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UTILITIES COMMISSION

BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

IN THE MATTER OF IDAHO POWER COMPANY'S APPLICATION TO IMPLEMENT SOALR INTEGRATION RATES AND CHARGES.	)))))	**CASE NO. IPC-E-14-18** **IDAHO CONSERVATION LEAGUE**

DIRECT TESTIMONY

CAMERON YOURKOWSKI

FILED

OCTOBER 23, 2014

Q. Please state your name, affiliation, and reason for this testimony.

A. My name is Cameron Yourkowski. I have been employed by Renewable Northwest (formerly Renewable Northwest Project) for the past seven years, primarily working on renewable energy transmission and integration issues. The purpose of my testimony in this docket is to review the technical details and merits of Idaho Power Company's ("Idaho Power") Solar Integration Study ("Study") and the solar integration costs and rates derived therein.

Q. Please describe your involvement in Idaho Power's Solar Integration Study.

A. I participated in the Technical Review Committee ("TRC") involved in the development of the Study and have reviewed the final Study, the accompanying testimony of Philip DeVol, and data responses submitted in connection with this docket. Initially, former Renewable Northwest staff member, Jimmy Lindsay, participated in the TRC and kept me apprised of TRC developments and discussions. In April of 2014, following Mr. Lindsay's departure from Renewable Northwest, I began participating directly in the TRC.

Q. Please summarize your professional opinion of the TRC process.

A. As I stated in my June 6, 2014 comments to Idaho Power and the TRC, included as Exhibit 201, Renewable Northwest appreciates the opportunity to participate in the TRC and work constructively and cooperatively with Idaho Power on solar integration issues. The TRC process and the Study itself had both positive and negative aspects. On the positive side, I appreciate that Idaho Power initially followed a set of principles for effectively engaging a technical review committee. The study also did a good job compiling a solar generation data set that is a fair representation of expect actual solar generation in Idaho Power's service territory. However, when the Study began analyzing the integration of the solar generation data into the broader system, both the TRC process and Idaho Power's analysis began to break down, and ultimately ended up relying on a flawed methodology.

Q. Have you reviewed the "Principles for Technical Review (TRC) Involvement" document cited by Idaho Power as a basis for the Study process?

A. Yes, I have. This document, authored by the National Renewable Energy Laboratory ("NREL") and the Utility Variable-generation Integration Group ("UVIG"), describes important principles to guide effective participation in a Technical Review Committee. I have included this "Principles" document as Exhibit 202 to my testimony.

Q. Please describe some of the important principles from this document that are relevant to your critique of the TRC process.

A. Most of the important functions and requirements of a working TRC are on the second page of the Principles document. Four of the principles are particularly relevant here:

1) The TRC will ensure that the findings are based entirely on facts and accurate engineering and science. Project sponsors need to embrace this aim so that the results and findings are objectively developed and not skewed to support any desired outcome.

2) The TRC requires access to all relevant information needed to properly evaluate the work and the results.

3) The TRC requires assurance that project sponsors will describe the project as having the benefit of expert review by a TRC only if the TRC has clearly expressed its acceptance of and agreement with the results of the study.

4) The TRC requires assurance that, in the event agreement is not reached by the TRC and other project participants, any reference to the TRC will be removed from the final report and any associated documents or publicity.

Q. In your view, did Idaho Power's TRC process live up to these principles?

A. No. While the TRC process adhered to some of the principles, it departed from certain critical principles. The TRC process started out in a very productive and congenial manner and helped Idaho Power do a good job collecting and developing a good solar data set. However, when the Study moved into the analysis phase:

1) The TRC was not able to ensure the findings of the Study were based entirely on facts and accurate engineering and science.

2) The TRC did not have access to all relevant information needed to properly evaluate the work and the results.

3) The TRC has not clearly expressed its acceptance of and agreement with the results of the Study.

4) Idaho Power has not accurately portrayed the comments and level of support in the final Study, associated documents and publicity.

Q. Please summarize your view of the TRC process as it relates to these principles.

A. The TRC could have provided more value if these principles were adhered to. Ultimately, the accuracy and meaningfulness of the Study was compromised because these principles were not adhered to. Adhering to these principles in the future is a necessary element to ensure that future integration studies provide a more accurate estimate of solar integration costs.

Q. Please summarize what you view as the positive aspects of this Study.

A. In general, the Study did a good job gathering solar data and modeling the output and performance of different solar buildout scenarios. As I described in my comments[1] to the TRC, I view the positive aspects of this Study to be:

1. Solar Data: Based on my understanding of the process and effort prior to my joining the TRC, I think that Idaho Power has done a good job collecting a quality set of solar data for Idaho Power's service territory for use in the Study.

2. Solar Diversity: The Study has appropriately analyzed both concentrated and dispersed solar buildout scenarios. The "diversity value" associated with dispersed buildouts significantly influences the need for balancing reserves and, based on the information available to me at this time, the Study has captured this effect sufficiently.

3. Wavelet Transformation: The Study's use of the Sandia National Lab's "wavelet-based variability model" to transform the raw single-point irradiance data into plant-level generation data is appropriate. This data transformation is important because the raw single-point irradiance data always exhibits more variability than actual plant-level generation will. The wavelet model is the best approach to handling this data transformation issue that I am aware of.

4. Hour-Ahead Forecast Methodology: The Study incorporated a lot of positive work on developing an hour-ahead forecast for solar generation. In concept, the use of a persistence forecast adjusted for the known curvature of the irradiance curve, based on a "clear sky index" for that day of the year, is a sound approach.

[1] Exhibit 201.

Q. Please describe in more detail where and how the TRC process broke down.

A. The TRC process associated with Idaho Power's Solar Integration Study did not provide for a thorough review of the Study methodology or its findings. The compressed timeline at the end of the process—during the analysis phase—diminished the TRC members' ability to comprehensively review the details of this Study and the merits of its findings. In order for Idaho Power to work constructively and cooperatively with stakeholders, it must be receptive to TRC member input on best practices, and must build time into the study process to adjust the study methodology to account for flaws or shortcomings identified by TRC members.

The most important process failure was the rushed nature of the integration study design and the production cost modeling which started and abruptly concluded in the spring of 2014. Beginning in May of 2014, Idaho Power began rushing the process in order to produce results more quickly. In fact, Idaho Power held only one TRC meeting, on May 16, 2014, to review Idaho Power's proposed study design and only one meeting on May 29, 2014, to review the results of the single production cost model run and resulting outputs. On June 2, Idaho Power provided the TRC with a Study draft to review. Following this, on June 5, 2014, the TRC received an email from Idaho Power, included here as exhibit 203, stating that it intended to finalize the Study regardless of the comments received from the TRC. On June 6th, 2014, I submitted my written comments. On June 17th, 2014, Idaho Power filed the Study with the Commission. The rushed nature of this phase of the Study significantly limited the ability of the TRC to provide value during the most important phase of the Study.

Another important failure is Idaho Power's dismissal of the critiques it received from TRC members on the draft Study as mere items for "future study." The problem is that some of these critiques identified fundamental flaws in the methodology that undermine the accuracy of the Study. For example, Idaho Power did not adjust the study methodology to account for the basic concept that the estimated scheduling error of solar facilities should be netted with the scheduling error of other resources and load.

One member of the TRC commented:

> In the report, it is important that the text provide an accurate representation of the elements of the study that were available and reviewed by the TRC and those that were not. I stated in the last meeting of the TRC that this is not a study but rather it is a document presenting the results of a single computer model run of an internal Idaho Power computer model that was not reviewed by the TRC for accuracy, sensitivity and variability.
>
> In conclusion, the items that are listed as "Phase II" study tasks are the tasks that need to be done now to consider the work an actual study. Absent that work, the work to date does not constitute a "study", and therefore should be labeled more accurately as a single computer model output run.[2]

Q. Do you agree with this TRC member's comments?

A. Yes.

Q. Do you have a sense of why Idaho Power rushed the critical final phase of the Study?

A. In the above-referenced June 5, 2014 email that Idaho Power sent to the TRC members, Idaho Power stated that "the recent interest surrounding potential PURPA solar development in our service territory, as well as the IPUC's directives from its May 28 Order, requires the urgent completion of the study." The email provided a link to the Commission's Order in Docket No. IPC-E-14-09, in which the Commission "ordered that Idaho Power complete its solar integration study as soon as possible."

[2] Exhibit 204

Q. What is your understanding of the Commission's order as it relates to the timeline for completing the Study?

A. I will leave the legal interpretations of the Order to the lawyers. However, my understanding is that the Commission's directive did not require Idaho Power to sacrifice quality or accuracy in exchange for rapid completion of the Study. In my opinion, it was Idaho Power's own interpretation of the Commission's direction on the timing of the Study that resulted in a breakdown of the TRC process and a flawed Study.

Q. Setting aside these process issues for now, what is your professional opinion of the technical aspects of the Study as it stands today?

A. My opinion is that the Study has some positive components and some shortcomings, including one fundamental flaw. I mentioned the positive aspects above, which relate to developing a data set that provides a fair to characterization of the expected solar generation in Idaho Power's service territory. However, when it came to modeling how this expected solar generation would integrate into Idaho Power's existing system, the Study has several shortcomings, including a fundamental flaw that systematically overstates the integration costs associated with solar generating resources. By including this fundamental flaw, the Study also ignores the potential to reduce the amount of load following reserves; reducing reserve requirements for following load could benefit Idaho Power's retail customers.

Q. Please summarize what you view as the shortcomings of this Study.

A. The shortcomings relate to how Idaho Power modeled the integration of the expected solar generation into its broader system. As I described in my comments[3] on the draft Study, the major shortcomings of this Study are:

1. No Netting Effect: The Study approach analyzes the incremental reserve requirement and associated production costs for solar assuming that there is no netting effect between the balancing reserves needed for wind, solar, other generation, and load. This assumption is inaccurate as the scheduling errors for wind, solar, other generation, and load offset each other, thereby reducing the total system reserve requirement and reducing the production costs attributable to all three components, including solar. This is an important shortcoming of this Study that has the effect of systematically overestimating the reserves needed for solar and the associated production costs. I discuss the issue in greater detail below.

2. Schedule Lead-Time: Idaho Power uses an extremely conservative assumption that it must use a 45-minute lead-time when calculating solar generation forecasts and submitting solar generation schedules. The amount of lead-time assumed for submitting schedules greatly influences the accuracy of persistence-based forecasts—the less lead-time, the more accurate the persistence-based forecast and the less incremental balancing reserves Idaho Power needs for solar, thereby reducing solar integration costs. NERC and WECC standards allow for schedules to be submitted up until 20 minutes before the hour.[4] A 30-minute lead-time is reasonable, as it allows for compliance with the 20-minute timeframe for submitting schedules, while also allowing 10 minutes to conduct

[3] Exhibit 201.
[4] Available at: http://www.nerc.com/docs/oc/is/Interchange_Reference_Guidlines_V2_2012_02_17_Final.pdf

trading activities before schedules are submitted. Other integration studies use a 30-minute lead-time.

3. Confidence Interval: The Study's use of a 95% confidence interval is significantly higher than the 90% confidence interval Idaho Power used in its wind integration study. A larger confidence interval greatly increases the amount of balancing reserves required.

Q. Of the three shortcomings you just stated, which is the most important flaw in the Study?

A. The most important flaw is that the Study fails to account for the netting effect between solar scheduling errors, load scheduling error, wind scheduling error, and the scheduling error of all other generation. As soon as I uncovered this flaw, I brought it to the attention of the TRC and Idaho Power.

Q. What do you mean, in general, by the term "netting effect"?

A. In maintaining the reliable operation of the electrical grid, a utility must constantly ensure that load and generation match. In order to accomplish this, utilities forecast their expected load and generation and schedule their generation to meet the expected load. In doing so, the load forecast (or "schedule") will have error associated with it; the solar, wind, and other generation forecasts will also all have errors associated with them. Utilities hold operating reserves (or "balancing reserves") in order to manage this unavoidable forecast and schedule error and maintain the reliable operations of the system. The term "netting effect" refers to the fact that in order to maintain the reliability of its system, Idaho Power need only balance the *net* variability and scheduling error of the total collective system, not the individual variability and scheduling error of each separate element (load, wind, solar and other generation). It is standard utility practice to use statistical methods to account for this netting effect while ensuring that a utility still has sufficient balancing reserves on hand, but not more than ratepayers need to pay for. Idaho Power's Study methodology ignores the standard utility practice that is commonly referred to as "netting."

Q. What is the effect of Idaho Power not netting the forecast error of loads and generation?

A. The effect of this flaw in the Study is to systematically overestimate the reserve requirement and integration costs not only for solar resources, but also for other generation and load. Correcting this flaw would lower the costs of solar integration and the cost of following load that are passed on to retail customers.

Q. Is it common utility practice to account for this netting effect in solar and wind integration studies such as the one Idaho Power has conducted here?

A. Yes. Absolutely it is. Every other integration study for wind and solar resources that I am aware of accounts for this netting effect. It is a bedrock principle of integration cost analysis to account for netting. All of the relevant integration study guidance documents and other utility integration studies cited by Idaho Power in this docket are founded upon and/or utilize the principle of netting. For example, "Evolution of Wind Power Integration Studies: Past, Present, and Future" describes this principle on page two; NV Energy's "Large-Scale PV Integration Study" describes this principle on page eleven at bullet number two; and, also, Arizona Public Service Company's "Solar Photovoltaic (PV) Integration Cost Study" discusses the same principle in Section 4 on pages two and four. I included excerpts from these studies as exhibit 205. Indeed, the *only* utility that I am aware of that does not incorporate netting into its integration studies is Idaho Power.

Q. Please explain in more detail the concept of "netting scheduling error."

A. "Netting" is simply the concept that positive and negative numbers cancel each other out; positive 4 plus negative 3 equals 1, not 7. Netting is a mathematical fact that underlies all of the statistical analysis used in solar and wind integration analysis. Electrically speaking, it is a physical reality that utilities comply with their reliability requirements to meet Control Performance Standards ("CPS") by balancing the netted variability of their collective system.

The reason that solar and load scheduling/forecasting error should be netted is because sometimes the load forecast errs in a positive direction (e.g. + 20 MW) and at the same time, the solar forecast errs in a negative direction (e.g. – 15 MW). In this example, the solar and load errors cancel each other out for all but 5 MW, and the system operator only needs to dispatch 5 MW of balancing reserves.[5] Five megawatts, in this simple example, would be the incremental balancing reserve need attributable to solar resources. By not accounting for netting, Idaho

[5] While solar and load forecasting errors do not necessarily cancel each other out every second of the year and can sometimes even be additive, on average, over the course of a year, they do offset each other in a manner that reduces the balancing reserve requirement for both load and solar. Balancing reserve requirements are designed to measure and prepare for the maximum amount of total system forecast error identified in the data, up to a predetermined confidence interval (e.g. 90% or 95%). Usually, a solar integration study will account for the netting effect by filtering a combined data set of solar, load, and other generation scheduling error to identify the moments with the greatest total netted system error. Once these moments are identified, the study will look at the contribution of each individual component's (load, solar, etc.) forecast error to the total netted system error during these defining moments. Solar's contribution to the netted total system error during these moments is the appropriate measure for calculating solar's incremental reserve requirement and is the appropriate method for calculating integration costs.

Power's Study proposes to charge solar resources for all 20 MW of balancing reserves. In this manner, failing to account for netting can have a significant impact on integration costs.[6]

The netting of different sources of variability and forecasting error on the system, including that of loads and generators, has been a cornerstone of efficient utility operations for more than a century. Idaho Power and other utilities already integrate hundreds of thousands of different loads on a daily basis, each with unique properties of variability and uncertainty.

Statistical techniques readily allow grid operators to determine the optimal reserve requirement needed to accommodate the combined variability and uncertainty of all loads and generation on the power system; this same principle applies when solar generation is added to the power system.

The methodology used in Idaho Power's Study is incorrect because it does not factor in this netting effect. The methodology Idaho Power uses is to first separately calculate the amount of balancing reserves required for load (3% of load) and calculate the production costs associated with this portfolio. Next, Idaho Power separately calculates the amount of balancing reserves needed for solar (roughly 4.5% of installed capacity) and then again calculates the production cost associated with the solar case. Idaho Power compares the difference between these two production cost runs to determine the incremental cost associated with balancing solar generation, which directly feeds into Idaho Power's proposed solar integration rates.

[6] Statistically speaking, only if solar and load variations were perfectly negatively correlated with a correlation coefficient of -1.0 would Idaho Power be correct that it is not necessary to net their offsetting variability. Well-established statistical principles dictate that the combined variability of uncorrelated sources of variability is equal to the square root of the sum of the squares of the individual sources' variability. As an example, given a fictitious power system with solar variability of 30 MW per hour, load variability of 100 MW per hour, and conventional generator variability of 40 MW per hour, the method for accurately calculating total power system variability is as follows:

Sum of squares variability = $(30^2 + 100^2 + 40^2) = 900+10{,}000+1{,}600= 12{,}500$

Total Power System Variability = Square Root of $(30^2 + 100^2 + 40^2) = 111.80$ MW

This method is essential to accurately capture the statistical fact that the combined variability of several uncorrelated factors is less than the sum of their parts, hence why in the example above the combined variability of 30 MW, 40 MW, and 100 MW is only 111.80 MW and not 170 MW.

The problem with this approach is that in reality, utilities do not balance the forecast errors of load and solar resources separately; utilities balance a netted electrical signal that is the sum of all load and generation forecast error. Reliability standards require Idaho Power to keep its system frequency at 60 Hertz. System frequency is an electrical signal determined by the system's load-resource balance and the netted scheduling errors of all loads and all resources on the system, collectively.[7] By including a methodological flaw in its Study that is inconsistent with mathematical principles and with how Idaho Power will comply with reliability standards, Idaho Power systematically overstates the balancing reserves needs for all components of the system—including solar, wind, other generators, and load.

Q. How should Idaho Power conduct a solar integration study to account for this netting effect?

A. What most other studies do is develop a time-synchronized five-minute dataset of all existing and anticipated sources of variability and scheduling error on their system, including solar, wind, other generation, and load. Idaho Power would then analyze the total system variability and scheduling error *collectively* as a whole. This single additional step would account for the netting effect. Idaho Power could then conduct its study much the same as it does today: First it would estimate the collective netted reserve requirement of load, wind and other generation—leaving out solar—and run the production cost model. Then, it would estimate the collective netted reserve requirement of load, wind, other generation *and* solar, and run the production cost

[7] Reliability standards (CPS) require utilities to keep their system frequency at 60 herts. Frequency is an electrical signal that is the collective product of all loads and resoruces on the system.
http://www.nerc.com/pa/Stand/Reliability%20Standards/BAL-001-1.pdf
http://www.nerc.com/docs/oc/rs/NERC%20Balancing%20and%20Frequency%20Control%20040520111.pdf

model again. The difference between the two production cost model runs would represent the incremental *netted* balancing reserve requirement associated with solar generation.

This is how the Arizona Public Service Company did its Study, which Idaho Power referenced in Mr. Devol's testimony: "The quantity of reserves for the "load only" case was determined, and then the reserves required for "load and solar" were calculated. The difference between the reserves required for the load only case and the load with solar case represents the incremental reserve requirements necessary needed for solar PV integration."[8]

Another approach Idaho Power could use to account for the netting effect is called the Incremental Standard Deviation ("ISD") method. BPA uses the ISD methodology to determine its integration costs associated with solar, wind, other generation and load following. In BPA's own words, "[the ISD methodology] takes into account any diversity benefits that may exist between the regulation signals for load, wind, solar, thermal, and hydro.... ... The result is a method identifying the relative drivers behind the BPA Balancing Authority Area's need for balancing reserve capacity and a reasonable methodology for assigning balancing reserve capacity to the various uses of the system for the purpose of allocating costs and establishing rates for different types of service."[9]

Q. Are there any other benefits associated with accurately modeling the impacts of the netting effect?

A. Yes. Regardless of which of the above-described approaches Idaho Power uses, if the netting effect was modeled not just for solar, but also for load, wind, and other resources, Idaho Power

[8] Exhibit 205 at pg 6 (highlighted text).

[9] Puyleart et al., BP-14-E-BPA-22 at Section 6, page 26, lines 5-19, available at https://www.bpa.gov/secure/RateCase/openfile.aspx?fileName=BP-14-E-BPA-22.pdf&contentType=application%2fpdf.

could determine the netting benefits associated with all of these sources of variability. For example, if Idaho Power analyzed the impact that netting scheduling errors had on loads, it would find that compared to its current methodology, it reduces the reserve requirement for load and thus saves ratepayers money.

Q. In preparing your testimony, did you ask Idaho Power why they did not incorporate this netting effect into their Study methodology?

A. Yes, ICL Data Request NO. 6, included at exhibit 206, asked Idaho Power if they recognized the principle of netting and, if not, to please explain "why." Idaho Power responds as follows:

> Idaho Power does not net solar generation schedule errors with other generation sources, other schedule errors, or load. Idaho Power designed the solar integration study to identify the integration issues specifically associated with solar generation. The objective of the solar integration study is to identify the effects of the intermittent solar generation in order to calculate the integration cost imposed by solar upon Idaho Power's existing system. Idaho Power's system design includes the capability of system dispatchable generators to manage variability in customer load and other generation. Intermittent solar generation introduces new variability and uncertainty into system operations. Because of the inherent differences and levels of confidence in load forecasts versus forecasts for intermittent generation, such as wind and solar, load forecast errors are often auto correlated, reflecting a tendency for forecast errors to persist in magnitude and direction throughout the day, and are more readily addressed as the system is managed through to real time. However, in order to maintain the reliable operation and stability of the system, as well as to meet its various regulatory reliability criteria, the Company must provide adequate reserves based upon the higher magnitude and nature of the forecast error present in intermittent and variable wind and solar forecasts. Thus, the challenges in forecasting wind and solar as compared to load for unit commitment are considerably different, requiring the system to treat differently the possibility of errors in forecasting these elements of load and resource balance.

Q. What is your reaction to Idaho Power's response?

A. A careful reading of Idaho Power's response illustrates that it does not actually explain or justify why Idaho Power does not net solar scheduling error with other generation and load scheduling error. I will expand on this point by examining each part of Idaho Power's response (shown in italics):

1) "*Idaho Power designed the solar integration study to identify the integration issues specifically associated with solar generation. The objective of the solar integration study is to identify the effects of the intermittent solar generation in order to calculate the integration cost imposed by solar upon Idaho Power's existing system.*"

I agree with this statement and find it to be a statement of the obvious. All solar integration studies "identify the integration issues specifically associated with solar generation" and, in doing so, all solar integration studies (other than Idaho Power's) account for the netting effect before determining the amount of balancing reserves attributable to solar generating resources. This statement from Idaho Power does not explain why they do not net solar scheduling error with other generation and load scheduling error.

2) "*Idaho Power's system design includes the capability of system dispatchable generators to manage variability in customer load and other generation. Intermittent solar generation introduces new variability and uncertainty into system operations.*"

I don't know any expert that would disagree with this statement. What is also true is that the new variability introduced by solar generation will net with the variability and associated scheduling error of other resources and loads, thereby reducing the reserve requirements for loads and resources and offsetting some of the impact of the incremental variability attributable to solar resources. This portion of Idaho Power's data response also does not explain why they do not net solar scheduling error with other generation and load scheduling error.

3) "*Because of the inherent differences and levels of confidence in load forecasts versus forecasts for intermittent generation, such as wind and solar, load forecast errors are often auto*

correlated, reflecting a tendency for forecast errors to persist in magnitude and direction throughout the day, and are more readily addressed as the system is managed through to real time."

The premise of this sentence is false. In statistics, autocorrelation refers to a time-series data set that exhibits statistical properties whereby an earlier data point in the time series is a statistically significant indicator of future data points in the same time series. Load forecast errors may be autocorrelated because of persistent biases in the load forecasts or because of the inherent patterns of weather and load. The statement that load forecast errors can be autocorrelated and are "more readily addressed as the system is managed through real time" has no bearing on the appropriateness of netting the scheduling error of solar with other generation and load. Regardless of the statistical properties of the forecast error (autocorrelated or not) and regardless of when the scheduling error is more "readily managed," when you get to real-time, it is an electrical and mathematical fact that the scheduling errors will net.

4) "*However, in order to maintain the reliable operation and stability of the system, as well as to meet its various regulatory reliability criteria, the Company must provide adequate reserves based upon the higher magnitude and nature of the forecast error present in intermittent and variable wind and solar forecasts.*"

The first part of this sentence is not controversial; Idaho Power must maintain adequate reserves to operate a reliable and stable system. The explanation fails in the next part of the sentence. Regardless of the magnitude and nature of the forecast error, the scheduling errors of solar, other generation, and load will net. I don't disagree that Idaho Power needs to carry adequate reserves to account for the observed/modeled magnitude of forecast error associated with the variability of solar resources; the point is that without accounting for the netting effect, Idaho Power will be systematically carrying *excessive* reserves for solar and load.

5) "*Thus, the challenges in forecasting wind and solar as compared to load for unit commitment are considerably different, requiring the system to treat differently the possibility of errors in forecasting these elements of load and resource balance.*"

I have not suggested—nor would I suggest—that forecasting solar generation is exactly the same exercise as forecasting load. I also have not suggested—nor would I suggest—that the statistical characteristics of the variability of load and solar are identical. No solar integration study does. The fact is that once you have taken into account the inherent differences between load and solar generation and have done your best to forecast both load and solar generation, there will be netting of the inevitable remaining real-time scheduling errors. Nothing in Idaho Power's data response, testimony, or Study demonstrates otherwise.

Q. Given the current status of Idaho Power's Solar Integration Study, what is your opinion about the proposed rates?

A. First and foremost, it is extremely important for Idaho Power to correct the flaws and improve the analysis in its Solar Integration Study before any of the estimated rates are approved. As solar power continues to come on line in Idaho, accurately calculating the integration costs is the only way to ensure solar projects pay their fair share: no more; no less. An accurate methodology will also reveal the positive benefits of the effect of netting solar (and wind) reserves with the reserve requirement for loads. Accounting for this decrease in the reserve requirement for load would reduce costs to Idaho Power's customers.

Ultimately, I recommend that the Commission not adopt Idaho Power's proposed solar integration rates until Idaho Power corrects the flaws in its solar integration analysis. At a minimum, a corrected solar integration study should account for the netting effect and should also include sensitivities around the scheduling lead-time and the confidence interval issues described above.

In the meantime, until Idaho Power corrects the flaws in its current Solar Integration Study, my recommendation is to allow PURPA solar projects and Idaho Power to negotiate integration charges, consistent with what is my understanding of current practices.

Q. Does this conclude your direct testimony?

A. Yes, it does.

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Attorney for the Idaho Conservation League

BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

IN THE MATTER OF IDAHO POWER COMPANY'S APPLICATION TO IMPLEMENT SOLAR INTEGRATION RATES AND CHARGES.	)))))	**CASE NO. IPC-E-14-18** **IDAHO CONSERVATION LEAGUE**

DIRECT TESTIMONY

CAMERON YOURKOWSKI

EXHIBIT 201

RENEWABLE NORTHWEST COMMENTS TO IDAHO POWER ON THE DRAFT SOLAR INTEGRATION STUDY

From Idaho Power Response to Sierra Club Production Request No. 12

Renewable Northwest

DATE: June 6, 2014

TO: Phillip DeVol, Idaho Power
Submitted Via Email to PDeVol@idahopower.com

FROM: Cameron Yourkowski, Senior Policy Manager

RE: Idaho Power Solar Integration Study Report (June 2014)

Renewable Northwest appreciates the opportunity to participate in the Technical Review Committee (TRC) for Idaho Power's Solar Integration Study (June, 2014) and we look forward to working with Idaho Power (IDP) on solar integration issues in the future.

The compressed timeline of this study process, especially at the end of the process and during the analysis phase, has diminished my ability to comprehensively review the details of this study. Clearly, more thinking and analysis will need to be done as Idaho Power and the region gain more experience with solar resources. That said, given the compressed timeline that IDP determined to be appropriate for completing this study, I appreciate the willingness of Idaho Power staff to try to make as much information available as possible. I hope that we can continue the dialogue going forward.

The compressed timeline and the inability of the TRC to obtain and work with any of the actual analysis behind this study makes it difficult to verify the accuracy of this study or to estimate the impact of the identified shortcomings. Instead, I will comment on the aspects of the study that are clear at this time and compare the results to other solar integration studies I have worked on.

I outline below what I view as the positive aspects of this study and also the areas where I believe further work is warranted. Based on my experience with other wind and solar integration studies, I observe that the estimated integration cost of
$0.40/MWh (associated with a 100 MW solar buildout) is within the range of what has been calculated by other studies. However, the issues identified below suggest that even this lower cost may be too high and that an adjustment is warranted.

Given the opaqueness of this study and the issues identified below, my recommendation is that Idaho Power not use the costs associated with the larger buildouts in any official manner at this time. Those scenarios are not imminent and the estimated costs should not be relied on until further analysis is completed.

Positive Aspects of the Study:

1. Solar Data: Based on my understanding of the process and effort prior to my joining the TRC, I think that the study has done a good job collecting a quality set of solar data for IDP's service territory.

2. Solar Diversity: The study has appropriately analyzed both concentrated and dispersed solar buildout scenarios. The "diversity value" associated with dispersed buildouts significantly influences the need for balancing reserves and, based on the information available to me at this time, the study has captured this effect sufficiently.

3. Wavelet Transformation: The study's use of the Sandia National Lab's "wavelet-based variability model" to transform the raw single-point irradiance data into what is always less volatile plant-level generation data is appropriate. The wavelet model is the best approach to handling this data transformation issue that I am aware of.

4. Hour-Ahead Forecast: The study incorporated a lot of positive work on developing an hour- ahead forecast for solar generation. In concept, the use of a persistence forecast adjusted for the known curvature of the irradiance curve, based on a "clear sky index" for that day of the year, is a sound approach. Unfortunately, due to the compressed timeline and the lack of data made available to the TRC, I did not have time to scrutinize the details of this approach as it was implemented for this study. See more below.

Shortcomings of the Study:

1. No Netting Effect: The study approach analyzes the incremental reserve requirement and associated production costs for solar assuming that there is no netting effect between the balancing reserves needed for load, wind and solar. This assumption is inaccurate as the scheduling errors for load, wind and solar will often offset each other, thereby reducing the total system reserve requirement and reducing the production costs attributable to all three components, including solar. This is an important shortcoming of this study that has the effect of systematically overestimating the reserves needed for solar and the associated production costs.

2. Hour-Ahead Forecast: While the study's conceptual approach to developing an hour-ahead forecast is sound, the rushed nature of this study has not allowed for any fine-tuning or analysis of its application here. Specifically, the mean absolute error of this forecast has not been made available to date and would be invaluable for assessing the accuracy, comparing it to other approaches, and improving its application within this study. This is an important area for further analysis, as the forecast error is an extremely important driver for determining balancing reserve requirements.

3. Schedule Lead-Time: Related to the forecast methodology is the use of a 45-minute lead- time assumption for submitting solar schedules. As page 13 of the study identifies, an area for future study is looking at shorter lead-times, such as 30 minutes. Schedules can be submitted up until 20 minutes before the hour. Leaving 10 minutes to conduct trading activities, a 30-minute lead-time is reasonable and is used in similar integration studies. The amount of lead-time for submitting schedules greatly influences the accuracy of a persistence-based forecast and thus the amount of incremental balancing reserves required. Similarly, as the region transitions to greater use of 15-minute scheduling, adjusting solar schedules every 15 minutes will greatly reduce the incremental reserve requirement and associated production cost.

4. Confidence Interval: The study's use of a 95% confidence interval is significantly higher than the 90% confidence interval IDP used in its wind integration study.

Recommendation:

The region's experience with integrating solar energy is rapidly evolving and new tools and methodologies are currently being implemented. This evolution, coupled with the rushed nature of this study and the ambitiousness of a 300 to 700 MW solar buildout in IDP's service territory, suggests that additional analysis should be completed before adopting the estimated costs associated with those larger buildouts of solar ($1.20/MWh-$2.50/MWh). The $0.40/MWh estimated cost associated with a 100 MW solar buildout is more imminent and is within the range of similar solar integration studies. However, the shortcomings of this study may also warrant reductions to the $0.40/MWh figure until more analysis can be completed.

June 13, 2014
Phil DeVol IRP Manager Idaho Power
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Dear IDP Solar Integration Study Team,

Thank you for the opportunity to participate on Idaho Power's Solar Integration Study (Study) Technical Review Committee (TRC). I found the exercise interesting, many of Idaho Power's methods innovative, and the results informative. Although the Study's methods warrant additional review, Idaho Power's results appear reasonable and comport with solar integration costs estimated throughout the region.

The Study development and TRC participation process was well meaning and appreciated, but ultimately limited by a near term regulatory requirement to file the Study results at the Commission. Nonetheless, the early phases of the Study process allowed for meaningful dialogue between the Study team and the TRC. This dialogue allowed for a refinement of data sources and led to at least two important enhancements to the Study methodology. Late phases of the TRC process were compromised by the Study's accelerated schedule. The accelerated schedule did not leave time to consider improvements to the reserve requirement methodology, to review the production cost simulation assumptions and models, or to review the Study in light of preliminary results. Despite these limitations, Idaho Power has made a strong effort to accurately measure solar integration costs. Subsequent efforts to estimate these costs will provide the opportunity for additional review.

Four Areas Where this Study Excels:

The solar integration study stood out in four ways where Idaho Power made a strong effort to refine assumptions and implement innovative ideas.

1) The Study used the difference between hour-ahead forecasts and actual generation to determine schedule errors. While this Study assumption is not innovative, it is a change from Idaho Power's earlier perspectives regarding variable energy resource integration. Re- evaluating old assumptions can be challenging, and Idaho Power's willingness to use hour-ahead schedule errors should be acknowledged as evidence where the Company challenged itself to develop a methodology suitable for solar integration.

2) The Study made creative use of algorithms to develop hour-ahead forecasts whose accuracy was superior to simple persistence forecasts. The function used to develop the hour-ahead forecasts recognizes the time of day and season to predict how hourly solar generation will differ from the preceding hour. This solution is impressive given the relatively few solar integration studies that exist nationally, many of which lack this forecast intelligence.

3) The Study applies an advanced "Wavelett-Based Variability Model" to gross up point source irradiance data into simulated output from a large utility scaled solar array. As a TRC member as I was not aware of this analytic approach and found myself learning through its application. I'd like to commend Idaho Power for using an innovative solution not widely known to the utility industry.

4) The Study gathered data from diverse solar sites and went to great lengths to gather the associated generation data. It would have been far easier to use solar data from one particular site, or to use a collection of synthesized data, but by using historical data from local AgriMet towers Idaho Power's study was able to include real ground based measurements. By including diverse resource sites, the Study well captures the beneficial effects of geographic diversity.

Areas Where Further Scrutiny is Merited:

The Study does include some assumptions and methodologies that warrant further review. Relatively little time was made available for the TRC to discuss assumed reserve requirements or production cost simulations. As a result, some of these suggestions may result from my own misunderstanding.

1) The Study assumes that a separate quantity of balancing reserves be held for load, wind, and solar resources. These separate capacity requirements are inputted into the production cost simulation model. However the total capacity of reserve requirements needed to integrate load, wind, and solar should be less than the sum of their constituent needs because the schedule errors for load, wind, and solar are generally non-correlated. The Study calculates the amount of reserves required to meet 95% of solar's schedule error, but it would be more accurate to calculate the reserves required to meet 95% of solar, wind and load combined schedule error. Then the amount of reserves attributable to solar can be determined by subtracting the reserve requirements for just load and wind. Making this adjustment would lower solar integration costs f or all portfolios.

2) The incremental and decremental reserve requirements (RRs) calculation methodology would benefit from additional review. The methodology is innovative and its ability to adapt to changing solar conditions on an hourly basis is advanced and highly desirable from an operational perspective. However, it's likely that the method to calculate RRs could be further refined to lower the intensity of RR limit excursions. Presently, the RRs are based on a percentage above and below the hourly forecast. This approach is counter-intuitive (but not necessarily wrong) because those hours which have lower forecasts can have some of the highest variability. For example, the most RRs should be required at mid-day with partial clouds, but because the hour ahead forecast will be low (due to clouds) the calculated RRs will be lower than it would with a clear sky. It's possible that this negative result is diminished by the diverse solar sites used to generate the forecast.

3) The Study used wind data that was not contemporaneous with the solar data used in the production cost simulation. While it is understandable why Idaho Power used generation data

from later years, the Study should try to determine whether wind and solar generation is correlated, or whether the intra-hour variability of wind and solar generation is correlated. Such follow up analysis would be helpful to understand what effect this data decision has upon results.

4) The Study used Solar Anywhere data at the Grand View site where AgirMet data was not available. Idaho Power showed resourcefulness for gathering data from a wide array of sites. However, I am concerned that the SolarAnywhere data would be difficult to time synchronize with the ground based AgriMet sites. Furthermore, because SolarAnywhere is based on satellite observations of clouds, and their approximated velocity, it seems that the satellite data would understate the solar variability relative to ground based measurements. The Study should address these concerns by comparing SolarAnywhere data to ground based AgriMet data *at the same site*. This type of follow-up analysis would determine how comparable the datasets are and help answer whether they are suitable for combination. It's possible that the aggregate variability of the solar resources is understated due to the under-represented correlation between SolarAnywhere's Grand View data and the rest of the portfolio.

5) The TRC did not review the production cost simulations assumptions or the internally developed simulation model.

Recommended Additions for Subsequent Studies:

Integration studies typically benefit from subsequent iterations when power costs are updated and additional scenarios can be considered. The following suggestions may be appropriate for study when that time comes.

1) Future studies should model solar portfolios with smaller projects. It is possible that few, if any QFs, are able to finance their projects at recently signed avoided costs. It is also possible that projects aggregate in one particular site and are less geographically diverse than assumed in this study. Future studies could model a portfolio with less than 100MW capacity and a portfolio with 300MW-500MW clustered near one particular site.

2) Future studies should include the sub-hourly scheduling periods. While sub-hourly markets are not currently widely used, they will become more liquid as BPA and the California Intertie begin offering 15-minute and 30-minute schedules. Idaho Power will likely want to know what type of savings may be achieved by transacting in sub-hourly markets. Studying sub-hourly scheduling in subsequent integration studies will be informative.

In summary, the results of the study are comparable other solar studies performed in the region. While improvements remain, Idaho Power should be commended for demonstrating considerable ingenuity and a commitment to accurately capturing solar integration costs. I appreciated the opportunity to participate on the TRC and am always available for follow-up questions.

Sincerely,

Jimmy Lindsay

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BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

IN THE MATTER OF IDAHO POWER COMPANY'S APPLICATION TO IMPLEMENT SOLAR INTEGRATION RATES AND CHARGES.	)))))	**CASE NO. IPC-E-14-18** **IDAHO CONSERVATION LEAGUE**

DIRECT TESTIMONY

CAMERON YOURKOWSKI

EXHIBIT 202

NATIONAL RENEWABLE ENERGY LABORATORY AND THE UTILITY VARIABLE-GENERATION INTEGRATION GROUP

PRINCIPLES FOR TECHNICAL REVIEW (TRC) INVOLVEMENT IN STUDIES OF VARIABLE GENERATION INTEGRATION INTO ELECTRIC POWER SYSTEMS

From Idaho Power Response to ICL Production Request No. 2

Principles for Technical Review Committee (TRC) Involvement in Studies of Variable Generation Integration

into Electric Power Systems

What Will a TRC Provide?

A properly constituted TRC will assist the project sponsors in ensuring that the quality of the technical work and the accuracy of results will be as high as possible. TRC participation will also enhance the credibility and acceptance of the study results throughout the affected stakeholder communities. And TRC members will be qualified to carry the key messages of the study to their respective sectors.

What Is a Properly Constituted TRC?

TRC membership should include individuals that collectively provide expertise in all of the technical disciplines relevant to the study. A TRC facilitator should be selected from among the TRC membership. Sponsorship and facilitation of the TRC should be independent from, but closely coordinated with, the project sponsors and the team conducting the work. Observers from relevant government agencies and other interested parties may attend TRC meetings and be included in TRC communication at the discretion of the project sponsors. Alternatively, a separate stakeholder group can be considered in order to update interested parties on study progress and key results.

What are the TRC's Functions and Requirements?

The TRC will

- Review study objectives and approach, and offer suggestions when appropriate to strengthen the study.
- Help ensure that the study:
    - Builds upon prior peer-reviewed variable generation integration studies and related technical work;
    - Receives the benefit of findings from recent and current variable generation integration study work;
    - Incorporates broadly supported best practices for variable generation integration studies;
    - Is developed with broad stakeholder input.
- Engage actively in the project throughout its duration. In general, project review meetings should be held nominally on a quarterly basis; some meetings can be held telephonically, but some should also occur face-to-face. A face-to-face kickoff meeting to establish and agree on the general direction of the work is required.

- Engender collegial discussions of methods and results among TRC members, the study team, project sponsors and other interested parties. The aim of these discussions is to improve accuracy, clarity and understanding of the work, and reach consensus resolution on issues that arise.
- Avoid public disclosure of meeting discussions and preliminary results. In general, findings should not be released until accepted and generally agreed upon by project sponsors, the study team and the TRC. When advisable, possible and agreed to by all project participants, interim progress reports can be provided to a broader stakeholder group.
- Ensure that findings are based entirely on facts and accurate engineering and science. Project sponsors need to embrace this aim so that the results and findings are objectively developed and not skewed to support any desired outcome.
- Document results of TRC meetings and distribute meeting presentations and minutes.

To carry out these functions, the TRC requires

- Access to all relevant information needed to properly evaluate the work and the results. When required, TRC members will enter into confidentiality agreements to protect this information. In no case can certain information needed by the TRC be declared "off-limits."
- Assurance that the study results will be made public through published documentation or other suitable means, with the understanding that business- sensitive information will not be made public.
- Assurance that project sponsors will describe the project as having the benefit of expert review by a TRC only if the TRC has clearly expressed its acceptance of and agreement with the results of the study.
- Assurance that, in the event agreement is not reached by the TRC and other project participants, any reference to the TRC will be removed from the final report and any associated documents or publicity.

How Can Project Sponsor(s) and a TRC Agree To Conduct A Study in Accordance With These Principles?

Each can sign below:

____

for the Project Sponsor(s)

____

for the Technical Review Committee

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BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

IN THE MATTER OF IDAHO POWER COMPANY'S APPLICATION TO IMPLEMENT SOLAR INTEGRATION RATES AND CHARGES.	**CASE NO. IPC-E-14-18** **IDAHO CONSERVATION LEAGUE**

DIRECT TESTIMONY

CAMERON YOURKOWSKI

EXHIBIT 203

JUNE 5, 2014 EMAIL FROM PHIL DEVOL, IDAHO POWER TO TRC MEMBERS

From Idaho Power Response to Sierra Club Production Request No. 11

Pankau, Kathy

From: DeVol, Philip
Sent: Thursday, June 05, 2014 2:45 PM
To: 'Cameron Yourkowski'; Paul Woods; Brian K. Johnson; Myers, Kurt S; Jimmy Lindsay; Rick Sterling; ANDRUS Brittany; CRIDER John
Cc: Stokes, Mark; Youngblood, Mike
Subject: IPC draft solar study report

Good afternoon,

I would like to take this opportunity to express to the entire TRC how much Idaho Power appreciates your involvement and participation throughout this process. Specifically, I want to apologize if, in recent meetings or correspondence, I have given the impression that the TRC comments are merely a formality. That is definitely not the case. Your feedback during the course of the study has been important to us, and continues to be important over the final stages of this first phase of the study.

As you know, the recent interest surrounding potential PURPA solar development in our service territory, as well as the IPUC's directives from its May 28 Order, requires the urgent completion of the study. The study needs to continue to move forward towards a target completion date of mid-June. However, the Company does value the participation and input from the TRC and other participants, and very much would like your review, comments, and observations incorporated into the process prior to completion of the final report and this Phase One process. I apologize that my prior comments may have given the impression to some of you that, "comments from the TRC were not going to impact the final report" and that it would not be a "worthwhile investment of time to discuss the report as a group." This is not the case, nor is that Idaho Power's view of the process and the role of the TRC.

As we've discussed before, the development of the appropriate integration costs for solar is a complicated process. Not many utilities have done this previously, and we have all learned new concepts along the way. We understand that some of you may feel the need to comment on what you may perceive as study shortcomings, at least for this Phase One process. It is, however, our hope and expectation that you will also comment on your perception of the strengths of the study, so that we all can gain throughout this process and continue to improve. My hope in sending the draft report out on June 2, 2014 was to allow everyone to review and communicate comments about it this week, and that we could meet to review, discuss, and comment sometime next week – with a goal of working towards a final report by mid-June. I am happy to take any comments, etc... by email or phone, but would certainly schedule a TRC meeting to discuss finalization of the report and phase one process if that was desired by the TRC.

Please let me know right away if you would like me to schedule a TRC meeting for review, discussion, and comment prior to finalizing the report – or if you prefer to submit comments and wrap-up this phase without an additional meeting. Either way, at this point the Company intends to move forward with a target completion of the Phase One process on June 16, 2014. The study will then be incorporated into a filing with the IPUC, which will not likely occur on the same day that the report is final, but instead a matter of days afterwards. Please feel free to contact me if you'd like to talk, and I look forward to your feedback and comments.

Many

thanks, Phil

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BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

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DIRECT TESTIMONY

CAMERON YOURKOWSKI

EXHIBIT 204

TRC MEMBER PAUL WOODS COMMENTS TO IDAHO POWER ON THE DRAFT STUDY

From Idaho Power Response to Sierra Club Production Request No. 12

Comments of Paul Woods, TRC Member

Idaho Power Solar Integration Study Report

June 2014

The following comments are provided on behalf of myself as a member of the Technical Review Committee (TRC) to Idaho Power staff on the draft Solar Integration Study Report. The comments are intended to clarify in the report the limited role of the TRC and to accurately reflect the study process.

General Comment

The concept of a TRC to provide input in completing a Solar Integration Study had the potential to provide real benefits to rate-payers, solar generation entities and Idaho Power in completion of the study. I appreciate the opportunity to serve on the TRC and commend Idaho Power for inviting someone of the general public to serve on the Committee with limited experience as compared to the knowledge and skills of my fellow members of the TRC.

The study started out in a very collegial manner and members of the TRC provided valuable input on how to acquire and incorporate solar characteristic data and generation estimates using wavelet techniques. I believe the initial phase of the Solar Integration Study represented a best practice in conducting such a study.

The study took a dramatic after the public meeting at which Idaho Power told all those present that the process had just begun. Immediately following the meeting Idaho Power filed with the PUC regarding solar generation contracts and the Solar Integration Study took a dramatic turn and the exposure to major assumptions and methods of study ceased to be elements of review by the TRC.

In the report, it is important that the text provide an accurate representation of the elements of the study that were available and reviewed by the TRC and those that were not. I stated in the last meeting of the TRC that this is not a study but rather it is a document presenting the results of a single computer model run of an internal Idaho Power computer model that was not reviewed by the TRC for accuracy, sensitivity and variability.

In conclusion, the items that are listed as "Phase II" study tasks are the tasks that need to be done now to consider the work an actual study. Absent that work, the work to date does not constitute a "study", and therefore should be labeled more accurately as a single computer model output run.

My specific comments on each section of the report are as follows:

Acknowledgments

The second sentence of the opening paragraph states that the TRC provided "substantial" guidance. This is not accurate and the word substantial should be deleted or replaced with the word limited. In addition I do not believe that the study methods were consistent with the UVIG and NREL TRC study guidelines and the reference to this standard should be deleted. Idaho Power did not actively engage the TRC on key elements of the study such as load reserves, production cost simulation sensitivity analysis and the interpretation of the output of one single model run. The limited opportunities for input and technical review of these elements of the study make the text of the report overstate the role of the TRC and imply technical review in areas where none occurred.

Page 4 Solar Plant Characteristics

The following sentence is not supported by data or analysis that was available to the TRC. "While panel orientation and tracking capability are key factors in the determination of avoided costs, these attributes are of lesser importance with respect to the variability and uncertainty driving integration costs." This sentence should be deleted or the report should produce data supporting this claim. The TRC did not review model runs of Idaho Power's production cost simulation model, nor were there multiple model run results that would support this statement. More information is required to support this statement in the report.

Page 5 Statistical-Based Analysis of Solar Characteristics

The top half of page 5 is a discussion of Idaho Power's participation in the Mid- Columbia electric power market that presents assumptions and arguments for the hour-ahead framework of the final study. The decision to use hour-ahead trading under the parameters discussed in this section is an important element of the study outcome. The report should clearly note that this analytical framework was not part of the TRC review.

In the last TRC meeting prior to issuance of this report, Idaho Power staff presented a power point showing the final report conclusions of integration charges based on a single Production Cost Model Simulation. This information was presented with virtually no supporting documentation or sensitivity analysis of the model assumptions and input variables. When asked whether there would be additional Productions Cost model runs to understand the sensitivity of the model to the various model parameters and assumptions, Idaho Power's response to this request was no. How sensitive the model is to this assumed framework is a key question that remains unanswered by the work to date and it is not clear what exposure rate- payers or solar generation entities face from this absence of analysis.

Pages 5 & 6 Hour-Ahead Solar Production Forecast

The framework and assumptions in this section were not an element of technical review by the TRC and the study report should accurately state this fact. The sensitivity of the final Production Cost Simulation as it relates to the required capacity to be held in reserves were not determined through multiple model runs and sensitivity analysis. This work should be done now in order to call the work a study.

Page 9 Simulation Model

The Production Cost Simulation Model was not part of the technical review of the TRC. More importantly the whole study is based on a single model run without any sensitivity analysis.

The exposure of the TRC to the Production Cost Simulation Model was a single power-point slide in a meeting immediately prior to issuance of the report. In the slide, the model output showed the need to dispatch natural gas peaker resources to meet load and reserve capacity on a day in April up to 200 MW. A day later the model showed the spin up of a coal resource to meet load reserves. Asked to explain the conditions that would dictate this type of dispatch pattern, the response of staff was that they just got the results in the last day and were not yet able to describe and defend the results. One explanation offered by staff was that flood control releases from the hydro system were perhaps driving the outcome which raised the question of why that condition becomes limiting on reserves for other resources.
The point is that the Production Cost Simulation model and the model output did not receive outcome technical review by the TRC and the few questions of the output by some TRC members were not been addressed in any meaningful manner.

Pages 9 and 10 Reserves

One of the key elements driving the analysis is the amount of reserves needed to integrate solar power. As a member of the TRC, I came into the study process supporting the concept of integration charges and looking forward to a robust discussion of the policy choices and reliability needs that would drive the integration analysis. Unfortunately there were no opportunities for the TRC to understand and provide input to Idaho Power on the types and characteristics of reserve capacity or how the other generation sources within the Idaho Power system work to minimize forecast errors and reliability and therefore reserve needs. There should be language in the report clarifying the TRCs limited role in reviewing the reserve needs.

Page 12 Further Study

All of the elements listed as suggestion for further study are elements that should have been performed in the initial study. Absent those elements, the title of the report should be Solar Integration Single Production Cost Model Results.

In conclusion, it is not often in today's age of analysis paralysis that I find myself recommending further analysis, but in this case I cannot see how a single Productions Cost Simulation Model run can be considered a "study" an how this provides the necessary information to insure that rate-payer and solar generation interests are fairly represented in the "study" outcome.

Lastly, please simply list my name in the report as Paul Woods, member of the public. Please do not refer to my Woods Consulting Group company status.

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DIRECT TESTIMONY

CAMERON YOURKOWSKI

EXHIBIT 205

EXCERPTS FROM:

IEEE: THE EVOLUTION OF WIND POWER INTEGRATION STUDIES

&

NVENERGY: LARGE-SCALE PV INTEGRATION STUDY

&

ARIZONA PUBLIC SERVICE COMPANY: SOLAR PHOTOVOLTAIC (PV) INTEGRATION COST STUDY

From Idaho Power Response to ICL Production Request No. 5

The Evolution of Wind Power Integration Studies: Past, Present, and Future

Erik Ela, *Member, IEEE*, Michael Milligan, *Member, IEEE*, Brian Parsons, *Member, IEEE*, Debra Lew, *Member, IEEE*, and David Corbus, *Member, IEEE*

Abstract--**The rapid growth of wind power as a generation resource in the past decade has given many utilities and Regional Transmission Organizations (RTO) concerns due to its unconventional characteristics. Because of these concerns, many of these entities have initiated studies that evaluate the feasibility of large amounts of wind power onto their system and the operational impacts present. This paper will discuss some of the past major studies, mostly focusing on the United States, and the basic methodologies that were used during these studies. The paper will also review many of the different results and conclusions of the studies and discuss how they have helped the power industry as a whole. Lastly, the authors will attempt to share their ideas on some of the limitations of the current and past integration studies, and some insight on how these may be evolving in the future.**

Index Terms— **Power system economics, power system operations, power system planning, power system reliability, power systems, wind energy, and wind power generation**

I. Introduction

WIND power in the United States and the world has experienced substantial growth in the past decade. Its zero-cost fuel and emissions-free output has been a favorable alternative to volatile-priced fossil fuel generation in a changing environmental climate. Because utility-scale wind is such a new resource and is increasing at such a rapid rate, utilities and system operators are becoming concerned about keeping up with the integration issues and costs that it brings. For this reason, many of the utilities and system operators have established wind power integration studies for their areas [1]-[12], [22]. These integration studies usually simulate a power system in the future with a large penetration of wind, and evaluate the system impacts on the grid and incremental operating costs that are incurred [13]. The impacts vary from study to study, region to region, but often show similar conclusions.

The results of these studies are used in many different ways. For instance, the New York integration study of 2005 [1], studied the impacts of 3300 MW of wind (10% of peak capacity) on its system and eventually incorporated that number in its market services tariff [14]. In other studies [4], [6], integration costs that are found through the study are considered for use as a basis for an integration rate that the utility charges incoming wind power. In these cases, the wind integration cost may be used as part of a comparison of costs of alternative forms of power generation and considered in the resource acquisition process. Many results are used for more informational purposes [1]-[12],[19]. The results and conclusions that come out of these studies give operations and system planners the information they need to plan for increasing wind penetrations on their systems, and are often referenced frequently during stakeholder meetings and working groups when deciding on new operational and market rules.

The National Renewable Energy Laboratory (NREL), under the sponsorship of the U.S. Department of Energy (DOE), has initiated two large regional wind power integration studies in 2008. These regional wind power integration studies were initiated for many reasons including to support the U.S. 20% wind energy by 2030 vision of DOE [15]. The Western Wind and Solar Integration Study (WWSIS) includes the WestConnect[1] utilities in the states of Wyoming, Colorado, New Mexico, Arizona, and Nevada. Inside this footprint, the study is evaluating penetrations of 30% of total energy consumption with wind energy and 5% with solar energy.[2] The study is modeling the entire Western Electricity Coordinating Council (WECC) outside of the WWSIS study footprint with 20% wind and 3% solar also, to address concerns that variability would be exported out from the WestConnect utilities to the rest of WECC. The outcomes of the study should show results from a regional scale on integration costs, ancillary services needs, and other impacts that a large mix of wind and solar have on the western study area. In the Eastern Wind Integration and Transmission Study (EWITS) project, most of the Eastern Interconnection is being studied for similar integration impacts. This study includes Midwest ISO, PJM, SPP, TVA, Mid-Continent Area Power Pool (MAPP), ISO New England, New York ISO, and other interested parties. EWITS will include both a wind integration

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[1] WestConnect Utilities consists of about 14 utilities in southwestern U.S. More information can be found on www.westconnect.com

[2] WWSIS included solar penetrations of 3.5% energy Concentrating Solar Power and 1.5% Photovoltaic to make up the 5% solar in the study.

component and a transmission expansion component. The study will evaluate the different integration impacts of 20% wind as a percentage of total energy consumption and the different impacts of having large transmission build-out to send wind from high wind-potential areas to large load centers. The WWSIS and EWITS studies are planned to be complete in 2009 and following the completion of this paper [25] and [26]. However, the authors will share some of the experiences gained from these two studies throughout the paper where appropriate.

Though many of these wind integration studies come up with different results and are often performed for different purposes, the general procedures and methodologies used in performing a wind power integration study usually follow a somewhat consistent structure. This paper will discuss the in-depth methodologies and conclusions resulting from these wind power integration studies, and will show how they have evolved in the past several years, including assumptions and observations from the authors on changes predicted in future studies. Section II will cover the introductory stage of the integration study. This includes the methodologies used in the data gathering that is required for all study pieces. One of the larger tasks of this part of the study is the undertaking involved with coming up with wind resource data that is needed to model future wind power output. The arrangement of assumptions and scenario developments needed before the analysis can be conducted are also discussed. Section III will go into some of the detailed analysis that goes into an integration study of this type. This will cover statistical analyses, production cost simulations, and reliability-based assessments. In section IV, we will discuss many of the results and conclusions that come out of these studies. Section V will introduce the authors' thoughts on certain limitations that are present in some of the past studies, and where we believe trends will continue and changes will occur in future integration studies. Section VI will provide a conclusion to the paper. It is important to note that many different studies involving wind and renewable energy have been conducted. This paper will focus primarily on U.S. studies along with results and observations of international studies where appropriate, and will be limited in scope to studies involved in analyzing power system operations of moderate to high penetrations of wind power.

II. Data Gathering and Scenario Development

Wind power integration studies that have been performed in the last several years in the United States have increased in complexity, realism, and geographic scope. This evolution is expected to continue for the foreseeable future. For a typical integration study, a significant effort is devoted to obtaining simulated wind plant data that is physically consistent with the underlying weather driver and with load. To achieve this, wind data from the same year as load data is required. Although actual wind plant data can be used, the focus of most studies has been to analyze the impact of a future wind scenario, representing wind plants that have not yet been built.

Typical integration studies analyze 3 years of wind and load data in an attempt to capture the inter-annual variability of the weather. Production or market simulations typically require hourly wind energy estimates, but most studies also use 5-minute or 10-minute wind data for statistical analysis. These wind data are developed using a Numerical Weather Prediction (NWP) model that recreates historical weather in time and space. Wind speed data can be extracted from the 3-year model runs at surface heights that correspond to the wind turbine hub height and converted to wind power using wind plant power curves. The gridded outputs of the NWP are the building blocks that can be aggregated to model hypothetical wind plants of various sizes. As an example, in WWSIS, each grid cell in the NWP simulation is about 2 km x 2 km, yielding a wind capacity per grid point of about 30 MW. This represents 10 3-MW turbines placed throughout the grid cell. A 90 MW wind plant would consist of the sum of the output of 3 grid cells. More detailed information on the wind resource modeling process can be found in [16].

Land use restrictions are applied so that wind development is excluded in urban areas, national parks and environmentally sensitive areas, and other unlikely developed areas. For wind power integration studies involving only one state, utility or RTO, scenarios may be designed manually, as promising wind locations are often known locally. For large, regional wind power integration studies such as WWSIS and EWITS, scenario selection can be a difficult task because of the extremely large number of potential locations, and must be partially automated. Wind scenarios are typically designed using existing or planned wind plants, plus various site selection algorithms for new sites which may include a combination of the following selection criteria: wind plant capacity factor, load correlation[3], proximity to existing or proposed transmission corridors, and geographic diversity [23]. A family of scenarios allows utilities to answer more questions than simply the cost of wind integration. By comparing different scenarios, the utility can examine issues such as the advantages or disadvantages of local versus remote wind resources and impacts of geographic diversity on integration cost.

To realistically simulate power system operation, the uncertainties associated with load forecast errors and wind forecast errors are important. Because wind and load forecast errors are generally statistically independent, they do not add arithmetically, and should be developed for the simulation in as realistic a manner as possible. Utilities often do not save old load forecasts, but these forecasts provide valuable information for the integration study. Because wind power is simulated for the integration study, it is also necessary to simulate wind power forecasts. This is because the unit commitment process is done to target the combined load and wind forecast, whereas the forecast errors will not become apparent until the operating hour. This approach is similar to what actually happens during power system operations, and is a valuable component of any wind power integration study. At

[3] Load correlation in this sense is typically looking at certain high-load hours and comparing wind output during these hours.

NAVIGANT ENERGY

Sandia National Laboratories

Pacific Northwest NATIONAL LABORATORY

LARGE-SCALE PV INTEGRATION STUDY

Prepared for

NVEnergy

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6226 West Sahara Avenue
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JULY 30, 2011

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1. Develop time-synchronized PV minute-by-minute output profiles and day-ahead forecasts of PV and DG hourly output. Analyze the results to quantify the impact on grid operations of increasing amounts of large-scale PV generation and DG.

2. Conduct a detailed evaluation of balancing area operations for minute-by-minute changes in net load (load – solar output) based on the large-scale PV and DG output profiles and NV Energy's generating unit operating data. Identify the additional regulation and load following requirements, including capacity and ramp rate, associated with each case study. Determine whether existing generation fleet can meet these requirements without and with generation redispatch. Quantify the impact of PV variability on generation fleet cycling and movements in regulation and load following, to establish a basis for the assessment of generator wear and tear.

3. Integrate the results of the balancing area studies and the PV and DG output profiles to quantify the impact of increasing levels of large-scale PV and DG on NV Energy's generation mix and production costs using hourly production simulation models. Identify the increased fuel and operations and maintenance (O & M) costs for existing generating units caused by higher operating reserves, increased cycling, higher heat rates, and changes in dispatch schedules.

4. Evaluate the impact of incremental DG on NV Energy's bulk power transmission system, including steady state and dynamic performance within NV Energy's southern Nevada balancing area operations.

5. Identify mitigation strategies or upgrades required to accommodate variable generation, including those needed to satisfy NERC balancing area performance requirements.

Assumptions

The evaluation of large PV and DG is performed assuming existing conditions, including a system grid configuration and generating resource mix for 2011.

Study assumptions include:

- The study assesses the ability of the system as it exists today, except that load and weather data from 2007 are used. Solar data needed to predict intermittency is not readily available for 2008 and beyond. 2007 is also the year when NV Energy

SOLAR PHOTOVOLTAIC (PV) INTEGRATION COST STUDY

B&V PROJECT NO. 174880

PREPARED FOR

Arizona Public Service Company

NOVEMBER 2012

Principal Investigators:

Tim Mason, Project Manager
Trevor Curry
Mon Hong
Benson Joe
Scott Olson
Mary Sprouse
Dan Wilson

BLACK & VEATCH
Building a world of difference.

4 Reserve Requirement Determination and Cost

This analysis seeks to quantify and value the incremental operating reserves needed in order to integrate the anticipated PV capacity on the APS system in 2020 and 2030. As discussed in Section 3, Black & Veatch used the current NERC CPS2 standard as a proxy to measure the reserves required and as the basis to estimate the costs of future reserves. Specifically, Black & Veatch considered the requirements and cost to achieve CPS2 compliance at the 90 percent, 95 percent, and 99 percent monthly levels.

The methodology to calculate the quantity and costs for solar PV reserves was completed in a two step process. The first step was to calculate the amount of incremental upward and downward regulating reserves required to maintain a specified level of monthly CPS2 performance caused by forecasting errors from the solar PV penetration levels in each case. The second step took the amount of incremental regulating reserves calculated in the first step and modeled the cost impact to the system using an electric system production simulation cost model[9] to capture the system energy cost differential of providing the regulating energy margin.

4.1 RESERVE CALCULATION METHODOLOGY

The incremental amount of reserve capacity required to maintain CPS2 compliance was calculated as a difference from the reserve capacity required due to loads only and that due to the combination of loads and solar. For the base case, it was assumed that APS would maintain a 99 percent CPS2 compliance (the standard that APS has historically achieved). Sensitivity cases were also generated to reflect different levels of CPS2 compliance (90 and 95 percent) and using solar profiles with greater variability.

To calculate reserve requirements for any given level of NERC CPS2 compliance, Black & Veatch developed a spreadsheet model using Microsoft Excel. The spreadsheet requires forecasted hourly loads and 10-minute expected generation inputs an entire year (the inputs used in the CPS2 model are discussed in Section 2). After the load and solar data are entered into the model the number of CPS2 violations is calculated. Violations due to load only were first calculated, assuming perfect solar forecasting. After the solar forecast variability was added, the incremental reserves required beyond what was needed for load only during daylight hours was calculated. The net difference between the actual load and solar generation and the forecasted load and solar generation is the forecast error.

As discussed in Section 2, the approach taken to estimate the solar output profiles was conservative, reflected in both the number of cloudy time periods forecast during daylight hours and the level of variability seen in the actual solar output data used. While it is possible that the level of variability (and hence CPS2 violations) could be lower, for planning purposes it is appropriate to take a conservative approach. A sensitivity case was developed that includes additional solar variability (more cloudy time periods and greater variation when there are clouds) to assess the potential impact on the quantity of CPS2 violations. After completion of this revised

[9] ABB/Ventyx ProMod production cost model was used in this study

dataset, the profiles were placed into the same CPS2 models as the base case, with the new level of 10-minute reserves calculated.

A number of assumptions were made in developing the CPS2 model for location of future projects, technology type, level of variability in the output profile, and forecast approach. The model is sensitive to changes in many of these inputs, impacting accuracy when estimating integration costs. As actual projects are developed in the future and specific algorithms are used for estimating solar output, the model should be revised. This will greatly increase the level of accuracy and confidence in integration costs.

4.2 RESERVE REQUIREMENTS

APS' L_{10} in 2012 is 46 MW. In 2020 and 2030 the L_{10} is estimated to be 51 MW and 59 MW respectively. Figure 4-1 depicts the calculated ACE for all the ten minute periods in a single day in 2020. Since the L_{10} is 51 MW for the year 2020, the ACE can stay at +/- 51 MW without a CPS2 violation for a ten minute period without having to deploy any additional resources. System operators would require 10-minute reserves to bring the system back into tolerable L_{10} range to avoid negatively impacting the system frequency. In instances where the system ACE experiences a large deviation it is possible for system operators to use 1-minute regulating reserves to bring the system back into balance.

To maintain a 95 percent CPS2 compliance monthly average for the year in 2020 APS would need to carry and deploy, on average, 81 MW of incremental regulation up and 81 MW of incremental regulation down reserves during hours when the solar is potentially operating.

Figure 4-1 below depicts the interdependence of the load and solar forecasting error to the open loop[10] ACE. In certain time periods the load and solar forecast error offset and keep the ACE low. In other periods the ACE is high because the load and solar forecast errors are both moving in directions that make the ACE worse.

[10] Open loop ACE is the Area Control Error of the system before AGC dispatch signals are deployed to correct for ACE. Closed loop ACE is the Area Control Error after AGC dispatch signals have deployed to correct for ACE.

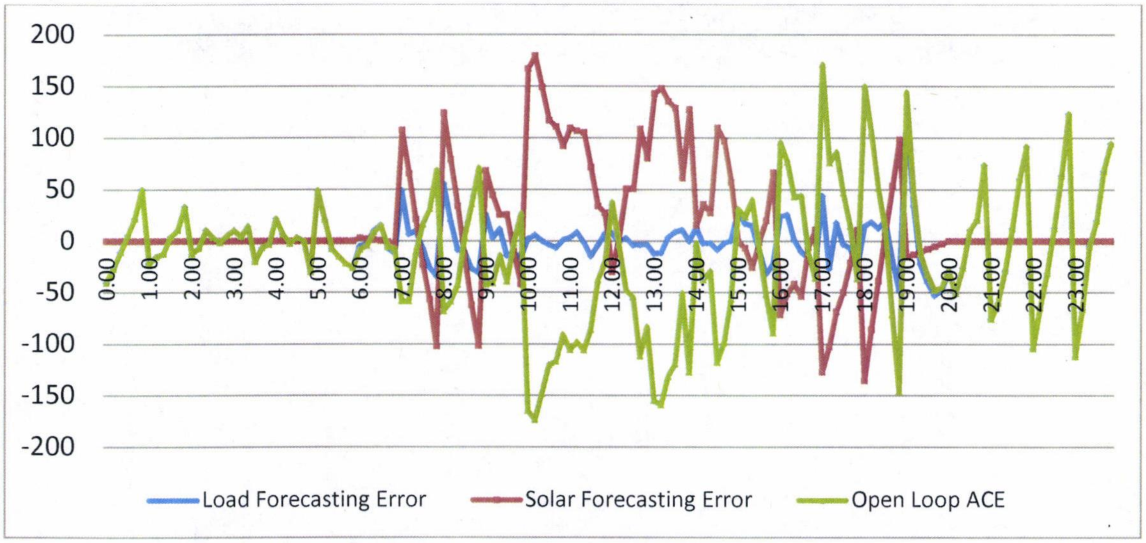

Figure 4-1 Incremental Regulating Reserves and ACE

4.2.1 Year 2020 Reserve Requirements

APS applied the methodology used by Black & Veatch to develop the incremental monthly reserve requirements necessary to maintain the CPS2 standards at 90 percent, 95 percent and 99 percent. Table 4-1 provides the monthly reserve requirements for different levels of CPS2 compliance during daylight hours, while Figure 4-2 depicts the inter-temporal reserve requirements for 2020. The incremental 10 minute reserve requirement applies only to hours when solar generating output is available.

Table 4-1 2020 Monthly 10-minute PV Reserves (+/- MW)

YEAR 2020	BASE SOLAR VARIABILITY CASE			HIGH SOLAR VARIABILITY CASE		
Month	**90%**	**95%**	**99%**	**90%**	**95%**	**99%**
Jan	117	136	133	119	133	133
Feb	95	94	103	97	92	94
Mar	137	140	139	141	141	144
Apr	126	122	221	133	145	221
May	50	57	96	55	62	102
Jun	31	52	75	35	62	70
Jul	-4	15	53	-3	20	53
Aug	7	24	61	10	25	61
Sep	25	40	68	28	41	73
Oct	74	88	140	76	85	145
Nov	128	111	95	133	116	96
Dec	107	91	90	107	89	90
Monthly Avg	**74**	**81**	**106**	**78**	**84**	**107**
June-Sept Avg	**15**	**33**	**64**	**18**	**37**	**64**

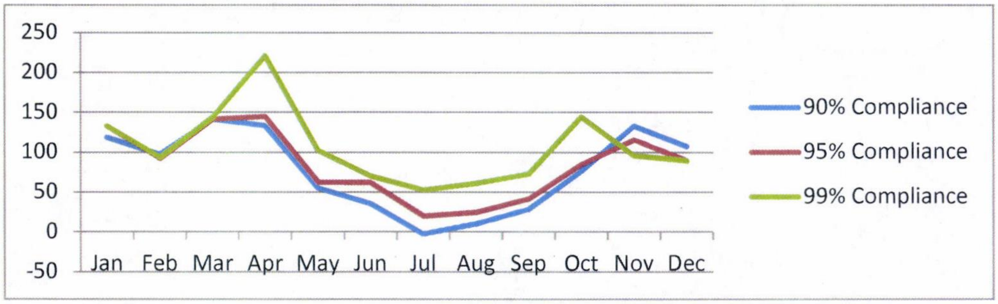

Figure 4-2 10-minute Reserve Requirement by Month in Year 2020 (+/-MW)

The amount of incremental regulating reserves required to integrate solar is less in the summer compared to other seasons during the year. This is the result of two factors. First, in the absence of incremental PV APS requires more reserves during the summer because loads are highest during this time and have greater variability. The higher amounts of reserves used to balance out ACE deviation caused by load forecasting errors also aids in solar integration. Second, there is less cloud coverage during summer months[11] which leads to less solar variability in the model, reducing

[11] May through September averages 20 clear days in Phoenix, while the rest of the year averages 16. See http://www.public.asu.edu/~aunjs/ClimateofPhoenix/wxpart4.htm#sun3

the need for reserves. The algorithm used to estimate variability in the solar datasets used the presence of clouds as the trigger for whether or not to add variability for a given 10 minute period. The net solar dataset shows the highest standard deviation between 10 minute periods from January to April, with relatively low variability from May to August. Review of actual 10 minute datasets provided by APS show mixed variability levels depending on location; since the model algorithm did not distinguish between partially cloudy and full cloudy days, this leads to months with full clear days (summer) having the least variation. The assumptions made in the model are conservative, likely producing more variation in the non-summer months than may actually exist.

As can be seen from Table 4-1, the "High Variability" case did not lead to a significantly greater amount of CPS2 violations in any of the cases. While the reasons are not entirely clear, this is likely due to three factors. First, the anticipated geographic diversity of the PV resources greatly smoothes out the aggregate generation profile. Referring back to Figure 2-3, this shows that for the aggregated solar profile in 2020 in one of the most volatile months (January), the average change from nameplate capacity over a 10 minute period is 2 to 3 percent. If the level of variation included in the dataset increases by 50 percent (as was assumed in the High Variability case), the maximum impact is modest (an increase in roughly 1 percent of nameplate, or 10 MW). However, this maximum impact assumes that the variation in each solar project is in the same direction, which is not the case. This leads to the second factor, that although individual project variation is now greater, the geographic diversity leads to some projects varying in the up direction while others vary downwards, eliminating some of the net impact. Finally, in modeling the High Variability solar datasets, additional time periods were included where clouds, and hence variability, is present. This does not necessarily lead to more CPS2 violations than the Base Case, since it is the level of variation, not the number of time periods where variation is present that is most important when calculating CPS2 violations. The level of reserves calculated in the Base Case may be sufficient to handle the majority of new variation created in High Variability time periods where there originally were none.

4.2.2 Year 2030 Reserve Requirements

The reserve requirements for 2030 are approximately 60 percent greater than the 2020 requirements at 99 percent CPS2 on an annual basis, consistent with the increase in solar PV. The summer requirements do increase at a greater rate, but still represent a small portion of the total installed PV capacity. Table 4-2 provides the monthly reserve requirements during daylight hours for different levels of CPS2 compliance, while Figure 4-3 depicts the inter-temporal reserve requirements throughout the year.

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BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

IN THE MATTER OF IDAHO POWER COMPANY'S APPLICATION TO IMPLEMENT SOLAR INTEGRATION RATES AND CHARGES.	)))))	**CASE NO. IPC-E-14-18** **IDAHO CONSERVATION LEAGUE**

DIRECT TESTIMONY

CAMERON YOURKOWSKI

EXHIBIT 206

IDAHO POWER RESPONSE TO ICL DATA REQUEST NO. 6

For Requests No. 6 through No. 10 please reference Exhibit 1 to the Direct Testimony of Phil Devol *[sic]*, Idaho Power Company Solar Integration Report (Solar Report).

REQUEST NO. 6: Please reference pages 10-11 of the Solar Report (pages 12- 13 of Exhibit 1):

a. When calculating the incremental reserve requirement for integrating solar generation, does the Company net the decremental, incremental, and total capacity needs identified for solar generation with the decremental, incremental, and total capacity held by the Company for managing the variability of other generation and load? Please explain why or why not.

b. Does the Company acknowledge that the scheduling error associated with solar generation nets with the scheduling error associated with other resources and load to form a total system error signal that is statistically smaller than the sum of the errors of the individual parts? If the Company disagrees with this principle, please explain why.

c. How much decremental and incremental capacity (in MW) does the Company hold in reserve to respond to wind scheduling errors?

d. Has the Company conducted an analysis of the effect of netting the scheduling errors of solar, wind, other generation, and load on the total reserve requirement? If so, please provide the results of such analysis. If not, please explain why the Company has not performed such an analysis.

RESPONSE TO REQUEST NO. 6:

a. Idaho Power does not net solar generation schedule errors with other generation sources, other schedule errors, or load. Idaho Power designed the solar integration study to identify the integration issues specifically associated with solar generation. The objective of the solar integration study is to identify the effects of the intermittent solar generation in order to calculate the integration cost imposed by solar upon Idaho Power's existing system. Idaho Power's system design includes the capability of system dispatchable generators to manage variability in customer load and other generation. Intermittent solar generation introduces new variability and uncertainty into system operations.

Because of the inherent differences and levels of confidence in load forecasts versus forecasts for intermittent generation, such as wind and solar, load forecast errors are often auto correlated, reflecting a tendency for forecast errors to persist in magnitude and direction throughout the day, and are more readily addressed as the system is managed through to real time. However, in order to maintain the reliable operation and stability of the system, as well as to meet its various regulatory reliability criteria, the Company must provide adequate reserves based upon the higher magnitude and nature of the forecast error present in intermittent and variable wind and solar forecasts. Thus, the challenges in forecasting wind and solar as compared to load for unit commitment are considerably different, requiring the system to treat differently the possibility of errors in forecasting these elements of load and resource balance.

b. Idaho Power does not acknowledge that the scheduling error associated with solar generation nets with the scheduling error associated with other resources and load to form a total system error signal that is statistically smaller than the sum of the errors of the individual parts. Please see the Company's response to 6.a above.

c. Idaho Power holds a minimum of .25 per megawatt ("MW") for up to 240 MW of wind or 60 MW incremental and 70 MW of decremental reserve for scheduling errors in real time; however, this is only a minimum and in most cases the operator will determine what amount of reserve is required beyond the minimum based on system conditions at that time. Additionally, the Company is required to hold 5 percent contingency reserve for the amount of wind generation on the system at any given time.

d. Idaho Power has not conducted an analysis of the effect of netting the scheduling errors of solar, wind, other generation, and load on the total reserve requirement. Please see the Company's response to 6.a above.

The response to this Request is sponsored by Phil DeVol, Resource Planning Leader, Idaho Power Company.

CERTIFICATE OF SERVICE

I hereby certify that on this 23rd day of October 2014, I delivered true and correct copies of the foregoing DIRECT TESTIMONY OF CAMERON YOURKOWSKI the following persons via the method of service noted:

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