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IDAHO PUBLIC
UTILITIES COMMISSION

BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

IN THE MATTER OF IDAHO POWER COMPANY'S APPLICATION TO UPDATE SOLAR INTEGRATION RATES AND CHARGES.	)))))	CASE NO. IPC-E-16-11

IDAHO POWER COMPANY

DIRECT TESTIMONY

OF

PHILIP B. DEVOL

Q. Please state your name and business address.

A. My name is Philip B. DeVol and my business address is 1221 West Idaho Street, Boise, Idaho 83702.

Q. By whom are you employed and in what capacity?

A. I am employed by Idaho Power Company ("Idaho Power" or "Company") as a Senior Planning Analyst in the Power Supply Planning group.

Q. Please describe your educational background and work experience with Idaho Power.

A. In May of 1989, I received a Bachelor of Science Degree in Mathematics from Miami University in Oxford, Ohio. I then received a Master of Science Degree in Biostatistics from the University of Michigan in May of 1991.

Q. Please describe your work history at Idaho Power.

A. I began my employment with Idaho Power in 2001 as an Engineering Specialist in the Water Management Department. In this position, I was responsible for modeling of the Idaho Power hydroelectric system for the Integrated Resource Plan (IRP) and relicensing studies. In 2004, I became a Water Management Operations Analyst, where I continued to be responsible for hydroelectric system modeling.

In 2005, I became a Planning Analyst in the Power Supply Planning Department. In this position, I was responsible for the compilation of Idaho Power's long-term operating plan prepared on a monthly basis as part of the Company's plan for managing risk. My duties in this position also expanded to include the study of wind integration.

I became the Power Supply Planning Leader in 2010 and Resource Planning Leader in 2013. I am currently a Senior Planning Analyst in the Power Supply Planning group. My duties in these positions have included project management for the most recent Idaho Power wind integration study, as well as the Company's two solar integration studies.

I have been involved in regional and national proceedings related to the study of wind integration. I participated in methodology discussions for the 2007 Wind Integration Action Plan produced by the Northwest Wind Integration Forum. I have attended numerous Utility Wind Integration Group ("UWIG") workshops, and presented at UWIG workshops in Oklahoma City, Oklahoma, in 2006 and Portland, Oregon, in 2007. I also presented to the Idaho Wind Working Group at its September 2011 meeting. In November of 2013, I presented at a Centre for Energy Advancement through Technological Innovation workshop focused on forecasting uncertainties for renewable energy supply. Lastly, I spoke on renewable integration in March of this year at the 16th Annual Integrated Resource Planning Conference held by Electric Utility Consultants, Inc.

I led the Company's 2014 solar integration study, which was Idaho Power's first solar integration study. I also led the Company's 2016 solar integration study, along with Ronald Schellberg, Idaho Power Transmission Policy and Development, who has since retired from the Company.

Q. What is the purpose of your testimony in this matter?

A. The purpose of my testimony is to describe Idaho Power's second solar integration study ("Study" or "2016 Solar Study") and to provide the results. The 2016 Solar Integration Study Report ("2016 Study Report") is attached to Idaho Power's Application as Attachment 1. The 2016 Solar Study was initiated in January 2015 following the execution of a settlement stipulation ("Settlement Stipulation") by all parties to the Idaho Public Utilities Commission's ("Commission") case regarding the Company's first 2014 solar integration study. The 2016 Study Report was completed in April 2016.

Q. Please provide a high-level description or summary of the Company's 2016 Solar Study.

A. As stated in my prior testimony regarding the 2014 solar integration study, electric power from solar generation resources exhibits greater variability and uncertainty than energy from conventional generation sources. The greater variability and uncertainty exhibited by solar resources requires an electric utility integrating solar to modify its operating practices by holding extra operating reserves on dispatchable generation resources. The effect of having to hold operating reserves on dispatchable resources is that the capacity held in reserve restricts the use of those resources and they cannot be economically dispatched to their fullest capability. The objective of the Study is to determine the costs of the operational modifications necessary to integrate intermittent generation from solar, where the operational modifications are in the form of differing system reserve requirements.

The Company's 2016 Solar Study determined solar integration costs for four solar build-out scenarios at installed capacities of 400 megawatts ("MW"), 800 MW, 1,200 MW, and 1,600 MW. Idaho Power currently has 320 MW of solar generation under contract to be on-line by the end of 2016. The Study utilized geographically dispersed build-out scenarios with solar generation located across the Company's service territory at Parma, Murphy Flats, Boise, Grand View, Orchard, Bliss, Twin Falls, and Aberdeen. Pages 3 through 6 of the 2016 Study Report provide additional information regarding the build-out scenarios.

The Study determined solar integration costs through paired simulations of Idaho Power's system for each solar build-out scenario. Each pair of simulations consists of a test case in which extra capacity in reserve is required of dispatchable generators to allow them to respond to unplanned changes in solar generation and a base case in which no extra capacity in reserve is required. The solar integration costs indicated by the simulations are provided below. These costs are also found in Table 2, page vi of the 2016 Study Report, as well as Table 9 and Table 10 on pages 21 and 22 of the 2016 Study Report.

Average Integration Cost Per MWh
(2016 dollars)

Build-out Scenarios	0-400 MW	0-800 MW	0-1,200 MW	0-1,600 MW
Integration Cost	$0.27	$0.57	$0.69	$0.85

Incremental Integration Cost Per MWh
(2016 dollars)

Penetration Level	0-400 MW	400-800 MW	800-1,200 MW	1,200-1,600 MW
Integration Cost	$0.27	$0.88	$0.92	$1.31

Q. When did Idaho Power initiate the current solar integration study?

A. Idaho Power initiated the first communications with parties for the 2016 Solar Study in January 2015, following the execution of the Settlement Stipulation by the parties to Idaho Power's initial 2014 solar integration case, Case No. IPC-E-14-18. The Settlement Stipulation is included in the 2016 Study Report at page 43. The Settlement Stipulation was executed by the parties on January 7, 2015, and filed with the Commission for approval on January 9, 2015. On February 11, 2015, the Commission approved the Settlement Stipulation, which implemented solar integration rates and charges for Idaho Power based upon the Company's 2014 solar integration study. Case No. IPC-E-14-18, Order No. 33227. The solar integration rates and charges were set forth in a new tariff Schedule 87, Variable Generation Integration Charges, at the incremental cost of solar integration for each 100 MW of solar nameplate penetration. The Settlement Stipulation also acknowledged that there were disagreements with respect to the methodology used in the 2014 solar integration study, and that Idaho Power would initiate a second solar integration study, to be completed as expeditiously as possible with the goal of not exceeding 12 months. Settlement Stipulation, p. 3. The Settlement Stipulation provides guidance regarding the conduct of the second solar integration study and sets forth a list of issues for consideration in that study. *Id.*, pp. 3-4. The Settlement Stipulation states that the second solar integration study should utilize a Technical Review Committee ("TRC") and anticipated the participation of commission Staff from both the Idaho Public Utilities Commission and the Public Utility Commission of Oregon, the appropriate personnel from Idaho Power, and a technical expert designated by each of the parties to the Settlement Stipulation. Settlement Stipulation, p. 3.

Q. How was the 2016 Solar Study initiated?

A. As was the case for the 2014 solar integration study, the Company initiated the 2016 Study with the formation of a TRC. Subsequent to the Commission's February 11, 2015, approval of the Settlement Stipulation, the TRC was selected and a kick-off phone conference was held on March 6, 2015. The intervening parties from the Settlement Stipulation (Idaho Conservation League, Sierra Club, and Snake River Alliance) requested the participation of Cameron Yourkowski, Renewable Northwest, and Michael Milligan, National Renewable Energy Laboratory ("NREL"), on the TRC. Idaho Power requested the participation of Brian Johnson, University of Idaho; Clint Kalich, Avista Utilities; and Kurt Myers, Idaho National Laboratory. Rick Sterling from the Idaho Public Utilities Commission and Brittany Andrus and John Crider from the Public Utility Commission of Oregon participated as observers throughout the 2016 Study process and the TRC activities. During the

2016 Study, Barbara O'Neill became the NREL representative on the TRC. However, NREL funding did not permit its active TRC participation through the entire process, although Idaho Power continued to include NREL on electronic correspondence through study completion. A TRC Study Plan ("Study Plan") was developed and finalized by May 28, 2015, and the Study was subsequently conducted during the remainder of 2015 according to that Study Plan. The Study Plan is found in the Appendix to the 2016 Study Report at page 44.

As stated in the "Acknowledgments" section of the 2016 Study Report, Idaho Power acknowledged the important contribution of the TRC in the development of the 2016 Solar Study. The TRC was involved from the Study outset in February 2015, and provided substantial guidance and helped shape the study methods followed. Prior to finalizing the 2016 Study Report, the TRC was provided with a draft report for its review and comment. The TRC members and regulatory observers served either voluntarily or were paid by their own employers and received no compensation from Idaho Power.

Idaho Power believes that the members of the TRC positively support the 2016 Study and 2016 Study Report.

Q. How was the 2016 Study conducted?

A. The conduct of the 2016 Study was initially agreed to and set forth in the previously referenced TRC Study Plan, included at page 44 of the 2016 Study Report. The parties agreed to generally adhere to the Principles for Technical Review Committee Involvement in Studies of Variable Generation Integration into Electrical Power Systems produced by the NREL and Utility Variable-generation Integration Group (UVIG). The TRC Study Plan sets forth the expectations, functions, and requirements of the TRC; incorporates consideration of the issues set forth in the Settlement Stipulation; prioritizes the consideration of various issues into the Study; set forth the basic Study approach; and set forth a specific schedule for proceeding with the Study.

Q. What was the process followed in the 2016 Study?

A. The 2016 Study was organized into four primary steps: (1) data gathering and scenario development; (2) statistical-based analysis of solar characteristics; (3) production cost simulation analysis; and (4) study conclusions and results. These steps were formulated based on an article published by the Institute of Electrical and Electronics Engineers ("IEEE") describing methods for studying wind integration. Ela et al. 2009. While the IEEE article, which was authored by leading researchers at

NREL, was written from the perspective of studying system integration of wind generation, the principles underlying the study of wind integration are readily transferrable to the study of solar integration. Both wind and solar bring increased variability to power system operation, and a key objective of an integration study for each is to understand how variability and uncertainty lead to system impacts and changed costs.

Q. Can you further describe how the Study progressed to completion?

A. Yes. The first step, data gathering and scenario development, is described on pages 3 through 6 of the 2016 Study Report. As stated in my summary above, the 2016 Study considered four solar build-out scenarios at installed capacities of 400 MW, 800 MW, 1,200 MW, and 1,600 MW. The Study utilized geographically dispersed build-out scenarios with solar generation located across the Company's service territory at Parma, Murphy Flats, Boise, Grand View, Orchard, Bliss, Twin Falls, and Aberdeen. The build-out scenarios were developed in consultation with the TRC to represent geographically dispersed build-outs of solar power plant capacity as informed by locations of proposed solar power plants in southern Idaho and eastern Oregon. Three years of solar data were developed for each build-out scenario. To acquire five-minute data for each site, data from either established U.S Bureau of Reclamation (USBR) AgriMet Network or modeled data acquired from SolarAnywhere was utilized. This data was used with water year data from water years 2011, 2012, and 2013, which represent a low, medium, and high type of water year, respectively.

The 2016 Study data also incorporated a technique initiated by the TRC in the 2014 solar integration study used to better reflect data conditions at a solar plant size, rather than data from a single point. A wavelet-based variability model (WVM) is utilized for simulating solar photovoltaic power plant output given a single irradiance point-sensor time series.

Q. How was the statistical based analysis of the data conducted?

A. The next phase of the 2016 Solar Study was the statistical-based analysis of solar, wind, and load data. This phase is described on pages 6 through 16 of the 2016 Study Report. The statistical-based analysis focused around two components: (1) the statistical-based analysis to determine the extent to which solar brings additional variability and uncertainty to system balancing and (2) the follow-on analysis to translate the additional variability and uncertainty to additional capacity in reserve required on dispatchable generators.

In considering the impact of variability and uncertainty from the perspective of integration impacts and costs, the focus is primarily on the shorter-term operations. That is, for the system operator responsible for maintaining system balancing, integration impacts arise because of variability and uncertainty over the coming minutes, hours, or perhaps days. Viewed from this perspective, the relevant components of system balancing which bring variability and uncertainty are customer demand (load) and intermittent sources of energy (solar and wind). Because of the relevance of these three components—load, solar, and wind—to the challenges with maintaining shorter-term system balancing, the statistical-based analysis performed for the Study takes into account variability and uncertainty for the three components, as well as possible interrelationships in variability and uncertainty between the three.

The 2016 Study focused on the assessment of variability and uncertainty occurring from the perspective of hour-ahead forecasting. This assessment for each of load, solar, and wind was based on the extent to which five-minute observations differ from hour-ahead forecasts. These differences, or deviations, between intra-hour observations and hour-ahead forecasts drive the need to carry operating reserves to maintain system balancing.

Thus, at a fundamental level, the statistical-based analysis to characterize variability and uncertainty was an analysis of deviations between five-minute observations and hour-ahead forecasts. Further, explanatory variables were identified that explain patterns in the deviations, and these explanatory variables were then used to more precisely define the operating reserve requirements.

A critical part of the statistical assessment was the determination of relationships describing the extent to which intra-hour observations for each of load, solar, and wind deviate from the hour-ahead forecasts. For example, the Study found that the extent of deviations between intra-hour solar observations and hour-ahead solar forecasts could be described as a function of two explanatory variables: (1) hour-ahead forecast solar production and (2) the period of day.

The individually determined relationships for load, solar, and wind were then added in a manner accounting for the combining effects occurring for the base case simulation of load netted with wind, and the test case simulation of load netted with wind and solar. The derivation of the operating reserve for the base and test case simulations is described on pages 13 through 15 of the 2016 Study Report, and an example reserve application is provided on page 16 of the 2016 Study Report. The accounting of the combining effects in the reserve methodology was discussed in great detail with the TRC, and is a notable change in methodology from the 2014 solar integration study. This change is thought to be a key driver of the comparatively lower solar integration costs in the 2016 Solar Study.

Q. What was the next step in the Study process?

A. The next step was the production cost simulations, which are described on pages 17 through 20 of the 2016 Study Report. As described earlier in my testimony, the Study followed the conventional design of paired simulations, simulating two scenarios: a base case vs. the test case, with the sole difference between paired simulation being the amount of capacity in reserve. The base case capacity in reserve is based on reserve analysis for load netted with wind, and the test case capacity in reserve is based on reserve analysis for load netted with wind and solar. The average reserve amounts for the two cases and the four solar build-out scenarios are provided in Table 6, on page 15 of the 2016 Study Report.

Q. Please describe the conclusions and results of the 2016 Solar Study.

A. The Study results and findings are discussed beginning on page 20 of the 2016 Study Report. The objective of the Study was to determine the costs of the operational modifications necessary to integrate solar generation. The integration costs are driven by the need to carry extra capacity in reserve to allow bidirectional response from dispatchable generators to unplanned variations in solar production. The simulations performed for the Study indicate the below costs associated with holding the extra solar-caused capacity in reserve.

Average Integration Cost Per MWh
(2016 dollars)

Build-out Scenarios	0-400 MW	0-800 MW	0-1,200 MW	0-1,600 MW
Integration Cost	$0.27	$0.57	$0.69	$0.85

Incremental Integration Cost Per MWh
(2016 dollars)

Penetration Level	0-400 MW	400-800 MW	800-1,200 MW	1,200-1,600 MW
Integration Cost	$0.27	$0.88	$0.92	$1.31

Michael J. Youngblood provides direct testimony setting forth the Company's request and proposal to update solar integration rates and charges utilizing the incremental cost at each 100 MW of solar generation penetration.

Pages 22 through 26 of the 2016 Study Report discuss the Study findings with regard to hour-ahead solar production forecasting; comparison to wind integration; geographic dispersion and solar variability; transmission and distribution; solar integration cost elements; Hells Canyon Complex spill; and spring-season integration.

Without repeating the discussion from these sections, issues and assumptions from these areas significantly impact the Study results, and should actual results diverge from assumptions made, issues should be re-examined.

Additionally, the findings clarify some things that were and were not considered by the Study. In particular, the four studied build-outs have solar capacity dispersed widely across southern Idaho. The extent of this geographic dispersion is considered to strongly influence the impacts and costs of integration. As solar capacity is developed in the coming years, Idaho Power will evaluate the geographic dispersion of the build-out capacity in comparison to that assumed for the 2016 Study. In particular, observed production data will be reviewed when available to verify the Study's assessment of solar variability and uncertainty.

Q. Does this conclude your testimony?

A. Yes.

ATTESTATION OF TESTIMONY

STATE OF IDAHO)
) ss.
County of Ada   )

I, Philip B. DeVol, having been duly sworn to testify truthfully, and based upon my personal knowledge, state the following:

I am employed by Idaho Power Company as a Senior Planning Analyst in the Power Supply Planning group and am competent to be a witness in this proceeding.

I declare under penalty of perjury of the laws of the state of Idaho that the foregoing pre-filed testimony is true and correct to the best of my information and belief.

DATED this 6th day of May 2016.

Philip B. DeVol

SUBSCRIBED AND SWORN to before me this 6th day of May 2016.

CHRISTA S. BEARRY NOTARY PUBLIC STATE OF IDAHO

Notary Public for Idaho
Residing at: Boise, Idaho
My commission expires: 02/04/2021