

Challenges of Wind and Hydro Integration

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The Pacific Northwestern region is ideal for windhydro integration

The PNW already depends on renewable energy (hydropower) and is familiar with its whims:

- Inexpensive power during good water years, plenty to export.
- Expensive power during bad water years, required to import.



Ultimate Question: Can we reliably integrate another weather dependant energy source?





Effect of ENSO-PDO on average April-September streamflow on the Columbia River at the Dalles.

Graphic courtesy of Climate Impacts Group, University of Washington



Electricity generation from wind energy is among the fastest growing segments of the energy sector.







These three are all very similar and we know they have a strong climate signal



Annual and Seasonal Correlation of Wind Energy Generation to Hydro Generation



Significant variability of winter wind resource (10 to 35% capacity), correlated to winter water conditions.

Significantly less variability in summer wind resources, with a slight negative (not significant) correlation to summer hydro supply (32 to 45% capacity)



Goodnoe Hills BPA Tower vs. Ross Reservoir (1980-2001)





Intermittency: The perceived problem with wind

HOURLY TO DAILY High wind volatility Low hydro volatility



We learned to deal with this



Wind and Hydro

- Wind and Hydro can work together to increase system reliability
- Offsetting characteristics
- An essential component to integration is forecasting:
 - 1: Understanding the expected variability of the resource (a long term retrospective forecast)
 - 2: Short-term prediction to control for intermittency of the wind (an operational forecast)





- Founded in 1999
- Focused on supply side (generation) forecasts for renewable energy sources
- Forecast processes based on latest proven scientific techniques
- Close relationship with leading research and operational communities
- We provide *forecast products* for all major renewable energy resources at multiple time scales



Renewable Energy Forecasting: Relevant Time Horizons



Atmospheric Predictability

Observations





Current Clients

1000 MW of Wind Energy Forecasting 2000 MW of Hydro Forecasting





Eurus Energy America





US Army Corps of Engineers ®







Wind Energy Forecasting & Assessment Products



Forecasting to control for short term (hours to days) variability of wind energy



Operational Wind Energy Forecasting





Forecast created at 11/02/2004 1751 MST



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Forecast issued: 11/02/2004 5:51 PM MST Forecast based on atmospheric conditions as of 11/2/2004 17:00 Hrs MST





How accurate is the current state of the art in forecasting?



Forecasting Reduces Occurrence of Large Unexpected Swings in Power:Persistence Forecasting:95% confident that power swing less than 75 MW3TIER Forecasting:95% confident that power swing less than 50 MW











Assessment to understand long term variability of wind energy (An extended forecast)



Renewable Resource Risk (R-Cubed) Analysis

A comprehensive system for assessing the long term variability of energy output from a renewable energy resource.







Results: The simulation model is almost always more representative of actual on-site measurements than nearby off-site stations.



For this location: MSite simulations were 28 percent more accurate than statistically corrected measurements from an airport only 5 miles from the site (based on reduction in Mean Absolute Error for each hour)



Hour to hour simulation accuracy can translate to significant skill in determining intra- and inter-annual variability.



Comparison of predicted versus observed average monthly wind speed for each month for an entire year

The final result is an accurate assessment of the variability of the wind resource that puts the observed data into a historical context.

Expected Variability of Monthly Average Wind Speed at Hub Height



Summary of Wind & Hydro Integration

HYDRO

- •Significant variability over seasons and between years
- •Due to reservoir storage, hydro can be dispatched in the short-term **WIND**
- •Dependable over the season and between years
- •Due to intermittency, wind itself can not be dispatched in the short-term

WIND AND HYDRO TOGETHER

- •Wind can provide a good hedge against poor water years
- •Reservoir storage and quick ramp rates of hydro can "firm" wind

TOOLS AVAILABLE

- •Forecasting for the short term
- •Accurate Assessment to understand long-term variability issues of wind.
- •Potential for long-term forecasting of wind

