**Q. Please state your name, business address and position with PacifiCorp dba Rocky Mountain Power ("Company").**

A. My name is Rick T. Link. My business address is 825 NE Multnomah St., Suite 600, Portland, Oregon 97232. My present position is Director, Origination.

**Q. Please describe your education and business experience.**

A. I received a Bachelor of Science degree in Environmental Science from the Ohio State University in 1996 and a Masters of Environmental Management from Duke University in 1999. I have been employed in the commercial & trading area of PacifiCorp since 2003 where I have held positions in market fundamentals, financial valuation, planning, and origination. Currently, I direct the work of the market assessment group, the structuring & pricing group, the integrated resource planning group, the origination group, and the marketing and trading contract group. Prior to joining the Company, I was an energy and environmental economics consultant for ICF Consulting (now ICF International) from 1999 to 2003.

## SUMMARY

**Q. What is the purpose of your testimony?**

A. The purpose of my testimony is tocomply with the Commission's order in Docket No. 12-035-100 ("Commission Order") to conduct and file a capacity contribution study for wind and solar resources. I explain the Company's analysis within its recently completed capacity contribution study for wind and solar resources and present the accompanying capacity contribution values applicable to wind and solar qualifying facility ("QF") projects located in Utah. PacifiCorp's capacity

contribution study isprovided as Exhibit RMP___(RTL-1) to my testimony.Finally, I support and recommend the adoption and use of the Company's capacity contribution study for purposes of calculating capacity payments for wind and solar QF projects under the Proxy/PDDRR method.

**Q. Please summarize your testimony in this proceeding.**

A. My testimony describes what the capacity contribution of solar and wind resources represents. I then explain the methodologyused by the Company in calculating its capacity contribution values for wind and solar resources and present the study results. The Company's capacity contribution values applicable to wind and solar QF projectslocated in Utah are as follows:

- Wind = 14.5 percent
- Single axis tracking solar = 39.1 percent
- Fixed tilt solar = 34.1 percent

## BACKGROUND

**Q. Please explain what the capacity contribution of wind and solar resources represents.**

A. The capacity contribution of wind and solar resources is a measure of the ability for these variable energy resources to reliably meet demand. The capacity contribution is represented as a percentage of plant capacity. In the realm of resource planning, the capacity contribution is the contribution that a generating resource makes toward achieving a target planning reserve margin. In this way, the capacity contribution of wind and solar resources directly influences the timing and amount of incremental generating capacity needed to maintain

reliability over time.

**Q. What differentiates capacity contribution from capacity factor?**

A. The capacity factor of a generating resourceis a measure of how much energy that resource is expected to produce over a given period of time. Like capacity contribution, the capacity factor is represented as a percentage of plant capacity; however, the two metrics have entirely different meanings. For example, consider two hypothetical power plants operating at a 50 percent capacity factor. Both plants produce energy at half of full capability over the course of a year. However, assume one plant achieves a 50 percent capacity factor by producing energy in hours when the probability of reliability events are lowest and the other plant achieves its 50 percent capacity factor by producing energy in hours when the probability of reliability events are highest. The former would have a low capacity contribution value and the latter would have a high capacity contribution value.

## METHODOLOGY

**Q. What methodology did the Company use to derive its capacity contribution values for wind and solar resources?**

A. There are a range of methodologies that can be used to derive capacity contribution values for variable energy resources. The methodologies differ in terms of computational complexity and data requirements. A widely accepted, but computationally intensive approach to deriving capacity contribution values is the effective load carrying capability method ("ELCC Method"). Considering the computational complexities and data requirements associated with the ELCC

Method, the Company used the capacity factor approximation method ("CF Method"), which considers loss of load probability ("LOLP"), to develop its capacity contribution values for wind and solar resources. The National Renewable Energy Laboratory ("NREL") studied the CF Method and found it to be the most dependable technique in deriving capacity contribution values that approximate those developed using the ELCC Method. The aforementioned NREL study is provided as Exhibit___(RTL-2) to my testimony.

**Q. What is LOLP?**

A. LOLP is a reliability metric defined as the probability that load exceeds available resources over a given period of time. Hourly LOLP metrics, as needed to calculate capacity contribution using the CF Method, represent the probability of load exceeding available resources for each individual hour over the course of the year.

**Q. Is the Company's use of the CF Method consistent with the Commission Order in Docket No. 12-035-100?**

A. Yes. In its order in Docket No. 12-035-100, the Commission directed "…PacifiCorp to calculate capacity contribution for wind and solar resources for the Proxy/PDDRR method using either the ELCC method or the CF method considering LOLP."[1]

**Q. Please describe the CF Method.**

A. The CF Method, described further in Exhibit___(RTL-1) and Exhibit___(RTL-2), uses hourly LOLP metrics and corresponding hourly wind and solar capacity

[1]See *In the Matter of the Application of the Application of Rocky Mountain Power for Approval of Changes to Renewable Avoided Cost Methodology for Qualifying Facilities Projects Larger than Three Megawatts*, Docket No. 12-035-100, Order on Phase II Issues (August 16, 2013).

factor data to determine the capacity contribution values for these variable energy resource technologies.Hourly LOLP data are weighted by dividing the LOLP for each hour by the total LOLP among all hours in the year. As noted by NREL in its description of the CF Method, the intuition behind weighting hourly LOLP data is that the capacity provided by a resource is especially needed during hours with the highest LOLP. Hourly weighting factors are then multiplied by the contemporaneous hourly capacity factor of each representative technology—east wind, Utah single axis tracking solar, and Utah fixed tilt solar. The capacity contribution for each technology is calculated by summing the hourly capacity factors that have been weighted by LOLP.

**Q. How did the Company calculate hourly LOLP metrics?**

A. Hourly LOLP metrics were determined by performing a 500-iteration hourly simulation of PacifiCorp's system using the Planning and Risk ("PaR") model for all hours in a samplecalendar year.For each iteration, stochastic variables that affect system reliability are subject to a Monte Carlo random sampling process. The stochastic variables include load, hydro generation, and thermal unit outages. The hourly LOLP metrics are calculated by summing the number of hours in which load exceeds available resources, then dividing this figure by 500 (the number of iterations used to simulate dispatch of PacifiCorp system). The stochastic simulation of PacifiCorp's system resulted in 527 hours having a LOLP greater than zero (approximately six percent of 8760 hours in the year).

NREL notes that approximation techniques have been tested using between one percent and 30 percent of the highest LOLP hours in a year, with

results suggesting that using the top 10 percent of the hours (876 hours) is typically sufficient. Because the LOLP of each hour is weighted when using the CF Method, hours in which the LOLP is zero receive a zero weight. Consequently, capacity contribution values calculated using the 527 hours in which LOLP exceeds zero (six percent of the hours in a year) are identical to capacity contribution values calculated using 876 hours (10 percent of the hours in a year).

As shown in Exhibit___(RTL-1), the 527 hours in which load exceeds available resources occur throughout the year, but are highest in the summer and winter, when loads are high, and in the early spring, when maintenance is often planned. Within these periods, LOLP is highest during on-peak hours and during morning and evening ramp periods, when units are transitioning between off-peak and on-peak operation.

**Q. Please describe the wind and solar capacity factor assumptions used in the Company's capacity contribution study.**

A. Hourly capacity factor data varies by resource type and location. For wind resources, PacifiCorp has access to actual generation data from existing wind resources operating within its system. These actual generation data were used to calculate hourly capacity factors for wind resources within PacifiCorp's east and west balancing authority areas ("BAA"). Wind capacity factor data for wind resources in PacifiCorp's east BAA are most applicable to QF projects in Utah.For solar resources, the Company used hourly generation profiles, differentiated between single axis tracking and fixed tilt projects, from a

feasibility studydeveloped by Black and Veatch, provided as Exhibit___(RTL-3) to my testimony. Representative profiles for projects located in Milford County, Utah and Lakeview County, Oregon were used. Considering that the Company has seen significant QF activity in and around Milford County, the representative hourly profiles for Milford County, Utah are most applicable to single axis tracking and fixed tilt QF projects located in Utah.

**RESULTS**

**Q. Please summarize the results of the Company's wind and solar capacity contribution study as applicable to QFs located in Utah.**

A. The capacity contribution for wind resources located in PacifiCorp's east BAA is 14.5 percent. The capacity contribution for fixed tilt and single axis tracking solar projects sited in Utah is 34.1 percent and 39.1 percent, respectively.

**Q. How do these results compare to the capacity contribution figures adopted by the Commission in Docket No. 12-035-100?**

A. Pending the Company filing a capacity contribution study using the ELCC Method or the CF Method, the Commission adopted a capacity contribution value of 20.5 percent for wind QFs, 68 percent for fixed tilt solar QFs, and 84 percent for single axis tracking solar QFs.

**Q. Why are the capacity contribution values from the Company's study different from those adopted by the Commission on an interim basis?**

A. Differences in wind capacity contribution values are a result of differences in methodology. The wind capacity contribution value adopted by the Commission on an interim basiswas developed by the Utah Office of Consumer Services by

averaging capacity factor data from wind resources inPacifiCorp's east BAA during the highest 500 load hours over a five year historical period. As discussed above, the Company's wind capacity contribution value was developed using the CF Method, which is based onhourly capacity factors from wind resources in PacifiCorp's east BAAduring the highestLOLPhours that are specific to the PacifiCorp system. This method is consistent with the Commission Orderin Docket No. 12-035-100.

Similarly, the solar capacity contribution values adopted by the Commission were chosen as an interim proxy based on the aforementioned NREL study. The NREL study did not have the benefit of LOLP statistics for PacifiCorp's system to analyze capacity contribution values consistent with its recommended methodology. The Company's study follows NREL's recommended CF Method and produces different values for solar resources because it is based onhourly solar profiles from areas in which PacifiCorp has seen significant solar QF activity coincident withhourly LOLP statisticsspecific to its system

**Q. Will the capacity contribution of wind and solar resources need updating over time?**

A. Yes.As variable energy resources such as wind and solar become more prevalent, it will be necessary to reexamine the capacity contribution values. A March 2014 NREL report cites studies that show the capacity contribution of solar resources is

sensitive to increasing levels of deployment.[2] With increasing solar penetration levels, the timing of events in which load might exceed available resources can shift to hours in which solar resources are not generating (when solar irradiance is low). Consequently, the capacity contribution value for solar resources would fall as more solar resources are added to PacifiCorp's system. PacifiCorp will study the implications of capacity contribution levels at different penetration levels in future studies.

## CONCLUSION

**Q. Please summarize the conclusions of your testimony.**

A. The Company has completed a capacity contribution study that provides capacity contribution values for wind and solar resources applicable to QF projects in Utah. The study was performed using the CF Method, which considers hourly capacity factors for wind and solar resources coincident with hours having the highest LOLP among hours in the year that is specific to PacifiCorp's system. The Company performed its capacity contribution study consistent with the Commission Order in Docket No. 12-035-100. The Company's capacity contribution values applicable to wind and solar QF projects located in Utah are as follows:

- East wind = 14.5 percent
- Single axis tracking solar = 39.1 percent
- Fixed tilt solar = 34.1 percent

**Q. What do you recommend?**

[2]Sigrin, B.; Sullivan, P.; Ibanez, E.; and Margolis, R. "Representation of Solar Capacity Value in the ReEDS Capacity Expansion Model" NREL/TP-6A20-61182, Denver, CO: National Renewable Energy Laboratory, March 2014.http://www.nrel.gov/docs/fy14osti/61182.pdf

A. I recommend that the Commission adopt the Company's capacity contribution values calculated using the CF Method for purposes of calculating capacity payments for wind and solar QF projects under the Proxy/PDDRR method.

**Q. Does this conclude your direct testimony?**

A. Yes.