2010 Wind Integration Study
Consultation Session Conference Call with Michael Milligan, National Renewable Energy Laboratory

Conference Call date: August 26, 2010

Conference Call Attendees

Michael Milligan (National Renewable Energy Laboratory)

PacifiCorp: Rick Link, Devon Williams, Pete Warnken, Greg Duvall, Dennis Desmarais, Brian Fritz

The Brattle Group: Judy Chang

Session Agenda and Overview

The focus of this consultation session was to get feedback from Dr. Milligan on the draft wind integration study report distributed to IRP participants on August 12, 2010, and answer additional clarification questions on the final wind integration study methodology. The main discussion topics covered included (1) recommendations for improving synthetic wind generation data in the future, (2) the suitability of PacifiCorp's approach for allocating reserves to meet a 97% Control Performance Standard 2 (CPS2) performance level, (3) and production cost reserve modeling. Dr. Milligan also provided a meeting summary, which is included as Appendix A.

Discussion Details

- In response to Dr. Milligan's question on the treatment of control area transfer opportunities, PacifiCorp described the east-west control area transfer capability that is managed on a system basis and reflected in the production cost model used for the wind integration study.
- Dr. Milligan suggested that PacifiCorp investigate the application of a Tobit model[1] for future validation of simulated wind development. A Tobit regression would be applied to actual and simulated wind output to derive parametric wind output estimates. Data for one month would be eliminated (recommendation was for February) and re-estimated with the Tobit model to compare with actual data for that month. PacifiCorp and Brattle Group staff then described the effort to validate modeled data by comparing calculated reserve requirements from both actual data and simulated data for various wind plants.
- Dr. Milligan agreed that the geometric sum approach for determining reserve requirements based on CPS2 error percentages is the right approach given that load and wind have little or no correlation at time intervals of 10 minutes and less. He noted that

[1] Also referred to as a censored regression model regression.

PacifiCorp's approach is close to what was used by NREL for the Eastern Wind Integration and Transmission Study (EWITS). However, Dr. Milligan claimed that by applying a percentage exceedence measure to wind and load separately does not result in a consistent measure of exceedence for the net load.

- Participants discussed PacifiCorp's approach for determining reserve quantities as the net error calculated from separate load and wind terms. Dr. Milligan questioned the validity of this approach. He pointed out that PacifiCorp should demonstrate how this "two dimensional" approach ties to CPS2 percentiles and the 97% target percentile assumed for the wind integration study. Specifically, PacifiCorp should determine if the approach under-or over-estimates reserves relative to the 97% target percentile.
- PacifiCorp explained the rationale for the two-dimensional reserve calculation approach and the bin analysis for determining variability between load/wind forecasts and actual values. One attribute of the two-dimensional approach is that it eliminates the load and wind correlations, which are assumed to be zero for this study. Dr. Milligan recommended for the next wind integration study to test the net wind and load ("single dimension") approach. PacifiCorp can sort the bin data and determine the reserve area under the curve at the 97% percentile level. He noted that the exceedence approach, applied to net load, makes no assumptions concerning the correlation of wind and load, or the underlying probability distribution of the net load. The 97 percentile level is appropriate if PacifiCorp currently maintains a 97% CPS-2 score; otherwise the percentile should be adjusted so that it matches the CPS-2 target.
- Dr. Milligan reiterated support for the EWITS approach for estimating regulation reserves using rolling average persistence forecasts. He suggested a 40-minute rolling average as one possibility, but advocated ensuring that any double-counting or over-counting should be tested for. Also, decomposing wind into rolling average and regulation reserves components helps eliminate any overlap or double-counting of load variability, if done properly. When the components are re-combined (regulation, load following) they should match the original data. This is a relatively simple test to determine whether double-counting or over-counting occurs. PacifiCorp acknowledged that what appears in the Study is the best available approximation of PacifiCorp's current operations.
- Dr. Milligan pointed out that the incremental effect of load forecast error was not isolated in the production cost simulations, and related costs removed from the system balancing cost estimate. Additional simulations to isolate load forecast error are needed.
- The parties discussed modeling of reserves in production cost models. Dr. Milligan stated that a general weakness is not releasing regulation down reserves if not needed. PacifiCorp asked Dr. Milligan how this issue was addressed in the Western Wind and Solar Integration Study (WWSIS). The strategy was to identify hours that contingency reserves were violated and change the reserve demand, focusing on the wind ramp hours. PacifiCorp indicated that this approach would be time and labor intensive. Mr. Milligan indicated that model vendors are considering introducing code in their models

to release reserves, but would need financial incentives and a push from clients to do so.

- Dr. Milligan again recommended a technical review committee approach in the future, and listed some process suggestions such as holding meetings once every 3-4 months and sending out materials at least one week in advance.

Action Items

- No action items.

Appendix A:
Dr. Michael Milligan's Summary of the August 26, 2010 Conference Call

This was the second of two 1-hour calls to discuss PacifiCorp's wind integration analysis. The discussion focused on 4 main areas:

- Wind data that was created for the analysis
- PacifiCorp's approach to calculating percentile exceedence for reserves
- PacifiCorp's approach to calculating load following impacts of wind
- Lack of accounting for imbalance created by load forecast error

In addition, I recommended to PacifiCorp that it would be worth considering broader technical review and stakeholder input for the next integration study.

General Comments

PacifiCorp appeared to be very open to discussion and committed to credible analysis and feedback, given the short timeline for the study. In the next integration study PacifiCorp will be able to fully address and correct the analysis, but it appears that there may be no opportunity available for the coming IRP cycle.

Wind data

PacifiCorp does not have adequate wind data to accurately represent the chronological performance of future wind plants for this study. Unfortunately, such a data set does not exist that addresses this shortfall. PacifiCorp did utilize other data, including the NREL WWSIS wind data, and statistical techniques to the extent they were available. It is unclear how the results of the study would change with more accurate data. The lack of recent meso-modeled wind data for integration studies is a critical issue as utilities continue integration work that must be informed by this data.

Percentile exceedence does not hold CPS2 constant in wind and no-wind cases

PacifiCorp did not want to make any assumptions regarding the underlying statistical distributions of load and wind. The geometric sum formula used to calculate the variability of the net load did not precisely follow that approach used in the DOE/NREL Eastern Wind Integration and Transmission Study (EWITS), which used the standard deviation metric in the geometric sum. PacifiCorp used a percentile exceedence instead. The resulting level of variability from this approach is unknown, and depends on the underlying statistical distribution of the data. There are three possibilities:

- The resulting data set shows a percentage exceedence level for load following that matches the CPS2 score. This is the goal, because it maintains CPS performance that was achieved before wind was added to the system, and holds CPS performance to the same level after adding wind. However, using the percentile term in the geometric sum will not likely result in this outcome.
- The percentage exceedence level after adding wind goes up from the no-wind case. This means that CPS performance worsens with the addition of wind, according to the formula.
- The percentage exceedence level after adding wind goes down from the no-wind case. This means that CPS performance improves with the addition of wind, according to the formula.

The likelihood is that the application of PacifiCorp's formula will result in either outcome 2 or 3, both of which are in contrast to the practice of accepted integration study best-practice, which is to hold CPS performance to the same, no-wind level after adding wind. This is a consequence of using the percentile term in the geometric sum formula. Other studies have used the standard deviation, or even calculated the percentage exceedence level directly (see Holttinen et al).

Regulation is not correctly separated from load following

PacifiCorp uses a non-centered rolling average as part of the calculation of the regulation impact of wind. It is likely that the use of the non-centered average mixes some load following with regulation, but that is not likely a critical issue as long as the regulation and load following portions of wind (and net load) are correctly separated into the two buckets.

However, PacifiCorp uses an instantaneous snapshot of the wind output 40 minutes before the top of the hour as a forecast for the next hour wind energy. The difference between the 40-min forecast and the actual wind is used as the load following impact of wind. However, because this 40-min wind value contains both the regulation component of wind and the load following component of wind, the regulation portion is double-counted. This will lead to an overestimate of wind integration cost.

A simple test can help catch this error. After parsing out the regulation and load following components of wind (or load or net load), adding the two components together should match the original time series. Although I did not have PacifiCorp data, I applied the PacifiCorp algorithm to publically-available wind and load data from BPA. I was unable to reconstruct the original time series after using PacifiCorp's method for calculating regulation and load following.

Load forecast error is erroneously included in wind integration cost

PacifiCorp ran several production simulations to isolate the integration cost of wind. One simulation (2) used actual wind and load with no forecast errors. Simulations 3 and 4 were used to determine unit commitment based on wind and load forecasts, and dispatch to actual wind and load. PacifiCorp used the difference between simulations 2 and 4 to capture the imbalance and other costs related to wind integration. Unfortunately, the cost difference also includes the cost of load forecast error, which should have been separated. By not separating the impact of load forecast errors, PacifiCorp has overestimated the wind integration cost.

Technical review committee and stakeholder process would be valuable

NREL has participated or led multiple TRC processes, which significantly enhance the integration study. In its next wind integration study, I recommend that PacifiCorp engage an expert TRC that starts at the beginning of the project, with periodic meetings and a rigorous peer-review process. Stakeholders can be brought in at key points for less technical interactions if desired.