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Renewable Northwest Project

August 26, 2010

Pete Warnken
PacifiCorp
825 NE Multnomah
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Dear Mr. Warnken,

The Renewable Northwest Project (RNP) would like to take this opportunity to once again thank PacifiCorp for the opportunity to comment on its 2010 Wind Integration Study. The present study was structured to address many of the concerns that were raised in the wind analysis performed as part of the 2008 IRP. RNP very much appreciates the company's responsiveness to the deep concerns we expressed over the previous study.

In stark contrast to PacifiCorp's earlier openness, the company has largely rejected comments offered with respect to the present study, even recommendations generally shared by diverse commentators. This has unfortunately led to an unreliable draft study. It appears that the company could in most cases address the cited defects with relatively little additional work, and RNP urges the company to undertake the needed changes prior to presenting this study to regulators.

In brief, the major shortcomings of the present draft that have previously been cited include:

1) **Determination of Cost and Reserve Requirements.** The cost of "following reserve" is at least partially double-counted in the model because reserve generation set aside for balancing hour-to-hour variability is unavailable for that purpose in the generator dispatch. In addition, the level of reserves generally, nominally targeted to cover 97% of the scheduling errors, are determined on the basis of an incorrect equation that effectively establishes a different (unknown and unstated) probability level that likely changes from month to month.
2) **System Balancing Costs.** The category of "interhour/System Balancing" costs is overstated, including costs due to day-ahead load forecast error, and what remains is discriminatory because traditional generation has completely analogous costs that are not assessed to them—this cost category should be removed altogether as a contributing wind integration cost.
3) **Wind Data Validation.** The wind data was developed using a novel methodology and the resulting dataset was not adequately validated to give reasonable confidence in the results.

These are not new concerns and are reflected in RNP's earliest comments, as well as those of other stakeholders.

We have one additional concern of sufficient impact to the study that we feel it necessary to raise it for the first time here. The Northwest is rapidly moving toward half-hour generation scheduling business practices that will have the effect of significantly reducing the reserve requirements for wind and load. Our concern about the potential effect of half-hour scheduling on the wind integration cost is detailed below.

We appreciate the vast improvement this study plan represents over the 2008 IRP, and respect the work that went into it, but are deeply disappointed that stakeholder comments were almost entirely, and in our view erroneously, dismissed. In our view, the study conclusion that $9.70/MWh is a reasonable value to use in planning analyses is invalid and likely overestimated by about a factor of two. Simply taking the incremental reserve requirements determined by the study and dividing by the study's estimated reserve costs results in an imputed reserve cost of more than $15/kW-month. This is more than the cost of a new combustion turbine, and higher than the cost Puget Sound Energy included in their proposed wind integration charge that was rejected by the Federal Energy Regulatory Commission.

Once again, we urge the company to give serious consideration to the stakeholder comments and make the changes necessary to bring this study into compliance with acceptable, if not best, practices. Our detailed comments follow.

1. Determination and Cost of Reserve Requirements

Reserve Level

The company repeatedly represents its intention to hold reserves to meet 97% of the ten-minute variability ("regulation") and inter-hour ("following") scheduling errors. It has agreed that the joint (net) error introduced by a combination of load and wind is appropriate. However, while the company explicitly calculates 97% error levels for wind and load separately, it rejects the proposition that the reserve level should be set on the 97% level of the joint errors, instead relying on a formula to calculate the net error from the individual components. Unfortunately, the formula on which they rely (formulas on pages 13 and 19 of the draft study) are incorrect for the data examined, and cannot be relied upon to ensure a 97% level of reserves, or any other specific level. Please see Attachment A for the applicability of PacifiCorp's proposed formulas.

These formulas were introduced in the February 26 Draft Study Design paper in a somewhat different, though equally incorrect form. The company has been repeatedly apprised of the incorrectness of the formulations proposed. RNP has sent the company a spreadsheet containing publicly available data that shows the formulation capable of overestimating the 97th percentile incremental reserve levels by more than a factor of two. Once again, we urge the company to calculate the 97th percentile of the net wind and load scheduling error in exactly the same way the company already computes the

97th percentile levels for wind and load individually. There is no need for a special formula to perform that function.

In addition to the likely overstating of reserve requirements cited above, PacifiCorp's calculation of east and west side regulating reserves results in an overestimate of the needed reserve levels. The company's dynamic overlay provides a cross-system transmission tie that allows the netting (full or partial) of regulation requirements across its east and west side system. PacifiCorp may reasonably propose to allocate the total reserve requirement between its eastern and western balancing areas, but the regulation requirements between east and west sides should be netted. PacifiCorp's computed regulating reserve requirements are likely overestimated by 25-40% due to this effect.

Reserve Cost

PacifiCorp calculates the bulk of its reserve costs as the difference between PaR simulations 1 and 2. Simulation 1 retains the energy value of the wind, shaped into heavy and light load hours, while simulation 2 allows the wind to vary on an hour-to-hour basis. Another difference is that Simulation 2 sets aside a quantity of reserves to meet sudden or unexpected decreases in wind generation. RNP has repeatedly warned the company that it is not appropriate to set aside reserves associated with hour-to-hour variability because the model will not actively deploy those reserves except in extreme loss of load circumstances. Thus the model is holding reserves that are not being used by the model to serve the purpose for which they are held.

To remedy that situation, RNP proposed two alternatives: Either A) determine the opportunity cost of the hourly ("following") reserves by putting them in a modified Simulation 1 where there is no need for deployment; or B) remove the "following reserve" component from the model input for purpose of establishing reserves.

The company has offered alternative justifications for treating the reserves as they do. One justification revolves around the hourly model "optimization" that the company claims addresses this issue. We do not understand this explanation, except to the extent the company may be suggesting that reserves are held on out-of-the-money units that would not be deployed anyway. This argument seems only to suggest that the opportunity cost of holding incremental reserves is small. While that may be the case, it does not address the contention that the opportunity cost of reserves are double-counted.

Alternatively, the company has suggested that the reserves are after all released by the model to be deployed for the purpose to which they were held. Although it is likely that the model deploys reserves for extreme and infrequent loss of load events, it is not likely that they are deployed on a routine basis by the model to address hourly wind variability. Indeed, doing so would be incorrect so far as the identified reserves are being held for within-hour variability.

PacifiCorp suggests it has contacted Ventyx to develop the current methodology. We do not dispute that, but our own conversation with Ventyx (8/24/10) confirmed our understanding of the model's deployment of reserves,

and our concern that some portion of the following reserve costs are double-counted.

2. System Balancing Costs

The system balancing costs are significantly overestimated, and in our view, fatally flawed to an extent that they should not be considered further as a part of a wind integration cost. They are computed by taking the cost difference between Simulations 2 and 4. Simulations 2 and 4 are identical except that unit commitments in Simulation 4 are established based on forecast wind and load data. The problem with the analysis is that there is no separation of the wind forecast error effect from the load forecast error effect. This is most likely why most of the costs are seen at the lowest level of wind penetration—most of the "System Balancing" costs in Table 10 for the 425 MW wind case are actually due to load forecast error that has not been taken out of the analysis. Almost all the system balancing costs in Table 11 for the higher wind penetration levels are also likely due to load.

Irrespective of the study's overestimate of these costs, RNP firmly believes they should not be a part of the wind integration analysis at all. There are completely analogous costs accruing to thermal resources that are not assessed. For example, unexpectedly large or small thermal unit outages are also a cause of system imbalance, yet these costs have never been assessed to thermal units and there appears to be no effort to do so. Levying such a cost to wind without doing so for thermal generation would incorrectly warp the actual economics of wind compared with competing resources.

In addition to straight thermal unit outages, natural gas must normally be purchased a day in advance of need. Utilities typically nominate their gas purchases based on the forecasted price differential between wholesale electric and gas prices. These forecasts can be in error, forcing the utility at times to burn fuel that would not otherwise be economic. This "gas integration cost" is also never assessed.

Unless the resources to which wind generation is being compared are subject to the analogous system balancing cost computations, including system balancing as a wind integration cost input to the IRP analysis is inappropriate.

3. Wind Data Validation

RNP and others previously recommended establishing a set of criteria that the synthetic wind generation data would be subjected for validation purposes. We recommended that among these would be correlations with other wind projects, average capacity factors, and distributions of temporal variability (hour-to-hour, and ten-minute to ten-minute). The accuracy of reserve requirements estimates are dependent on capturing these characteristics reasonably well.

Unfortunately, the only validation reported by the company is that the resulting level of reserve requirement was within the company's expectations at relatively low wind penetration levels. While this is arguably a reasonable validation component, it is not in our view a sufficient one. Given that the

methodology is based on lagging generation from a single historical plant, with lag times no greater than 60 minutes, there is a significant danger that the synthetic generation may be over correlated with the historical data from which it was derived. Correlations between the modeled wind generation output and output from the historical plants must be examined and defensible for projects of roughly similar geographic relationships. It is also important that the variability of synthetic data be analyzed for consistence with data from actual wind plants.

These relatively simple validation procedures should be undertaken for the study to have credibility. As we suggested previously, analysts should have met and decided the validation criteria before producing the data to avoid the temptation of fitting the validation tests to the resulting data. In any event, some additional validation is warranted. If the modeled data should be deemed sufficiently outside the parameters of historical data, it should either be redone, or at a minimum the effects of using modeled data on the results estimated.

4. Effects of Half-Hour Scheduling

The need to hold reserves is dependent on part on the length of scheduling periods in the Northwest. Regional utilities have begun scheduling in half-hour blocks, specifically to reduce the burden of holding reserves for wind generation. This move helps increase the economic efficiency of the power system as a whole, and business practices are continuing to liberalize to allow more liquid trading in half-hour increments. Today it may be appropriate to assess reserve requirements on one-hour schedules as is the more common practice, but this assumption is no longer appropriate for longer term resource plan purposes.

The effect of scheduling in half-hour increments is a relatively straightforward reduction in inter-hour reserve requirements. PacifiCorp should estimate the extent of the reduction and reduce its cost determination by such a fraction for use in any long term resource planning studies.

Conclusion

PacifiCorp's proposed wind integration cost of $9.70/MWh is not supportable by the work offered to date. RNP and others have repeatedly advised the company that some of its assumptions are in error and need to be addressed. Among these is an incorrect formula used to compute reserve levels, a double counting of costs associated with holding following reserves, the incorporation of extraneous "System Balancing" costs that are not assessed to other generator technologies with similar costs, and the lack of validation of modeled wind data. We hope these comments are useful, and look forward to a revised and improved wind integration study.

Sincerely,

Ken Dragoon
Research Director
Renewable Northwest Project

Attachment A

Applicability of PacifiCorp Formulation for Net Reserves

The derivation below shows that although the functional form of equations on pages 13 and 19 are correct for standard deviations of any set of numbers, the formulation as applied to percentile levels can only be derived assuming the constituent variables (wind and load schedule errors in our case) are normally distributed.

The standard deviation of a set of N numbers can be denoted by σ_x and is defined as:

$\sigma_x^2 = \sum_{i=1}^{N} \frac{(x_i - \bar{x})^2}{N}$, where

the various values taken by the set of N numbers are denoted by x_i, and $\bar{x}$ is the average of those numbers.

Taking another set of numbers y_i, with standard deviation denoted by σ_y, the standard deviation of the sum $z_i = x_i + y_i$ follows from the definition of the standard deviation as:

$$\sigma_z^2 = \sum_{i=1}^{N} \frac{[(x_i + y_i) - (\overline{x+y})]^2}{N} = \sum_{i=1}^{N} \frac{[x_i + y_i - (\overline{x+y})]^2}{N}$$

$$= \sum_{i=1}^{N} \frac{[x_i + y_i - (\bar{x} + \bar{y})]^2}{N} = \sum_{i=1}^{N} \frac{[(x_i - \bar{x}) + (y_i - \bar{y})]^2}{N}$$

$$= \sum_{i=1}^{N} \frac{(x_i - \bar{x})^2 + (y_i - \bar{y})^2 + 2(x_i - \bar{x})(y_i - \bar{y})}{N}$$

$$= \sum_{i=1}^{N} \frac{(x_i - \bar{x})^2}{N} + \sum_{i=1}^{N} \frac{(y_i - \bar{y})^2}{N} + 2\sum_{i=1}^{N} \frac{(x_i - \bar{x})(y_i - \bar{y})}{N}$$

$$= \sigma_x^2 + \sigma_y^2 + 2r\sigma_x\sigma_y, \text{ where } r = \sum_{i=1}^{N} \frac{(x_i - \bar{x})(y_i - \bar{y})}{N\sigma_x\sigma_y}$$

or:

1) $\sigma_z = \sqrt{\sigma_x^2 + \sigma_y^2}$, if r= 0

This relationship among the standard deviation of a sum of pairs of numbers and the standard deviations of the constituent data is true for any sets of numbers, irrespective of how those sets may be distributed—it is a very general result that follows directly from the definition of standard deviation.

There is a stronger statement that can be made about the percentiles that has the functional form of equation 1). That statement derives from the fact that irrespective of the specific mean and standard deviation of a *normally distributed* data set, percentile levels can be accurately estimated as a fixed

number of standard deviations from the mean.

For example, in a normally distributed data set, the 97th percentile levels are found at 1.88 standard deviations above and below the mean. For distributions with zero mean,

2) $P_{97} = 1.88\sigma$, or equivalently $\sigma = P_{97} / 1.88$

It would be tempting to substitute this relationship into equation 1) to find,

$\frac{P_{Total}}{1.88} = \frac{\sqrt{P_x^2 + P_y^2}}{1.88}$, or

3) $P_{Total} = \sqrt{P_x^2 + P_y^2}$

Equation 3) is the functional equivalent of PacifiCorp's formulation. However, this is only true for distributions where the percentiles are a fixed number of standard deviations from the mean. This is not a general result, and although many sets of numbers (in the limit of large N) follow a normal distribution, wind schedule errors are typically not normal, and not well approximated by normal distributions.

Any use of the formulation in 3) must be justified on the basis of normality of the variables, or at least minimally show that as a practical matter for the specific distributions under consideration, formula 3) is a reasonable approximation.