BEFORE THE UTAH PUBLIC SERVICE COMMISSION

IN THE MATTER OF THE APPLICATION OF ROCKY MOUNTAIN POWER FOR AUTHORITY TO INCREASE ITS RETAIL ELECTRIC UTILITY SERVICE RATES IN UTAH AND FOR APPROVAL OF ITS PROPOSED ELECTRIC SERVICE SCHEDULES AND ELECTRIC SERVICE REGULATIONS	))))))	DPU EXHIBIT 11.0 DOCKET NO. 09-035-23

Pre-filed Direct Testimony

Of

William A. Powell, PhD

On Behalf of

Utah Division of Public Utilities

October 8, 2009

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Artie Powell, PhD

Direct Testimony

Division of Public Utilities

Docket No. 09-035-23

Introduction

Q: Please state your name, business address, and employment position for the record.

A: My name is William "Artie" Powell; my business address is Heber Wells Building, 160 East 300 South, Salt Lake City, Utah; I am employed by the Utah Division of Public Utilities ("Division" or "DPU"); my current position is manager of the energy section.

Would you please summarize your education and experience?

A: I hold a doctorate degree in economics from Texas A&M University. Prior to joining the Division, I taught courses in economics, regression analysis, and statistics both for undergraduate and graduate students. I joined the Division in 1996 and have since attended several professional courses or conferences dealing with a variety of regulatory issues including, the NARUC Annual Regulatory Studies Program (1995) and IPU Advanced Regulatory Studies Program (2005). Since joining the Division, I have testified or presented information on a variety of topics including, electric industry restructuring, incentive-based regulation, revenue decoupling, energy conservation, evaluation of alternative generation projects, and the cost of capital.

Scope of Testimony and Recommendations

Q: What is the purpose of your testimony in this proceeding?

A: The purpose of my testimony is to discuss the Company's wind integration costs (WIC) included in the net power cost study for this case. Specifically, I take exception to a couple of assumptions or omissions in the Company's WIC study. As explained in Company witness Mr. Greg Duvall's testimony, the WICs can be decomposed into two parts, namely, inter-hour and intra-hour costs. While I am not questioning the methodology the Company used in estimating these costs, I question whether some assumptions or inputs in the intra-hour cost estimates are appropriate. In particular, the Company assumes that the underlying data used to estimate the intra-hour costs are normally distributed. Statistical theory and the sample data employed in the Company's study do not support this assumption. Additionally, the Company's WIC study does not consider the effects that the variation in loads will have on WICs, which other studies have found to be significant. Given these issues, and in addition to the issues discussed in DPU witness Mr. George W. Evans' testimony, the Division is recommending an adjustment to the Company's WICs, which when applied to the GRID model results, will decrease net power costs (NPC). Mr. Evans will provide more detail on this adjustment.

I am also recommending NPC adjustments to the Kennecott, Tesoro, and U.S. Magnesium qualifying facility (QF) estimates, as presented in Company witness Mr. Greg N. Duvall's exhibit GND-1.

Q: Do you have a summary of the adjustments and recommendations that you are making in this case?

A: Yes. DPU witness Mr. George Evans discusses in detail the Division's adjustment to the Company's estimated WICs. In brief, because of considerably uncertainty surrounding the Company's intra-hour integration cost estimates, the Division recommends that the Commission disallow these costs and value the WIC at the Company's estimate for the inter-hour costs only.

In direct testimony, Company witness Mr. Greg Duvall presents the Company's estimates for WICs. The costs included by the Company in NPC for the inter-hour and intra-hour variation are, respectively, $2.08 and $4.83 per megawatt hour. If the WICs are limited to the inter-hour costs, $2.08 per megawatt hour, NPC decreases by approximately $20 million system wide, or about $8 million on a Utah allocated basis.

The GRID model used for this filing does not estimate power costs for the Kennecott, Tesoro, or U.S. Magnesium Corp. (U.S. Magnesium) QFs after December 2009. The Power Purchase Agreements (PPAs) for each of these QFs expire on December 31, 2009. However, based on experience, these agreements are likely to be renewed. As a result, these QFs should be included in the Company's NPC estimate for the remaining six months of the test year. Including these QFs in the Company's NPC study increases the Company's Utah allocated NPC by about $474,456.

Wind Integration Costs

Q: Does the Company describe its WIC study?

A: Yes. The Company provides a description of its WIC cost study and methodology in Mr. Duvall's direct testimony and in Appendix F to the Company's 2008 Integrated Resource Plan (IRP), which is attached to Mr. Duvall's testimony as Exhibit RMP_(GND-3), referred to herein as GND-3. According to Mr. Duvall's description, the Company's WIC study estimates five cost elements associated with integrating intermittent resources. For the inter-hour costs, these elements include day-ahead and hour-ahead system balancing costs. For the intra-hour costs, these elements include variation (or errors) in hour-ahead forecasts, and two defined variations, namely, regulate-up and regulate-down.

As I previously stated, some assumptions utilized in the intra-hour estimates are not well supported by statistical theory or the sample data employed by the Company.

Q: Would you please explain the concerns you have with the Company's estimates of the intra-hour integration cost?

A: Yes. The Company utilizes three elements in its WIC study to estimate the intra-hour integration costs. These three elements are (1) the hour-ahead forecast error, (2) regulate-up, and (3) regulate-down. Estimates for each of these elements are developed using hourly data for existing and incremental (or planned) wind resources. The total variation among these elements multiplied by a given critical value determines a required level of incremental reserves. It is the cost of these reserves, as determined in the Company's resource stack model, that constitute the intra-hour integration costs requested by the Company in its rate case filing.

As explained by Mr. Duvall in direct testimony, the necessary reserve levels are determined "by multiplying the [intra]-hour standard deviation from all wind projects in each of the three regions in this study by a Z score of 1.96."[1] The standard deviation is the square root of the sum of the associated covariances among the three elements for all of the wind projects. For example, for the East side of PacifiCorp's system (i.e., Utah) the total variation is measured by the sum of the covariances among the three elements for four wind projects: Wolverine Creek, Mountain Wind, Spanish Fork, and a generic incremental wind project. The standard deviation is the square root of this total variation.

[1] Gregory N. Duvall, "Direct Testimony of Gregory N. Duvall: Net Power Costs," Docket No. 09-035-23, June 2009, Exhibit RMP_(GND-3), p. 276.

My first concern has to do with the choice of the Z-score or critical value of 1.96. As explained by Mr. Duvall in GND-3, the choice of this particular Z-score is meant to represent a 97.5% confidence interval for the observed intra-hour variation and, thus, consistent with the NERC Control Performance Standard II.[2] The choice of this Z-score, however, is valid only if the underlying data, in this case the three elements for the four wind projects, are normally distributed. Neither statistical theory nor the sample data support the choice of 1.96 as the critical value in this case. Secondly, the Company's WIC study for the intra-hour costs utilizes the covariances among the three elements but does not include the potentially offsetting covariance with loads.

Q: Why do you say that theory does not support the choice of 1.96 as the Z-score?

A: By choosing 1.96 as the critical value, the Company is implicitly assuming that the sample data, in this case, the three elements – the hour-ahead forecast error, regulate-up and regulate-down – are normally distributed. That is, the data represent a random sample drawn from a population that is normally distributed. While the forecast error may be normally distributed, it is unlikely that the other two elements, regulate-up and regulate-down, are normally distributed.

Both the regulate-down and regulate-up elements are defined using extreme value statistics, the maximum and minimum respectively. For example,

[2] GND-3, pp. 271-272.

regulate-down is defined as the difference between the maximum output in a given hour measured on ten-minute intervals and the output at the top of the hour,

$$Regulate - Down = Max\{x_0, x_1, x_2, x_3, x_4, x_5\} - x_0 \qquad (1)$$

where x_i represents the output (of a wind resource) and the subscript the 10 minute interval within the hour: 0 equals the top of the hour, 1 equals 10 minutes after the hour, 2 equals twenty minutes after the hour, etc. Similarly, regulate-up is defined as,

$$Regulate - Up = x_0 - Min\{x_0, x_1, x_2, x_3, x_4, x_5\} \qquad (2)$$

Generally, the extreme values for a population or sample would follow a Gumbel distribution that is quite different from the normal distribution. In the case of the maximum, the distribution is skewed to the right meaning, the right tail of the distribution is “fatter,” or contains larger probability, than does the right tail of a normal distribution. In other words, in order to capture 97.5% of the values under the Gumbel distribution, the critical value would have to be considerably larger than the 1.96 Z-score used by the Company. For a standard

Gumbel distribution, the appropriate critical value for the maximum statistic would be 3.68.[3]

Given the definitions of regulate-down and regulate-up in Equations 1 and 2, which restrict the possible values to be equal to or greater than zero, I would expect the distributions for both elements to be right-hand skewed. Skewness is a measure of how much fatter the tails of the distribution are relative to a comparable normal distribution. A right-hand skew implies that the right tail of the distribution is fatter, or contains more probability, than a normal distribution.[4]

Q: Did you analyze the Company's sample data to determine if your expectation about the skewness in the distributions was correct?

A: Yes, I did. Summary or descriptive statistics for each of the three elements for seven wind plants, three on the East side and four on the West side of PacifiCorp's system, are contained in DPU Exhibit 11.1 attached to my testimony.

Q: Would you please explain your findings?

A: I would be delighted. Since the pattern of the descriptive statistics is similar for each wind plant across the three elements, similar or general conclusions can be reached for each of the three elements utilizing one wind project. For example,

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[3] The percent function for the Gumbel distribution (maximum) is given by the function F(p) = -ln[ln(1/p)], where p = 0.975 and ln is the natural log. Alternatively, the critical value can be determined by solving the cumulative distribution function G(x) = Exp{-Exp(-x)} = 0.975 for x, where Exp is the exponential function. See Alexander M. Mood, Franklin A Graybill, and Duane C. Boes, "Introduction to the Theory of Statistics," 3rd Edition, [McGraw –Hill: New York, New York], 1974, pp. 118, 182-185, 542.

[4] John Neter, William Wasserman, G.A. Whitmore, "Applied Statistics," 4th Ed., [Allyn and Bacon: Boston, Massachusetts], 1993, pp. 85-92.

the descriptive statistics for Wolverine Creek lend themselves to several observations. First, while the distribution of the forecast error may be somewhat symmetrical around its mean, the distribution is much more peaked than would be expected for a comparable normal distribution. This conclusion is apparent from comparing the mean and median, and analyzing the kurtosis value. Kurtosis is a measure of how "peaked" a distribution is relative to a comparable normal distribution. For convenience, I reproduce some of these summary statistics in Table 1.

Table 1: Summary Statistics, Wolverine Creek

	Forecast Error	Regulate Up	Regulate Down
Mean	0.0061	2.6510	2.7207
Median	0.0457	0.7211	0.7632
Standard Deviation	10.1214	4.5975	4.6550
Kurtosis	4.1605	16.9026	18.3031
Skewness	-0.1432	3.3733	3.4145
Count	10,197	10,199	10,199

For a normal distribution, the mean and the median would be approximately the same, and both the skewness and kurtosis values would be zero.[5] As can be seen in Table 1, the skewness value for the forecast error does not appear to be significantly different from zero and, even though the median is

[5] For a normal distribution, the population mean and the median are the same value. The population skewness is equal to the third moment (or expected value, E) of the distribution about the mean: $E[(X - \mu)]^3$, which for a normal distribution is equal to zero. The kurtosis is defined as the fourth moment of the distribution about the mean: $E[(X - \mu)^4]$, which for a normal distribution is equal to three (3). Many statistical packages such as Excel© define kurtosis as the difference between the fourth moment and three, thus, the value for a normally distributed sample would be approximately zero.

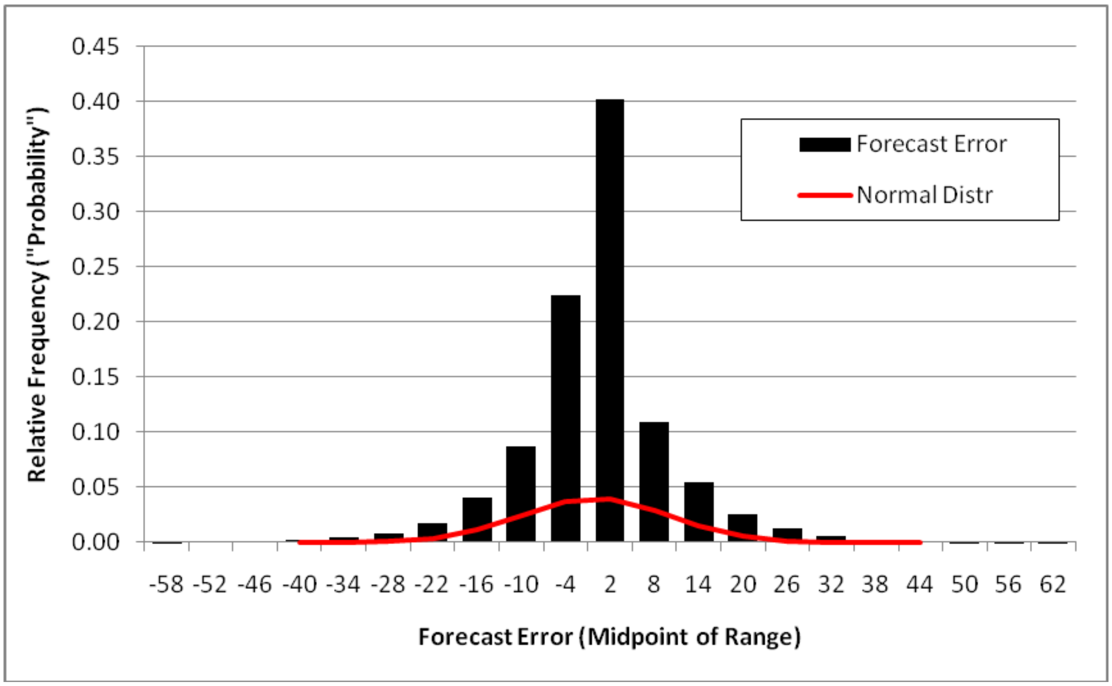
larger than the mean by a factor of ten (10), I would conclude that the forecast error is approximately symmetrically distributed around the mean, as would a normal distribution. However, the kurtosis value of 4.2 indicates that the distribution is much more peaked than a normal distribution.

Second, the summary statistics for the regulate-up and regulate-down elements appear to be similar. For example in the case of Wolverine Creek, the mean is larger than the median by a factor of ten, which would lead one to conclude that the distribution of these two elements has a right-hand skew. Unlike the forecast error, the skewness value, which appears to be significantly greater than zero, supports this conclusion. Additionally, the kurtosis values also appear to be significantly greater than zero. Therefore, I conclude that neither the regulate-up nor regulate-down elements are likely to have a normal distribution.

Q: Do you have any other observations concerning your analysis of the three elements, namely, the forecast error, regulate-up or regulate-down?

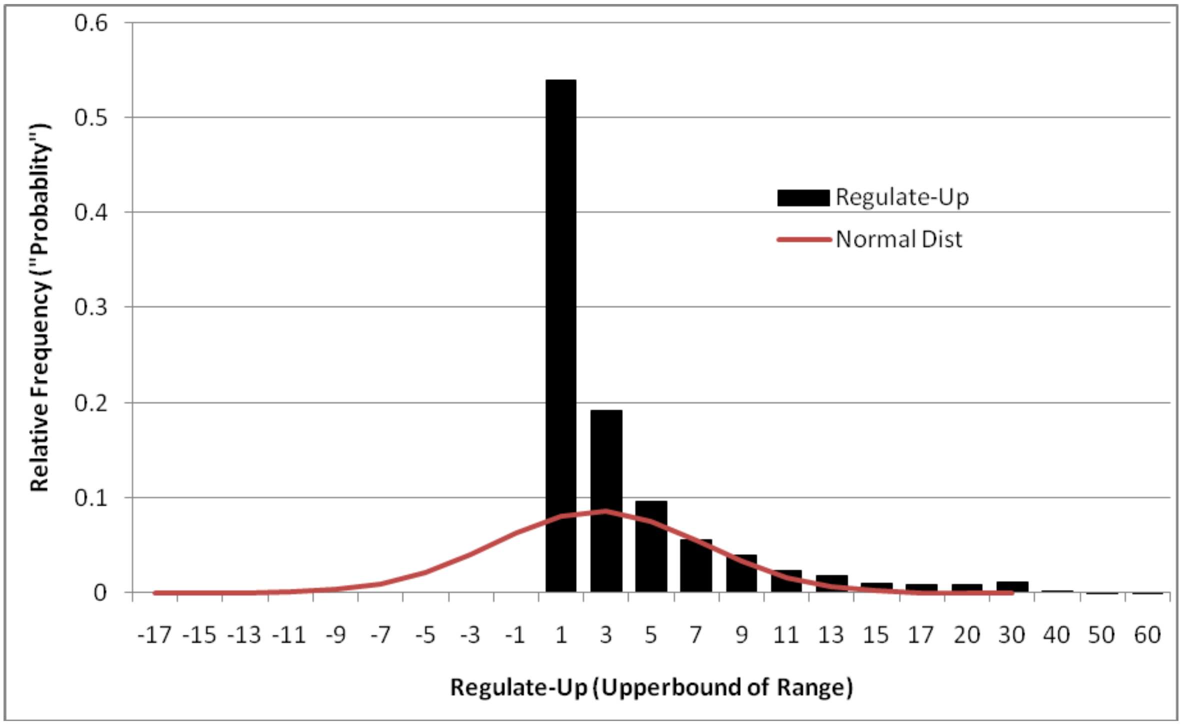
A: Yes. I used the sample data for Wolverine Creek from the Company's WIC study to construct a histogram, or an estimate, of the distribution for each of these elements. In each case, the histogram reflects the conclusions drawn from the summary statistics. The relative histogram for the forecast error is in Figure 1. In this graph for the forecast error, I have also superimposed a comparable normal distribution, a normal distribution with the same mean and variance as the forecast error. As can be seen in the graph, the distribution for the forecast error, while relatively symmetric around the mean, is significantly more peaked than the normal distribution.

Figure 1: Forecast Error Distribution, Wolverine Creek



A similar depiction of the relative histogram for the regulate-up element for Wolverine Creek is shown in Figure 2. Again, the histogram supports the conclusions drawn from the summary statistics. The distribution is considerably skewed to the right and more peaked than the normal distribution.

Figure 2: Regulate-Up Distribution, Wolverine Creek



Q: With regard to the Company's WIC study, would you summarize your conclusions and recommendations?

A: Yes. Based on my analysis of the data provided in the Company's WIC study, I conclude that the sample data is not normally distributed and, therefore, the Company's assumption or use of a 1.96 Z-score to determine the amount of needed incremental reserves is invalid. Thus, the Company's estimate of the necessary intra-hour WIC included in its net power costs for this case are not reliable. The Division recommends that the Commission allow only the WIC associated with the inter-hour variation, which Company witness Mr. Duvall indentifies as $2.08 per megawatt hour.

Q: If the Company were to increase the critical value from 1.96 to say 3.68, as you indicated for the Gumbel distribution, would that lead to an acceptable level of intra-hour wind integration costs?

A: Perhaps, but at this point it would be premature to reach any conclusions of this nature. Remember, there are three elements in the intra-hour variation: the forecast error, regulate-up, and regulate-down. The Company's WIC methodology estimates the total variation for a portfolio of wind resources across all three elements. If there are four wind projects and the three elements, then there are 12 variables whose pair-wise covariances must be measured. A determination of an appropriate critical value requires the use of the joint distribution of all twelve variables. It is not certain what this joint distribution will look like at this point. In the final analysis, the appropriate critical value may be larger or smaller than the 1.96 chosen by the Company.

Additionally, the Company's WIC study did not employ loads as an offsetting element to the other intra-hour sources of variation. This is potentially a critical shortcoming of the Company's WIC study. For example, some industry experts have concluded that:

> [A]t high penetration levels the cost of required reserves is significantly less when the combined variations in load and wind plant output are considered, as opposed to considering the variations in wind plant output alone.…
>
> It is now clear that, even at moderate wind penetrations, the need for additional generation to compensate for wind

variations is substantially less than one-for-one and is generally small relative to the size of the wind plant.[6]

Before the Company can reliably estimate the intra-hour cost of integrating wind resources into its system, the issues I have raised, as well as those presented by DPU witness Mr. Evans, will need addressing.

Net Power Cost Adjustments

Q: Is it correct that you are making an adjustment for several QF contracts, which effect NPC?

A: Yes. I am making adjustments for three QF contracts: Kennecott, U.S. Magnesium, and Tesoro.

Q: Why are you making these adjustments?

A: Although the Company does not model these contracts in the latter half of the test year, I expect that all three contracts will be renewed and, therefore, the NPC study for this case should include them.

Q: Could you please explain why renewal of these contracts is likely?

A. The Company has filed and asked for approval of new QF contracts for both Kennecott and U.S. Magnesium. For these two contracts, the Company has reached agreement over the contract terms, including energy prices and associated line loss factors through the period ending December 31, 2010.

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[6] J. Charles Smith, Brian parsons, Edgar A. DeMeo, and Michael Milligan, "Wind Power Impacts on Electric Power System Operating Costs: Summary and Perspective on Work to Date," National Renewable Energy Laboratory, Presentation at the American Wind Energy Association Global Wind Power Conference, Chicago, Illinois, March 28-31 2009(?).

Furthermore, contracts with Kennecott and U.S. Magnesium have been in place and periodically renegotiated or renewed for a number of years. At this time, there is no reason to believe contract renewals will not continue to occur in the future. The Division is currently reviewing these agreements and will participate in hearings to present its recommendations to the Commission in early November 2009. The Division anticipates submittal of the Tesoro QF by early October 2009. The Division expects that that the Commission will issue its order on all of these agreements prior to the end of 2009, well in advance of February 18, 2010, which marks the end of the 240 day clock for this rate case.

Q. Is there a possibility that the Commission could reject these QF contracts?

A. Yes. But based on the progression of the negotiations and resulting preliminary agreement between the Company and the respective parties for each of these agreements, there is no reason to expect that the contracts will not receive approval in one form or another.

Q: Do you have any other comments on the use of these contracts in the present case?

A: Yes. The Division deems that the current information as proposed by the Company for the Kennecott and U.S. Magnesium QF contracts provides a reasonable estimate of NPC for these QFs for the remaining six months of the test year. Likewise, the Company's most recent avoided cost data provides a reasonable estimate of Tesoro's estimated NPC for its QF through the period

January 1, 2009 to June 30, 2009. If modifications were made to the proposed contracts, such changes would probably have no material impact on the total NPC estimate that the Division is recommending. Of course, such modifications can be incorporated in the Commission's final order in this case.

Finally, the Division has not yet developed final recommendations on the U.S. Magnesium or Kennecott QF contracts. As such, my use of the proposed QF data as submitted by the Company does not constitute a final recommendation or endorsement of these agreements.

Q. Can you briefly describe your recommended adjustment for these QF contracts?

A. Yes. For the Kennecott and U.S. Magnesium QF estimates, the Division entered the proposed energy prices and associated line loss factors for the period January 2010 through June 2010, as contained in each proposed QF, into the GRID model. This information is proprietary, and may be found in the associated filings under Docket Nos. 09-035-20 (U.S. Magnesium QF) and 09-035-62 (Kennecott QF). The Tesoro estimate was developed using the monthly avoided energy prices (January – June 2010) listed in Appendix B of the second quarter 2009 avoided cost input changes developed in the Company's Quarterly Compliance Filing for Schedule 38 under Docket No. 03-035-14. These monthly prices were multiplied by a line loss factor that is comparable to the proposed factor included in the Kennecott QF, an approach that has been used in the previous two Tesoro QF applications. With the inclusion of these three QFs, the Company's NPC estimate increases by about $1.16 million on a system basis or about $474,456 on a Utah-allocated basis. While arguably this is not the only way to make an adjustment for these QFs, it is consistent, I believe, with similar adjustments done in the past. For example, in Docket No. 07-035-93, the Division made a similar adjustment for the Tesoro QF contract that expired just prior to the beginning of the test year.

Q: Does that conclude your direct testimony?

A: Yes, it does.