BACKGROUND

In 2009, DNV Global Energy Concepts Inc. (now DNV GL) completed two wind studies for BC Hydro. The BC Hydro Wind Data Study[1] identified 104 potential wind projects, with a total installed capacity of almost 16,000 MW. In this study, pre-determined criteria[2] were applied using GIS to identify theoretical projects. The installed capacity of each project was estimated using assumptions on wind turbine technology and wind turbine density. Numerical mesoscale modelling[3] was used to create 10 years of 10-min wind speed time series for each project. These wind speed time series were then crossed with appropriate power curves and loss assumptions to produce time series power data. As the short-term variability is generally underrepresented in the modelled data, statistical corrections (referred to as the SCORE-lite process) were then applied to the power data to ensure the inclusion of short-term variability.

The BC Hydro Wind Data Study covered approximately two thirds of British Columbia. A second study, the BC Hydro Wind Data Study Update[4], was completed to identify the wind potential in the areas not covered in the first study. An additional 26 projects, with a total installed capacity of 3,800 MW were identified. The second study follows roughly the same methodology as the first study. However, separate numerical mesoscale modelling to create time series data for the identified sites was not done. Instead, a 5-km resolution wind map produced by 3TIER for the province of British Columbia was used to obtain information on the mean wind speed at the identified sites.

Both studies were used to describe the onshore wind resource potential in the 2010 Resource Options Report, but only the BC Hydro Wind Data Study was used in the 2010 Wind Integration Study, since the wind integration analysis requires time series power data. For the 2013 Resource Options Report Update, DNV KEMA (now DNV GL) was commissioned to provide a wind turbine power curve for IEC Class III wind sites, and to update the power curves for IEC Class I and II turbines. The three wind power curves were developed by blending wind turbine power curves from a number of recent and current models for each of the three IEC classes. These new power curves were then applied to the modelled wind speeds from the BC Hydro Wind Data Study to create new hourly generation profiles for each wind project. No changes were assumed for turbine hub heights, installed wind capacity of the individual wind projects or wind farm losses. With the application of the revised power curves, the annual net energy production increased on average by 13% for IEC Class I wind projects, 6% for IEC Class II wind projects, and 18% for IEC Class III wind projects.

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

[2] The criteria included a minimum long-term wind speed average of 6 m/s, a maximum distance from transmission of 200 km, and a maximum slope of 20%.

[3] The 10-year 10-minute time series were created by blending together data from a 1-year, 2 km resolution simulation with a 10-year, 6 km resolution simulation.

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

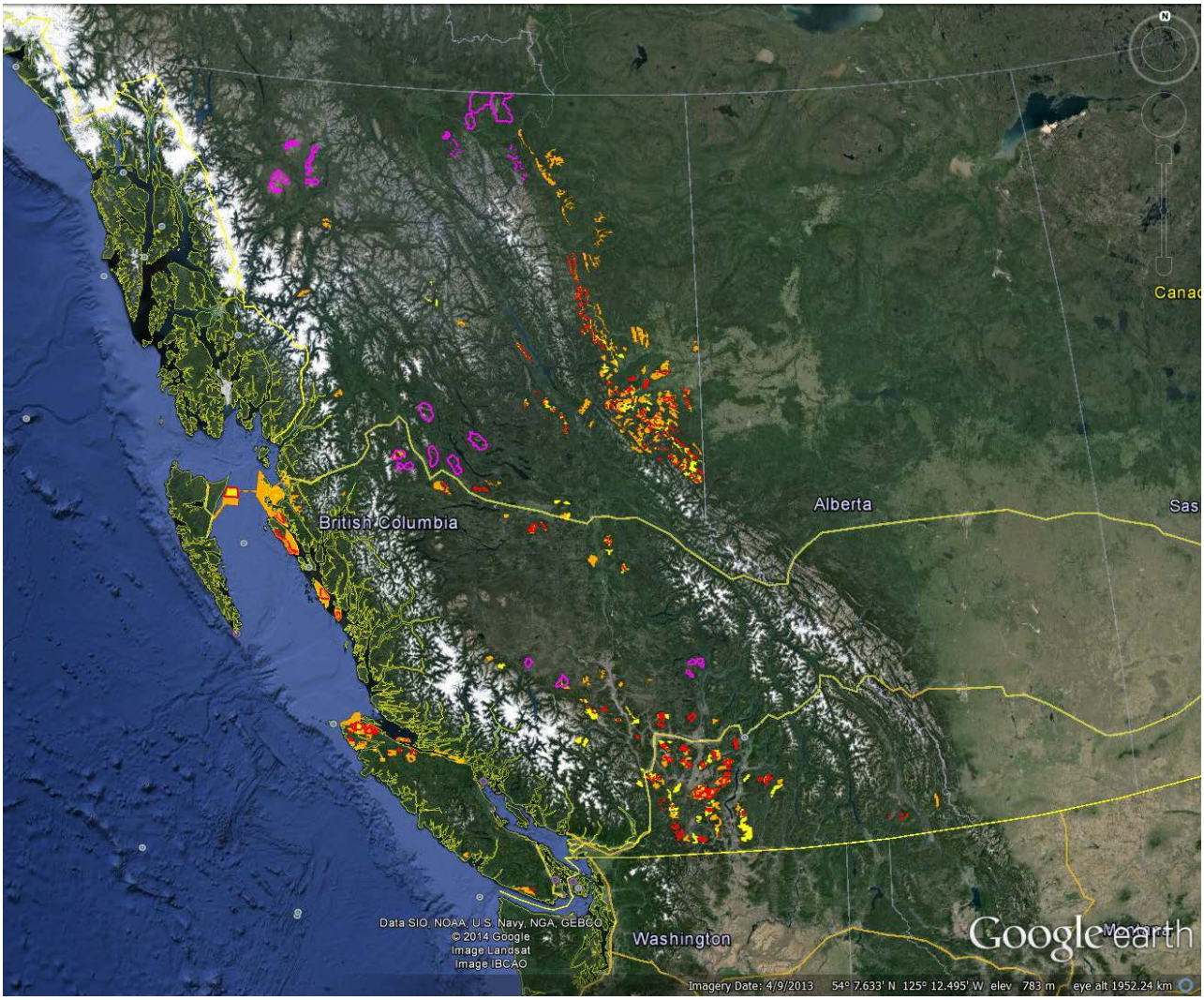
FEEDBACK REQUESTED

In order to update the wind integration study, new 10-minute time series power data are required. Below is a review of all the input assumptions, and proposed updates we are seeking your feedback on, along with questions to help guide the discussion and input.

1. List of Theoretical Projects

The map below shows the theoretical projects identified in the BC Hydro Wind Data Study (red lines) and the BC Hydro Wind Data Study Update (pink lines), as well as areas with actual investigate licenses (orange areas) or licenses of occupation (yellow areas). There is generally a good overlap between the theoretical projects identified in the Resource Options reports and where IPP interest has been focused.

Proposed Change: None



2. Turbine Size and Project Installed Capacity

The original BC Hydro Wind Data Study used two turbine models: the Siemens 2.3-93 for IEC Class II wind sites and the Vestas V90 – 3MW for IEC Class I wind sites. Although new power curves were applied for 2013 Resource Options Report Update, the turbine sizes were left unchanged.

Question: Should the turbine size be updated? If so, should the total installed capacity for each project be kept the same (by changing the number of turbines for each site)? Presently, the median project size is 117 MW, with the maximum project size 662 MW, and the minimum project size 35 MW.

3. Losses

In the BC Wind Data Study, total losses of 18.5% are assumed.

Question: Should the loss assumption be updated?

4. Hub Height

Both wind data studies assume a hub height of 80 m.

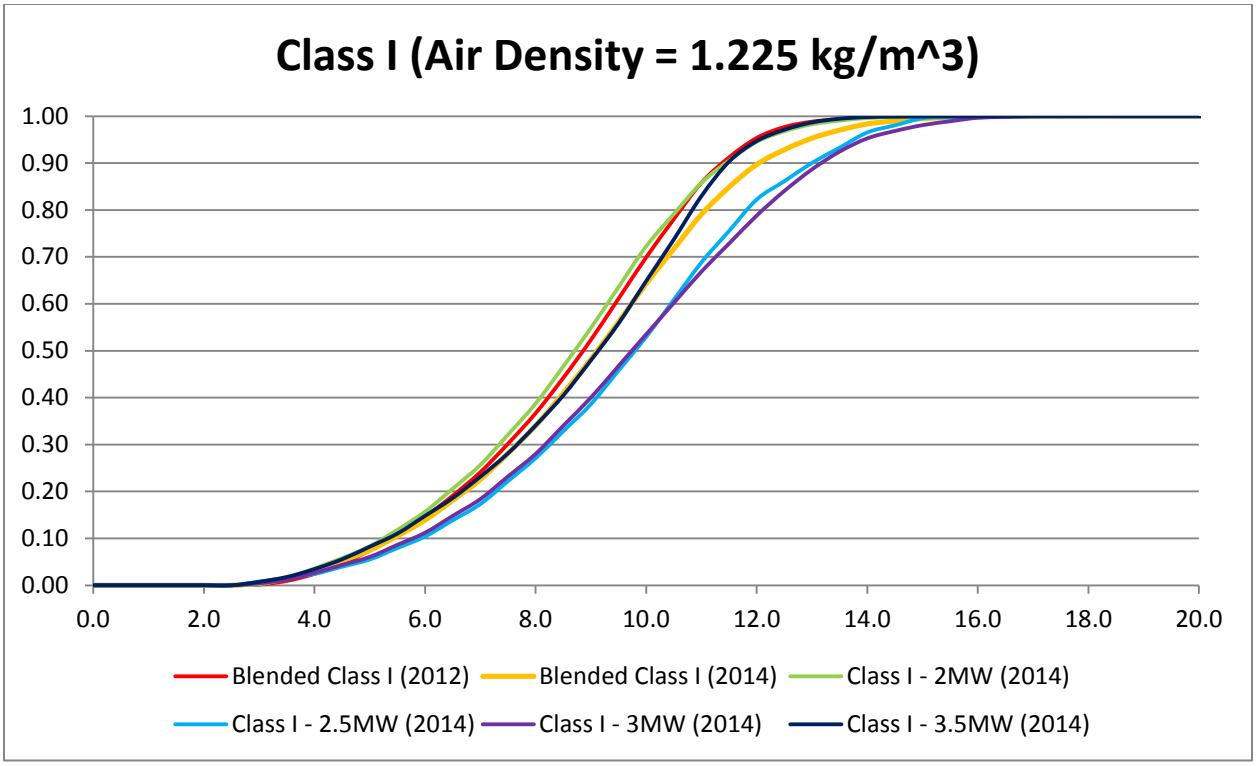
Question: Should a higher hub height be used? If so, the extra cost in the higher hub height (tower, foundation, etc.) should be reflected in the costs.

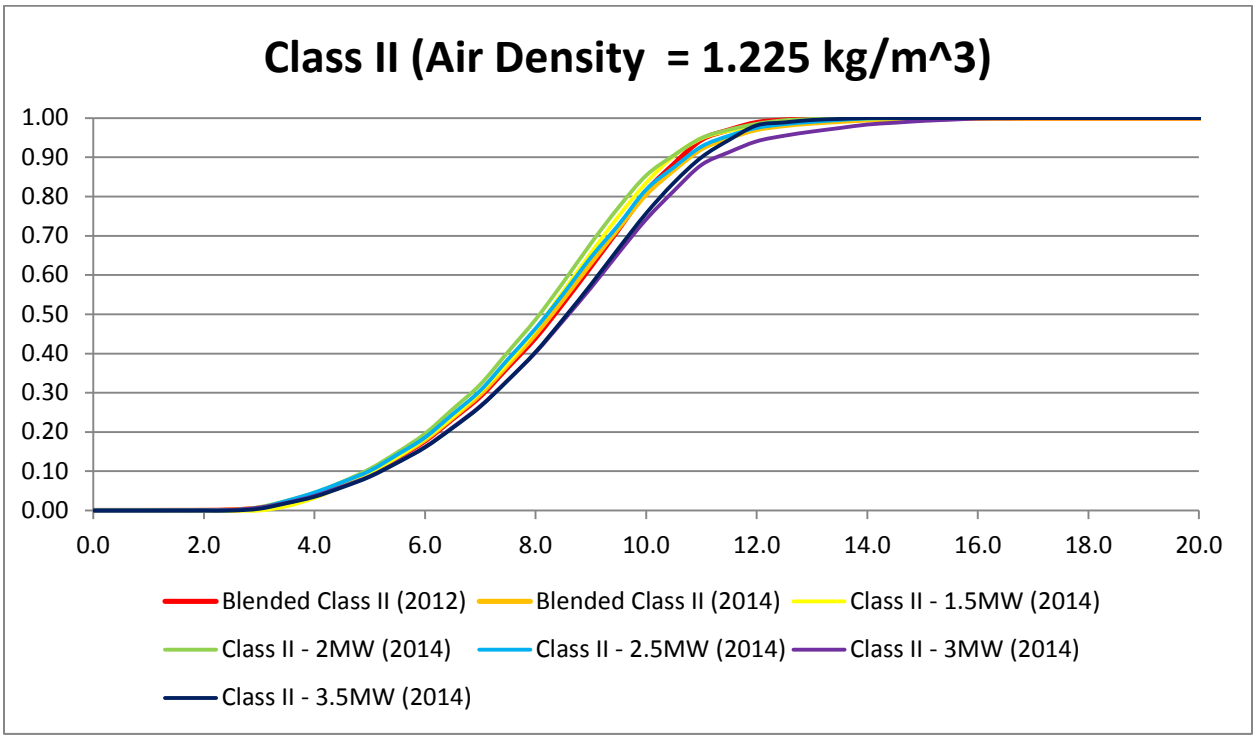
5. Turbine Efficiency

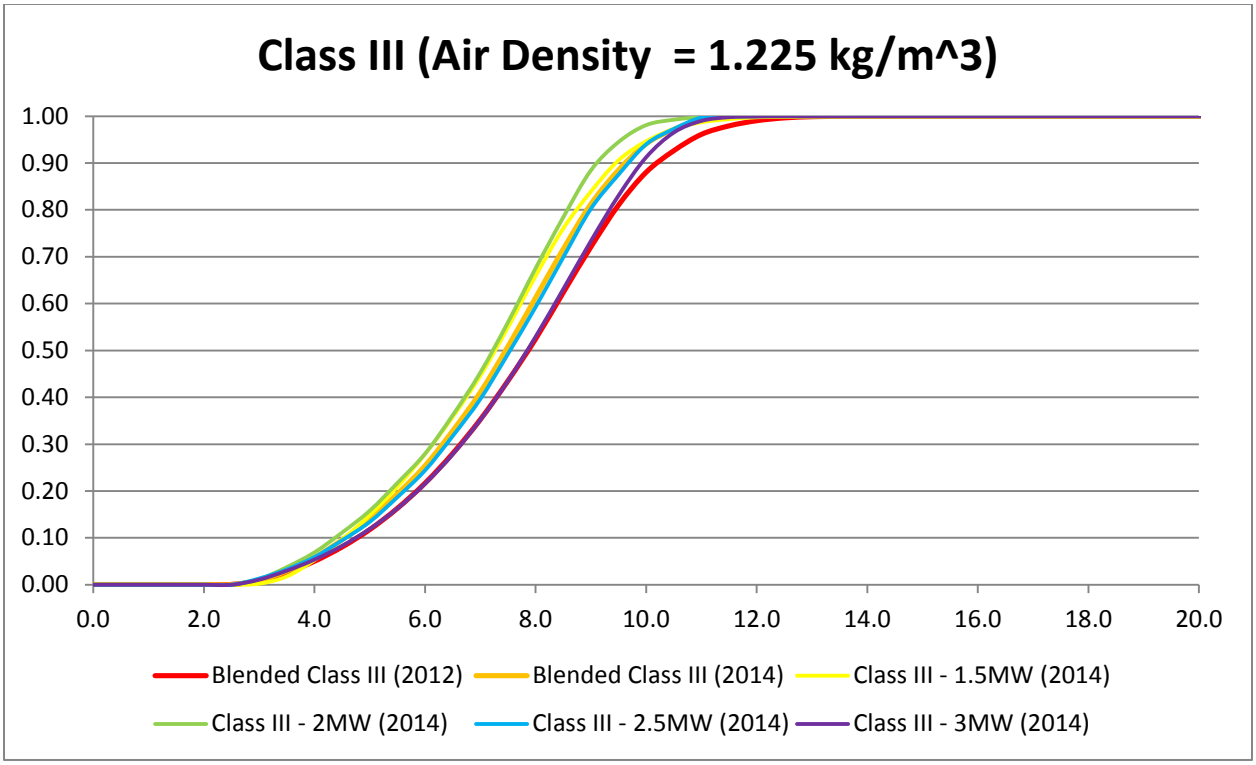
In May 2014, DNV GL was commissioned once again to provide updated power curves (see attached document). The graphs[5] below provide a comparison of normalized power curves by IEC wind class between the 2012 and 2014 updates. For the previous update, power curves of turbines within an IEC wind class were averaged or blended together, regardless of size of turbine. When the same blending approach was applied to the recent update, a large decrease in efficiency was found for IEC Class I turbines, the efficiency for IEC Class II turbines remained roughly the same, and a large increase in efficiency was found for IEC Class III turbines.

Proposed Change: Instead of using updated blended power curves, it is proposed that generic normalized power curves by nominal nameplate capacities are used.

[5] The graphs have been truncated at 20 m/s to better show the differences in the power curves in the 'knee' of the curves. All turbines are assumed to have a high wind speed cut-out of 25 m/s.


Class I (Air Density = 1.225 kg/m^3)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Blended Class I (2012)
Blended Class I (2014)
Class I - 2MW (2014)
Class I - 2.5MW (2014)
Class I - 3MW (2014)
Class I - 3.5MW (2014)


Class II (Air Density = 1.225 kg/m^3)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Blended Class II (2012)
Blended Class II (2014)
Class II - 1.5MW (2014)
Class II - 2MW (2014)
Class II - 2.5MW (2014)
Class II - 3MW (2014)
Class II - 3.5MW (2014)


Class III (Air Density = 1.225 kg/m^3)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Blended Class III (2012)
Blended Class III (2014)
Class III - 1.5MW (2014)
Class III - 2MW (2014)
Class III - 2.5MW (2014)
Class III - 3MW (2014)