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BEFORE THE PUBLIC SERVICE COMMISSION OF UTAH

In the Matter of Review of Electric Service Schedule No. 38, Qualifying Facilities Procedures, and Other Related Procedural Issues	**DOCKET NO. 14-035-140** **Utah Clean Energy Exhibit 2.0**

Rebuttal Testimony of Ken Dragoon
on behalf of
Utah Clean Energy

May 28, 2015

RESPECTFULLY SUBMITTED,
Utah Clean Energy

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INTRODUCTION

Q: Please state your name and business address.

A: My name is Ken Dragoon. My business address is 3519 NE 15th Avenue, #227, Portland, Oregon 97212.

Q: Are you the same Ken Dragoon who filed direct testimony on behalf of Utah Clean Energy in this matter on April 28, 2015?

A: Yes.

RESPONSE TO DIRECT TESTIMONY

Q: Please summarize the issues you will address in your rebuttal testimony.

A: The testimony submitted by Charles Peterson of the Division of Public Utilities ("Division") concludes that Rocky Mountain Power's ("the Company") proposed capacity values for wind and solar appear reasonable. The Division's reliance on a standard of reasonability seems to be driven by the difficulty in performing a systematic evaluation of the Planning and Risk ("PaR") model results, are a primary component of the Capacity Factor Approximation Method ("CFAM") the Company used in its capacity value determination. The PaR model loss of load probability ("LOLP") results are a critical input into CFAM calculation of the capacity value for renewable resources.

Mr. Peterson characterizes the PaR model as a "black box" [at 155]. Although Mr. Peterson's testimony cites a commentary letter from the National Renewable Energy Laboratory (NREL) broadly endorsing the Company's application of the CFAM method, NREL also states that it did not validate the

Company's *assumptions or results* [at 107-108]—effectively leaving the assumptions and results of the Company's PaR model (the "black box") unexamined. My previous testimony calls to question some of the PaR model's results and assumptions, which we believe the Company has not sufficiently addressed.

Altogether abandoning evaluation of PaR and the question of whether its results are valid, the Division's testimony turns to whether the resulting capacity contribution values are at least reasonable compared with other studies of capacity values. However, the Division's testimony used some data from solar resources vastly inferior to Utah's (Portland, Oregon and Toronto), and in one case relied on outdated data that has more recently been significantly increased (Arizona). A more careful review of the available information leads to a different conclusion: that the Company's result for solar capacity value is *low* in comparison with other studies of similar resources, and that the Company's model results should be more carefully validated.

My testimony addresses the Division's assessment that the PaR Model is a "Black Box." I conclude that we need to review and evaluate the outputs of the PaR model to determine if they make sense based upon what we know about PacifiCorp's system before we can rely on its LOLP results as a critical input in CFAM analysis. My testimony also addresses the basis on which the Division concludes that the Company's capacity value proposal is reasonable, and I conclude that it is flawed.

The PaR model and loss of load results

Q: What is your response to the Division's characterization of the Planning and Risk Model (PaR) as a Black Box"?

A: The PaR Model is a very complex analytical tool that is commonly used in utility resource planning studies. Its complexity is a reflection of the complexity of the interactions among loads and resources in a diverse group of utilities throughout the west. The complexity of the model is a natural product of the complexity of the system whose operations it represents. There is a wide range of information that can come out of economic dispatch models such as PaR—including market prices, emission rates, economic analyses of decisions around building or retiring new power plants and transmission corridors. The model requires literally millions of numbers that represent a multitude of assumptions about the current and future state of the power grid. Beyond the sheer volume of data feeding the model, the model itself has a complex of algorithms and modeling options that process the data to produce hundreds of millions of numbers in output. Given that many of the algorithms are actually proprietary to the vendor, it is understandable that anyone not expert (and perhaps some who are) might characterize the model as a "black box."

Q. What is your experience with the PaR model and other models like it?

A: I received a week of training from the PaR model vendor when I was a PacifiCorp employee, and was charged with overseeing the Integrated Resource Plan modeling group that ran the model for a few months before my departure from PacifiCorp. I have experience with a number of these kinds of models and

recently completed developing a vastly simplified version for a client. I would say that I have a general understanding of these kinds of models.

Q: How was PaR used in determining the capacity value of renewable resources?

A: Computing capacity values using CFAM involves combining two basic components: the availability of the resources at different hours of the year; and the relative need for power over the hours of the year. The availability and need are multiplied together for each hour. The resulting hourly products are summed over all the hours of the year to determine the average contribution to meeting demand, which is implicitly defined as the capacity value of the resource.

The relative need for power in each hour is developed using the PaR model. As an economic dispatch model, PaR simulates the operation of the study region's power plants to meet loads under a range of study assumptions: loads, generator outages, gas prices, transmission constraints, etc. The model is run in a "stochastic" mode whereby different combinations of demand assumptions and unit outages (and some other parameters) are selected at random to examine how the system operates under different conditions. The Company had the model evaluate the system operation over a single year (2017) with 500 different sets of assumptions ("500 iterations") about the stochastic variables (assumptions that change over each iteration).

There will almost inevitably be some combinations of loads and unit outages in which the model cannot cover all of the assumed demand. Those instances are counted as "energy not served" events for each of the hours of the

year in which they occur. For example, if the model has insufficient resources to meet load on a given hour on three of the 500 iterations, then the number 3 is recorded for that hour. Outside the model, the total number of events are summed for the Company's system and sums over all 500 iterations for each individual hour are also recorded. The individual hour sums are divided by the overall total to get the relative importance of capacity for each hour

For example, if there are a total of 715 energy not served events over all the hours in all the iterations, then in the example for the hour where there were three events, that number would be divided by 715 to arrive at a "normalized" relative importance value that is used directly as a multiplier for resource availabilities in the CFAM computation. The set of normalized values for each hour of the year are termed "LOLP" values in the Company's analysis, and the 500 iteration PaR model runs are sometimes referred to as the LOLP study.

Q: Did you validate the PaR results in this case?

A: I cannot say that my investigation is complete. I have requested information from the Company to help in that process and not all the numbers I need are available to me. Given that, and the fact that time and resources are limited, it appears unlikely that I will be able to get to the bottom of what is going on with the model results. That said, some of the results I have examined are surprising and certainly warrant more investigation prior to approving capacity values based upon the results of PacifiCorp's analysis.

One of the more fundamental concerns I have is that I could not replicate the value the Company used in its normalization process. For example, there are a

large number of events occurring in the Colorado area that the Company did not count. However, even taking those events out of the calculation, the remaining energy not served events appear to be higher than the number used by the Company in its normalization— I am still looking through the Company's responses to our Data Requests to try to understand the apparent discrepancy.

Q. Do you question the validity of the PaR results?

A. Yes. The results of any model should be questioned generally, and it should also be understood that the sheer volume of numbers and sometimes obscure modeling options means that a full validation is rarely, if ever, performed. At some point, analysts come to be comfortable that for the purposes at hand, the results are good enough.

Q. In general, how do analysts arrive at the "good enough" point in validating model results?

A. Ideally, there are automated validation procedures, though limitations in time and resources on the utility side generally mean that those are limited if they exist at all. One of my goals as a manager of modeling groups was to put such automated validation procedures in place, but it was mostly a losing battle competing with other priorities.

Most validation is performed by looking at key outputs of model runs and making an assessment of whether the results seem reasonable. If some result is questionable, my philosophy was generally that it was either due to some kind of modeling error or else that our initial intuition was somehow wrong—in other words, we had an opportunity to learn something new about the power system.

Q. In your assessment, are the results of the PaR model correct in this case?

A. I have verified the Company's application of the CFAM and reviewed the post-PaR calculations (i.e, normalization process described above) but must still conclude that I do not know whether the results of PaR's LOLP analysis are valid. The results are surprising, so I have concluded that there has either been a modeling error that we need to find or that we have an opportunity to learn something new about the PacifiCorp system.

Q. What is surprising about the PaR LOLP results?

A. The Company is reporting that there are three time periods in which they are most likely to need peaking resources: the middle of summer, April, and in the winter time. Historically, on the east side of the system, the need for peaking resources has been the summer time when loads are highest, due mainly to high demand for air conditioning loads. So there is nothing at all surprising about loss of load events on the east side of the system in the summer.

Most unusual about the PaR results is April, because April loads are not high. My earlier testimony points to how the model likely arrived at that result: an overabundance of maintenance assumed to occur in April. More mystifying is that the April loss of load events occur almost entirely (all but one) in the NE and SW Wyoming regions. This suggests that the issue may be some combination of maintenance schedules and transmission congestion.

Energy shortages are simply not expected to occur in April, which is why it is a good candidate for maintenance in the first place. The Company's PaR model had more scheduled maintenance in April than in any other month. That

seems completely clear. Merely spreading the maintenance out a bit would eliminate the April loss of load events, which would have a significant impact on the resulting solar resource capacity value.

The matter of the winter month loss of load events is more perplexing, and is crucially important to the computed capacity value from the CFAM. The CFAM multiplies the availability of resources by their relative need in various parts of the year. Generally, solar capacity values are relatively high (40-80%) in summer-peaking utilities with high-quality solar resources. At first approximation, Utah seems an ideal case for that, but the Company's application of the CFAM comes to a different conclusion. The reason is mostly because the PaR model output shows winter loss of load events in the NE and SW areas of Wyoming.

These PaR results indicate that the Company is short of peaking capacity in the winter time or that it is difficult to get power to these parts of Wyoming to meet load. This is an unexpected result, and merits much closer attention. Unfortunately, the Division appeared not to investigate the outputs of the PaR study to determine whether they comported with their understanding of PacifiCorp's system. They focused instead on examining whether the Company's proposed capacity value numbers are reasonable compared to other utilities' systems.

It is my hope that we shed a little more light on the "black box" to understand whether the LOLP results are real, or whether they are due to

modeling artifact or error. The Commission's interest in valid, Utah-specific capacity values warrants credible and transparent analysis.

Q: In your direct testimony, you concluded that the likeliest cause of winter time loss of load events was a lack of transmission capacity. Has your conclusion changed?

A: Although I initially questioned, based on my understanding of PacifiCorp's system and the data I had reviewed to that point, that the likeliest cause of wintertime loss of load events was constrained transmission, the model results did not support that conclusions—there were very few loss of load events on the west in the Winter. Rather, the model shows the wintertime shortages are located in Wyoming, which is a surprising enough result that it calls into question the validity of PaR results. It is also unclear which loss of load events were included in the processing of PaR output for the CFAM analysis, or why it is appropriate to leave out some events (e.g. Colorado) and not others (e.g., Wyoming).

Q: Is it a reasonable course of inquiry for the Division to evaluate the 'reasonableness of the CFAM results'?

A: Yes, of course, but equally important is to evaluate the reasonableness of the outputs from the PaR model, which drive the results of the CFAM analysis.

Q. Is it possible that the PaR results for winter time Wyoming outages are correct?

A. Unlike the April maintenance issue, this is more difficult to ascertain—it is conceivable that the results are indeed an accurate representation of a feature of

the Company's system, but it is at least equally plausible that the results are an erroneous artifact of the modeling. The Company is part of a larger system that includes loads in Oregon and Washington—states where loads are highest in the winter time. I initially thought that the most logical reason for the results had to do with the influence of those loads on the model. However, a closer inspection of the Company's responses to data requests unearthed something very unexpected—there were almost no loss of load events occurring on the west side in the winter time. In other words, what I thought was the most likely explanation was not what was happening.

Rather, almost all of the loss of load events occurred in Wyoming. This was again surprising because of Wyoming's relatively small population. My understanding is that most of the load there is from the oil and gas exploration and production industry. It is unclear to me whether it makes sense that this would be a legitimate source of winter time peaking needs. Again, a surprising result that might be due to modeling assumptions or errors, or perhaps represents an opportunity to learn something new about the system.

Q. How might it be possible for this to be an error?

A. There are a number of ways the results could be in error. One macro-scale modeling error might be related to the choice of base year. The model simulates more than 4 million hours of operation (500 iterations times 8760 hours per year), but focuses on less than 0.01% of those hours to calculate capacity value. One of the reasons for the very low number is that 2017 is in the "resource sufficiency

period"—a time when the Company is not short on capacity. It would be more logical to choose a year in the insufficiency period for the calculation.

Another possibility is that the loads modeled were simply too high, that the variability of industrial Wyoming loads was modeled as being much more volatile than they actually are or that there are insufficient transmission capabilities in these areas of Wyoming to meet the projected load. There are many ways this result could be an error. Or, the results could be valid, but they are unusual enough to merit additional attention to fully explain them, prior to the Commission using them to calculate the capacity value of renewable resources.

Q. If the loss of load events in Wyoming are found to be due to lack of transmission transfer capabilities serving those load areas, should those loss of load events be included in the calculation of the capacity value using the CFAM?

A: No, as I explained in my direct testimony, the CFAM implicitly assumes that the system it is being applied to has no, or at least minimal, congestion. A fair application would be to discount loss of load events occurring in regions where there were binding transmission constraints. Those are events that neither renewable nor traditional resources could address and should not be included in the CFAM calculation. Unfortunately, the Company claims it has no data regarding hours on which there was transmission congestion in the model.

Q. You said that at some point results are deemed "good enough." In your opinion, are the present PaR results good enough to utilize in the CFAM analysis?

A. If I were in charge of quality control, I could not accept these results without more fully understanding how and whether they make sense, if they are caused by factors such as transmission constraints, and/or whether they are an artifact of a maintenance schedule that could be modified slightly to avoid loss of load events prior to accepting them as 'good enough' for the use in determining the capacity value for renewable resources.

The Division referred to the PaR model as a black box and did not review the PaR results feeding into the CFAM analysis; rather, the Division used other states' capacity valuation studies to evaluate whether the Company's proposed capacity values were reasonable. While I can see the appeal of this approach, I cannot recommend that the Commission rely on the Division's analysis or conclusions as support for the Company's proposed capacity values. There is too much that is questionable about the PaR model results. Furthermore, the Division's conclusion that the Company's results are reasonable—based on factors other than the full application of CFAM—is problematic for other reasons, which I discuss below.

Q. The Division cites a statement from NREL endorsing the Company's application of CFAM. What is your response?

A. The NREL statement includes the assertion that NREL's evaluation of PacifiCorp's application of the CFAM "did not include verifying PacifiCorp data nor verifying the capacity contribution values." I believe this means that the PaR model assumptions and results were as unexamined by NREL as they were by the Division.

I agree with NREL that the Company did a reasonable job applying the CFAM method, and that the solar capability values established by Black & Veatch are reasonable. On the other hand, I am completely unsure that the Company's PaR model results accurately reflect the timing of the Company's capacity needs. Certainly I question the April figures which seem clearly an artifact of heavy loading of maintenance in that month (e.g., I don't know of any utility that specifically needs to add a resource to cover an April shortfall), and the winter results from Wyoming certainly deserve closer scrutiny.

Unfortunately, the CFAM method is equally sensitive to the PaR results as it is to the resource characterization (i.e., the Black & Veatch analysis), so I conclude NREL cannot say with any certainty, and indeed did not say, that the Company's *results* are correct.

Reasonableness of Results

Q. Do you agree with the Division's conclusion that the Company's capacity contribution values "fall within the zone of reasonableness" [at 162].

A. I think the wind capacity values calculated by the company are reasonable, but that the solar values are not.

Q. On what basis do you disagree with the Division's conclusion with respect to solar capacity values?

A. The Division appears to have relied on two main sources of information with respect to whether the Company's proposed solar capacity values are reasonable. These were the data provided by the Company [at 71-81, including

Table 1], and a 2012 study by Mills and Wiser [at 168-185, including chart on page 10]. I agree that it makes sense to look at values determined by other studies; however, some additional scrutiny of that data is warranted.

The two biggest factors in ascertaining a capacity value for solar is the quality of the solar resource and the extent to which a utility is short of capacity during the sunny months or during the winter months. Additionally, care needs be taken to ensure that the most recent results available are considered because the understanding of the issues is evolving relatively rapidly (as evidenced by the newness of this proceeding).

The Division's analysis falls somewhat short in these regards. It includes data from Oregon, Washington, and Canada where the solar resource is a fraction of what it is in Utah and other parts of the Southwest, and where loads are highest in the winter time. Those facts explain why those regions have lower solar capacity values than other places. For example, the solar radiation in Portland during January when loads tend to peak is roughly one-fifth the June solar radiation in Salt Lake City.[1] That may sound like an unfair comparison, but if Portland peaks in January and Utah peaks in June, then that is the correct comparison.

[1] Data from www.Porta-energy.com/insolation_usa.htm.

316 Moreover, the Mills and Wiser chart on which the Division bases its
317 conclusion not only includes representations for poorer quality resources (PGE
318 and Toronto), but also includes data from a now dated study from Arizona Public
319 Service ("APS"). A newer study for APS shows a much higher capacity value at
320 the penetration level depicted in the Mills and Wiser Chart[2]—approximately 50%
321 higher capacity value at the 5% penetration level than the older results depicted in
322 the 2012 Mills and Wiser report.
323 If the data from lower quality solar resources is removed from the Mills
324 and Wiser chart (or conversely, increased by a factor of five to adjust for the
325 relative quality of the resource), and the APS data is updated, the Division might
326 well reconsider its conclusion, as of course I would urge it to do, and find that the
327 Company's results do not fall within the zone of reasonableness.
328 It should also be pointed out that the methodologies used to determine
329 capacity values in the Mills and Wiser chart the Division used were not
330 necessarily of equivalent merit to CFAM or other LOLP methods. Another chart
331 in the same Mills and Wiser paper includes only those analyses that were based
332 on LOLP methods, as shown in Figure 1 below:

[2] *2013 Updated Solar PV Value Report*, Table 2-2, p. 2-7 (statement based on "Expected Case" values).

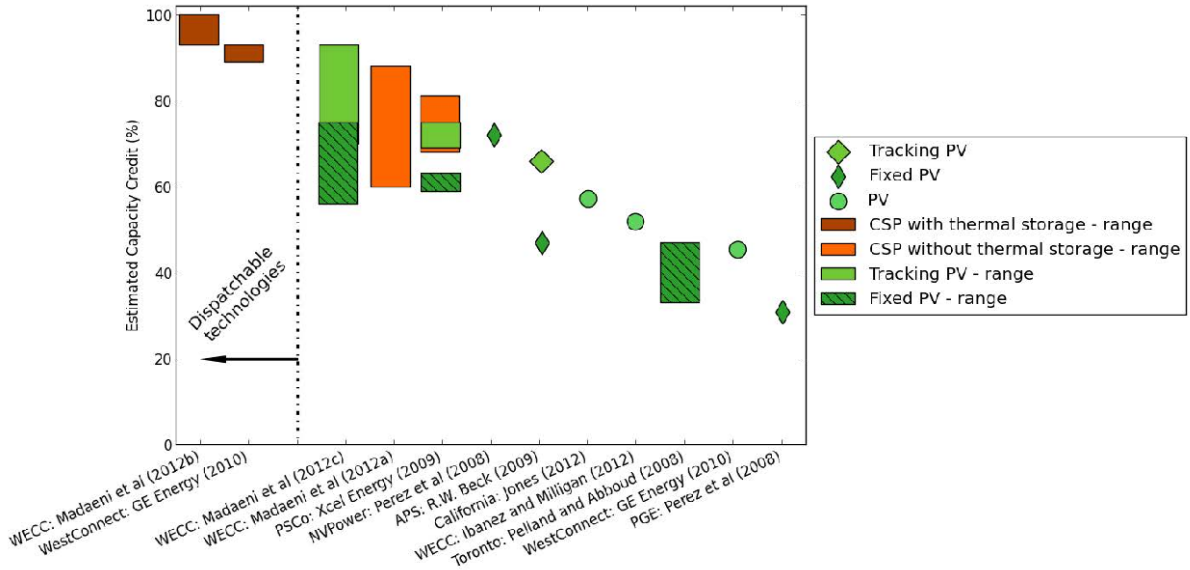

Figure 1 Estimated capacity credits at low penetration from studies that use LOLP-based methods (Mills & Wiser 2012, p. 22)

This figure clearly shows that the Company's value of 34.1% is at the low end of these studies, and that the low end is represented by the lower quality solar resource in PGE's system. From this chart, the Division could well have come to the opposite conclusion—that the Company's proposed solar capacity value is indeed not reasonable for Utah's solar resource and system attributes.

Q. Why do you challenge the solar capacity valuation but not the wind capacity valuation?

A. First of all, the wind capacity values do fall into a reasonable zone. There are lower numbers for places where the resource is not as good, but there are higher numbers for resources that are better. The value the Company comes up with in this analysis are reasonably close to the ones I personally calculated as a PacifiCorp employee. It should also be pointed out that because average wind resource availability varies relatively little by hour of the day and day of the year,

errors in the timing of the need for capacity (e.g., winter or summer) are far less important in evaluating the capacity value of wind resources than they are for solar. Even though there are concerns with the PaR results, I agree with the Division that the end result for the wind capacity value is within the "zone of reasonableness."

CONCLUSION

Q: Please summarize your rebuttal conclusions.

A: In short, the Division's characterization of the PaR model analysis as a "Black Box" is apt—its results are anomalous and cannot be relied upon as a dependable input for solar capacity value analysis without further investigation. The Division's approach to ignore the PaR results and instead base their support of the proposed capacity values on a comparison with other capacity value studies is problematic for the reasons outlined herein.

Furthermore, the Division's conclusion that the proposed solar capacity values fall into a "zone of reasonableness" is flawed because:

1. It relies on data from regions with a far lower quality solar resource than Utah.
2. It relies on data that has since been updated to reflect a significantly higher solar capacity value.
3. The 2012 Mills and Wiser examination of other studies that used LOLP methods in low solar penetration areas shows that the Company's solar capacity value falls well below the most comparable

results (see Figure 1), and is close only to the lowest end of capacity values, representing relatively poor resource areas that are unlike Utah (Portland and Toronto).

The Company's solar capacity values do not fall within a zone of reasonableness. However, I agree with the Division's conclusion that the Company's proposed wind capacity values are within the zone of reasonableness.

Q: What are your recommendations for the Commission?

I recommend the following:

- The Commission should not accept or approve the Company's proposed solar capacity values until questions about the anomalous results of the PaR model are addressed.
- The Commission should continue to use the currently effective "interim" capacity values for solar resources until further review and analysis of the company's PAR model results is complete.
- After the anomalous results from the PaR analysis are corrected, or adequately explained, the CFAM for both wind and solar should be re-run. If the NE and SW Wyoming events are the result of transmission constraints to these areas, these events should not be included in CFAM analysis.

Q: Does that conclude your testimony?

A: Yes.