

# BC HYDRO WIND RESOURCE OPTION ENGAGEMENT

MAY 5, 2015



FOR GENERATIONS

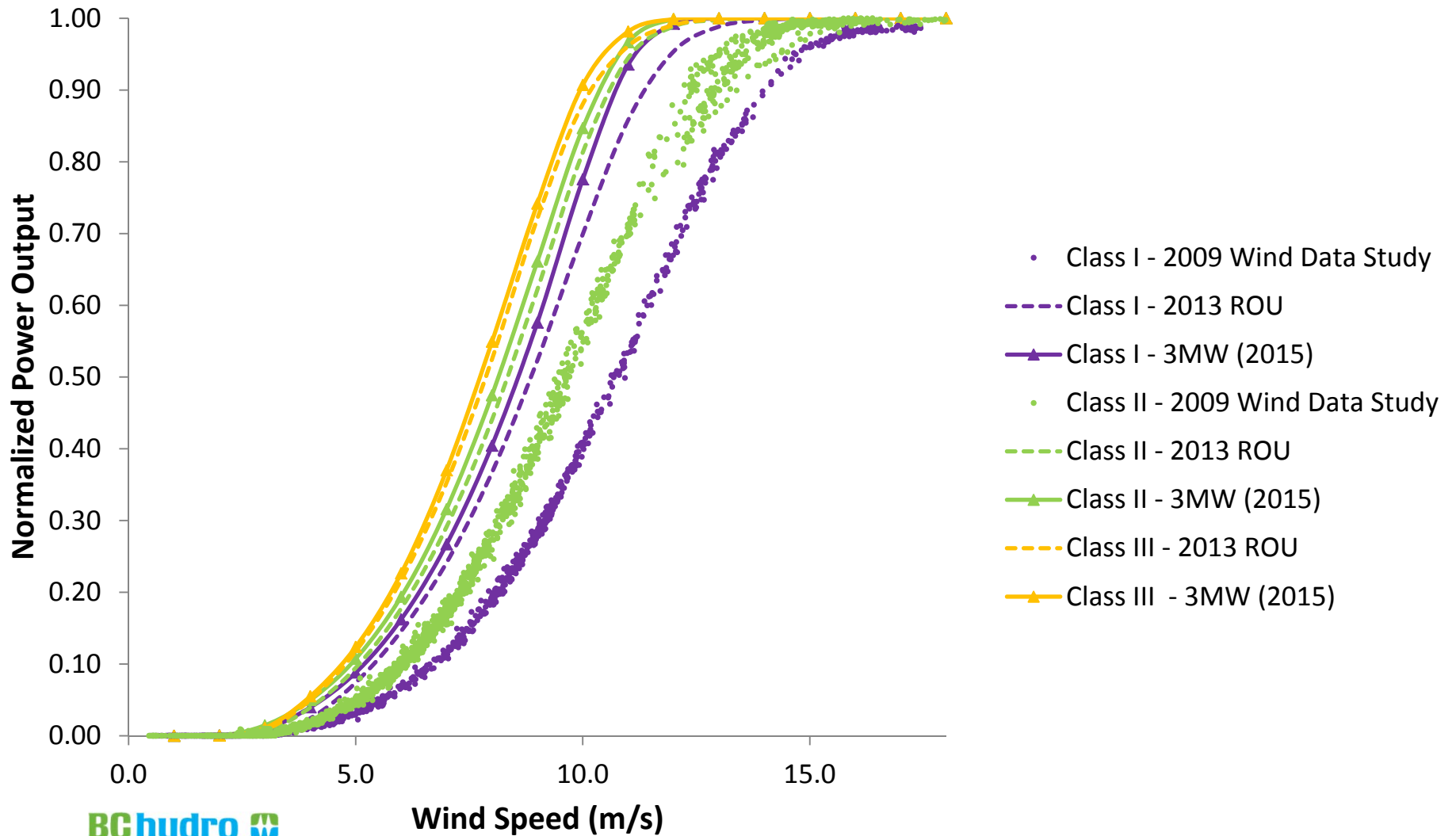
## AGENDA

- Review impact of updated turbine characteristics on net CF
- Review updated wind costs and assumptions

## SUMMARY OF PROPOSED CHANGES TO TURBINE CHARACTERISTICS

- Increase hub height (HH) from 80m to 100m
- Use uniform turbine size of 3 MW (no impact)
- Increase loss factor from 11.6% to 12.75%
- Update power curves based on current/forward looking turbine technology

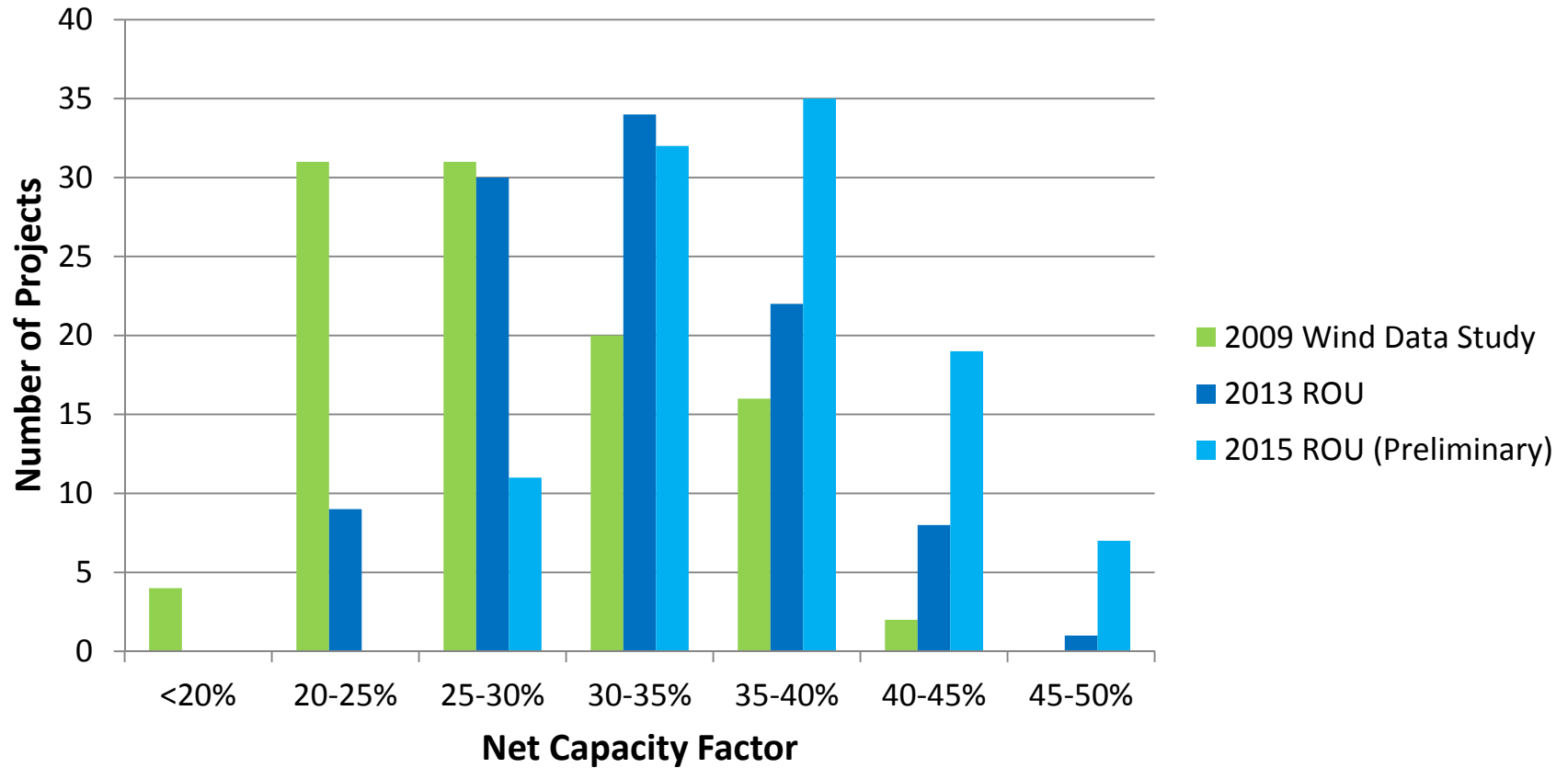
# POWER CURVES UPDATE



# SUMMARY OF PROPOSED CHANGES IN TURBINE CHARACTERISTICS

	Average net CF percentage point increase from 2013 ROU due to updated power curves	Average net CF total percentage point increase from 2013 ROU (includes updated power curves, 100 HH and new loss assumptions)	Average net CF total percentage point increase from 2009 BC Hydro Wind Data Study
IEC Class I	1.3	3.5	8.1
IEC Class II	1.9	3.6	7.9
IEC Class III	1.0	3.4	8.2

# IMPACT OF CHANGES IN TURBINE ASSUMPTIONS ON NET CF



## WIND CAPITAL AND O&M COSTS UPDATE

Cost information obtained through:

- Wind project cost review by Hatch
- Survey of developers active in BC, conducted by GE Power & Water
- EPC cost review for Canadian wind projects by Borea Construction (confidential report)

## HATCH COST REVIEW FOR BC WIND PROJECTS

- Cost analysis includes pre-construction costs, turbine supply agreement, BoP costs, and owner's cost during construction
  - Out of scope for Hatch analysis
    - Financing costs
    - Transmission/interconnection costs
    - Off-site road access
  - Wind Participation Rent and community/FN accommodation calculated separately (based on CF/revenue)
- Common to all resource options



## HATCH COST REVIEW - APPROACH

- Based on line item analysis for a base case wind project in each of the four regions (PC, NC, SI, VI)
- Cost estimates based on information from publically available sources and interviews with turbine vendors, EPC contractors and developers
- Total capital cost adjusted to reflect that larger projects benefit from economies of scale

## BASE CASE PROJECT ASSUMPTIONS

- Base case reflects median project size in each region
- Assume generic `best case scenario` site conditions:
  - Good site access via existing public roads and located in proximity to services in a small community
  - No considerable importation/exportation of material required
  - No rock blasting
  - Minimal number of waterway crossings
  - Does not cover costs associated with challenging topography with high relief approaches

# CAPITAL AND O&M COSTS FOR BASE CASE PROJECTS (\$/KW)

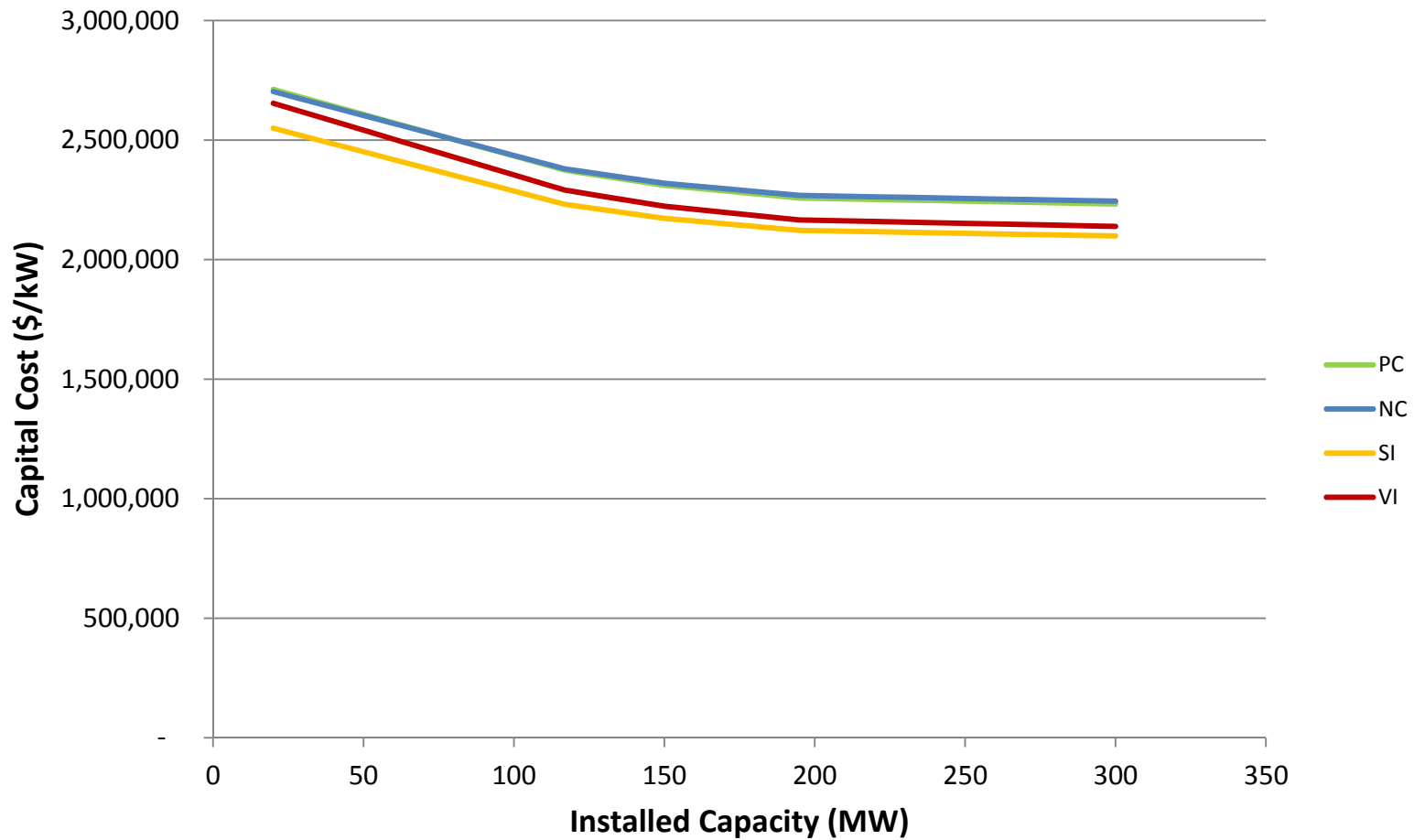
Project Phase	NC (195 MW)	PC (117 MW)	SI (117 MW)	VI (48 MW)
Pre-Construction	50	80	67	137
Wind Turbines*	1,384	1,383	1,366	1,415
BoP	635	686	603	759
Owner's Costs during Construction	198	225	196	238
<b>Total Capital Cost</b>	<b>2,268</b>	<b>2,374</b>	<b>2,231</b>	<b>2,549</b>
Annual O&M Cost	68	73	67	74

\* Cost estimates based on a 20-yr project life. For a 25-yr project, expect 3-4% increase in turbine cost.

## CAPITAL AND O&M COSTS FOR A 102 MW WIND FARM (\$/KW)

Project Phase	NC	PC	SI	VI
Pre-Construction	78	86	71	75
Wind Turbines	1,396	1,383	1,367	1,403
BoP	699	695	610	654
Owner's Costs during Construction	221	227	200	215
<b>Total Capital Cost</b>	<b>2,394</b>	<b>2,391</b>	<b>2,248</b>	<b>2,347</b>
Annual O&M Cost	79	74	68	72

# ADJUSTMENT OF COST FOR SIZE OF PROJECT



## SURVEY OF DEVELOPERS ACTIVE IN BC

- Organized/conducted by GE Power & Water
- Small number of respondents, but all reputable, active in BC and experienced with bringing wind projects to completion
- Cost estimates based on a 100 MW+ project
- Includes engineering, development fees, insurance, FN accommodation, legal fees, BoP (i.e. everything but turbine costs)
- Respondents asked to specify if project site is plateau or complex
- Results: US \$1,060/kW for plateau site  
US \$1,400/kW for complex site

## COMPARISON OF CAPITAL COSTS (\$/KW)

	Hatch	IPP Survey (Plateau Site)*	IPP Survey (Complex Site)*
Development, BoP, Owner's Costs	881-1,010	1,180	1,550
Turbine Cost	1,370-1,400	1,330**	1,390**
<b>Total</b>	<b>2,250 – 2,395</b>	<b>2,510</b>	<b>2,940</b>

\* Cost estimates were provided in USD. Exchange rate of 1 USD = 0.9 CAD was used to convert to CAD.

\*\* Turbine costs estimated by GE

## EPC ESTIMATES BY BOREA CONSTRUCTION

### General learnings:

- BoP cost estimates for PC region in line with Hatch's estimates
- BoP costs in Peace region can be competitive with rest of Canada
- Project site (water crossings, terrain complexity, etc) matters
  - Can substantially increase BoP costs



## PUTTING EVERYTHING TOGETHER...

- Hatch cost estimates are representative of `best case scenario` sites in the four regions of BC
- These sites exist, but likely do not overlap with high wind speed sites (presumably more complex terrain)
- Concern – combination of high wind speed sites and low cost estimates will underestimate UECs

Feedback from Stakeholders?

## FUTURE TURBINE PRICING

- Turbine prices have fallen ~30% from peak in 2008/2009
- No significant additional reductions expected in foreseeable future
- Future trends in turbine pricing?
  - Future wind energy price reductions usually attributed to changes in wind turbine technology which lead to cost reductions and/or improvements in turbine efficiencies
  - Market/economic conditions can drive turbine prices higher (e.g. as seen in 2004-2009 period)
- Propose to treat future turbine pricing as scenarios