BC HYDRO WIND RESOURCE OPTION ENGAGEMENT

DECEMBER 15,2014

BC hydro

FOR GENERATIONS

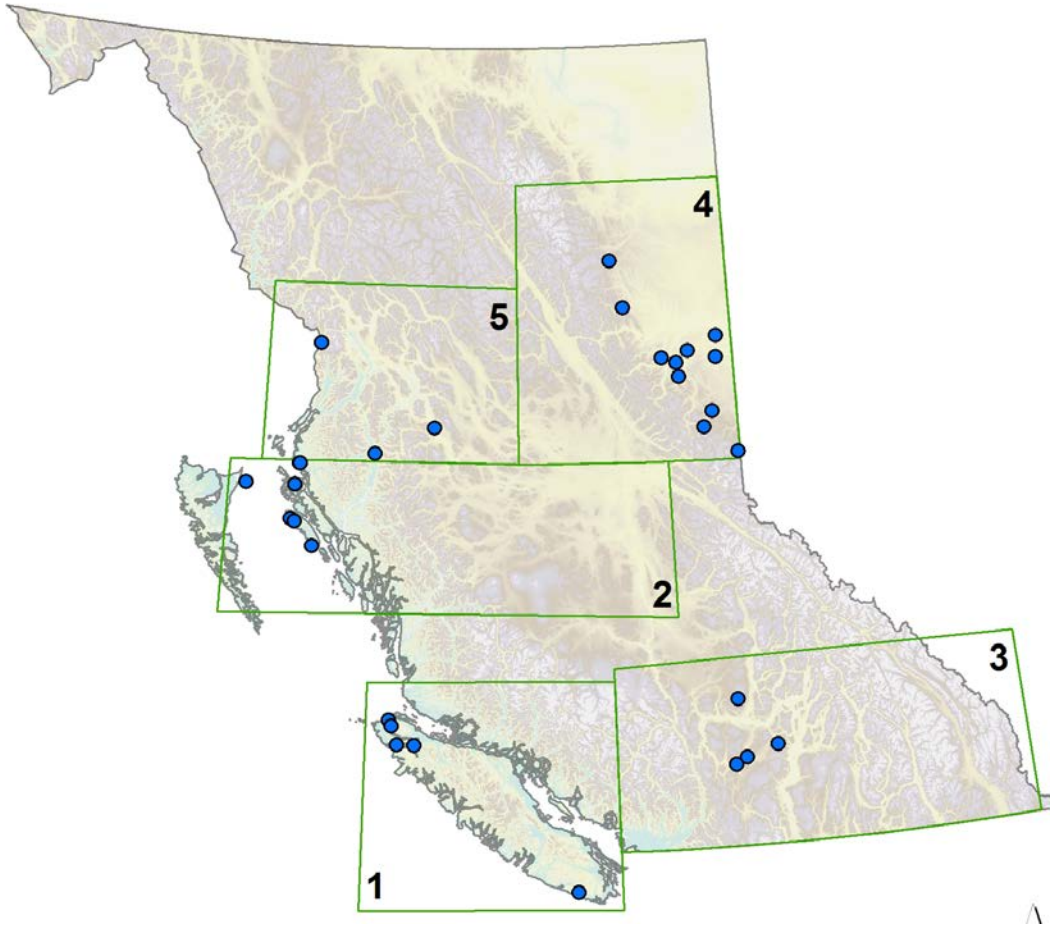
AGENDA

- BC Hydro – FortisBC collaboration on resource option database
- Follow-up on action items from previous engagement session
  - Review wind speed adjustment for Peace Region
  - Investigate if AWS Truepower high resolution wind data is suitable for resource planning
  - Review loss assumption
  - Collect information on turbine characteristics from OEMs
- Proposed changes for input assumptions
- Next steps

BC HYDRO- FORTISBC COLLABORATION ON RESOURCE OPTIONS INVENTORY

- Goal is to share information on resource options and develop a common resource option inventory (where possible)
- Will benefit future engagement and regulatory processes
- Not expected to impact this engagement process

WIND SPEED ADJUSTMENT APPLIED IN THE 2010 WIND DATA STUDY



- Validation was completed for 30 points
- Modelled wind speed bias in NC, VI and SI generally within ±15%, with no persistent bias
- Persistent -ve modelled wind speed bias (-18% to -26%) found for validation sites in PR, specifically in the high country east of the Continental Divide

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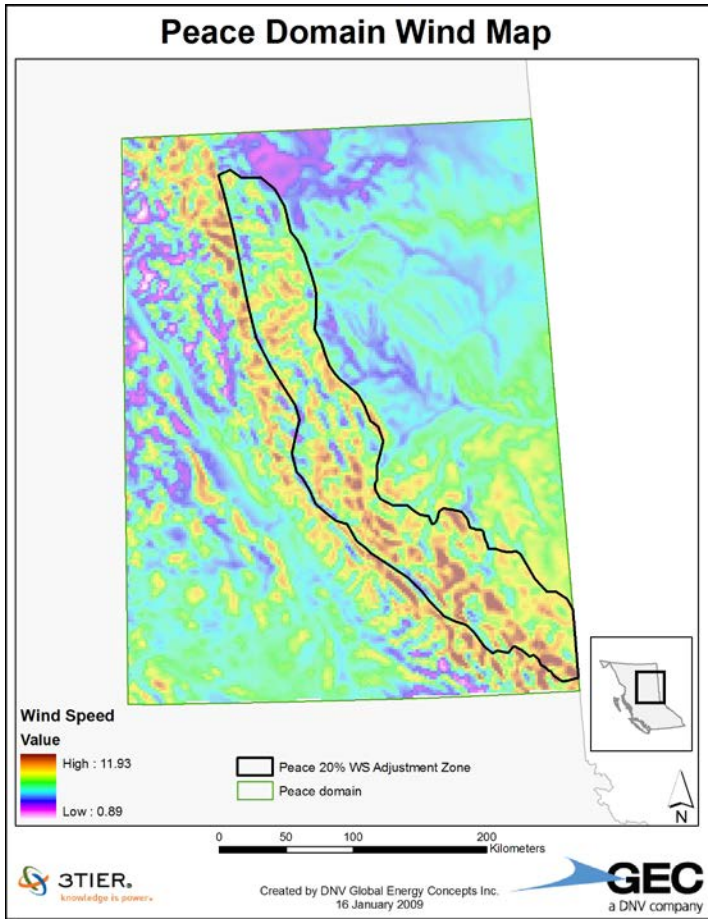
WIND SPEED ADJUSTMENT APPLIED IN THE 2010 WIND DATA STUDY



- Wind speed adjustment of 20% was applied to a specific area to correct for persistent and significant under-prediction of wind speed

APPLICABILITY OF AWS TRUEPOWER'S HIGH RESOLUTION WIND DATA FOR RESOURCE PLANNING

- AWS Truepower applies microscale modelling to mesoscale model output to create 200-m grid resolution wind maps
- Underlying mesoscale modelling is based on 366 days sampled from a recent 15-year period (i.e. representative meteorological year)
- Does not provide time series (or length of time series) required for wind integration study

FEEDBACK ON 18.6% LOSS ASSUMPTION

- Fair range for total technical losses considered to be 18% to 22%. This range does not include icing losses.

  → Loss assumption of 18.6% on the low side

- Icing can range 0 to 18%, but very challenging to estimate
- Current assumption on turbine performance too low
- Missing losses due to curtailment

PROPOSE TO CHANGE LOSS ASSUMPTION FROM 18.5% TO 20.4%

Energy Loss Category	Losses assumed in 2010 Wind Data Study	Proposed Losses
Availability	5.9%	5.9%
Wake Effect	6.5%	6.5%
Electrical	2.5%	2.5%
Environmental	4.8%	**5.3%**
Turbine Performance	0.3%	**1.5%**
Curtailment	0.0%	**0.5%**
Total	**18.6%**	**20.4%**

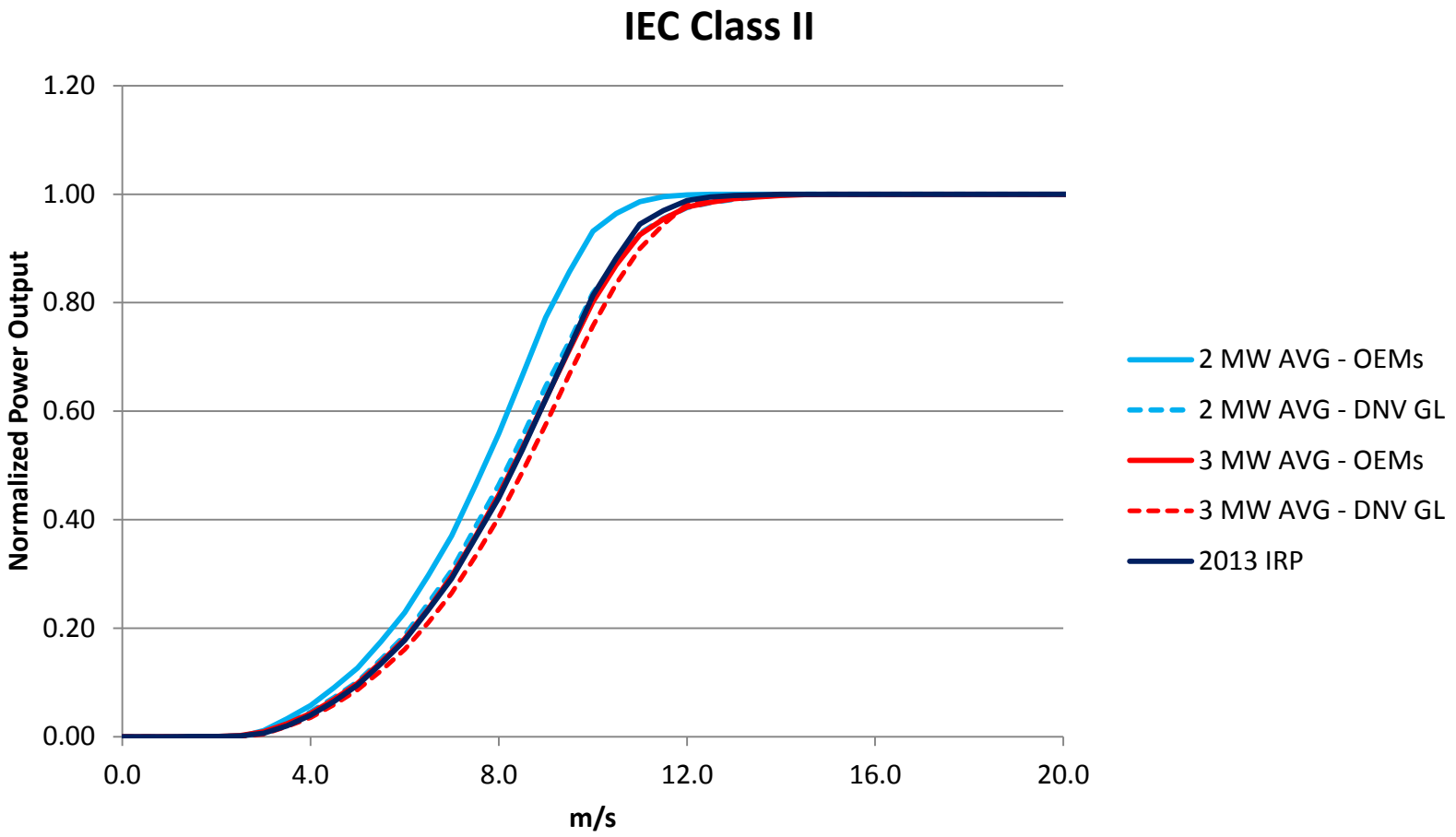
TURBINE CHARACTERISTICS

- Contacted and received information from 5 turbine manufacturers
- Turbine summary:
  - Received information on 15 turbine models:
  - Nameplate capacity predominantly in the 3.0 - 3.3 MW range
  - 14 of submitted models are IEC Class II and III
- Other comments:
  - Install turbines with larger nameplate capacity in more complex terrain to save on construction costs
  - ‘Mix-and-matching’ of turbine models with different rotor sizes

TURBINE CHARACTERISTICS

- Hub height:
  - Seen as trending up
  - New tower developments will allow hub heights of 140m+
  - Several OEMs suggested hub height of 100-120 m for the near-term future
  - Still depends on location, wind condition, etc

TURBINE CHARACTERISTICS



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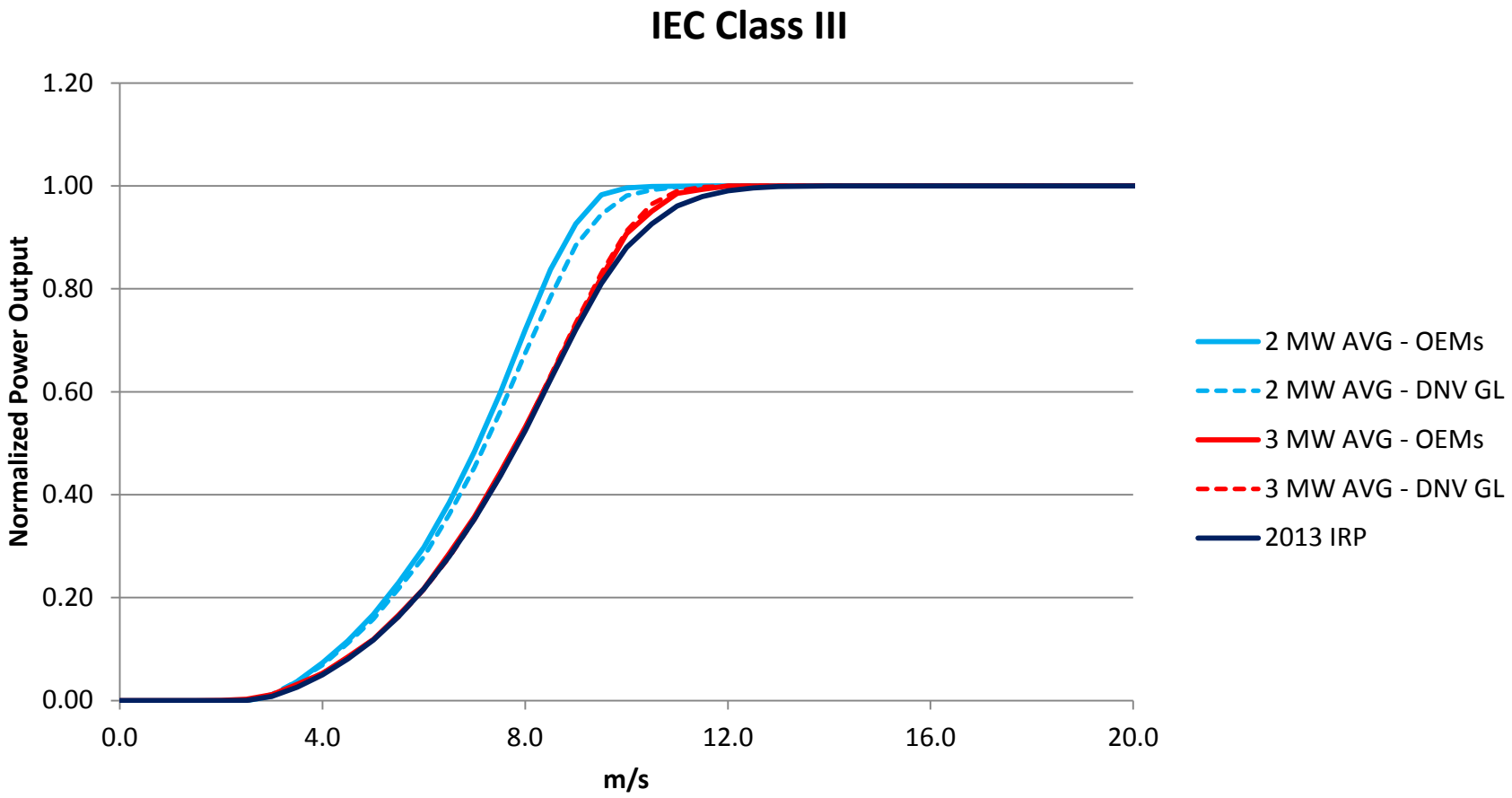

PROPOSED CHANGES FOR INPUT ASSUMPTIONS

- Keep list of projects and installed capacity for each project unchanged
- Keep using wind speed time series from the 2010 Wind Data Study
- Increase loss assumption from 18.6% to 20.4%
- Increase hub height from 80 m to 100 m
- Assume a nameplate capacity of 3.3 MW across all IEC classes
- Use power curve for generic 3.3 MW for each IEC class, based on information obtained from OEMs

NEXT STEPS

- 3TIER to create new wind power generation time series, based on updated input information
- Work with engineering/construction firms to obtain BoP costs specific to BC
- Wind Integration Study Technical Review Committee kick-off meeting scheduled for early April 2015