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TESTIMONY of
FRANCIS R. PUYLEART, JUERGEN M. BERMEJO,
STEPHEN H. ENYEART, and KEVLYN D. MATHEWS
Witnesses for the Bonneville Power Administration

SUBJECT: BALANCING RESERVE CAPACITY QUANTITY FORECAST

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SUBJECT: BALANCING RESERVE CAPACITY QUANTITY FORECAST

Section 1: Introduction and Purpose of Testimony

Q. Please state your names and qualifications.
A. My name is Francis R. Puyleart, and my qualifications are contained in BP-14-Q-BPA-52.
A. My name is Juergen M. Bermejo, and my qualifications are contained in BP-14-Q-BPA-05.
A. My name is Stephen H. Enyeart, and my qualifications are contained in BP-14-Q-BPA-17.
A. My name is Kevlyn D. Mathews, and my qualifications are contained in BP-14-Q-BPA-44.

Q. What is the purpose of your testimony?
A. The purpose of our testimony is to sponsor the Balancing Reserve Capacity Quantity Forecast in the Generation Inputs Study, BP-14-E-BPA-05, section 2 (Study), and Generation Inputs Documentation, BP-14-E-BPA-05A (Documentation). Our testimony describes the development of the forecast of the balancing reserve capacity necessary to provide within-hour balancing services during the rate period. In addition, we describe the key components of the analysis and assumptions underlying the forecast methodology. Finally, we describe the results of our analysis using data sets that reflect 99.5 percent of the balancing reserve capacity requirement values, the impacts of
assuming that some generators may self-supply imbalance reserves during the rate period, the impacts of assuming that variable generators (wind and solar generation) schedule on the half-hour and quarter-hour scheduling intervals, and the impacts of 30-minute and 45-minute persistence scheduling accuracy for wind generation.

Section 2: BPA’s Balancing Reserve Capacity Requirements

Q. Why must BPA maintain balancing reserve capacity to provide within-hour balancing services within its balancing authority area?

A. BPA must maintain load-resource balance within its balancing authority area at all times. Study section 2.1.2. Load-resource balance means that the amount of energy being consumed inside the BPA balancing authority area (load) plus the amount of energy that is being scheduled out to other balancing authority areas equals the amount of energy being generated inside the BPA balancing authority area plus the amount of energy being scheduled in from other balancing authority areas. On a broad level, BPA must provide within-hour balancing in order not to burden the rest of the interconnection with changes to load or generation inside the BPA balancing authority area boundaries.

More specifically, BPA must comply with multiple North American Electric Reliability Corporation (NERC) and Western Electricity Coordinating Council (WECC) reliability standards. The primary standards that relate to within-hour balancing services are BAL-001-0a, Real Power Balancing Control Performance, and BAL-005-0b, Automatic Generation Control (AGC). The purpose of BAL-001-0a is to maintain interconnection steady-state frequency within defined limits by balancing real power demand and supply in real time. The requirements in BAL-001-0a limit how far out of load-resource balance a balancing authority can be before it violates the standard.
BAL-005-0b establishes requirements for balancing authority AGC necessary to deploy regulating reserve to maintain load-resource balance.

Q. What components make up the balancing reserve capacity requirements?

A. BPA separates its balancing reserve capacity requirements into regulating, following, and imbalance components. Id. The following reserve component is sometimes referred to as “load following” reserve. Our testimony and the Study use “following” and “load following” interchangeably.

Q. Please describe these components and how they interrelate.

A. Regulating reserve is the amount of balancing reserve capacity needed to balance the changes in load or generation on a moment-to-moment basis. Following reserve is the amount of balancing reserve capacity needed to balance the changes in average load and average generation every ten minutes over the course of an hour. The imbalance reserve component is the additional amount of following reserve caused by a difference between the actual hourly average load or generation and the hourly amount estimated (scheduled) for the load or generation. The summation of these components determines the total balancing reserve capacity requirement. Id.

Q. How is the imbalance component different from Generation or Energy Imbalance?

A. Generation and Energy Imbalance are used to settle the energy difference between schedules and actuals after the fact, while the imbalance component in the forecast is used to determine the amount of balancing reserve capacity needed to meet the balancing authority area balancing reserve capacity requirement. In addition, Generation Imbalance is based on the difference between the one-hour average actual generation and the generation estimated (scheduled) for the hour. Energy Imbalance is based on the difference between the one-hour average actual load and the load estimated (scheduled) for the hour.
Q. How does BPA use the balancing reserve capacity requirement and the various components determined in the Balancing Reserve Capacity Quantity Forecast?

A. The component quantities determined in the Balancing Reserve Capacity Quantity Forecast are used in the cost allocation methodology to forecast the revenues BPA will receive from providing balancing reserve capacity. *Id.* section 2.1.1. They are also used to assign costs to the Ancillary and Control Area Services rates, which use the component quantities to establish rates for these services. *Id.*

Q. Please explain how the balancing reserve capacity requirements are used to set the deployment limits for DSO 216.

A. Balancing reserve capacity requirements are used to establish the trigger setpoint levels for deployment of DSO 216. Warnings are sent to the wind projects when 85 percent of the balancing reserve capacity requirements are deployed for incremental (*inc*) or decremental (*dec*) reserves. When 90 percent of the *inc* balancing reserve capacity is deployed, schedules for all wind projects are reduced to the wind projects’ current generation level plus their allocated amount of the *inc* balancing reserve capacity requirement, if less than their schedule. If in the same operating hour the *inc* balancing reserves deployed reaches 100 percent, schedules for all wind projects are reduced to their current generation level, if less than their schedule. At the point when 90 percent of the *dec* balancing reserve capacity is deployed, all wind projects are instructed to reduce generation to their schedule plus their allocated amount of the *dec* balancing reserve capacity requirement. If in the same operating hour the *dec* balancing reserves deployed reaches 100 percent, all wind projects are instructed to reduce generation to their schedule.
Q. What resources does BPA use to provide generation for the overall balancing reserve capacity requirement to maintain balance within the hour?

A. BPA designates Federal Columbia River Power System (FCRPS) generating resources under AGC to provide the generation inputs necessary to maintain within-hour load-resource balance. BPA’s AGC system adjusts plant generation of these designated FCRPS resources based on the differences between scheduled and actual load and generation. The cumulative \textit{inc} and \textit{dec} generation required to maintain load-resource balance within the hour forms the basis for the balancing reserve capacity requirement. As the balancing reserve capacity requirement exceeds the amount of within-hour balancing reserves the FCRPS can provide, BPA will need to procure within-hour balancing reserves from non-FCRPS generators. AGC will deploy non-FCRPS within-hour balancing reserves in a similar manner to those provided by the FCRPS.

Section 3: Background of the Balancing Reserve Capacity Quantity Forecast Methodology

Q. How does the Balancing Reserve Capacity Quantity Forecast methodology used for this Initial Proposal differ from the methodology used for the FY 2012-2013 rate period?

A. The base methodology is similar to the one that was used to forecast balancing reserve capacity requirements for the FY 2012-2013 rate period, but we have continued to improve the methodology and have made certain modifications for the FY 2014-2015 rate period. We are using larger data sets to forecast the balancing reserve capacity requirement in this proceeding, and we have updated the data sets to include more recent information. The forecast for the FY 2012-2013 rate period was based on data sets for a 24-month study period from October 1, 2007, to September 30, 2009. The study period
for the Balancing Reserve Capacity Quantity Forecast in this Initial Proposal is the 48-month period from October 1, 2007, to September 30, 2011. *Id.* section 2.1.2.

In addition to wind generation data retrieved from BPA’s Plant Information system (PI) for the 48-month period listed above, we requested supplemental data from the wind project owners and operators in the BPA balancing authority area for the FY 2014–2015 rate period to use in instances where the PI wind generation data was not the most accurate data. The supplemental data is estimated generation data from the wind project, which is the theoretical output of the wind turbines online as calculated from the wind speed readings at each turbine and the power versus wind speed curve for that turbine. See Study section 2.3.1 for more details on these data.

For the FY 2012–2013 rate period, BPA used a generalized approach for assigning balancing reserve needs to solar generators of one-half of the balancing reserve requirements of wind generation’s regulation and load following. For the FY 2014–2015 rate period, BPA has acquired actual solar photovoltaic generation data from Sacramento Municipal Utility District (SMUD). We use this data to run a full analysis, similar to wind and load, of the balancing reserve capacity needs for solar generation. See Study section 2.4.3 for more details on these data.

We have refined the data set used to “scale in” the generation of wind projects expected to be online during the rate period. *Id.* section 2.3. We now have more actual wind generation data available to use in the Balancing Reserve Capacity Quantity Forecast than was available in the FY 2012–2013 rate proceeding, and we have incorporated more actual generation data into our analysis. In addition, we have expanded the methodology used to “scale in” generation to fill all missing data points in the wind generation. Section 2.3.2 of our testimony describes the changes in detail.
Section 4: Assumptions in the Balancing Reserve Capacity Quantity Forecast Methodology

Q. Have you prepared a detailed description of the Balancing Reserve Capacity Quantity Forecast methodology and the assumptions in your analysis?

A. Yes. Study section 2.7 describes our methodology in detail. The following sections of our testimony summarize key components of the methodology and certain assumptions.

Section 4.1: Installed Generation Capacity Assumption

Q. Please describe how you estimate the amount of generation capacity that will be online in BPA’s balancing authority area during the rate period for purposes of the Balancing Reserve Capacity Quantity Forecast.

A. BPA manages a generator interconnection “queue” that currently has over 80 requests pending, including small generation, representing almost 15,000 MW to interconnect to BPA’s transmission system. Many of those requests originally sought to interconnect by 2013. Because the majority of the interconnection requests in BPA’s queue at this point are for new wind generators, most of the discussion below reflects how we estimate the wind generation that will be online in BPA’s balancing authority area in the future. The Study includes all non-AGC-controlled generation types coming online during the rate case, such as hydroelectric, thermal, and solar photovoltaic generation as well as wind.

Prior to BPA offering an interconnection agreement and allowing the project to interconnect, each interconnection request must go through a series of studies called for under the interconnection procedures in BPA’s Open Access Transmission Tariff and environmental studies required under the National Environmental Policy Act (NEPA) and other Federal laws. Projects vary widely in terms of their siting process, the time it takes to complete the environmental studies, and the time required for BPA to construct the
required interconnection and network projects. We have used this internal forecast to
forecast the installed generation capacity during the rate period. See Documentation
Tables 2.1, 2.2, and 2.3.

Q. What factors and information do you consider in developing its assumptions about the
number of projects that will come online in the future and the timing of the
interconnection and energization of those projects?

A. We consider a variety of factors and information. One of the primary sources that we
consider is information that developers provide during the interconnection process. Each
request in the queue must go through a study process under BPA’s interconnection
procedures before BPA can offer an interconnection agreement and allow the project to
interconnect. Under this study process, we completed a series of studies regarding the
interconnection and conducts meetings with the customer to review the study results at
each phase. Those meetings include discussions with the customer regarding its project’s
plan of service, including the schedule for the interconnection.

The developer submits a proposed project schedule with the interconnection
request. We typically assume that the project will not interconnect earlier than the date in
the proposed project schedule, but most often the date is determined as the plan of service
is developed. During the meetings with us, the customer provides information such as its
siting process and timing, project scheduling, financing commitments, and turbine orders.
This information provides some general indicators of when the project is likely to
interconnect. We update the internal forecast of the study request at each study phase
based on customer-provided information and BPA’s schedule requirements. If the
developer has not demonstrated a desire to interconnect (for example, obtained financing
commitments or ordered turbines), we take that lack of readiness into account when
forecasting interconnection of that particular project.
The information provided by the developer in the interconnection process typically does not provide a complete picture of the circumstances surrounding a particular request. Based on our experience, we also evaluate the project schedules based on certain other criteria. For example, as described previously, BPA must conduct an environmental review before deciding whether to interconnect a particular generator. This review can take substantial time to complete, and BPA typically coordinates the review with the timing of the state or county environmental permitting process. As a result, the status of the environmental review process and interconnection customer permitting process for a request plays a significant role in our assumptions regarding interconnection and energization schedules. We also consider the specific interconnection and system projects that will be required to interconnect a particular project. Larger, more complex interconnection projects and network additions typically require more time to complete and are a factor for any particular project. As BPA and the customer establish a more well-defined plan of service in the interconnection process, we refine the forecast of the interconnection based on the particular network additions and interconnection plan of service required to interconnect the generator. Other projects in the queue, especially those with earlier request dates, also may affect the plan of service and related forecast for the later queued requests.

A customer may execute an engineering and procurement agreement to determine the project schedule once the studies have been completed, prior to completion of the environmental review. An engineering and procurement agreement typically commits the customer to provide funds for BPA to begin work on the design of the necessary interconnection projects or acquisition of equipment with a long lead time. When a customer executes an engineering and procurement agreement, we will incorporate the
project into its construction program schedule, which provides more certainty as to the
schedule for that particular project.

The last major factor is the customer’s commitment to a schedule to execute and
fund an interconnection agreement. Finally, once a customer agrees to fund the
interconnection projects and signs an interconnection agreement, we can establish a firm
construction schedule to be included in the forecast.

Q. When did you estimate which future projects would be online for purposes of the
Balancing Reserve Capacity Quantity Forecast used in the Initial Proposal?

A. For purposes of the Balancing Reserve Capacity Quantity Forecast prepared for the Initial
Proposal, we used a June 2012 forecast of generation interconnection dates. There are
several study stages that need to be completed to provide the balancing reserve capacity
and associated costs for the Initial Proposal, including the balancing reserve capacity
calculations and the cost determination of the reserve requirements. The installed
generation forecast is the first building block needed for the Balancing Reserve Capacity
Quantity Forecast. We finalized the forecast of projects in June to allow that data to be
used for the other studies and documentation that must be completed for the Initial
Proposal.

Q. What is your overall estimate for the amount of installed capacity for the different types
of generators that you expect to be online during the rate period?

A. Study Table 2.1 identifies the amount of installed capacity that we estimate will be online
during the FY 2014–2015 rate period for each type of generation in the Balancing
Reserve Capacity Quantity Forecast. The forecast of installed wind capacity is an
average of 4,871 MW; installed solar capacity is an average of 15 MW; non-
AGC-controlled hydroelectric capacity is an average of 2,527 MW; non-Federal thermal
capacity is an average of 5,192 MW; and Federal thermal capacity is 1,276 MW.
Q. Will you update your assessment of the amount of installed capacity that will be online
during the FY 2014–2015 rate period for the Final Proposal based on the most recent
information available at that time?
A. Yes. BPA periodically updates its projections regarding the amount of generation that
will come online in the future, and we intend to update our assessment for the Final
Proposal based on BPA’s most current update.

Q. How does your assessment account for economic factors such as recession, natural gas
prices, or changing tax incentives?
A. We rely on the customer meetings and conversations as to their project scheduling, and
the information on the progress of their site permitting process and expected completion.
This information provides some general indicators of when the project is likely to
interconnect, taking into account external economic factors. Indirectly, we also note the
utility industry direction and appetite for new generation, as discussed at public meetings
with BPA and others. More recently, we are now considering the overall goals of the
region for renewable portfolio standards as a more general indicator for the installed
capacity forecast over the next several years.

Section 4.2: Assumptions for Wind Generation: Scaling in Wind Generation

Q. What is meant by “scaling in” wind generation?
A. Scaling in wind projects refers to the process of estimating the output of future wind
projects or gaps in the data of existing wind projects based on the output of existing wind
projects. The term “scaling” in this case refers to applying a percentage to the existing
wind projects’ output (with associated lead or lag, explained below) to estimate the future
wind projects’ output.
Q. Why is scaling necessary for developing the Balancing Reserve Capacity Quantity Forecast?

A. The generation variability of all existing and future wind projects, and their associated schedules, affects the amount of balancing reserve capacity required in BPA’s balancing authority area. Without the scaled-in future wind projects in the Study, we risk forecasting less balancing reserve capacity than BPA would need to carry to meet the within-hour balancing requirements through the FY 2014–2015 rate period.

Q. Did you make any changes to your scaling methodology from that used for the FY 2012–2013 rate period? If so, what were the changes?

A. Yes. The scaling methodology was improved to allow for the methodology to fill in all missing data points. The FY 2012–2013 methodology was unable to fill in several large sections of missing data because of the way it used existing projects to scale in new projects and to fill missing data. There were several large sections of missing data for all projects that resulted in the scaling methodology attempting to use missing data to fill missing data. For example, if data from five minutes in the future is being used to fill in missing data for now and the data is also missing for five minutes into the future, then the scaling methodology cannot fill in the missing data point for now. The improvements made to the scaling methodology allow the code to rank and select other groups of existing plants to scale in the missing sections left by the FY 2012–2013 scaling methodology. Study section 2.3 describes the new scaling methodology in detail.

Q. Please summarize your analysis with respect to scaling in the generation for wind projects.

A. We use a 48-month data set (October 1, 2007, through September 30, 2011) with one-minute average actual wind generation data as a starting point. Study section 2.3.1. With that data set, we forecast the wind generation output for the rate period. We use the
installed capacity of the wind projects that BPA forecasts to be online during the rate period and calculate the future output using the prevalent direction of weather pattern changes and time delays between existing and future projects within the BPA balancing authority area. We use three existing projects to scale in the generation of a particular future project. The result is an estimate of the generation for the different amounts of installed wind capacity during the rate period. Id.

Q. Why do you use wind generation data from the study period October 1, 2007, to September 30, 2011, as the basis for your analysis regarding the generation of future wind projects?

A. As part of BPA’s ongoing efforts to reflect actual system behaviors in its rates, we expanded the data set used for the study to include the most up-to-date full-year data. For the FY 2014–2015 rate proceeding, we use the same data set as the FY 2012–2013 rate proceeding, with the following two years of data added, for a total of four years of data. For the FY 2012–2013 rate proceeding, BPA selected the two-year period prior to October 1, 2009, in order to avoid using data that would reflect operator interventions associated with the implementation of reliability and operating protocols by BPA. In order to address the potential issues that operator interventions cause in the data for the two additional years, BPA used a combination of expected generation output supplied by the existing wind projects in the BPA balancing authority area and the wind scaling methodology.

Q. What are the BPA reliability and operating protocols that could result in operator interventions, and how would those affect the data?

A. The reliability and operating protocols implemented by BPA are DSO 216, the CSGI pilot program, and BPA’s Oversupply Mitigation procedures. On October 1, 2009, BPA implemented DSO 216 to maintain reliability during severe and extremely low-
probability ("tail") events. The implementation of DSO 216 may result in limiting the output of projects to maintain reliability during tail events when those projects might have otherwise been generating. See Fisher et al., BP-14-E-BPA-21, sections 2, 5. Data from a period when DSO 216 was in effect might not fully reflect the variability in generation that BPA could face during the rate period.

In August 2010, BPA initiated the CSGI pilot program, in which participants supply the generation imbalance portion of their within-hour balancing reserves (there is currently only one participant in CSGI). The CSGI participant must meet performance metrics for the station control error of its wind projects netted with its balancing resources. While the participant may use a variety of means to meet the performance metrics, at times it must use operator limitation of its wind projects’ output to meet the metrics. Data from a period when the CSGI participant was modifying the output of its projects might not fully reflect the variability in generation that BPA could face during the rate period.

In the spring of 2011, BPA first adopted Oversupply Mitigation protocols to address times of concurrent high water flow and high wind generation that could affect Biological Opinion obligations. During the periods of Oversupply Mitigation, wind project operators were required to limit the output of their facilities to allow BPA to increase generation from the FCRPS. Fredrickson et al., OS-14-E-BPA-1, section 3. Data from a period when the Oversupply Mitigation protocol was in use might not fully reflect the variability in generation that BPA could face during the rate period.

Q. What was the expected generation output used in your analysis?

A. Prior to beginning the studies for the FY 2014–2015 rate proceeding, BPA requested the expected generation output of every wind project online during the period of October 1, 2009, to September 30, 2011. While some wind project owners have tuned the
calculation of expected generation beyond a basic approach, expected generation is
fundamentally a calculation of the predicted output for every online turbine based on the
wind speed reading from each turbine’s anemometer and the power versus wind speed
curve for that turbine. BPA received the expected generation data for approximately
75 percent of the wind projects in the BPA balancing authority area. The remaining
plants were filled through the scaling methodology laid out above.

Q. What is the basis for your assumption that you can predict generation for future wind
projects by using leading or lagging generation values from existing projects?

A. Weather data typically reflect a west-to-east wind pattern across the area from Hood
River east along the Columbia River, which is where most of the future wind projects are
planned. Documentation Table 2.2. 3TIER, a renewable energy forecasting and
assessment company, provided data to BPA in 2008 that showed the leads and lags
between the locations of certain existing and future projects in the balancing authority
area. That data reflected the west-to-east wind pattern, as well. The amount of time it
takes for a weather pattern to move across the area was calculated by BPA from
numerical weather model data provided by National Renewable Energy Laboratory for
calendar year 2004–2006. Study section 2.3.1. In addition, BPA used actual minute-by-
minute wind plant generation data and a mathematical modeling tool, MATLAB, to
analyze correlations between existing wind plants at various time offsets. The highest
correlated time offsets found between different existing wind plants reflected the west-to-
east wind pattern. Based on all this information, we forecast the future project generation
using the leads and lags from other projects. Id. Study section 2.3.1 explains the
development of the correlation and lead and lag data.
Q. How do you decide which existing projects to use to scale in a particular project?

A. Correlations, distances, and time delays are calculated for every project to every other project. For each future project, trios of existing projects are created and ranked by correlation, distance, and time delays. The highest ranked trio is used to scale in the new project. Id. section 2.3.2.

Q. Why did you use more than one existing project to scale in a future project?

A. The diversity of the output of the existing wind projects is an important factor when scaling in a future wind project. By using three existing wind projects, we are able to ensure that some of the diversity in wind output is reflected in the future wind projects. In other words, use of multiple projects at multiple time delays provides a means to reflect diversity in the analysis. If a single project were used, the estimated output of the future project would have the same pattern as the existing project, merely moved forward or backward in time.

Q. Please explain the adjustments that you made to the generation data to develop generation estimates for a particular wind project.

A. We time-shift generation of the existing project and develop ratios of the existing project capacity to the future project capacity. Id. Time-shifting means that the output of an existing project is moved forward in time if the weather pattern normally would reach the existing project before the future project or backward in time if the weather pattern normally would reach the existing project after the future project. We base the number of minutes the project output is shifted on the prevalent pattern seen in the area for existing projects and the lead and lag data.

As three projects are always used to create a scaled-in project, each of the three projects must be adjusted to reflect the scaled-in project’s installed capacity and the correlation of the three projects to the scaled-in project. To adjust for the installed
capacity of the scaled-in project, the existing project’s output is multiplied by the proposed installed capacity of the future project over the installed capacity of the existing project. *Id.* To adjust for the correlation of each existing project to the scaled-in project, the existing project’s output is multiplied by the existing project’s correlation to the scaled-in project over the sum of all three existing projects’ correlations to the scaled-in project. *Id.*

**Section 4.3: Assumptions for Thermal Generation**

**Q.** Please summarize your analysis regarding the balancing reserve capacity requirement associated with thermal generators.

**A.** We examined the historical balancing reserve capacity requirements of thermal generators in the BPA balancing authority area by analyzing the actual thermal generation and schedules for the same time period used for wind generation (October 1, 2007, to September 30, 2011). We assumed that future thermal projects would have the same balancing reserve capacity requirement as an existing thermal project per megawatt of installed capacity. Using 48 months of actual minute-by-minute data, we integrated thermal generation into balancing reserve capacity calculations similarly to wind, that is, as a reduction from load to account for coincidental balancing reserve capacity usage. We analyzed load, wind projects (existing and future), future solar projects, existing thermal projects, and existing hydro projects simultaneously for their contribution to the balancing reserve capacity requirements. As seen during the last rate proceeding, we found the use of balancing reserve capacity to be due primarily to the station control error (generation minus schedule) of thermal generators during startup, station control error during shutdown, and periods of excessive movement during the operating hour. *Id.* section 2.4.
Q. Is your method of analysis regarding the balancing reserve capacity requirement associated with thermal generators different from that used for the FY 2012–2013 rate period? If so, what has changed?

A. Yes. The primary analysis is identical to the FY 2012–2013 rate proceeding, but we reduce the non-Federal thermal projects’ within-hour balancing reserve requirement based on their improved performance between FY 2010 and FY 2011. This is consistent with the method used in the FY 2012–2013 rate proceeding and reflects the change in behavior seen after notification to the non-Federal thermal generators of the pending rate. The improvement seen from FY 2010 to FY 2011 was 7.8 percent in inc reserves and 5.1 percent in dec reserves. Any improvement seen during FY 2012 will be reflected in the Final Study.

Section 4.4: Assumptions for Hydroelectric Generation

Q. Please summarize your analysis regarding the balancing reserve capacity requirement associated with hydroelectric (hydro) generators.

A. We examined the historical balancing reserve capacity requirements of hydro generators in the BPA balancing authority area by analyzing the actual hydro generation and schedules for the same time period used for wind generation (October 1, 2007, to September 30, 2011). We assumed that future hydro projects would have the same balancing reserve capacity requirement as an existing hydro project per megawatt of installed capacity. We analyzed only non-AGC-controlled hydro generation because AGC-controlled hydro generation is used to supply BPA’s balancing reserve capacity requirement. Using 48 months of actual minute-by-minute data, we integrated hydro generation into balancing reserve capacity calculations similarly to wind, that is, as a reduction from load to account for coincidental balancing reserve capacity usage. Load,
wind projects (existing and future), future solar projects, existing thermal projects, and
existing hydro projects were analyzed simultaneously for their contribution to the
balancing reserve capacity requirements. Study section 2.4. Our analysis shows that
hydro’s use of balancing reserve capacity was minimal. Documentation Table 2.16.
Thus, hydro generators are not assessed balancing reserve capacity requirements for the
FY 2014–2015 rate proceeding. We propose to incorporate the balancing reserve
capacity requirements into the load-balancing reserve capacity requirements.

Q. Is your method of analysis regarding the balancing reserve capacity requirement
associated with hydro generators different from that used for the FY 2012–2013 rate
period? If so, what has changed?

A. We are using the same method of analysis for hydro for the BP-14 rate case as we used
for the BP-12 case.

Section 4.5: Assumptions for Solar Generation

Q. Please summarize your analysis with respect to scaling in the generation for solar
projects.

A. The forecast of installed capacity for the rate period includes an average of 15 MW of
solar generation. Because BPA has no utility-grade solar projects in its balancing
authority area at this time, BPA contacted other regional utilities with solar generation
and received one-minute solar photovoltaic generation data for an unscheduled
1.655 MW Sacramento Municipal Utility District (SMUD) project for the 48-month
period of study. The SMUD data is scaled to a 15 MW solar project, as forecast to be
online for the entire FY 2014–2015 rate period, by multiplying the generation data by
15 MW and dividing by the 1.655 MW installed capacity. Schedules were synthesized
from the data provided. Using the 48 months of actual minute-by-minute data, we
integrated solar generation into balancing reserve capacity calculations similarly to wind; that is, as a reduction from load to account for coincidental balancing reserve capacity usage. Load, wind projects (existing and future), future solar projects, existing thermal projects, and existing hydro projects were analyzed simultaneously for their contribution to the reserve requirements. *Id.* section 2.4.3.

**Q.** *How is this scaling method different from the method you used for scaling solar generation for the FY 2012–2013 rate period?*

**A.** During the FY 2012–2013 rate case, no actual solar data was available to integrate into the study, so we made assumptions regarding the variability of solar resources for the FY 2012–2013 rate period. The FY 2014–2015 Initial Proposal uses real solar generation data in a manner similar to that used for wind and load.

**Q.** *Please describe how you synthesized schedules for the solar generation data?*

**A.** From conversations with SMUD and other utilities with solar generation, we determined that a reasonable proxy for solar generation schedules is the hour of day average generation by month. All of the solar generation data was separated into bins by hour of day and month and then averaged, resulting in a value to be used for the schedule for that hour of the day in that month. For example, all of the one-minute data for the hour ending 12 (11:00 AM to 11:59 AM) for all four of the Julys in the data set were averaged, and that average was used as the schedule for every hour ending 12 in all four Julys in the data set. *Id.*
Section 4.6: Load Assumptions

Q. Please summarize how you derived the actual balancing authority area load and balancing authority area load forecasts in your analysis.

A. Similar to the generation data, we used a 48-month data set (October 1, 2007, to September 30, 2011) with one-minute average actual load data as a starting point. With that data set, we forecast the load through the rate period using load growth projections. We used hourly archived data for the load forecasts and adjusted that data using load growth factors for the forecasts for future years. Id. section 2.5.

Q. Has your method of deriving balancing authority area load and load forecasts changed from that used for the FY 2012–2013 rate period? If so, how has it changed?

A. We are using the same method of analysis for hydro for the BP-14 rate case as we used for the BP-12 case.

Q. Why is it necessary to take load estimates and forecasts into account in forecasting BPA’s balancing reserve capacity requirements?

A. Load variations affect the within-hour balance similarly to the impact of variation in generation. To accurately calculate the amount of balancing reserve capacity needed, the methodology needs to account for all factors that contribute to the balancing reserve capacity requirements forecast for the same time period as the generation in the Study.

Section 5: Forecasting the Total Balancing Reserve Capacity Requirement

Q. Please summarize your methods for forecasting the incs and decs associated with each reserve component.

A. With the generation and load data described previously, we created load net generation actual and load net generation schedule data sets for the forecast. The load net generation actual data set is the total actual load minus the total wind generation minus the total
actual thermal generation minus the total actual hydro generation. The load net

generation schedule data set is the total load forecast minus the total wind schedule minus
the total thermal schedule minus the total hydro schedule ramped in over 20 minutes. We
calculate the load net generation numbers for every one-minute clock period in the Study.
Id. section 2.7.1.

We used the load net generation numbers to create the ten-minute averages, one-
hour averages, and total schedules that are used to forecast the overall balancing reserve
capacity requirements for the BPA balancing authority area. To calculate the total
balancing reserve capacity components (regulation, following, and imbalance), we
determined the difference between the one-minute average of load net generation actual
and the ramped-in load net generation schedule for each minute of the 48-month study
period. Id.

To calculate the regulating reserve component, we determined the difference
between the one-minute average of load net generation actual and the ten-minute average
of the load net generation actual for each minute of the study period. Id. To calculate the
following reserve component, we determined the difference between the ten-minute
average of load net generation actual and the ramped-in one-hour average of the load net
generation actual for each minute of the study period. Id. To calculate the imbalance
component, we determined the difference between the ramped-in one-hour average of the
load net generation actual and the ramped-in load net generation schedule for each
minute of the study period. Id.

We calculated those values for each hour of the study period, resulting in 24 data
sets representing each hour of the day throughout the study period for each balancing
reserve capacity component. For example, all data that we downloaded or created for
regulating reserve for hour 1:00 to 2:00 for each day of the study period are combined
into one regulating reserve data set for hour 1:00 to 2:00. To develop our base forecast, we removed the highest 0.25 percent of the numbers from the *inc* side and the lowest (largest negative) 0.25 percent of the numbers from the *dec* side from the data set for each hour of the day. *Id.* section 2.7.2.

The resulting numbers contain 99.5 percent of values for each of the regulation, load following, and imbalance forecasts by hour of day for the FY 2014–2015 rate period. We used the maximum of the remaining numbers in each data set as the total *inc* and *dec* needed for each respective hour of the day and balancing reserve capacity component. The maximum of the 24 hours of the day is taken as the requirement for each balancing reserve capacity component. This entire process is repeated for the increasing levels of forecast installed wind to determine the balancing reserve capacity requirement for each month throughout the rate period. *Id.* section 2.7.3.

**Q.** Has your method of forecasting the *incs* and *decs* associated with each reserve component changed from that used for the FY 2012–2013 rate period? If so, how has it changed?

**A.** Our method of forecasting *incs* and *decs* has not changed from FY 2012–2013.

**Q.** Why do you discard a percentage of the highest numbers from the *inc* side and the lowest numbers from the *dec* side?

**A.** BPA has historically used 99.7 percent (three standard deviations) of the values resulting from the studies when calculating the amount of reserve needed for within-hour balancing reserve. This methodology was modified for the FY 2010-2011 rate period to 99.5 percent—in conjunction with the development of DSO 216—as a way to provide reliable service without the expense of providing balancing reserve capacity for every possible situation. Removing the additional 0.2 percent of variation slightly decreases the overall balancing reserve capacity requirement but, with existing reliability and
operational protocols BPA has in place, this 0.2 percent variation has not created
reliability issues or risk of violating the NERC or WECC standards or criteria.

Q. Why do you use the maximum values out of the hour-of-day data as the basis for the total balancing reserve capacity requirements?

A. BPA must set aside enough resources to meet almost all of the extreme contingencies on its system; so, for purposes of forecasting the amount of balancing reserve capacity required, it is reasonable to use the maximum hour out of the day after removing the most extreme events. In addition, this method more accurately distributes the total balancing reserve capacity requirement among the different components. While wind in the BPA balancing authority area is relatively independent of daily patterns, load, thermal generation, and hydro generation can be highly correlated to time-of-day patterns, which are more accurately captured using the maximum values out of the hour of day data.

Section 6: Allocation of the Total Balancing Reserve Capacity Requirement

Q. Please describe your method of allocating the total balancing reserve capacity requirement between generation resources and load.

A. Using the maximum numbers out of the 99.5 percent of the total inc and dec values described above, we determined the contribution of wind, solar, thermal, hydro, and load to the regulating reserve, following reserve, and imbalance reserve components for each hour of day using incremental standard deviation (ISD). Study section 2.7.3. The ISD measures how much the load and generation types contribute to the total load net generation reserve requirement, based on the sensitivity of the total balancing reserve capacity to variation in the individual components. Id.

We used the observed maximum allocation of reserve by component to calculate the relative contribution of each component to the total load net generation requirement.
Finding each component’s maximum allocated contribution to the reserve need regardless of the hour of day is done because the total load net generation requirement did not necessarily occur during the same hour of day as the maximum generation or load component. In order to ensure that we take into account the full variation, and therefore balancing reserve capacity requirements caused by load and the generation types, we used the maximum number from load, thermal, hydro, solar, and wind components irrespective of the hour of day in which those occurred. *Id.*

For each component, its percent allocation is calculated as the individual component’s requirement divided by the total requirement. For example, the wind percentage is calculated as the wind requirement divided by the load requirement plus wind requirement plus solar requirement plus thermal requirement plus hydro requirement. *Id.*

**Q.** Has your method of allocating the total balancing reserve capacity requirement between generation resources and load changed from that used for the FY 2012–2013 rate period? If so, how has it changed?

**A.** Our method of allocating the total requirement between generation and load has not changed.

**Q.** Please explain your basis for using the maximum wind, solar, thermal, hydro, and load components that you mention above.

**A.** We used the maximum components to depict most accurately the use of balancing reserve capacity in the BPA balancing authority area by the respective component (wind, solar, thermal, hydro, or load). *Id.* Because the maximum usage by wind, solar, thermal, hydro, and load does not occur on the same hour of the day, we propose to fairly distribute the total balancing reserve capacity requirement by using the maximum
requirement for each when calculating the percentage of the total requirement assigned to each.

Q. Why do you propose to use ISD to allocate the total reserve requirement to wind, solar, thermal, hydro, and load as opposed to other allocation methods?

A. ISD allocates the balancing reserve capacity need based on how each component contributes to the total balancing reserve capacity need. This approach takes into account any diversity benefits that may exist between the regulation signals for load, wind, solar, thermal, and hydro; the following signals for load, wind, solar, thermal, and hydro; and the imbalance signals for load, wind, solar, thermal, and hydro. *Id.* The result is an allocation of the 99.75 percent and 0.25 percent load net generation balancing reserve capacity requirements, where the individual load, thermal, hydro, solar, and wind reserve requirements linearly sum to the load net generation balancing reserve capacity requirement. *Id.*

Because the BPA balancing authority area is effectively a portfolio of megawatts, we use a calculation rooted in financial portfolio analysis. 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 purposes of allocating costs and establishing different rates for different types of service.

The expansion of ISD for the Initial Proposal allows us to allocate the reserve requirements among more components than the previous calculation used in the FY 2010–2011 rate case, which allocated reserve requirements between wind and load. This facilitates accounting for multiple sources identified as contributing to the balancing reserve capacity requirement. *Id.*
Section 7: Potential Impacts of Customer-Supplied Generation Imbalance and Intra-Hour Scheduling on the Generation Reserve Forecast

Q. What impact does CSGI have on balancing reserve capacity requirements during the rate period?

A. CSGI reduces the balancing reserve capacity requirements for the FY 2014–2015 rate period. We developed a forecast of the impact of CSGI that may result from customers supplying their own imbalance reserves. The results for 99.5 percent balancing reserve capacity levels with the CSGI assumptions are presented in Documentation Tables 2.17 through 2.24. The results for the 99.5 percent balancing reserve capacity levels without any CSGI assumptions are presented in Documentation Tables 2.10 through 2.16.

Q. What did you assume about the amount of installed wind capacity that will be partially balanced as a result of CSGI for purposes of your estimate?

A. We assumed that customers would self-supply imbalance reserves for approximately 1,438 MW of installed wind capacity as of October 2013 and that this amount would increase to approximately 1,538 MW by the end of the rate period. Documentation Table 2.17.

Q. What information did you rely on to make that assumption?

A. Our assumption is based on the most recent information about the CSGI pilot program and the extent of participation at this point. The current business practices related to CSGI establish processes and requirements for customers that want to participate in the CSGI pilot program. The process starts with a customer applying to participate in the CSGI pilot program and fulfilling the requirements of the CSGI business practice. Our assumption about CSGI reflects the most up-to-date information available, which is based on current CSGI participation data including the amount of installed wind capacity for
existing CSGI pilot program participants that have satisfied the requirements of BPA’s
CSGI-related business practices.

Q. **What impact would committed 30/30 or committed 30/15 scheduling have on the balancing reserve capacity requirement?**

A. Committed 30/30 or committed 30/15 scheduling reduces the balancing reserve capacity requirements for the FY 2014–2015 rate period. We developed a forecast of the impact of committed scheduling that may result from all wind generation scheduling on a 30-minute basis at 30-minute persistence forecasting accuracy and on a 15-minute basis at 30-minute persistence forecasting accuracy. The savings that would result from all wind generation in the BPA balancing authority area scheduling with 30-minute persistence on a 30-minute basis are presented in Documentation Tables 2.25 and 2.26. The savings that would result from all wind generation in the BPA balancing authority area scheduling with 30-minute persistence on a 15-minute basis are presented in Documentation Tables 2.27 and 2.28.

Q. **Do you intend to update the estimates based on CSGI election estimates for the Final Proposal?**

A. Yes. We intend to update the estimate based on the most up-to-date information available prior to the Final Proposal.

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

A. Yes.