

BC Hydro Resource Options Update Onshore Wind Technical Workshop

Summary Notes for March 5, 2020 and April 3, 2020

Includes post-session comments and consideration of feedback

AGENDA

- Review technical characteristic and cost assumptions for the wind resource in B.C.

ATTENDEES

- BC Hydro: Magdalena Rucker (Technical Lead), Anne Wilson
- Ron Percival, Avro Wind Energy
- Juergen Puetter, Aeolis Wind
- Wagner Ksenhuk, Aeolis Wind

SUMMARY NOTES FOR MARCH 5, 2020

Magdalena welcomed participants and reviewed the agenda and purpose of today, which is to review turbine characteristics and cost assumptions for the wind resource option, as well as the unit energy costs. Magdalena invited participants to provide their input on the assumptions.

Comments captured below are organized based on slide number of the session presentation “BC Hydro – Wind Resource Option Update March 5, 2020”

Slide 3 – Wind resource / project Info

- Participants asked if the study results that BC Hydro used to update the assumptions (2009 BC Hydro Wind Data Study) are available. It was confirmed that the report is on the BC Hydro website.
- It was mentioned that a significant number of the Investigative Use Permits that formed the basis for the potential project sites in the Wind Data Study) have been abandoned, sometimes due to lack of constructability. One participant raised the question If a site is not considered commercially viable under existing circumstances, should it be captured within the resource options dataset?

Slide 6 – Power curve update

- Assumptions look fine.

Slide 7 – Impact of changes in turbine assumptions on net capacity factor

- Magdalena confirmed this is all on-shore wind
- A comment was made that a 50% net capacity factor would mean a gross capacity factor of over 60%. This would require some very high wind speeds.
- Participants noted that developers will select turbine model based on specific factors. Magdalena acknowledged this but noted that this is difficult to implement when modelling the province as a whole. She also noted that turbine manufacturers will have input as well in terms of what turbine model is approved for a particular site.
- A participant will provide some written comments after the presentation.
- A participant mentioned that some developers in Canada will put a Class 3 turbine on a Class 1 site, and then deal with warranty issues later. However, that is not an issue for this study.

Slide 8 – Cost updates

- Participants asked if they could see the 2018 Hatch update to the 2015 cost analysis. Magdalena confirmed that if the study was not already online, a copy will be made available.

Slide 9 – CAPEX assumptions

- Assumptions look good.
- Project life depends on the turbine model, but 25 years is a good average.
- Financial model – one participant noted that the financial assumptions have a big impact on unit energy costs, and asked what the assumption for rate of return is, and whether it is levered or unlevered (levered model includes debt and equity, unlevered is all equity). Magdalena noted that Weighted Average Cost of Capital (WACC) is based on future expectations of the return on equity, cost of debt and the balance between equity and debt towards financing. The WACC to be used to calculate unit energy costs for this resource options inventory update are still under consideration. The WACC is previous estimates of unit energy costs was 5%.

Slide 10 – O&M assumptions

- A participant asked for the source of the O&M cost information. Magdalena replied that it was from personal communication but that it also corresponded with information out of the Wind Technology Market Report.
- One participant expressed that location of the project has a large impact on the O&M cost (impacts accessibility, personal availability, etc.) and hence it is difficult to come up with a generic O&M cost for all of B.C.

Slide 11 – Unit energy cost at gate (preliminary)

- Participant expressed interest in seeing a supply curve that only shows the first 10,000 GWh, and understanding better what kinds of projects are included in that first 10,00 GWh.
- Participants mentioned that B.C. has world class wind sites, and that the developers have learned from experience. Projects that are not competitive have been abandoned. There is still investment going into the low cost projects. Hence, only the projects that are competitive and cost effective should be considered and the rest should be ignored. Magdalena mentioned that the selection process of projects takes place in the portfolio modelling where only the most cost-effective projects get chosen.

- Magdalena noted that these unit energy costs are at gate (which includes the collection system and substation). It does not include the transformation to transmission voltage or the transmission line to connect to the BC Hydro system.
- It was agreed to show the supply curve going up to 20,000 GWh since some projects may drop out (i.e. become too expensive) once interconnection costs are included.
- A key thing to know is return on rate of investments, and debt/equity ratio.

Additional comments

- It was asked when the resource options update is going to be completed? It is projected to be completed by the summer of 2020.
- Wind and solar are getting pretty competitive. There are select wind and solar projects that are going to have a future in B.C.
- One participant mentioned that they have identified over 5000 MW worth of wind projects. Another participant noted that they have reduced their B.C. portfolio to less than 10 projects, but these projects are almost as competitive as the projects in AB.
- The opinion was expressed that a lot of numbers have been published in AB, but that there would be a big attrition rate in AB.
- Participants expressed that there were no big surprises in the wind resource option update and that the trend was in the right direction. They thought that since the analysis and assumptions cover a large area it will be rough around the edges (i.e. high level).
- Magdalena asked if it would be worthwhile to have another call. Participants did not object to another call, but would like to look at the requested information first.
- Magdalena asked if participants would like to see the UEC at POI (since this was requested during the 2015 engagement session). It was agreed that presenting the UEC at gate is reasonable since interconnections are very project specific. It was mentioned that a great project with high interconnection costs would be difficult to develop.
- Participants asked how utility scale is defined. BC Hydro should be looking only at large projects. Magdalena mentioned that the CAPEX cost is scaled by project size. For the purpose of the presentation, only the CAPEX cost for a 200 MW project was shown. The participants asked to see the scaling assumption.
- So many projects that were considered in 2008 and 2009 are not deemed realistic. BC Hydro should consider removing these.
- NREL has some good data that is quite transferable.

Session closing

- Magdalena thanked the participants for their time and comments. She will aim to have the requested information to the early next week, with a call at the end of the week.

POST SESSION COMMENTS

- One set of written comments was received, reflecting mostly comments received during the meeting.

SUMMARY NOTES FOR APRIL 3, 2020

A phone call was held on April 3, 2020, to follow-up on an email sent to the participants with information requested from the previous meeting (Attachment A). The participants expressed that the assumptions were mostly in the ‘ball park’, but that any refinements of the assumptions would be futile, given the uncertainty around what impacts COVID-19 will have. Short-term impacts on the wind energy sector have already been observed, and there may be long-term impacts that are difficult to predict early in the pandemic.

CONSIDERATION OF FEEDBACK

Feedback	BC Hydro’s consideration of feedback
<p>The representation of 130 potential wind project sites is incorrect and perhaps misleading. Many proposed wind project sites on B.C. Crown land in 2009 have since been abandoned as experience was gained by the wind sector. There are significantly fewer cost competitive wind power sites in British Columbia in 2020. Wind speed is only one of many site characteristics which determine the cost of wind projects. Sites must also be buildable, not permitting constrained and in proximity to low cost grid interconnection.</p>	<p>The resource options database tries to capture the technical energy potential of the various resource options in B.C., recognizing that this large potential captures both the relatively lower cost resources (with better quality resources, unconstrained by permitting issues and proximity to the grid) as well as those that meet high-level technical viability criteria but do not possess the beneficial economic characteristics mentioned above. The purpose of the resource inventory is not to apply undue economic viability screens at this stage, rather to err on the side of including a very broad range of potential resources.</p>
<p>Capex cost can vary by COD year according to global turbine availability and other factors. Generally, longer lead times provide lower CAPEX, and the reverse is also true. For example, a 200 MW project in easy build terrain and COD of 2022 would be less than \$1,600/kW.</p>	<p>BC Hydro acknowledges that the capex cost can vary by COD year due to turbine availability and other factors. However, this variability is difficult to capture in a long-term cost projection.</p>
<p>Project life with machines from leading turbine suppliers is now 30 to 40 years (and not 25 years), subject to turbine choice and wind climate.</p>	<p>BC Hydro acknowledges that the project life of wind projects continues to increase. However, since the turbine design life provided by OEMs for this update ranges between 20 and 25 years and the 2019 NREL Annual Baseline Technology database assumes a project life of 25 years for wind projects, it was decided to keep the project life unchanged (i.e. 25 years) for this update.</p>
<p>Participants expressed that COVID-19 may have long-term impacts that are difficult to predict right now.</p>	<p>BC Hydro acknowledges that the long-term impacts of COVID-19 on the resource costs are uncertain, but will examine the potential effects through sensitivity analysis and monitoring.</p>

ATTACHMENT A – EMAIL SENT ON MARCH 23, 2020

Hi all,

Sorry for the delay in the follow-up with you. There has been a lot to process over the Coronavirus and adjust to a new work/life environment. I hope you are all healthy and keeping safe.

I have attached the meeting notes from our conference call to this email. Below are the follow-up items that we discussed as well as some corrections/updates. I would like to set up another conference call for next week. Please let me know if you are interested and able to participate as well as dates/times that would work for you.

Thank you,
Magdalena

Follow-up Items and Updates

Slide 3 – Here are the links to the 2009 BC Hydro Wind Data Study and the 2009 BC Hydro Wind Data Study Update reports:

https://www.bchydro.com/content/dam/hydro/medialib/internet/documents/environment/winddata/pdf/wind_data_study_report_may1_2009.pdf

https://www.bchydro.com/content/dam/hydro/medialib/internet/documents/planning_regulatory/iep_ltap/2010q3/bc_hydro_wind_data.pdf

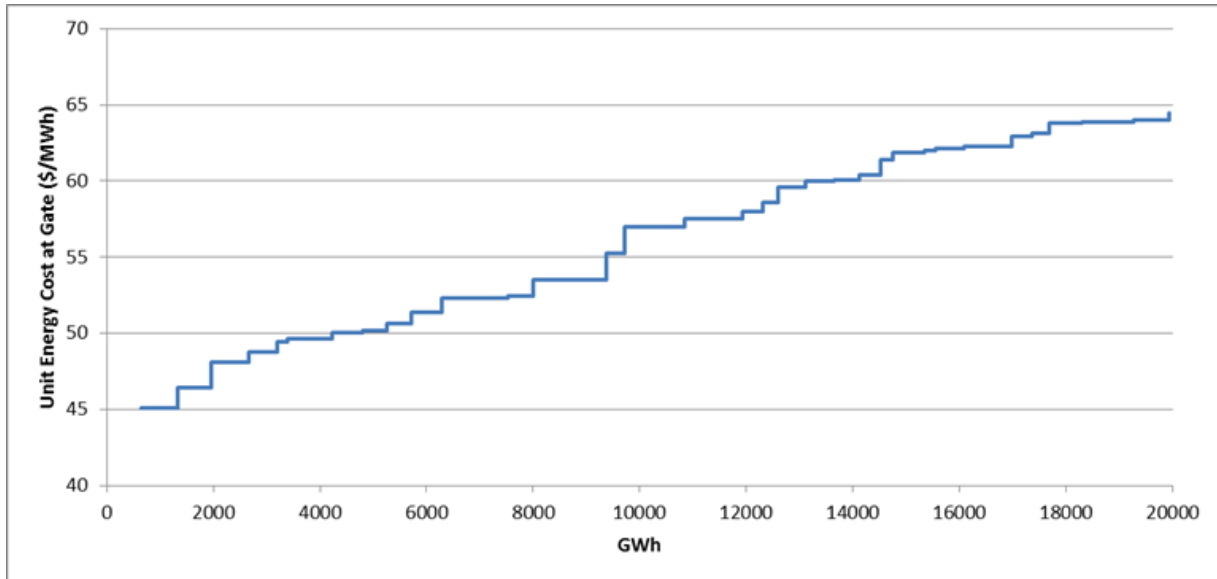
Slide 5 – I need to make a correction. The loss assumption that was agreed to in 2015 was 20.4%, not 12.75%. However, following the modelling approach taken in the 2009 BC Hydro Wind Data Study, the loss assumption is applied to wind speed, not generation. The 20.4% loss to generation translates to a 12.75% drop in wind speed.

Slide 8 – here is the link to the 2018 Hatch update of its 2015 cost analysis:

<https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/regulatory-planning-documents/integrated-resource-plans/current-plan/wind-report-20180822-hatch.pdf>

Slide 9 – when I calculated the UECs in preparation for our meeting, I used a WACC of 5% real. This was based on a 2018 Navigant report that assumed for its mid forecast of WACC in 2025 a debt of 75-85%, a cost of debt of 7% and a cost of equity of 9-11%. I should note that at the time of our meeting, the WACC had not been finalized. We are now assuming a WACC of 3.9% real for IPPs (same as for BC Hydro). This recognizes that power production development is increasingly mainstream, that banks are much more comfortable with financing power production projects, and that bigger, global entities are getting into the business that have lower cost of financing in the same way that BC Hydro does.

Slide 11 –Below is the supply curve (at gate) for the first 20,000 GWh, based on the new WACC.



The majority of the projects in the first 20,000 GWh are in the 100-200 MW range, with capacity factors ranging from 35% to 53%. Since I am looking at unit energy cost at gate, projects with transmission lines in excess of 100 km are included in the first 20,000 GWh. Once the transmission cost is included in the unit energy cost, the projects would certainly get re-ordered.

Other – The graph below shows how the capital cost is scaled with project size.

