

## Sixth Northwest Conservation & Electric Power Plan

# Wind Resource Assessment

Jeff King

Northwest Power and Conservation Council  
Generating Resources Advisory Committee

Portland, OR  
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## Issues affecting future role of wind power

- Least-cost renewable resource available in bulk quantity
- No direct production of carbon dioxide or criteria air pollutants (SO<sub>x</sub>, NO<sub>x</sub>, etc.)
- Ecological impacts usually avoided with judicious siting
- Public perception:
  - Wind projects - generally very favorable; some scenic areas excepted
  - Some resistance to transmission needed to access remote resource areas
- Little peaking capacity value
  - Supplemental sustained peaking capacity may eventually be needed to maintain resource adequacy



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## Issues affecting future role of wind power, continued

- **Investment risk:**
  - High capital cost (currently \$2000 - 2200/kW)
  - Short development and construction lead time
  - Transmission in advance of development will be needed to access remote resource areas
- **No fuel price risk**
- **Intermittent output incurs integration cost**
  - Nature of integration costs becoming better understood
  - "Its the ramp, not the ripple"
  - Institutional, procedural, technical measures enabling full use of existing system flexibility + ramp control are available at moderate cost.
  - Capacity additions eventually needed to maintain peak sustained capacity may coincidentally provide adequate system flexibility.
  - Individual balancing authority situations may differ.



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## Revisions & refinements to wind assessment

- 1) Revised capital cost
- 2) Revised operation and maintenance costs
- 3) Revised operational integration costs
- 4) Revised future capital cost assumptions
- 5) Expanded supply curve (added resource areas)
- 6) Representative hourly project output by resource area
- 7) Optimize transmission, integration, energy production
- 8) Assessment of offshore wind

Draft assessment complete for #1 - #5

Data available for #6, planned for inclusion in draft 6<sup>th</sup> Plan.

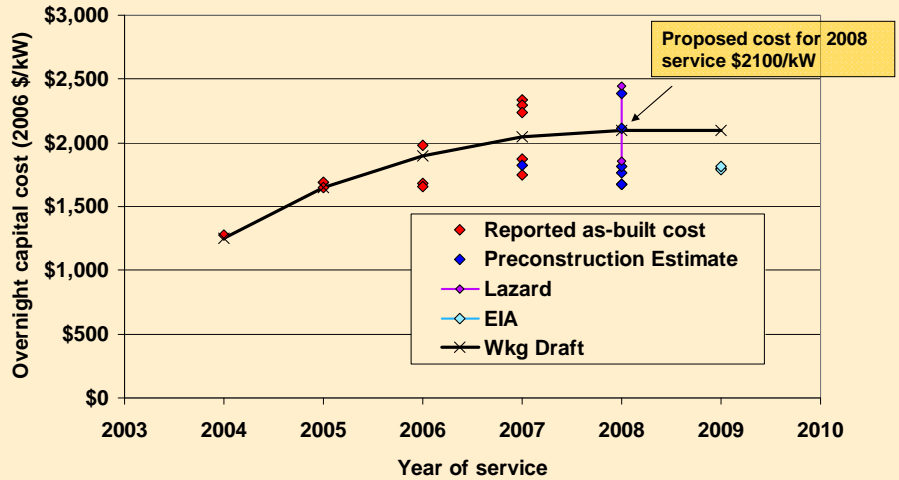
First cut at implicit tradeoffs of #7 planned for inclusion in draft 6<sup>th</sup> Plan. Follow-on, more detailed assessment proposed by the Wind Integration Forum

Overview of #8 planned for January GRAC



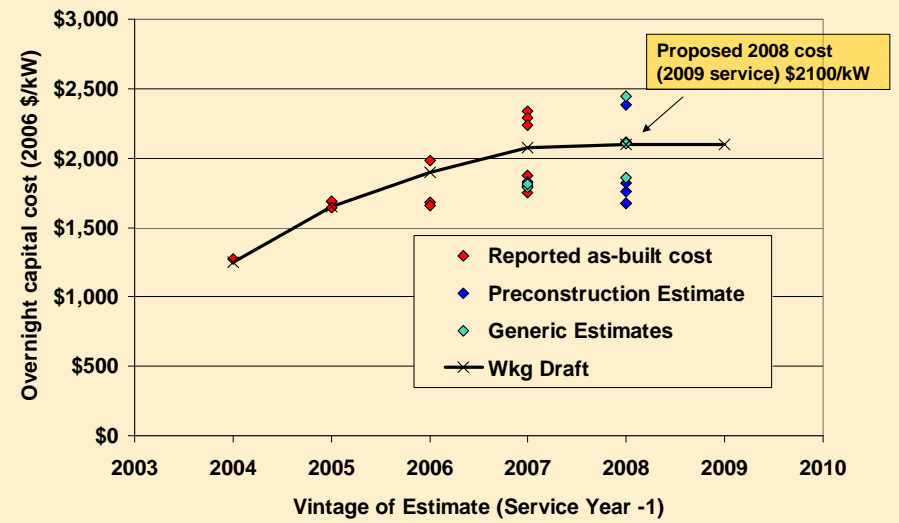
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### Proposed base year wind plant capital cost



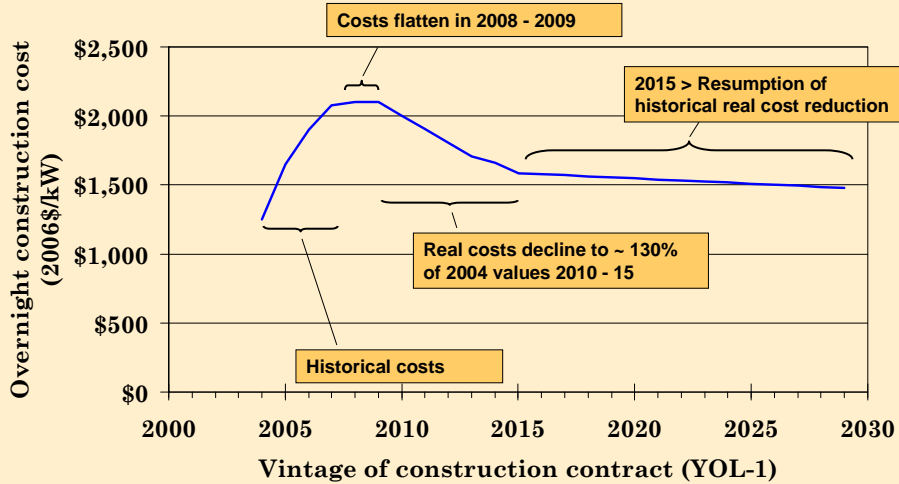
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### Proposed base year wind plant capital cost



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## Thinking on future construction costs (Slightly evolved, but still provisional)



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## Operation and Maintenance Cost Elements

- Wind plant only (e.g., to point of interconnection), exclude transmission
- Each of the following, with the exception of fixed O&M and capital replacements is separately input to the Council's models

### Fixed O&M

- Labor
- Routine maintenance contracts, labor and materials
- Administrative and general costs

### Variable O&M

- Land rent/royalties

### Property Taxes and in-lieus

### Insurance

### Capitalized replacements over life of project

- Gearbox, blade replacements, etc.
- Added to fixed O&M for modelling purposes



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## Derivation of operation & maintenance costs

- Assume fixed O&M costs are a function of capital cost (typical approach for feasibility-level estimates)
- Scaling O&M costs of the 5<sup>th</sup> Plan by observed escalation of capital costs yielded:
  - Fixed O&M (including capital replacement) - \$41.58/kW/yr
  - Property Tax at 1.4% of depreciated plant value - \$6.07/kW/yr (levelized)
  - Insurance at 0.25% of depreciated plant value - \$1.09/kW/yr (levelized)
- Variable O&M assumed to increase only with inflation - \$1.16/MWh
- The sum of the four elements yield total O&M of 2.5% of annual capital cost - consistent w/IEA (next slide)
- Adjusting fixed O&M and variable O&M to round values while maintaining total O&M as 2.5% of annual capital cost, resulted in the following proposed values:
  - Fixed O&M including capital replacements, excluding property tax and insurance - \$43/kW/yr
  - Variable O&M - \$1.00/MWh



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## Comparisons of proposed O&M costs w/other sources

- Average of eight 2009 rate requests by Northwest utilities owning wind capacity - \$33.98 (2006\$) + 10% G&A allowance (approx per PGE) yields \$37.38/\$kW/yr
  - Generally exclude land rent or royalties and property taxes
  - Include near-term O&M contracts and warranties (potential longer-term capital replacements implicitly excluded).
- IEA rules of thumb:
  - 2.0 - 3.5% of annual capital cost (proposed values are 2.5%)
  - 20 - 25% of total energy cost, inclusive of capital replacement (proposed values are 22%)
- Lazard (financial and capital management advisors)
  - \$40 - \$50/kW/yr
  - Inclusions and exclusions not specified



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## Wind power operating and maintenance costs

	5 <sup>th</sup> Plan	Proposed 6 <sup>th</sup> Plan	
Routine O&M + capital replacement	\$23/kW/yr	\$43/kW/yr	Fixed - Cap Rep treated as an expense
Land & ROW rent/royalties	\$1.16/MWh	\$2.00/MWh	Variable
Property Taxes	1.4%/yr of depreciated investment	Unchanged	"Regional average" Common to all resources
Insurance	0.25%/yr of depreciated investment	Unchanged	Common to all resources
Integration	\$5 - 10/MWh	\$8.70 - 11/MWh	



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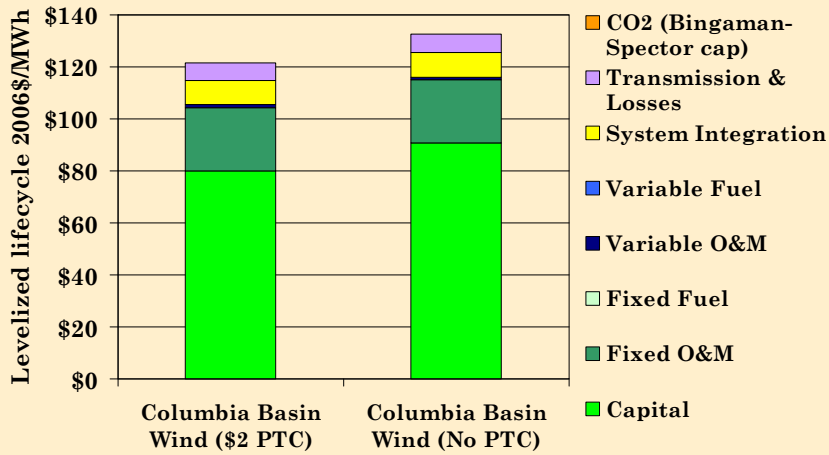
## Planning assumptions - Basic wind project

- 150 MW project
- \$2100/kW overnight development and construction cost (2008 base)
- Plant capital cost stable through 2009, declining to 130% (real dollar terms) of 2004 costs by 2015, then resuming historical (pre-2004) learning curve through 2025 (provisional assumption)
- Operating costs:
  - Fixed O&M - \$43.00/kW/yr
  - Variable O&M - \$1.00/MWh
  - Integration - \$8.70 (near-term) - \$10.90 (long-term) per MWh
- 36 mo from conceptualization to service (minimum)
  - 18 mo Development phase (site identification through completion of permitting) - 2% of TPC
  - 9 mo Preparation phase (turbine order through turbine shipment) - 12% of TPC
  - 9 mo Construction phase (turbine shipment to commercial operation) - 86% of TPC
- Earliest service for new Northwest project ~ 2011
  - Construction initiated at permitted site 2010



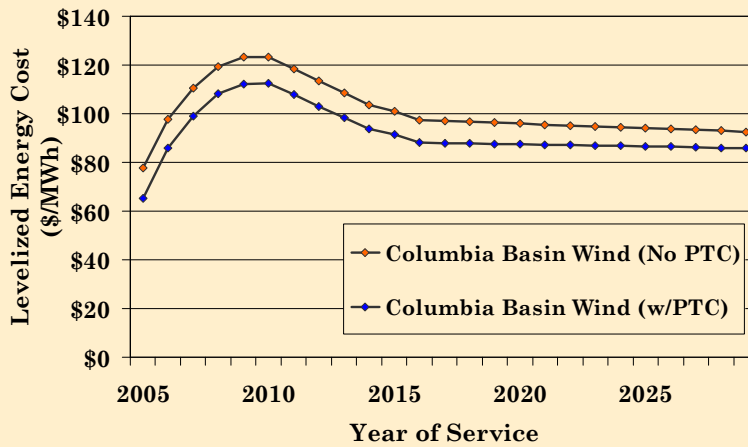
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## Elements of wind energy cost



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## Effect of historical and forecast cost trends



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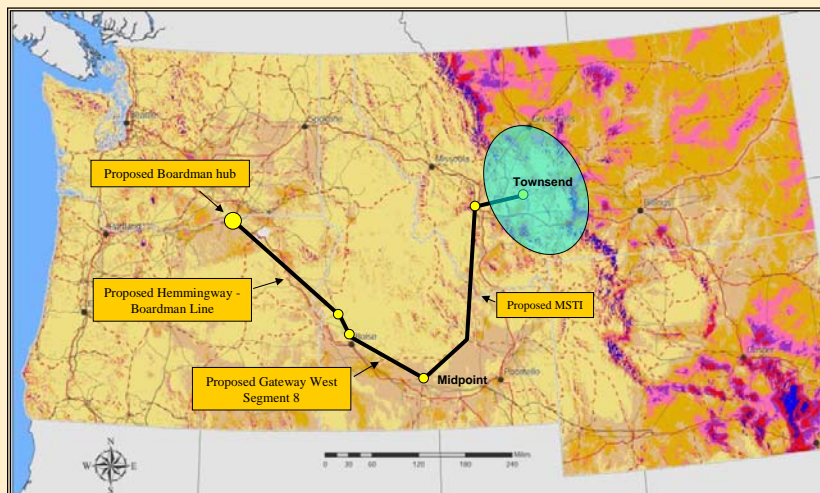
## Transmission assumptions

- Incremental transmission system cost fully allocated to wind energy transfer (no network reliability credit).
- Transfer capacity provided for 100% of project output.
- Transfer costs based on typical capacity factor (30 - 38%) operation.
- Estimates based on line miles and substations proposed for B2H, applicable Gateway and MSTI segments.
- Lines assumed to be single-circuit 500kV AC w/1500 MW transfer capacity
- Line and substation unit costs from Bonneville Nov 2008.
- ROW, communication, EPC, owner's cost and O&M cost percentages are from MSTI proposal.
- Losses are from 2006 NTAC Canada-Northwest-California study



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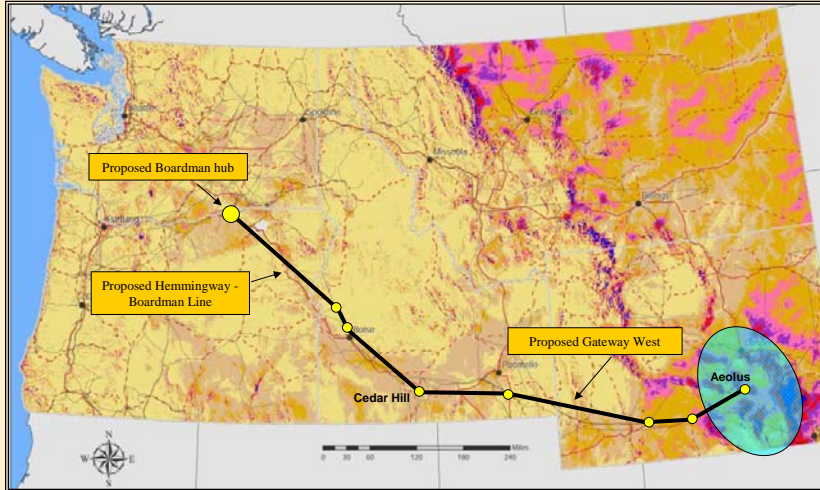
## Montana wind to S. Idaho, Oregon & Washington



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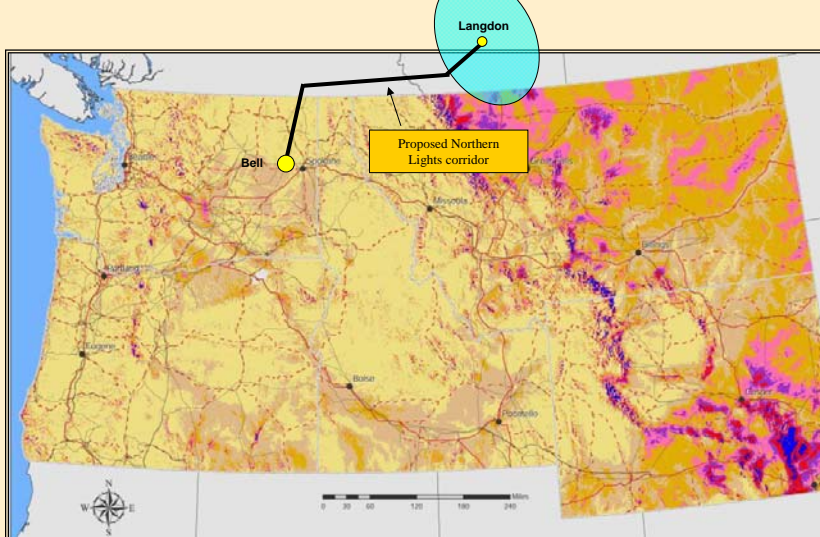


## Wyoming wind to S. Idaho, Oregon & Washington



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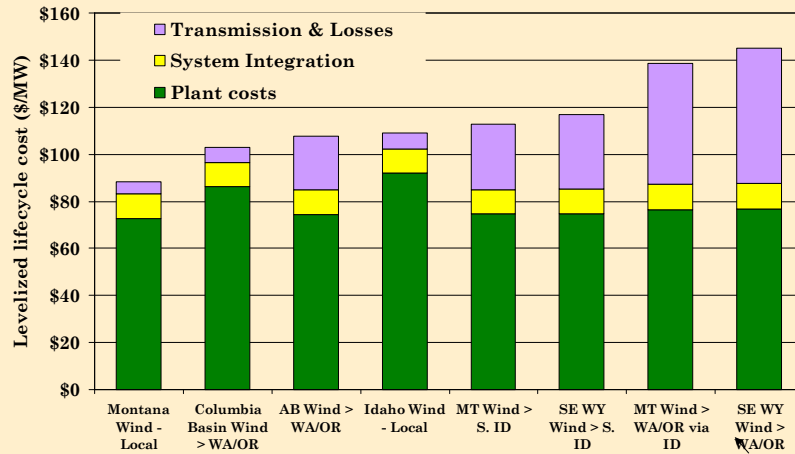
## Alberta wind to Oregon & Washington



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## Wind supply options 2020 Service

Point-to-point transmission included  
No federal production tax credit  
Assumes Boardman or Bell > OR/WA @ embedded cost  
All other segments at full incremental cost



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## Estimating quantities for 2020 supply curve

**Montana Local: 300 MW** - 30% of est. 2020 NWE hourly peak less current wind capacity

**Columbia Basin: 3500 MW** - Preliminary estimate of remaining BPA BA integration capability

**Idaho Local: 1200 MW** - 30% of est. 2020 S. ID hourly peak less current wind capacity

MT > S. ID - Preempted by ID Local

WY > S. ID - Preempted by ID Local

**AB > WA/OR: 1500 MW** - Capacity of single-circuit 500kV AC line

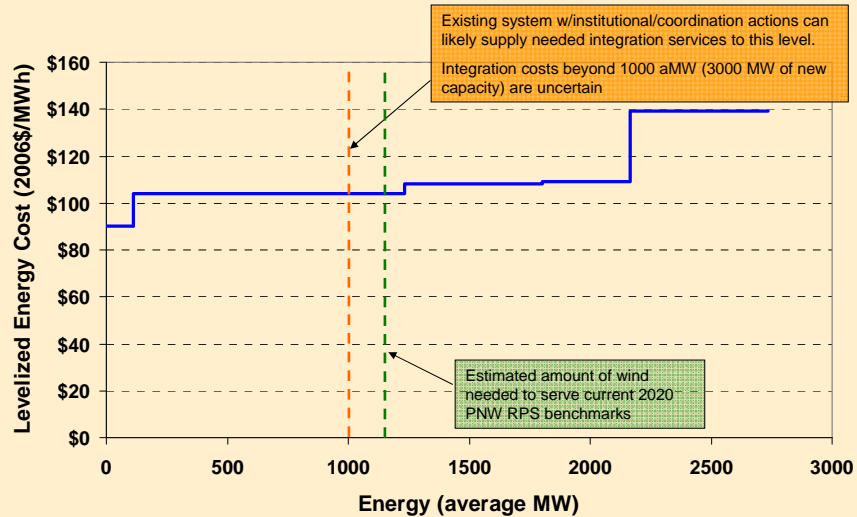
**MT > WA/OR: 1500 MW** - Capacity of single-circuit 500kV AC line

WY > WA/OR - Preempted by MT > WA/OR



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## Post-2008 wind power supply curve (ca: 2020)



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## Additional wind analysis

1. Improved production estimates and understanding of seasonal value
2. Sustained peaking capacity needs
3. Tradeoff: Incremental transfer capacity cost vs. incremental energy value
4. Value of locating generation or storage at wind resource area
5. Impact of geographic diversity on short-term volatility of wind power production, including ramping events

3 - 5 are Wind Integration Action Plan Action 15 - Framework for long-term regional wind development

Further analysis, e.g. subhourly, likely needed to achieve full understanding of 3 -5  
6<sup>th</sup> Plan Action item may be needed for further refinement



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