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Renewable Northwest

December 14, 2015

Via Electronic Mail

Public Utility Commission of Oregon
Attn: Filing Center
PUC.FilingCenter@state.or.us

Re: In the Matter of PUBLIC UTILITY COMMISSION OF OREGON, Investigation to Explore Issues Related to a Renewable Generator's Contribution to Capacity
Docket No. UM 1719

Dear Filing Center:

Enclosed for electronic filing in the above-referenced docket is Renewable Northwest's Opening Testimony of Michael H. O'Brien.

Thank you for your assistance. Please do not hesitate to contact our office if you have any questions.

Sincerely,

/s/ Silvia Tanner
Silvia Tanner
Staff Counsel
Renewable Northwest

Enclosure

BEFORE THE PUBLIC UTILITY COMMISSION
OF OREGON

UM 1719

In the Matter of PUBLIC UTILITY COMMISSION OF OREGON, Investigation to Explore Issues Related to a Renewable Generator's Contribution to Capacity	OPENING TESTIMONY OF MICHAEL O'BRIEN ON BEHALF OF RENEWABLE NORTHWEST

INTRODUCTION

Q. Please state your name, occupation and business address.

A. Michael O'Brien, Senior Policy Advisor at Renewable Northwest. My business address is 421 SW 6th Avenue, Suite 1125, Portland, OR 97204.

Q. On whose behalf are you testifying?

A. This testimony is on behalf of Renewable Northwest.

Q. Mr. O'Brien, please describe your educational background and work experience.

A. I hold a Ph.D. in Physics from the University of Birmingham, in the United Kingdom, which included an MSc in the Physics and Technology of Nuclear Reactors. I also hold a BSc(Hons) in Physics from the University of Birmingham. After post-doctoral research with the United Kingdom Atomic Energy Authority, I completed an MPhil in Technology Policy at the University of Cambridge. Following Cambridge I worked for the UK Parliamentary Office of Science and Technology as Energy Advisor, and then for the House of Commons Energy and Climate Change Select Committee as Committee Specialist. I moved to the United States in June 2012, and have been working at Renewable Northwest on energy policy since then.

Q. What is the purpose of your testimony?

A. Our Opening Testimony addresses the matters identified by the Public Utility Commission of Oregon ("Commission") in the Memorandum and Notice of Prehearing Conference for UM 1719 issued August 22, 2015 in the following order: the pros and cons of using an Effective Load Carrying Capability ("ELCC") calculation; the pros and cons of requiring an alternative or approximation method to be benchmarked against an ELCC calculation; the preferred methodology to calculate renewable generator's contribution to capacity; and. finally, the pros and cons of requiting the utilities to use the same calculation method. To begin with, we will address capacity-related terminology.

CAPACITY-RELATED TERMINOLOGY

Q: What do you understand the term "contribution to capacity" to mean?

A: The terms "capacity credit" (or "contribution to capacity") and "capacity value" are often used interchangeably. However, while the former refers to the percentage of a resource's nameplate capacity that contributes to system adequacy, the latter often reflects the economic value associated with that capacity credit for which the generator is compensated via a capacity payment.[1] A renewable generator's contribution to capacity ("CTP") is the proportion of a renewable generator's nameplate capacity that contributes to system adequacy.[2]

Q: Is contribution to capacity different from contribution to peak-load capacity?

A: Staff's February 9, 2015, Report to the Commission on the subject "Renewable Generation Contribution to Capacity", recommended that "an investigation be opened into the determination of renewable generator's

[1] Lawrence Berkeley National Laboratory, Andrew Mills, An Evaluation of Solar Valuation Methods Used in Utility Planning and Procurement Processes, OPUC, August 17, 2015, Slide 9.

[2] Utility Variable-Generation Integration Group, Capacity Value of Variable Generation, June 2014, Slide 3, www.uwig.org/shortcourse2014/Session-6-Milligan.pdf

contribution to *peak-load capacity*" [emphasis added].[3] Peak-load capacity is an operational view of capacity credit, and is concerned with how much capacity a variable generator will produce at a given date and time when the system experiences peak-load. [4]

In contrast, "contribution to capacity" in general—or capacity credit—typically refers to system adequacy, and to whether there is enough installed capacity in a certain year to reliably serve load.[5] A renewable generator's contribution to capacity is the variable generator's contribution to system adequacy.

Q: Can you define these two types of capacity credit, "operational" and "system adequacy"?

A: These two types of capacity credit are characterized by the National Renewable Energy Laboratory's Michael Milligan, PhD. in a publically available presentation given to the Utility Variable-Generation Integration Group in June 2014.[6] Operational capacity value is concerned with how much capacity a variable generator will produce at a given date or time.[7] System adequacy capacity value is concerned with whether there is enough installed capacity in a certain year to reliably serve load.[8] These

[3] OPUC, Renewable Generator Contribution to Capacity, Staff Report, February 9, 2015, p 1.
[4] Utility Variable-Generation Integration Group, Capacity Value of Variable Generation, June 2014, Slide 3, www.uwig.org/shortcourse2014/Session-6-Milligan.pdf
[5] Ibid.
[6] Ibid.
[7] Ibid.
[8] Ibid.

two views of capacity value are described as "[…] two very different questions".[9]

Q: Are there any metrics for system adequacy?

A: Two of the most commonly used metrics for system adequacy are loss of load probability ("LOLP") and loss of load expectation ("LOLE").[10] The LOLP is the probability of a loss of load event in which the system load is greater than available generating capacity during a given time period.[11] The LOLE is the sum of LOLPs during a planning period, usually one year, and gives the expected number of time periods in which a loss of load event occurs (for example 0.1 days per year).[12]

Q: How does the LOLP relate to a resource's contribution to capacity?

A: The Effective Load Carrying Capability ("ELCC") is defined as the amount by which the system's loads can increase when the resource is added to the system while maintaining the same system reliability, as measured by a system adequacy metric such as LOLP or LOLE.[13] The percentage of the ELCC (in MW) to the nameplate capacity of the resource added (in MW) is the capacity credit (in per cent) of the added generator.

USING AN EFFECTIVE LOAD CARRYING CAPABILITY ELCC CALCULATION

Q: What does the ELCC calculation represent?

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[9] Ibid.

[10] Michael Milligan, Ph.D., Methods to Model and Calculate Capacity Contributions of Variable Generation, OPUC, August 17, 2015, Slides 7–9.

[11] National Renewable Energy Laboratory, "Comparison of Capacity Value Methods for Photovoltaics in the Western United States", July 2012, p 2.

[12] Ibid.

[13] Ibid, p 4.

A: When presenting to the Commission on "Methods to Model and Calculate Capacity Contributions of Variable Generation" on August 17, 2015, Michael Milligan, Ph.D., described the ELCC by stating that it "essentially decomposes the contribution that an individual generator (or group of generators) makes to overall resource adequacy. A generator contributes to resource adequacy if it reduces the LOLP in some or all hours or days".

Q: What are the pros of the ELCC method?

A: The ELCC method is recognized as a common and robust approach to determining capacity credit. The North American Electric Reliability Corporation ("NERC") recommended "the use of LOLP, LOLE, or related metrics for resource adequacy calculations and for determining the capacity contribution of VG [variable generation]". [14] In addition, the National Renewable Energy Laboratory ("NREL") concluded that the ELCC method is "…well recognized and widely used due to [it's] robustness'.[15]

Q: What are the cons of the ELCC method?

A: The data requirements for an ELCC are non-trivial. Generation data from the renewable resources and load data—both of which data sets are driven by weather and therefore correlated—from the same year are needed for consistent analysis and plausible results.[16]

REQUIRING AN ALTERNATIVE OR APPROXIMATION METHOD TO BE BENCHMARKED AGAINST AN ELCC

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[14] NERC, "Methods to Model and Calculate Capacity Contributions of Variable Generation for Resource Adequacy Planning", March 2011.
[15] National Renewable Energy Laboratory, "Comparison of Capacity Value Methods for Photovoltaics in the Western United States", July 2012, p 27.
[16] Michael Milligan, Ph.D., Methods to Model and Calculate Capacity Contributions of Variable Generation, OPUC, August 17, 2015, Slide 22.

Q: What are the pros of using an approximation method?

A: The use of approximation methods can avoid some of the data requirements necessary for an ELCC calculation. A rigorous capacity valuation of variable generation requires sufficiently long term data on wind and solar, which may not be available.[17] NREL concludes that while the ELCC method is widely used due to its robustness, the found that some approximation techniques can yield similar results, finding that "the CF (capacity factor approximation method) to be the most dependable technique".[18]

Q: What are the cons of using an approximation method?

A: In presenting to the Commission, NREL's Michael Milligan, Ph.D., described approximation methods as "less than ideal," adding that they "often do not take LOLP or risk into account".[19]

Q: Can you describe the capacity factor allocation method for approximating capacity credit?

A: The Capacity Factor Allocation Method (often referred to as the "capacity factor" method) is discussed in NREL's "Comparison of Capacity Value Methods for Photovoltaics in the Western United States", where a variety of methods to approximate the ELCC (effective load carrying

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[17] Michael Milligan, Ph.D., Methods to Model and Calculate Capacity Contributions of Variable Generation, OPUC, August 17, 2015, Slide 22.
[18] National Renewable Energy Laboratory, "Comparison of Capacity Value Methods for Photovoltaics in the Western United States", July 2012, p 27.
[19] Michael Milligan, Ph.D., Methods to Model and Calculate Capacity Contributions of Variable Generation, OPUC, August 17, 2015, Slide 13

contribution) are evaluated.[20] Three capacity factor approximation methods are presented:

1) the average capacity factor during the peak-load hours;

2) the capacity factor during the peak-LOLP hours; and

3) the capacity factor during the peak-LOLP hours, where the capacity factor is weighted by the LOLP.

Q: Are some approximations better than others?

A: Michael Milligan, Ph.D, et al published a paper in 1999 on "A Comparison and Case Study of Capacity Credit Algorithms for Intermittent Generators" in which the different capacity factor approximation methods are investigated and compared to an ELCC calculation. ".[21] In this study, the authors conclude that method 2) (referred to as the "LOLP method") should be used over method 1) (referred to as the "load" method) and method 3) (referred to as the "weighted method") because it is closest to an actual ELCC calculation.[22]

Q: Why might weighting the capacity factor by the LOLP not be the best way to approximate the capacity factor?

For some utilities, possibly because of the make up or size of their service territory, the peak load hours may not be coincident with the highest LOLP hours. Calculating the capacity value using LOLP hours, and then

[20] National Renewable Energy Laboratory, "Comparison of Capacity Value Methods for Photovoltaics in the Western United States", July 2012, p 6.

[21] (NREL, 2007) http://wind.ucdavis.edu/rpsintegration/library/NREL-CP-440-22591%20Mar97%20Milligan%20Parsons.pdf

[22] (NREL, 2007) http://wind.ucdavis.edu/rpsintegration/library/NREL-CP-440-22591%20Mar97%20Milligan%20Parsons.pdf p6

further weighting the capacity factor by the LOLP may exacerbate the problem.

PREFERRED METHODOLOGY TO CALCULATE RENEWABLE GENERATOR'S CONTRIBUTION TO CAPACITY

Q: Please describe your preferred methodology to calculate renewable generator's contribution to capacity?

A: Renewable Northwest's preferred methodology for determining the long-term capacity credit of a variable generator's contribution to capacity—in terms of capacity needed for system adequacy—is the ELCC. If performing the appropriate ELCC calculation is not possible for a utility (for example owing to insufficient data or complexity) then the capacity factor approximation method that uses the capacity factor during peak load hours should be used.

Q: How many of the highest load or highest LOLP hours should be examined.

A: NREL's "Comparison of Capacity Value Methods for Photovoltaics in the Western United States", suggest that the top 10% of hours is typically sufficient.[23] The implication of this suggestion is that a minimum of 876 hours should be examined.

REQUIRING THE UTILITIES TO USE THE SAME CALCULATION METHOD

Q: Should the utilities be required to use the same calculation method?

A: Specific utilities should not necessarily be required to use the same calculation methodology. A utility may have insufficient data to perform

[23] National Renewable Energy Laboratory, "Comparison of Capacity Value Methods for Photovoltaics in the Western United States", July 2012, p 6.

an ELCC, or, given a utility's system size, such a calculation could be too complicated. In the latter case, the utility may have to perform an approximation. However, Renewable Northwest suggests that a utility should be required to use the same calculation method when trying to determine the same capacity metric.

For example, Staff's Report to the Commission of February 9, 2015 on the subject "Renewable Generation Contribution to Capacity", described a renewable generator's contribution to capacity as "a measure of the most likely amount of capacity (megawatts) the resource can deliver at the exact time of the utility's peak annual load".[24] . PacifiCorp, in its 2013 Integrated Resource Plan ("IRP") (Appendix O), undertook such an approach by determining the 100 annual hours with the highest peak loads, and then analysing generation data to identify which resources were generating at those hours.[25] This resulted in a capacity credit for solar resources of 13.6%. [26] This is in line with the operational view of capacity, i.e. how much capacity of a variable generator produce at a given date and time, as described by Michael Milligan Ph.D.[27]

However, in PacifiCorp's 2015 IRP (Appendix N) they undertook a 500-iteration Monte Carlo simulation of the utility's system in order to

[24] OPUC, Renewable Generator Contribution to Capacity, Staff Report, February 9, 2015 p 1.
[25] Ibid, p2.
[26] Ibid,
[27] Utility Variable-Generation Integration Group, Capacity Value of Variable Generation, June 2014, Slide 3, www.uwig.org/shortcourse2014/Session-6-Milligan.pdf

determine the LOLP for each hour in a year.[28] In accordance with the third approximation method described above—the capacity factor during the peak-LOLP hours, where the capacity factor is weighted by the LOLP[29]—weighting factors were determined by the LOLP in each hour divided by the sum of LOLP among all hours, and then applied to the capacity factors of the variable resource in the corresponding hours.[30] This resulted in a maximum capacity credit for solar of 39.1% (single-axis tracking solar PV in the East Balancing Area Authority).[31] This methodology is in line with the system adequacy of capacity, i.e. is there enough installed capacity in a year to reliably serve load, as described by Michael Milligan Ph.D.[32]

Furthermore, in PacifiCorp's Capacity Contribution Closing Brief in UM 1610, the utility responded to an argument that the capacity credit calculated in its 2015 IRP should be used in avoided cost calculations for Qualifying Facilities ("QF") under the Public Utility Regulatory Policies Act ("PURPA"), as opposed to those calculated using the different methodology in its 2013 IRP.[33] PacifiCorp responded that, "Cherry-

[28] PacifiCorp, 2015 IRP Volume II—Appendices, Appendix N (Wind and Solar Capacity Contribution Study), p 407.
[29] National Renewable Energy Laboratory, "Comparison of Capacity Value Methods for Photovoltaics in the Western United States", July 2012, p 6.
[30] PacifiCorp, 2015 IRP Volume II—Appendices, Appendix N (Wind and Solar Capacity Contribution Study), p 407.
[31] Ibid.
[32] Utility Variable-Generation Integration Group, Capacity Value of Variable Generation, June 2014, Slide 3, www.uwig.org/shortcourse2014/Session-6-Milligan.pdf
[33] PacifiCorp, UM 1610—Investigation into Qualifying Facility Contracting and Pricing PacifiCorp's Capacity Contribution Closing Brief and Motion to Admit Pre-Filed Direct Testimony and Exhibits, pp 10–11.

picking the updated capacity contribution values without considering the other downstream impacts in the IRP is inappropriate".[34]

In this example, a utility moved from an operational capacity credit in its 2013 IRP to a system adequacy capacity credit in its 2015 IRP, but maintained the same operational capacity credit for determining avoided costs for Qualifying Facilities under PURPA. Renewable Northwest suggests in such a situation a utility should have to use a consistent methodology to determine capacity credit.

[34] PacifiCorp, UM 1610—Investigation into Qualifying Facility Contracting and Pricing PacifiCorp's Capacity Contribution Closing Brief and Motion to Admit Pre-Filed Direct Testimony and Exhibits, pp 10–11.