that Yukon Energy is required to rent to meet the N-1 planning criterion and the industrial loads on the YIS.

Part 1 in Section A describes the increasing electrical load patterns that the YIS is experiencing. In order to serve these increasing electrical loads Yukon Energy will, in the next few years, add more renewable energy supply the YIS. While some of this is reliable capacity and energy (hydro turbine uprates at existing plants, for example), there will also be up to 40 GWh per year of mostly intermittent supply from the IPP SOP, primarily solar and wind power. With such supplies increasing it may be more difficult in future for Yukon Energy to continue to provide the present level of power quality and reliability to the growing electrical loads.

11. The effect of the BESS project on this capability

Section A describes in my words the various functions that the BESS will be fulfilling on the YIS based on the Application, the IR responses and the virtual hearing. These functions will either increase the utilization of existing renewable energy sources or improve the grid power supply quality and reliability. None of these functions will degrade the utilization of renewable energy nor will they degrade power supply quality and reliability. Below is a summary of each of these functions as described in Section A and the resultant effect on the YIS of the BESS.

In summary:

1. ***N-1 capacity reserve criterion: reduces costs (diesel rentals).***
2. ***Operating reserve: improves hydro utilization and decreases thermal generation.***
3. ***Diesel and LNG peak shifting: improves hydro utilization and decreases thermal generation.***
4. ***Grid reliability: improves grid reliability (reduces outages).***
5. ***Load loss stabilization: improves grid reliability (reduces outages).***
6. ***Blackstart and outage restoration capability: improves grid reliability (reduces length of outages).***
7. ***Ancillary services and reactive power support: improves power quality.***

Section C Risks for the BESS project and effect on rates and reliability

12. Technical risk

BESS systems based on Li-ion technology are used in many parts of the world and their popularity is rapidly expanding. The largest presently claimed is at Moss Landing in California at 300 MW and 1,200 MWh (https://www.energy-storage.news/ last accessed May 12, 2021). The first larger scale one was installed (by Tesla) in 2017 in the state of South Australia and is called Hornsdale Power Reserve. It was 100 MW and 129 MWh at the outset and was expanded in 2020 to 150 MW and 194 MWh (https://hornsdalepowerreserve.com.au last accessed on May 12, 2021). Positive results are being claimed for the South Australia Hornsdale project. There are now many other BESS projects in operation or in construction throughout Australia and the USA. These large battery systems are all modular containerized systems such as proposed by Yukon Energy for their BESS project.

There are also BESS projects In operation in Canada. Trans Alta has a 10 MW 20 MWh system (Western Sustainable Power Corp.) near Pincher Creek, Alberta. Drumheller Longspur has an 8 MW 8 MWh battery in conjunction with a 16.5 MW solar power project. Hatch provided information on some BESS projects in Canada's and Alaska's north (Tr p318 L2-17, and p340 L2 to p341 L8) and explained that BESS projects use the same modular projects wherever they are located (Tr p358 L11 to p359 L10). Kodiak Electric Association (Kodiak City on Kodiak Island in Alaska) has had a BESS since 2012 (initially using lead-acid batteries) which has since been expanded to include flywheels.

The only difference between these projects whether located in Australia's heat or in Canada's arctic is the heating, ventilating and air conditioning (HVAC) or temperature management systems required to meet local ambient conditions. The Whitehorse location is not unique in that respect. We have dependable technology to heat and cool buildings, so the modules should not pose any problems in this regard.

In my view the technical risk in the technology is low. As with every other BESS project, the uniqueness of Yukon Energy's BESS will be the programming of the controls to meet the desired project specific functionality. It is likely, in my opinion, that some tuning of the control parameters will be required as experience is gained with the project and in future as the grid changes with respect to its generation supplies and electrical loads.

13. Impact on reliability

As discussed in Section B above, all the planned functions of the BESS have positive results on either the YIS costs or on power reliability and quality. As mentioned in the immediately preceding paragraph, there is likely some tuning of control parameters that will be required based on experience with the project operation. Control tuning requirements would also apply in future as the nature of the YIS generation and electrical loads change. In summary it is my view that the extent of the improvements

in grid reliability and power quality theoretically possible might not be fully realized. However, Yukon Energy has been very conservative in their Application not to suggest any particular level of improvements with respect to reliability and power quality, so I am sure that we will be pleasantly surprised by the results.

14. Potential impact on rates

In Table 4-3 on page 39 of Yukon Energy's Application, the financial benefits of the BESS that support the Application are tabulated. The net present value of the project benefits is $12.676 million. In my view Yukon Energy is very conservative in the calculation of these financial benefits; there are other significant financial benefits that the Board should factor into their deliberations in preparing their report to the Yukon government. The financial and other considerations that I believe the Board should factor into their deliberations are outlined in the following paragraphs.

1. Avoided diesel rental costs – this is reasonably portrayed by Yukon Energy and I have nothing further to add.
2. Annual savings from operating reserve – this matter is discussed in the Application (pages 10 to 13), was explored in various IRs (JM-YEC-1-18 and 19, UCG-YEC-1-8 and 9, and YUB-YEC-1-20, 36, 51 and 52, among others) and discussed in cross-examination (Tr p49 L24 to p52 L17). In the referenced cross-examination discussion Yukon Energy acknowledges that their estimates are very conservative. The 2021 forecasted grid load is 542 GWh (JM-1-YEC-1-15(b) Attachment 1) and with long-term average (LTA) water for hydro generation, Yukon Energy shows that year-round thermal generation would be required. During the June to October period the monthly estimates of thermal generation averages over 6 MW (23,724 MWh/3672 hours). In its 2021 GRA Yukon Energy is forecasting about 84.4% of its energy would be supplied by LTA hydro and IPPs (YEC 2021 GRA, Table 2.2 page 2-17, lines 24 to 28). However, Hatch appears to be basing their analyses on an older forecast that indicates that Yukon Energy generates over 90% of its energy by hydro (Application page B-22 bottom [Hatch report page 13]). Yukon Energy assumes only one-third of the Hatch estimate of savings so there is a doubly conservative factor here with Yukon Energy assuming one-third of less than 10% thermal generation requirement as opposed to one-third of 15.6% thermal generation requirement. Just the ratio of thermal generation numbers would suggest that the annual savings might be closer to $1.755 million in year 1 (15.6/10 X $1.125 million).
3. Annual savings from peak shifting – Yukon Energy has estimated that $10,600 could be saved in year 1 of the project. Given the year-round thermal generation required in the coming years under LTA water conditions as discussed in 2 above, I think that this financial benefit is also underestimated.
4. The financial savings detailed in the Application are based on the 2021 GRA fuel prices of $0.2051 per kWh for diesel and $0.1814 per kWh for LNG generation. The recent (February and March 2021) price for diesel generation is $0.2732 per

kWh and for LNG generation is $0.1936 per kWh (JM-YEC-1-20(a)). Applying the recent prices to Table 4-3 increases the NPV of project benefits by $1.851 million to $14.527 million (JM-YEC-1-33(a)).

5. Variable operating cost savings are not presently included in thermal generation savings. Variable operating costs are in the order of $0.015 per kWh (JM-YEC-1-32). Table 3-3 in the Application on page 12 indicates that Hatch estimates 1,837 MWh of diesel generation and 17,043 MWh of LNG generation would be avoided by the use of the BESS for operating reserve. Taking only the one-third of this thermal generation that Yukon Energy assumes, and applying this variable operating cost saving to this reduction suggests additional first year savings of over $94,000. This amount is not included in Yukon Energy's estimated savings in Table 4-3, and really it should be.

6. Hatch has estimated a modest efficiency gain of 0.5% to 1% in the hydro generator operation with the BESS providing the operating reserve. This would increase the hydro generation by 2.2 to 4.4 GWh per year. To be conservative Yukon Energy has not included a financial benefit for this in its analyses. Taking the lower 2.2 GWh per year and the lower 2021 GRA LNG price of $0.1814 per kWh yields an annual benefit of $0.399 million. The NPV of the project would increase by over $2 million (ratio of $0.399 million to first year benefit of $2.351 million in Table 4-3). If 0.5% is a realistic efficiency gain, then an appreciable portion of the thermal displacement would be in diesel generation further increasing the savings because of its higher fuel price.

7. A reduction in grid outages and a faster restoration from outages would reduce the diesel generation used during these events and reduce Yukon Energy's costs. This is not factored into the savings calculations.

8. Not considered in Yukon Energy's analyses are the losses that industrial and General Service (business) customers suffer as a result of unscheduled outages – they have a real cost. These customers would experience a significant benefit in terms of reduced costs.

9. Power generation in Canada's north is exempted from the carbon tax. This is an indirect taxpayer subsidy to diesel and LNG generation. At $40 per tonne of CO2 the charge on diesel would be equivalent to about $0.0268 per kWh and on LNG would be equivalent to $0.0172 per kWh based on Yukon Energy's fuel efficiency rates (2021 GRA, and per unit fuel costs for fuel from Fuel_Charge_Rates_-_Canada.ca accessed on February 18, 2021). A 90% LNG 10% diesel mix would cost almost $0.02 per kWh or about $0.125 million per year for the operating reserve saving only. There is a federal commitment to increase the carbon tax to $170 per tonne or over $0.5 million per year for the operating reserve saving only. Climate change mitigation by CO2 emissions reduction or other mitigation measures is a real cost to all people in Canada, including Yukon ratepayers. This serious issue deserves consideration by the Board even if it feels that it cannot use specific financial numbers for it.

In summary the benefits of the BESS project are significantly underestimated as outlined below in more detail.

In summary:

1. ***Operating reserve benefit conservatively underestimated.***
2. ***Diesel and LNG peak shifting benefit very likely underestimated.***
3. ***Present fuel costs are not included, NPV increases by $1.85 million.***
4. ***Variable operating cost savings are not included, $94,000 annual benefit for operating reserve only.***
5. ***Hydro operating efficiency gain not included, NPV of over $2 million.***
6. ***Reduction in Yukon Energy's or customers' costs of outages, not considered.***
7. ***Taxpayer subsidy for carbon tax savings, not considered.***

Section D reasonable alternatives to the BESS project

15. Alternative to the BESS project

I believe that the only reasonable alternative to the BESS project is a 20 MW or larger diesel thermal generation plant. Such a plant should be able to maintain more or less the same level of service to ratepayers as we are now experiencing. However, it is clear from the LNG project proceeding and the public consultation on a proposed new thermal plant, that the public opposition to such a project would be significant. It is also contrary to Yukon government policy (YUB-YEC-1-1 (f) and (g)). Such a thermal plant must be diesel rather than LNG because diesel generators have a much better ability to restore the grid from outages; LNG generators are very limited that capability. A thermal plant would not provide ratepayers with the savings from reduced thermal generation that the BESS can, nor would it provide the reliability, load loss stabilization, blackstart and outage restoration benefits that a BESS provides. Also, a thermal plant could become a stranded asset when the Moon Lake (or other) pumped hydro storage project is built.

I would not consider a diesel thermal plant to be an advisable alternative to the proposed BESS project given its lack of financial and other benefits that the BESS will provide.

Section E Impact on YEC and rates of the debenture investment opportunity…

16. Debenture investment opportunity

The debenture investment opportunity for KDFN and TKC was explored in IRs (YUB-YEC-1-7) and in cross-examination of Yukon Energy (Tr p132 L11 to p135 L24, and p267 L5 to p283 L11). The evidence indicates that the debenture investment opportunity has no impact on Yukon Energy or on the ratepayers of Yukon. For me personally it is very important that, as a Yukon resident, I support reconciliation with First Nations peoples, especially locally, for past injustices. I am in full support of this opportunity and Yukon

Energy's decision to contribute to these efforts by locating the BESS project on a very suitable parcel of KDFN land.

I recommend that the Board supports this debenture investment opportunity in its report to the Yukon government.

Section F Is it prudent to build the proposed BESS project at this time

17. Prudency of the BESS project

Sections A to E of this submission outline the facts and my views on the BESS project in some detail. These sections are physically organized as per the Terms of Reference as requested by the Board Chair. The information provided and discussed strongly supports the prudency and advisability of completing this proposed BESS project as requested by Yukon Energy. Yukon Energy has been extremely conservative in estimating the benefits, in fact I feel that they should have been estimated less conservatively.

Even with the financial benefits as (under) estimated by Yukon Energy, the project has a significant NPV ($12.676 million) and provides ratepayer benefits starting in year 1. At a 30% cost over-run the project still provides a positive NPV to ratepayers (JM-YEC-1-33(d)). At the present (March) fuel prices the project would be breakeven at a 42.5% capital cost overrun (JM-YEC-1-33(b)).

Benefits to customers from a higher level of grid reliability have not been factored into the financial benefits by Yukon Energy, yet these benefits are significant, particularly to business and industrial customers. Such benefits, although not quantified, can and should be considered by the Board in its deliberations.

In conclusion the BESS project is a very prudent project to be built at this time. In my view it would be imprudent not to build it at this time.

Section G other matters

18. Aishihik downstream benefits

The BESS project is indicated to have potential environmental benefits downstream of the Aishihik generating station if it can reduce the flow fluctuations in winter. This issue was discussed in IRs (JM-YEC-1-21 and YUB -YEC-1-14) and discussed in cross-examination (Tr p93 L5 to p94 L18). Since the impact of the Aishihik power plant and its operation has been a concern to the Champagne and Aishihik First Nations (CAFN), any reduction in environmental impacts would be beneficial to the relationship between Yukon Energy and CAFN. It would also promote the spirit of reconciliation.

I recommend that Yukon Energy be encouraged to use the BESS to ameliorate the downstream effects of fluctuating water flows in winter within the constraints of its other uses.

19. Tone of some Board questions

During cross-examination of Yukon Energy by Board counsel there were a small series of questions that had a biased tone (starting at Tr p202 L8 to about p210 L19). The wording of the first question in this series clearly says that thermal projects (such as diesel or LNG I assume) are "traditional" projects as opposed to renewable projects (hydro, solar, wind). It further implies that thermal projects are more economical than renewable projects. I would suggest to the author of these questions that they have not properly considered the full costs of diesel and LNG generation to Yukon ratepayers and furthermore the author is completely disregarding the present and future cost and other implications of climate change caused by fossil fuel use. I agree that BESS projects are not yet common, even though the Alberta Utilities Commission (AUC) has obviously already dealt with some of these. But the implication that renewable energy projects are not "traditional" implies a strong pro-fossil fuel bias that is inappropriate and that I strongly object to. I really hope that the bias portrayed in this case is an exception. We are fortunate that the mainstream electricity generation projects in Canada are hydro, wind and solar, and regulators and their advisors should be aware of this. The Yukon Utilities Board and its advisors must be unbiased, the wording and tone of these questions indicates not all are.

I recommend that the Yukon Utilities Board keep an open mind with respect to the full and true cost of fossil fuel use, including the cost of climate change, in comparison to renewable energy projects and newer but proven technological innovations such as BESS projects designed to reduce the use of harmful fossil fuels.

Respectfully submitted,

John Maissan
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