PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

2010 Wind Integration Study

PacifiCorp Response to Follow-up Comments, Consultation Session Conference Call with Michael Milligan, National Renewable Energy Laboratory, held May 24, 2010

June 21, 2010

Introduction

This document represents a response to follow-up comments from Michael Milligan of the National Renewable Energy Laboratory (NREL) received subsequent to a consultation conference call held on May 24, 2010. The comments relate to how reserves should be treated in production cost models, the use of the NREL mesoscale wind data to model future wind resource penetration, calculations for deriving regulation reserves and NREL's Eastern Wind Integration and Transmission Study (EWITS), and day-ahead balancing.

Handling Reserves in Production Cost Models

NREL Comment 1:

This can be a surprisingly tricky area. Because most of the wind that you are integrating is used to serve internal loads (my notes say it is about 90%), operating reserves can come from unloaded generation that would have been used to serve load in the absence of wind. Of course that depends on the success of the unit commitment process in ensuring sufficient committed capacity. It also depends on the ability of the committed capacity (and any resources that can be quickly brought online) to provide flexibility (ramping). When the wind capacity is delivered outside of the BA to serve other loads, and especially when the host must hold the wind schedule until the top of the next hour, there is a different reserve implication. This is explored in more detail in http://www.nrel.gov/docs/fy09osti/46274.pdf . Fundamentally, a 1000 MW peak load (including contingency reserve, reg, and losses to keep the example simple) requires 1000 MW of capacity. If you now introduce 200 MW of wind in that hour, you must either back down 200 MW of other generation, creating up-reserves, or sell outside the BA. Since the latter case is uninteresting for the moment, which leaves us with the requirement that we have 800 MW of internal capacity that is needed during the hour. If the wind should fall from 200 MW to 100 MW, for example, we already have 200 MW that could be tapped. Since that capacity would have been used to supply load in the absence of wind, it does not represent additional needed capacity compared to the no-wind case.

PacifiCorp Response to NREL 1:

PacifiCorp's production cost model balances the system using Pacificorp's assets, and does so with wind generation present in the resource stack. This assures thermal, hydro, and other generation assets displaced by the wind generation will be applied to carry reserves as their ramping and other characteristics permit in an orderly, economical fashion.

NREL Comment 2:

Further, there is the issue of how the model treats the various types of reserves. Wind does not change quickly enough to constitute a contingency reserve, which is typically modeled as capacity that is "set aside" and never used within the simulation (unless doing some type of Monte Carlo to simulate outages). Regulating capacity is similar – set it aside and don't use it because the production model does not have the fidelity to look sub-hourly. But the flexibility reserve (the induced reserve from wind that is typically at the 10s of minutes to a few hours time frame) can be used – and should be used – by the model. For example, if there is a 100 MW forecast error that the unit commitment algorithm doesn't know about, that must be resolved in real time by the model. If there is 100 MW spinning during that hour, it can be used without re-committing or otherwise increasing capacity by 100 MW. This is different than contingency reserves, which must always be maintained. EWITS used the regulation reserve feature of Pro-Mod, combining the regulation and load following reserve. This overstated the load following reserve that is needed. The more recently completed Western Wind and Solar Integration Study (WWSIS) did a more thorough job of analyzing the impact that wind has on reserves. (See http://www.nrel.gov/wind/systemsintegration/wwsis.html)

PacifiCorp Response to NREL 2:

The Planning and Risk production cost model distinguishes reserve types by the priority order for unit commitment scheduling, and optimizes them to minimize cost in response to demand changes and the quantity of reserves required on an hour-to-hour basis. The highest-priority reserve types are Regulation Up and Regulation Down, followed in order by spinning, non-spinning, and finally, 30-minute non-spinning. Given the hourly time frame of the model, there is no distinction between reserves categorized as regulation (including the WECC's definition of Contingency Reserves) and load-following in terms of how the model optimizes their use. Both are released for economic dispatch when needed on an hour-to-hour basis, and thus is it appropriate to combine them for modeling purposes. PacifiCorp contacted the model vendor, Ventyx Energy, LLC, to verify this.

NREL Mesoscale Wind Data

NREL Comment 3:

From the discussion it is apparent that you have some folks with a very good knowledge of statistics and time-series analysis. Given the difficulty of creating data sets that represent a future wind buildout, it would be helpful to know more about how you are planning on using the NREL data in that process. The NREL data does a good job of preserving the temporal and geographic correlations in wind speed (power) because it is based on a physical simulation of the atmosphere. Of course the problem is that the meso data is stale, and does not correspond to the load years you are using. But it would seem that the NREL data could be used as the basis of a set of regression equations that relate the unknown sites (i.e. the sites with little or no data) to the sites with known data. One would hypothesize that the relationship, and hence the regression coefficients, would be a function of the time of year (and possibly other factors) which could be represented by dummy variables. A second stage approach might be able to apply the faster data so that sub-hourly variability could be represented.

PacifiCorp Response to NREL 3:

A regression method using the 2004-2006 timeframe NREL Mesoscale data to estimate regression parameters for the 2007-09 timeframe production is in the works.

Regulation Calculation and EWITS

NREL Comment 4:

Some of the early EWITS work attempted to use L10 as part of the root-square equation. But on review, it was determined that this is not appropriate, since the radical term involves distance from the mean and the root-square of the term involving L10 does not map to a known characteristic. Instead, EWITS used the standard deviation. That does not necessarily assume normality. For example, one could determine that, with a non-normal distribution, that 3.2s (where s = standard deviation) corresponds to a 99% exceedence value. Of course 3s provides the same value for a normal distribution. The attached paper has a discussion of this issue.

PacifiCorp Response to NREL 4:

PacifiCorp is considering removing the L10 feature from the root square calculation; applying after the regulation and load-following features are combined through the root-square term. This will address the lack of a physical parallel to the calculation.

The use of the standard deviation to imply a level of exceedence seems more coincidental than causal in the paper provided. To date, our stakeholders have expressed interest in culling levels of exceedence as much from the natural distribution as possible. While we can compare the percentiles to calculated standard deviations as an interesting academic exercise, its value in setting Pacificorp policy is unclear.

Day-ahead Balancing

NREL Comment 5:

It is not clear how you intend to calculate this cost, or what components you propose to include. Any wind integration cost should assess costs that would not occur in the absence of wind. So the day-ahead balancing cost would consist of the incremental cost of balancing energy compared to the no-wind case. In the no-wind case, you would need to supply (either by purchase or owned generation) the energy. If wind were perfectly forecast day-ahead, there would be no impact on DA. But given imperfect wind forecasts, the implication is that in some cases you would be short on energy, and would need to supply the shortfall from already committed generation or going to market. In other cases you would be long on energy, and would sell. Over the year, the combination of higher/lower prices and sell/purchase would likely come close to canceling out. You could model this explicitly, and might find a relatively small cost (or income), but I doubt it will be significant either way.

PacifiCorp Response to NREL 5:

In fact, the integration cost necessary is best represented serving the system with and without wind's variable shape, as a flat delivery would require virtually no extra reserves and maintain as similar a resource stack setup as the variable wind shape would allow. Not including the wind generation in the first run would not be a valid comparison as the wind generation is, in fact, present on the system at all times at the fixed and variable costs to require it on its own merit. The integration of wind generation is therefore the cost to supply incremental reserves to include this non-dispatchable resource, not to replace it with a fictitious stack of fossil generation.

In other words, the goal of the study is not to assign the full cost differential of using wind generation (which is not free) as compared to not using wind generation on Pacificorp's system, because a large part of those economics have already been part of prior rates calculations. What has not been adequately calculated for rates is the cost of maintaining reserves adequate to maintain system integrity in light of wind generations' inherent variability and the inability to dispatch it. These reserves represent difficulties and inefficiencies wrought by shifting resource allocations due to forecast errors, running plants in less efficient states than full operation to provide flexibility for up and down reserves, and keeping units on standby whether they ultimately operate or not.