Northwest Power and Conservation Council

March 6, 2012

MEMORANDUM

TO: Power Committee

FROM: John Fazio, Senior Power System Analyst

SUBJECT: Wind Load Carrying Capability

As the amount of installed wind grows in the Northwest, it becomes more important to properly characterize its energy and capacity contributions to the power supply. Annual reports, such as BPA's White Book and PNUCC's Northwest Regional Forecast, provide a tally of regional resources and demand. The resulting balance between resources and load is often used as a rough guide to indicate whether the region has ample supply or not. Currently, BPA uses average annual wind generation for the energy component and zero for its capacity component. PNUCC simply aggregates utility provided energy and capacity values for wind resources. The Adequacy Forum has agreed to assume average wind generation for energy and 5% for the sustained-period capacity value (6 hours per day over 3 consecutive days).

None of the above mentioned assumptions regarding the energy and capacity values for wind are desirable. Simply aggregating utility provided data doesn't ensure that proper (or similar) methods are being used. Using average generation for wind's energy contribution is overstating its load carrying capability because of the lack of system flexibility and storage. With infinite storage, average generation would be the correct value to use. With no storage or flexibility, a "worst wind year" approach would likely be better. The real answer is likely somewhere between the results of these two approaches.

The effective load carrying capability (ELCC) of any resource is defined as the amount of annual load (shaped) that it can serve without degrading adequacy. It is commonly expressed in units of percent, namely the amount of load divided by the amount of resource needed to serve that load. A preliminary assessment of ELCC for NW wind shows that for the current amount of installed wind, its ELCC is in the range of 22 to 24 percent. Average wind generation is about 30 to 32 percent. Results also indicate that ELCC will decrease as more wind is added (and more system flexibility is used up). Adding more storage or diversity in wind generation will increase ELCC.

More work is required to develop methods to assess the hourly ELCC for wind.

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The Effective Load Carrying Capability for PNW Wind

Power Committee Meeting
March 6, 2012
Portland, Oregon

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Outline

- Reporting capability of wind resources
- Problems with current methods
- Alternatives
- Why ELCC is a better option
- Methodology
- Preliminary results

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Reporting Wind Resources

- BPA's White Book and PNUCC's NRF are tallies of regional resources and demand
- Both energy and capacity contributions for each resource are reported
- Both reports used as a quick assessment for need, thus important to get wind right
- Question: How should we report wind resources?

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Reporting Wind Resources

- NRF – uses utility provided values
- BPA – uses expected average values for energy and 5% for capacity

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Problems with Current Methods

- NRF
  - Not sure how each utility calculates energy and capacity components for wind
  - Likely use different methods
- BPA
  - Because of limited storage, using average generation overstates energy contribution
  - 5% capacity value is based on anecdotal evidence

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Alternatives for Energy Reporting

- BPA investigating a "critical wind year" approach (similar to hydro reporting)
- Can use a monthly percentile value (e.g. lowest 20% value for each month)
- Percentile method yields an annual value that is extremely unlikely and understates contribution
- Other methods examining wind data only

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Alternatives for Capacity Reporting

- Investigate how wind generates during peak load hours and develop a measure
- Use zero %, implying that wind will not be used for capacity expansion plans
- Other methods examining wind data only

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ELCC is a Better Option

- "Effective load carrying capability" is defined as the amount of incremental (shaped) load a resource can serve without degrading adequacy.
- It is usually expressed as a percentage of a resource's nameplate capacity.

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Why ELCC is Better

- ELCC generally accepted as best approach
- ELCC is assessed by performing a system analysis
- ELCC is a function of the system the resource is added to
- It yields a better indication of how much resource is needed to maintain adequacy

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Estimating Annual ELCC

- In a system with infinite storage,
  ELCC = Average wind generation (~30%)
- With no storage,
  ELCC = Worst year wind generation (?%)
- PNW power system has limited storage,
  Worst year < ELCC < Average

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Methodology to Assess Annual ELCC

- Begin with a system with no wind
- Use Monte-Carlo simulation to assess average annual curtailment
- Add an increment of (shaped) load – curtailment will increase
- Add increments of new resource until the average curtailment equals that in the base
- ELCC = load/amount of new resource

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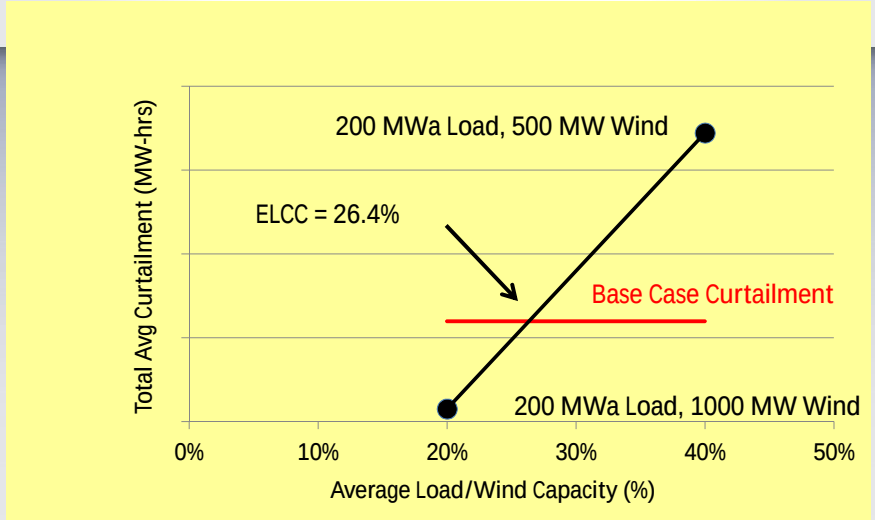
ELCC Results (+200 MWa load)



Preliminary Results

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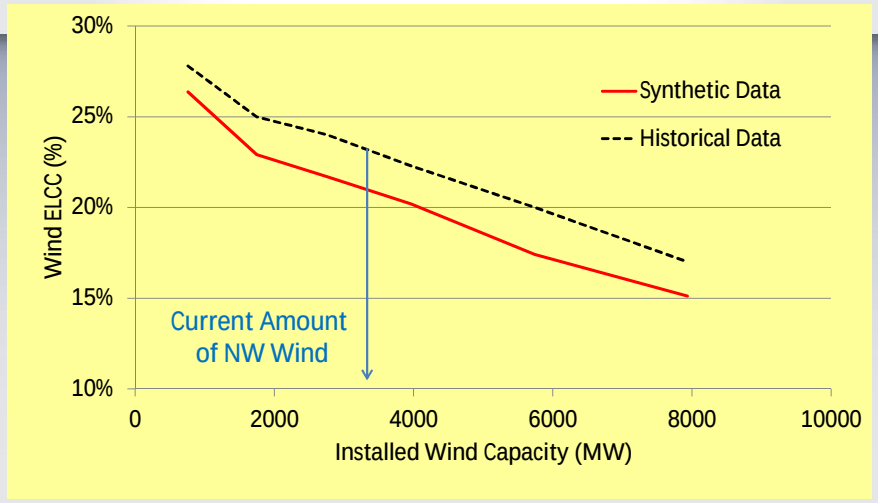
Annual ELCC – Synthetic vs. Historical Data



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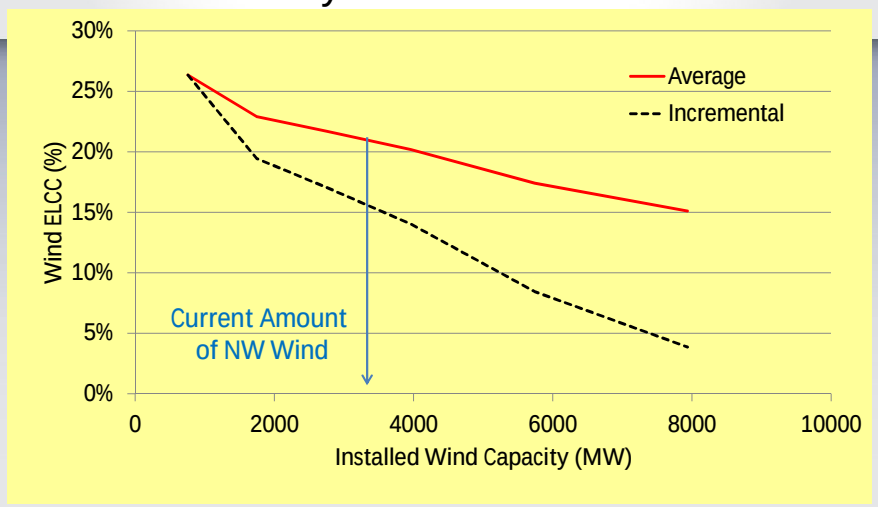
Average and Incremental ELCC Synthetic Data



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Preliminary Results

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Observations

- ELCC declines with increasing amounts of wind because system flexibility is used up
- Eventually wind ELCC will flatten out
- Average annual wind generation is about 30%, yet aggregate ELCC is 22 to 24%
  Thus, can't plan on average wind generation
- Adding storage will increase ELCC
- Adding more diverse wind generation will also increase aggregate ELCC

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Future Work

- ELCC is likely very sensitive to wind data, thus developing more robust data is critical
- This methodology should be appropriate to assess monthly ELCC values
- Assessing hourly (capacity) ELCC values for wind will be more challenging

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