B O N N E V I L L E   P O W E R   A D M I N I S T R A T I O N

2015 Pacific Northwest Loads and Resources Study

January 2016

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

January 20, 2016

In reply refer to: PGPR-5

Dear Interested Parties:

The Pacific Northwest Loads and Resources Study, commonly called "The White Book", is the Bonneville Power Administration's (BPA) annual publication of the Federal system and the Pacific Northwest (PNW) regions loads and resources for the upcoming ten year period.

The White Book is a planning document that summarizes BPA's latest forecast of loads and resources in the Pacific Northwest. The White Book forecasts the expected power obligations and generating resources for both the Federal system and the PNW region. The White Book is used by BPA as a planning tool, as a data source for the Columbia River Treaty studies, as an information source for customers, and as a published source of loads and resources information for other regional interests. The White Book is not used to guide day-to-day operations of the Federal Columbia River Power System or to determine BPA revenues or rates.

This 2015 White Book presents Federal system and the region's load obligations, contracts, and resources as of June 30, 2015 for operating years (OY) 2017 through 2026. The 2015 White Book includes four distinct studies:

- **Federal System Analysis**—forecast of Federal system firm loads and resources based on expected load obligations and different levels of generating resources that vary by water conditions. The results are summarized below:
  - Annual Energy Surplus/Deficits: Under critical water conditions; the Federal system is projected to have small annual energy surpluses of up to 102 aMW reducing to annual energy deficits of -298 aMW in 2025. These projections show smaller annual energy deficits than those projected in the 2014 White Book. In average water conditions; the Federal system is projected to have annual energy surpluses through the study period.
  - January 120-Hour Capacity Surplus/Deficits: Under critical water conditions; the Federal system is projected to have January 120-Hour capacity deficits over the study period, ranging from -880 MW to -1,195 MW. These 120-Hour capacity deficits are larger than those presented in the 2014 White Book, mainly driven by hydro modeling updates that impacted winter reservoir operations. In average water conditions; the Federal system is projected to have January 120-Hour capacity surpluses over the study period.
- **PNW Regional Analysis**—forecast of regional firm loads and resources based on expected retail loads and different levels of generating resources that vary by water conditions. This study assumes modest load growth and the availability of all uncommitted PNW Independent Power Producer (IPP) generation to serve regional loads. The results are summarized below:
  - Annual Energy Surplus/Deficits: Under critical water conditions; the PNW region is projected to have large annual energy surpluses of up to 2,912 aMW decreasing to 2,260 aMW over the study horizon. These projections show smaller annual energy surpluses than those shown in the 2014 White Book. In average water conditions; the PNW region would see even larger energy surpluses over the study horizon.

- January 120-Hour Capacity Surplus/Deficits: Under critical water conditions; the PNW region is projected to have small 120-Hour capacity surpluses through OY 2018 and deficits of up to -5,107 MW over the study horizon. These projections show larger 120-Hour capacity deficits than those shown in the 2014 White Book. In average water conditions; the PNW region has January 120-Hour capacity surpluses throughout the study horizon.

- **Federal System Needs Assessment**—evaluates the ability of Federal system resources to meet projected firm load obligations under a specific set of conditions and timeframes. These conditions include: extreme temperature conditions consisting of extreme winter and summer temperature events, varying economic conditions, changes in customer contract elections, and climate conditions. Of the metrics analyzed, HLH energy showed the largest deficits and as a result is the most limiting metric for the Federal system. The Needs Assessment was last presented in the 2012 White Book. The results of the Needs Assessment analysis are used as inputs to BPA's 2016 Resource Program, which analyses future resource needs for the Federal system.

- **Federal System Resource Adequacy**—analyses the ability of the Federal system to meet the aggregate energy and capacity demands at any time. This analysis provides a stochastic assessment of the probability of the Federal system not meeting firm load obligations, under many different load demand and resource supply combinations. To complete this analysis, BPA uses a Federal system version of the Northwest Power and Conservation Council's (Council) Generation Evaluation System (GENESYS) model.

BPA continues to work with other regional entities, particularly the Council and the Pacific Northwest Utilities Conference Committee, to coordinate loads, contracts, and resource information used in loads and resources planning. Deficits identified in these studies could be mitigated through the options discussed in the Council's Seventh Power Plan, as well as, additional regional mitigation options discussed through the Council's Resource Adequacy Advisory Committee.

Copies of the 2015 White Book may be obtained from BPA's Public Information Center, 1-800-622-4520. Details regarding regional loads, contracts, and generating resources are available in the 2015 Technical Appendix. The 2015 White Book and the 2015 Technical Appendix are available on BPA's website: *www.bpa.gov/power/whitebook*. Technical appendices are only available in electronic format.

Please send questions and/or comments to Tim Misley (503) 230-3942 or Steve Bellcoff (503) 230-3319.

Sincerely,

Kieran P. Connolly
Vice President, Generation Asset Management

Enclosure

2015 PACIFIC NORTHWEST LOADS AND RESOURCES STUDY
The White Book

BONNEVILLE POWER ADMINISTRATION
January 2016

Cover Picture:

Columbia Generating Station.
Source: Energy Northwest

The Columbia Generating Station (CGS) nuclear facility is the third largest electricity generator in Washington, behind Grand Coulee and Chief Joseph dams. CGS (formerly named WNP-2 until April 27, 2000) is the only commercial nuclear energy facility in the region. Columbia Generating Station is operated by Energy Northwest, BPA is contracted to sell and distribute the power generated. CGS began delivering power to the region in 1984, and is located north of Richland Washington on the Department of Energy's (DOE's) Hanford Nuclear Reservation. The plant uses water from the Columbia River for cooling.

ACKNOWLEDGMENTS

Preparation of the annual Pacific Northwest loads and resources study is a complex, multidisciplinary effort. BPA wishes to acknowledge the team—BPA staff and others—whose diligence and dedication result in a reliable, high quality document.

<u>Bonneville Power Administration</u>

Generation Asset Management:

Long Term Power Planning Group
Regional Coordination Group
Operational Planning Group

Customer Support Services:

Load Forecasting and Analysis Group

Bulk Marketing and Transmission Services:

Long Term Sales and Purchasing Group

NW Requirements Marketing:

Office of General Counsel

Power Services Business Operations

<u>Pacific Northwest Utilities Conference Committee</u>

<u>Northwest Power & Conservation Council</u>

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Section 1: Summary

Planning Context

The Pacific Northwest Loads and Resources Study (White Book) is a planning document produced by the Bonneville Power Administration (BPA) that presents its projection of load and resource conditions for the upcoming ten year period. The White Book analyzes BPA's forecasts of expected power obligations and generating resources for both the Federal system and the Pacific Northwest (PNW) region. The White Book contains information that is used for: 1) long-term planning throughout BPA; 2) planning studies for the Columbia River Treaty (Treaty); and 3) a published record of information and data for customers and other regional planning entities. The White Book is not used to guide day-to-day operations of the Federal Columbia River Power System (FCRPS) or to determine BPA revenues or rates.

BPA's White Book traditionally focuses on ong-term deterministic power planning, for the Federal system and the PNW region. BPA's Federal System Analysis calculates the Federal system load and resource balance by comparing expected Federal system loads and contract obligations to Federal system resources and contract purchases. In the same manner, BPA's PNW regional analysis calculates the regional load and resource balance by comparing expected regional retail loads and contract obligations to regional resources and contract purchases. Generating resource estimates for the Federal system and PNW region include hydro generation variability by incorporating streamflows from the PNW region's 80-historical water conditions. These deterministic analyses are modeled by operating year (OY[1]) to be consistent with BPA's water year planning processes. Results are presented in: 1) annual and monthly energy—expressed in average megawatts (aMW); and 2) monthly peak capacity—compiled for both 120-Hour and 1-Hour peak megawatts (MW). The Federal System Analysis is presented in Section 3, page 31, and the Pacific Northwest Regional Analysis is presented in Section 6, page 79.

BPA, like the rest of the electric power industry, continues to explore ways to more comprehensively plan and assess the power system using different sets of metrics and analysis. As a result, this White Book document incorporates two additional comprehensive studies to portray the ability of the Federal system to meet long-term load obligations. Along with the deterministic long-range planning results, this document includes the following studies: 1) Federal System Needs Assessment—that models a variety of load, contract, and weather events; and 2) Federal System Resource Adequacy—the stochastic modeling of the Federal system's ability to meet obligations under many different combinations of resource supply and load demands. The Federal System Needs Assessment and Federal System Resources Adequacy are fiscal year (FY[2]) based, unlike BPA's deterministic analyses which present information in OY.

[1/] Operating Year (OY) is the time frame August 1 through July 31. For example OY 2017 is August 1, 2016 through July 31, 2017.

[2/] Fiscal Year (FY) is the time frame October 1 through September 30. For example FY 2017 is October 1, 2016 through September 30, 2017.

Federal System Needs Assessment: The Federal System Needs Assessment evaluates the hourly ability of the existing Federal system resources to meet projected firm load obligations under a specific set of conditions and timeframes. These conditions include: extreme temperature conditions consisting of extreme winter and summer temperature events, varying economic conditions, changes in customer contract elections, and climate conditions. Resulting Federal system surplus/deficits serve as the foundational input to BPA's Resource Program. While the Resource Program is coordinated with the Needs Assessment, the Resource Program is published separately by BPA. The Needs Assessment was last presented in the 2012 White Book. Those results were provided as input to BPA's 2013 Resource Program. The Federal System Needs Assessment analysis is presented in Section 4, page 43.

Federal System Resource Adequacy: The Federal System Resource Adequacy analysis provides an hourly stochastic assessment of the probability of the Federal system to not meet firm load obligations under many different combinations of load demand and resource supply. Resource adequacy simply refers to the ability of a power system to meet the aggregate energy and capacity demand at any time. This analysis is used by BPA as it continues to explore and advance its understanding of resource adequacy as it relates to the Federal system. BPA uses a Federal system version of the Northwest Power and Conservation Council's (Council) Generation Evaluation System (GENESYS) model to stochastically assess the ability of the Federal system resources to meet Federal system load obligations. The Resource Adequacy study and results are presented in Section 5, page 61.

The Federal System Needs Assessment and Federal System Resource Adequacy assumptions are aligned with the draft version of the Council's Seventh Power Plan.

The 2015 White Book is published in three documents: 1) This Loads and Resources Summary document that presents BPA's deterministic Federal system and PNW regional loads and resources used for long-range planning. This document also includes the Federal System Needs Assessment and Federal System Resource Adequacy; 2) the 2015 White Book Technical Appendix, Volume 1, Energy Analysis—that shows detailed components of the annual and monthly energy for the Federal system and PNW regional loads, contracts, and resources; and 3) the 2015 White Book Technical Appendix, Volume 2, Capacity Analysis—that shows detailed components of the monthly 120-Hour and 1-Hour peak capacity for Federal system and PNW regional loads, contracts, and resources. The Technical Appendices are only available in electronic format at:

www.bpa.gov/power/whitebook

The total retail load, contract, and resource forecasts used in this study are for OY 2017 through 2026 and were updated June 30, 2015. This document supersedes the 2014 White Book.

Sources of Uncertainty

The forecasts and studies presented in this document represent the best information currently available under each of the defined metrics for loads and resources. However, almost all data forecasts are affected by uncertainty in economic conditions, weather, environmental and governmental policies, and other factors that could significantly affect the magnitude, duration and timing of projected surpluses and/or deficits. Some of these uncertainties include:

- Natural variations in weather affect electrical power demand and streamflow runoff that dictates hydroelectric power generation;
- Potential increases or decreases in retail loads due to changes in local, regional, and national economic conditions;
- Potential new large individual retail loads, and/or changes to major industrial operations;
- Potential service to new loads such as new public utilities, Department of Energy (DOE)-Richland vitrification plant operations, and major industrial operation that take service directly from BPA;
- Future local, state, and national policy requirements regarding the amount and type of renewable resources, conservation standards, electric vehicle saturation, and/or carbon emissions;
- Cost and availability of fuel due to environmental laws or competing uses for industry, transportation, and import/export markets; and changes to operating limits on existing and future thermal power installations resulting from environmental or climate-change objectives;
- Failure of existing or contracted generating resources to operate at anticipated times and/or output levels;
- Changes to hydro system operations in response to Endangered Species Act or other environmental considerations;
- Changes to Treaty obligations and operations;
- Availability of new and existing uncommitted regional resources that can be purchased to serve retail load;
- Availability and reliability of extra-regional import/export markets and transmission limits; and
- Future climate change impacts to retail loads, streamflows, and resources.

The potential effects from the variability of these and other factors on future loads and resources are not quantified for this report.

Resource Types

Regional resources consist of "on the ground" generating facilities and contract purchases that are used to serve retail loads and contract obligations. PNW resources—which include the Federal system—are predominately hydro based and generation levels can vary greatly from month-to-month and season-to-season. Resources are classified as: 1) Hydro resources—regulated, independent, and small hydro projects; 2) Other resources—cogeneration, combustion turbines, large thermal *(i.e. coal and nuclear)*, renewable resources *(i.e. wind and solar)*, and small thermal and miscellaneous resources; and 3) Contract purchases *(i.e. imports and intra-regional transfers)*. The generation forecasts for these resources are provided by BPA models or the project owners and are described as follows:

<u>Regulated Hydro Projects</u>: Regulated hydro projects mainly consist of PNW Columbia River Basin hydro dams for which the operation and generating capability is hydraulically coordinated to meet power and non-power requirements. BPA estimates the coordinated energy and capacity production from these hydroelectric power projects using its Hydrosystem Simulator (HYDSIM) model. The HYDSIM model takes into account individual project operating characteristics and conditions to determine energy production expected on a project-by-project basis. Generation estimates for these projects incorporate the month-to-month variations in power and non-power requirements that change for each of the 80-historical water conditions of record (1929 through 2008 water years). The HYDSIM model is described in Hydro Resource Modeling, page 10.

<u>Independent Hydro Projects</u>: Independent hydro projects include those hydro projects whose generation output typically varies by water conditions—like Regulated Hydro projects—but which are not operated as part of the coordinated Columbia River Basin system. Independent hydro generation estimates vary month-to-month for energy and capacity, and are developed and provided by individual project owners/operators for the same historic 80-historical water conditions set as the Regulated hydro projects.

<u>Small Hydro Projects</u>: Small hydro project generation forecasts are provided by individual project owners, or are based on historic actual generation. These generation forecasts can vary month-to-month but are not assumed to vary by water year.

<u>Thermal, Cogeneration, and Non-Wind Renewable Resources</u>: These projects include nuclear, coal, gas-fired, cogeneration, and renewable resources such as geothermal, solar, and biomass projects. Generation forecasts for these projects are based on energy and capacity capabilities submitted by individual project owners. These forecasts typically vary month-to-month and total plant generation outputs are reduced to account for scheduled maintenance.

Renewable Resources: These projects are comprised of wind farms, solar and biogas resources within the PNW. The forecast of firm wind generation incorporates the statistical modeling of wind generation based on historical weather data and actual generation from currently operating PNW wind projects. The operating year with the lowest total PNW wind generation is selected as the firm wind year. Each project's monthly generation (actual or estimated) during the firm wind year becomes that project's wind energy forecast. This methodology is consistent with previous White Books. The Federal system and PNW regional capacity analyses assume no capacity contribution from wind generation. Generation forecasts for solar and biogas resources are based on energy and capacity forecasts submitted by individual project owners.

Contract Purchases: Signed Federal system and regional contract purchases are treated as resources in both the Federal system and regional analyses. Purchases between entities within the PNW are called Intra-regional Transfers (In) and purchases with entities outside the PNW are called Imports. With the exception of the Columbia River Treaty, all existing Federal system and regional contract purchases follow individual contract terms through the life of the contract and are not assumed to be renewed.

Adjustments to Resources

Resources and contract purchases must be delivered to load centers. In order to distribute these resources within the region, this study makes adjustments to generating resource forecasts to account for: 1) operating reserves that are held to meet Federal system and regional reliability standards; and 2) transmission losses associated with power deliveries. These resource adjustments are reductions to both energy and capacity and are detailed below:

Operating Reserves: These studies include resource capacity reductions for operating reserves. Operating reserves consist of: 1) Contingency reserves (spinning and non-spinning) that respond to the unforeseen loss of a resource. Contingency reserve obligations are calculated by summing 3 percent of forecast load and 3 percent of forecast generation; and 2) Balancing reserves (regulating, load following, and generation imbalance) that are dedicated to maintaining within-hour load and resource balance, and include reserves for wind integration. BPA sets limits the for the amount of Incremental and Decremental reserves that can be served by the Federal hydro system. The modeling of Incremental and Decremental reserves, including those for wind integration, are described more thoroughly in Hydro Resources Modeling, page 10. The reserve forecasts included in this 2015 White Book are consistent, in calculation and assumption with the BP-16 Final Rate Proposal.

Transmission Losses: During the distribution and transmission of power to load centers some of this electrical energy is lost, usually in the form of heat. This lost energy is known as transmission losses. Transmission losses are calculated monthly based on the sum of all generating resource and contract purchase forecasts. Transmission losses vary year-to-year and by water conditions. The transmission loss factor is 2.97 percent for monthly energy, and 3.38 percent for monthly peak deliveries. These loss factors are assumed to be the same for every month and do not vary from year to year.

Hydro Resources Modeling

Hydro Energy Modeling: HYDSIM estimates the energy production that can be expected from the regulated hydroelectric power projects in the PNW Columbia River Basin. This includes the 14 largest projects in the Federal system, the mid-Columbia projects, and other major projects in the PNW. Project level generation forecasts are produced for each of the 80-historical water conditions of record—1929 through 2008 water years. Hydro energy production is maximized by coordinating hydro operations while continuing to meet power and non-power requirements. HYDSIM produces results for 14 periods, which are composed of 10 complete months plus April and August each of which is divided in half because natural streamflows often change significantly during the middle of these months. This is because in April and August there are key changes in operating constraints, such as flood control elevations, and fish migration streamflows which occur during the middle of the month. Consequently, the potential of hydro system generation can differ significantly between the beginning and end of these months. For simplicity, these 14-period results are referred to as "monthly" values in this report.

HYDSIM studies incorporate the power and non-power operating requirements expected to be in effect, including those described in the National Oceanographic and Atmospheric Administration (NOAA) Fisheries FCRPS Biological Opinion (BiOp) regarding salmon and steelhead, published May 5, 2008; the NOAA Fisheries FCRPS Supplemental BiOp, published May 20, 2010; the NOAA Fisheries FCRPS Supplemental BiOp, published January 17, 2014; the U.S. Fish and Wildlife Service (USFWS) FCRPS BiOp regarding bull trout and sturgeon, published December 20, 2000; the USFWS Libby BiOp regarding bull trout and sturgeon, published February 18, 2006; relevant operations described in the Northwest Power and Conservation Council's (NPCC) Fish and Wildlife Program; and other fish mitigation measures. Each hydro regulation study specifies particular hydroelectric project operations for fish, such as seasonal flow objectives, minimum flow levels for fish, spill for juvenile fish passage, reservoir target elevations and drawdown limitations, and turbine operation efficiency requirements.

The Pacific Northwest Coordination Agreement (PNCA) coordinates the planning and operation of the member's hydro power projects in the PNW Columbia River Basin. All PNCA project owners provide physical plant data and all power and non-power constraints in an annual data submittal. BPA incorporates this project data into HYDSIM to simulate the coordinated operation of the PNW hydro system with the most current characteristics.

The Columbia River Treaty (Treaty) between the United States and Canada enhanced the volume of storage in the Columbia River Basin with the construction of three large storage projects in Canada. These projects provide downstream power benefits by increasing the firm power generating capability of U.S. hydro projects. The Treaty calls for an Assured Operating Plan (AOP) to be completed six years prior to each operating year, and allows a Detailed Operating Plan (DOP) to be completed, if agreed, the year prior to the operating year. The Canadian project operations simulated in HYDSIM are based on the best available information from the Treaty planning and coordination process. As the DOP is usually completed a few months prior to the operating year, Canadian operations included in this

2015 White Book are based on the official 2016 AOP and 2017 AOP studies with minimal modifications that reflect expected updates in the official DOP studies.

Although either Canada or the United States have the ability to terminate most of the provisions of the Treaty any time after September 16, 2024, with a minimum 10 years' written advance notice. This study assumes the Treaty continues with the same or similar agreement through the study horizon.

Balancing reserves reduce the Federal system HLH generation forecast to account for within-hour reserve levels and include Incremental and Decremental reserves. Incremental reserves are modeled by reducing the maximum amount of generation at several projects. For this analysis, these Incremental reserves are shown—for capacity only—as *Load Following* reserves and *Generation Imbalance* reserves. The amount of Incremental balancing reserves supplied by the Federal system to 900 MW in all months, with the exception of April through July, where the supply is 400 MW. Decremental reserves represent the ability of the Federal system generation to decrease on command. Decremental reserves are incorporated in the calculation of useable hydro capacity which is estimated using BPA's Hourly Operating and Scheduling Simulator (HOSS) model discussed in Hydro Capacity Modeling, page 12. Decremental reserves supplied by the Federal system are to 900 MW for all months.

BPA has other operational agreements with Canada that are not part of the Treaty. One agreement is the Non-Treaty Storage Agreement (NTSA) with Canada that allows additional shaping of Columbia River flows for power and fish operations by utilizing additional storage in Canadian reservoirs not specified by the Treaty. The NTSA allows water to be released from Canadian non-Treaty storage during the spring of dry years. The NTSA also allows water to be stored in the spring during years when the spring flow targets from the 2008 NOAA BiOp are being met with a subsequent release of water in the summer. These operations have been included in this study based on the long-term agreement signed with B.C. Hydro in April 2012.

<u>Critical Water Planning</u>: To ensure sufficient generation to meet load, BPA bases its resource planning on critical water conditions. Critical water conditions are when the PNW hydro system would produce the least amount of power while taking into account the historical streamflow record, power and non-power operating constraints, the planned operation of non-hydro resources, and system load requirements. For operational purposes, BPA considers critical water conditions to be the eight month critical period of September 1936 through April 1937. However, for planning purposes the "critical period" is represented by the historical streamflows from August 1936 through July 1937 (1937-critical water conditions). The hydro generation estimates under 1937-critical water conditions determine the critical period firm energy for the regulated and independent hydro projects.

<u>Variability of Hydro Generating Resources</u>: The generating capability of Federal system and regional hydroelectric projects depends on the amount of water flowing through the facilities, the physical capacity of the facilities, streamflow requirements pursuant to biological opinions, and other operating limitations. Water conditions that

drive hydropower generation vary greatly year to year depending on weather factors such as precipitation, snowpack, and temperature. Project level hydro generation estimates are calculated for each of the 80-historical water conditions of record which are based on the period from 1929 through 2008 using HYDSIM. HYDSIM provides project level generating forecasts that incorporate streamflows and other modeling variables that estimate the coordinated operation of the reginal hydro system for each of the 80-historical water conditions.

To simplify the presentation of the variability in Federal system and regional hydro generation projections, this study uses three streamflow scenarios to represent the magnitude of hydro generation variability:

- Low water flows: 1937-critical water conditions—
  represented by 1936-1937 streamflows.
- Average water flows: 1958-water conditions—
  represented by 1957-1958 streamflows.
- High water flows: 1974-water conditions—
  represented by 1973-1974 streamflows.

Hydro Capacity Modeling: BPA uses its Hourly Operating and Scheduling Simulator (HOSS) model to calculate the amount of usable hydro capacity for long-range capacity planning purposes. The HOSS model is used to simulate the relationship of hydro energy to hydro peaking capability for Federal system regulated hydro resources. The hydro peaking capability assumes monthly heavy load hour (HLH) hydro generation is maximized and is not an indication of the Federal hydro system's ability to react to system distress. This relationship was simulated for a variety of hours per month over the sequence of the 80-historical water conditions.

The types of capacity shown in these studies are 1-Hour, 120-Hour, and 18-Hour. These capacity metrics were created by evaluating hourly generation over a specific period of time using the HOSS model and are defined as follows:

- 1-Hour Capacity—represents the monthly 1-Hour maximum capacity per month. BPA's forecasted 1-Hour capacity for Columbia River Basin regulated hydro projects are based on individual project full-gate-flow maximum generation, at mid-month reservoir elevations, over the sequence of 80-historical water conditions. The 1-Hour hydro capacity estimates, however, do not consider the ability of the hydro system to sustain generation levels needed to meet hour-to-hour, day-to-day, and/or month-to-month hydro operations. This inability to sustain full hydro capacity is because there are more hydro generating units than fuel (water) available to operate all units on a continuous basis. For this reason, other methodologies are used to produce hydro capacity estimates that better reflect the actual ability of the hydro system to generate peaking energy needed to meet expected peak firm load obligations throughout each month, based on the quantity of water available.

- 120-Hour Capacity—is defined by averaging the forecasted generation from the 6 highest heavy load hours per day, 5 days a week, for 4 weeks across a month *(6 x 5 x 4 = 120 hours)*. BPA's 120-Hour capacity forecasts for the Federal hydro system are calculated monthly and are aggregated in a specified manner from hourly HOSS studies. HOSS studies use the same HYDSIM monthly distribution of reservoir storage and streamflow runoff as a base. For each month, the HOSS model estimates hourly Federal system hydro generation by maximizing energy and capacity production while meeting non-power requirements. The 120-Hour capacity forecasts take into account scheduled hydro maintenance estimates, as well as operating and balancing reserves, which are netted out for reporting purposes.

- 18-Hour Capacity—is defined by averaging the 6 highest load hours for 3-consecutive days assuming a specific set of weather conditions *(6 x 3 = 18 hours)*. The 18-Hour capacity metric estimates the Federal system's hydro generating capability over the 3-day extreme weather event. Extreme weather events in this study are modeled in February—representing a cold snap and the 2nd half of August—representing a heatwave. These months tend to be the most limiting timeframes for the Federal system to meet load obligations.

The two main capacity methodologies focused on in this study are: 1) the 120-Hour capacity included in the Federal System Analysis and the PNW Regional Analysis; and 2) the 18-Hour capacity included in the Federal System Needs Assessment. The 1-Hour capacity forecasts are included in the Technical Appendix for informational purposes only. The capacity presented in this analysis can be expressed as either capacity in megawatts (MW) or as an energy over peak load hours in average megawatts (aMW).

Key Assumption Changes

The 2015 White Book includes updated forecasts of the Federal system's power sales contract (PSC) obligations, the region's retail load, contracts, and generation through June 30, 2015. Notable updates include:

- Lower load estimates due to slower than anticipated economic growth (recovery from the 2008 recession);
- Improved peak load forecasts that better approximate recent actual peak loads;
- Lower Federal system DSI load obligations due to the reduction in BPA's Alcoa contract demand from 300 aMW to 75 aMW; and
- Adjusted WNP-3 Settlement contract purchase amounts with Puget Sound Energy and Avista Corporation, to account for the decommissioning of the San Onofre Nuclear Generating Station (SONGS) nuclear plant by removing the project from the segregate project group used in the settlement calculation.

No changes have been made in regard to possible future modifications to the Treaty or to climate change assumptions.

Section 2: Federal System Analysis

The Federal System Analysis provides a deterministic projection of Federal system loads and resources over a 10-year period from OY 2017 through 2026. This analysis incorporates forecasts of firm requirements Federal system power sales contract (PSC) obligations, contract sales and purchases; and generating resources. Firm Federal load and resource forecasts for energy and 120-Hour capacity are presented in this document. Detailed components from the Federal system study are available electronically in the 2015 White Book Technical Appendix, Volume 1, Energy Analysis—which presents annual and monthly energy in aMW; and the 2015 White Book Technical Appendix, Volume 2, Capacity Analysis—which presents monthly 120-Hour and 1-Hour peak capacity.

Load Obligations

BPA's Agency Load Forecasting (ALF) tool is used to forecast Federal system and regional load forecasts. ALF uses a statistical approach to generating 'Load Forecasts' that is based on time-series-based regressions that follow the fundamental assumption that historical retail electricity consumption patterns will continue into the future. The Federal System Load Obligation forecast includes: 1) Federal reserve power obligations to the U.S. Bureau of Reclamation (USBR); 2) BPA's projected Regional Dialogue PSC obligations to Public and Federal agency customers; 3) contract obligations to investor-owned utilities (IOUs); 4) contract obligations to DSIs; and 5) other BPA contract obligations—including entities outside the Pacific Northwest region (Exports) and those within the Pacific Northwest region (Intra-Regional Transfers (Out)). Summaries of BPA's forecasts of these obligations are as follows:

PSC obligations to Public & Federal agency customers: In December 2008, BPA executed PSCs with Federal agency, Public agency, and Tribal utility customers under which BPA is obligated to provide power deliveries from October 1, 2011, through September 30, 2028. Three types of contracts were offered to customers: Load Following, Slice, and Block. Of the 135 BPA Public agency customers who signed Regional Dialogue Contracts; 118 are Load Following, 16 are Slice, and one is a Block only contract.

Under these PSCs, customers must make periodic elections to serve their load growth and Above Rate High Water Mark (A-RHWM) load by 1) adding new non-Federal resources; 2) buying power from sources other than BPA; and/or 3) requesting BPA to supply power. The current customer elections have been set through FY 2019, and are assumed to continue through the study period. Based on this assumption, Federal system PSC obligation forecasts include elected and forecasted A-RHWM load for the study period. Table 2-1, page 16, presents the A-RHWM load included in BPA's obligations and is shown in FY to be consistent with the BP-16 Final Rate Case.

Table 2-1

Federal System
Annual Above Rate High Water Mark (A-RHWM) Obligations
FY 2017 through 2026

Energy (aMW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
A-RHWM Obligations	79	182	209	216	251	284	319	340	361	376

IOU Load Service under PSCs: The six IOUs in the PNW region are Avista Corporation, Idaho Power Company, NorthWestern Energy Division of NorthWestern Corporation (formerly Montana Power Company), PacifiCorp, Portland General Electric Company, and Puget Sound Energy, Inc. The PNW IOUs all signed BPA PSCs for FY 2011 through 2028; however, no IOUs have chosen to take service under these contracts and no net requirements power sales are assumed for the IOUs through the study period. If requested, BPA would serve any net requirements of an IOU at the New Resource Firm Power rate.

DSI contracts: BPA is currently making power sales and deliveries to Alcoa and Port Townsend Paper Corporation (Port Townsend). Both Port Townsend’s and Alcoa’s contracts run through September 30, 2022. As noted, the Federal system DSI load obligation to Alcoa has been reduced from 300 aMW to 75 aMW.

USBR obligations: BPA is obligated by statute to provide Federal reserve power to several irrigation facilities and districts associated with USBR projects in the PNW. These irrigation districts have been congressionally authorized to receive reserved power from specific FCRPS projects as part of USBR project authorization.

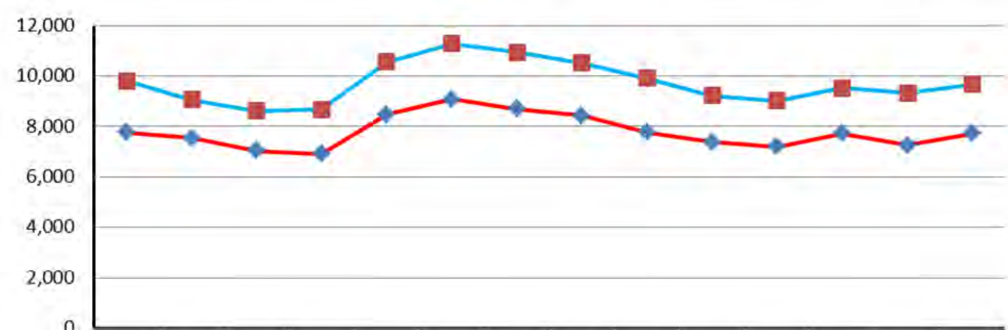
Other Contract Obligations: BPA provides Federal power to customers under a variety of contract arrangements not included under its Regional Dialogue PSC and reserve power obligations. These contract obligations are categorized as 1) power sales; 2) power or energy exchanges; 3) capacity sales or capacity-for-energy exchanges; 4) power payments for services; and 5) power commitments under the Treaty. These arrangements, collectively called “Other Contract Obligations,” are specified by individual contract provisions and can have various delivery arrangements and rate structures. BPA’s Other Contract Obligations are assumed to be served by Federal system firm resources regardless of weather, water, or economic conditions. These contracts include power deliveries to entities outside the PNW region (Exports) and obligations delivered to entities within the PNW region (Intra-Regional Transfers (Out)). With the exception of power commitments under the Treaty, these deliveries follow individual contract terms and are not assumed to be renewed after expiration. All Treaty power deliveries are assumed to be in place through the study horizon.

Load Shape: The forecasted Federal system firm loads show a modest average annual growth rate of approximately 0.24 percent over the study period. While BPA's PSC firm requirements load increases over the study period, BPA exports and intra-regional transfers are lower due to the expiration of contracts and settlement agreements through the study period. Contracts that expire over the study horizon include surplus Federal power sales with the Cities of Pasadena and Riverside, the wind energy shaping contract with Pacific Gas and Electric, and WNP-3 settlements with Avista Corporation and Puget Sound Energy. When all of these factors are considered, the total Federal system firm load obligations remain relatively flat on an annual basis over the study period.

BPA loads on a monthly basis can vary greatly throughout the year. BPA forecasts higher loads in the winter (November through February) mainly due to lower temperatures that increase residential heating loads. Lower load obligations are forecasted during the summer and early fall when temperatures are mild. Summer loads in July and August tend to be slightly higher than the rest of the summer due to increased PNW residential air conditioning load to cool homes. Table 2-2, below, illustrates the monthly shape of the forecasted Federal system firm load obligations. Monthly average energy and 120-Hour capacity are projected to maintain a similar monthly shape over the study period.

Table 2-2

Federal System
Monthly Energy and 120-Hour Capacity Firm Load Obligations
OY 2017



	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Energy (aMW)	7,764	7,545	7,033	6,906	8,478	9,069	8,686	8,428	7,756	7,385	7,205	7,725	7,257	7,726
120 Hour Cap (MW)	9,804	9,057	8,618	8,666	10,566	11,286	10,952	10,512	9,909	9,217	9,022	9,534	9,328	9,663

Conservation: The PSC obligation forecasts developed by ALF are based on historic retail load consumption; therefore, public power's share of embedded conservation is included in these forecasts. Table 2-3, below, shows embedded conservation estimates that are included in BPA's obligation forecast, and are based on the public power share of regional conservation, that has historically been considered to be 42 percent. The Council tracks historic regional conservation which provides the conservation amounts embedded in historical loads. These conservation amounts are used to estimate the regional conservation embedded in the retail load forecast, which are presented in Table 3-2, page 32.

Table 2-3

Federal System
Annual Embedded Conservation in BPA's Obligation Forecast
OY 2017 through 2026

Energy (aMW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation in Forecast	77	90	92	95	98	100	103	105	108	111

Resources

In the PNW, BPA is the Federal power marketing agency charged with marketing power from Federal dams and other projects, and providing transmission to serve the firm electrical load needs of its customers. BPA does not own generating resources, rather, BPA markets power from Federal and certain non-Federal generating resources to meet BPA's customer's load obligations. In addition, BPA purchases power through contracts that add to the Federal system generating capability. These resources and contract purchases are collectively called "Federal system resources" in this study. Federal system resources are classified as 1) Hydro Resources—regulated, independent, and small hydro; 2) Other Resources—large thermal, renewable, cogeneration, combustion turbines, and small thermal and miscellaneous; and 3) Contract Purchases—imports, intra-regional transfers(in), non-Federal CER deliveries, and slice transmission loss returns.

Federal System Resources Types: Table 2-4, page below, summarizes BPA's resources and contract purchases available to meet the Federal system firm load obligations. For OY 2017, Federal system firm energy resources—under 1937-critical water conditions—are comprised of approximately 83 percent hydro, 11 percent nuclear, 5 percent contract purchases and 1 percent renewables. Federal system renewable resources are mainly comprised of wind and a small amount of solar.

Table 2-4

Federal System
Generation by Resources Type
OY 2017
1937-Critical Water Conditions

Resource Type	Annual Energy (aMW)	Percent of Firm Energy	January 120-Hour Capacity (MW)[a/]	Percent of Capacity
Hydro	6,711	83.0%	10,144	85.1%
Nuclear	916	11.3%	1,120	9.4%
Cogeneration	0	0.0%	0	0.0%
Renewables	60	0.7%	0	0.0%
Contract Purchases	402	5.0%	659	5.5%
Total Federal Resources	8,089	100.0%	11,923	100.0%

[a/] Federal resource estimates are before adjustments for reserves and transmission losses

Details of the summarized resources and contract purchases presented in Table 2-4, above, are presented in the following tables.

Federal System Hydro Resources: Table 2-5, page 21, shows the Federal system hydro resources from which BPA markets firm and non-firm power. Additionally, Table 2-5 also shows the variability of individual Federal system hydro project generation levels for the 3 water conditions that represent critical, average and high streamflow conditions. The variability of hydro generation is discussed starting on page 11.

Non-Hydro Federal System Resources: Federal system non-hydro resources are generating resources whose output are either assigned to or have been purchased by BPA. Table 2-6, page 22, shows these generation resources, which include: 1) Columbia Generating Station (Large Thermal); and 2) renewable energy from wind projects—including wind projects that BPA shapes for other entities under contract—and several small solar projects. These forecasts are generally consistent from year to year, but may change annually based on annual maintenance, refueling, and incorporating capital improvements into generation estimates. Since the 2014 White Book, BPA's generation output purchase from the Georgia Pacific Wauna project has expired (March 31, 2016).

Federal System Contract Purchases: BPA purchases or receives power under a variety of contract arrangements—from both inside (Intra-Regional Transfers (In)) and outside the PNW region (Imports)—to help meet Federal load obligations. These contract purchases, presented in Table 2-6, page 22, are made up of; 1) power purchases, 2) power or energy exchange purchases, 3) power purchased or assigned to BPA under the Treaty, and 4) transmission loss returns under Slice contracts. BPA's contract purchases are considered firm resources that are delivered to the Federal system regardless of weather, water, or economic conditions. The transmission loss returns category captures the return of Slice transmission losses to the Federal system that are part of the Slice contracts, which acts as a Federal system resource. With the exception of Treaty and Slice contracts, each contract purchase follows specific delivery terms and expiration dates and are not assumed to be renewed. The Treaty and Slice contracts are assumed to be in place through the study horizon.

Table 2-5

Federal System
Hydro Resources by Project
Energy and Capacity OY 2017

Project	Initial Service Date	Operator	Number of Units	Nameplate Rating (MW)	120-Hour Generating Capacity [a] (Peak MW)	High Streamflows Energy (aMW)	Average Streanflows Energy (aMW)	Firm Energy [b] (aMW)
Regulated Hydro								
1. Albeni Falls	1955	USACE	3	49	22.5	19.2	23.6	23.6
2. Bonneville [c]	1938	USACE	20	1,195	921	618	566	390
3. Chief Joseph	1955	USACE	27	2,614	2,374	1,561	1,361	1,101
4. Dworshak	1974	USACE	3	465	434	215	193	138
5. Grand Coulee /	1941	USBR	27	6,735	5,121	2,856	2,439	1,924
GCL Pumping	1973		6	314				
6. Hungry Horse	1952	USBR	4	428	319	123	89	76
7. Ice Harbor	1961	USACE	6	693	586	298	206	109
8. John Day	1968	USACE	16	2,480	2,295	1,396	1,083	786
9. Libby	1975	USACE	5	605	483	258	231	192
10. Little Goose	1970	USACE	6	930	859	420	283	179
11. Lower Granite	1975	USACE	6	930	737	419	288	174
12. Lower Monumental	1969	USACE	6	930	810	451	308	181
13. McNary	1953	USACE	14	1,120	1,036	617	594	479
14. The Dalles	1957	USACE	24	2,052	1,830	1,031	823	601
15. *Idled Federal Capacity*	-	-	-	-	*-7,933*	-	-	-
16. Total Regulated Hydro Projects			**173**	**21,540**	**9,894**	**10,283**	**8,486**	**6,355**
Independent Hydro Projects								
17. Anderson Ranch	1950	USBR	2	40	4.3	19.7	19.6	13.0
18. Big Cliff	1954	USACE	1	21	3.2	13.2	12.2	9.7
19. Black Canyon	1925	USBR	2	10	3.3	8.3	7.5	6.2
20. Boise Diversion	1908	USBR	3	3	0.0	1.2	1.3	1.1
21. Chandler	1956	USBR	2	12	4.5	6.1	6.3	5.6
22. Cougar	1964	USACE	2	28	5.9	17.9	19.6	18.8
23. Cowlitz Falls	1994	LCPD#1	2	70	10.0	40.3	27.7	26.2
24. Detroit	1953	USACE	2	115	102.7	52.2	44.6	33.3
25. Dexter	1955	USACE	1	17	2.9	11.7	11.2	9.3
26. Foster	1968	USACE	2	23	3.2	14.3	11.7	12.2
27. Green Peter	1967	USACE	2	92	8.0	39.4	29.0	26.9
28. Green Springs	1960	USBR	1	18	6.7	7.3	7.3	7.3
29. Hills Creek	1962	USACE	2	34	4.0	22.0	22.3	17.8
30. Idaho Falls Bulb	1982	IFP	4	27	22.3	19.7	16.4	14.0
31. Lookout Point	1954	USACE	3	138	7.5	47.2	40.7	35.3
32. Lost Creek	1975	USACE	2	56	43.7	43.4	45.4	30.0
33. Minidoka	1909	USBR	4	28	2.1	22.5	16.6	11.2
34. Palisades	1957	USBR	4	176	9.2	96.2	84.1	69.2
35. Roza	1958	USBR	1	13	1.9	8.7	7.6	6.9
36. Total Independent Hydro Projects ***(sum lines 17 through 35)***			**42**	**921**	**245**	**491**	**431**	**354**
Small Non-Federally Owned Hydro Projects								
37. Dworshak/Clearwater Small Hydro	2000	ID DWR	1	5.4	3	2.6	2.6	2.6
38. Rocky Brook	1985	MCPD#1	1	1.6	1.6	0.3	0.3	0.3
39. Total Non-Federally Owned Hydro Projects ***(line 37 + line 38)***			**2**	**7**	**4.6**	**2.9**	**2.9**	**2.9**
40. Total Hydro Generation ***(line 16 + line 36 + line 39)***			**217**	**22,468**	**10,144**	**10,777**	**8,920**	**6,711**

[a] This is the maximum hydro generation using optimum conditions for January 2017 assuming 1937-critical w ater conditions
[b] Firm energy is the 12-month annual average for OY 2017 assuming 1937-critical w ater conditions
[c] Bonneville Dam includes the Bonneville Fishw ay generation in totals

Table 2-6

Federal System
Non-Hydro Resources by Project and Contract Purchases
Energy and Capacity OY 2017

Project	Initial Service Date	Resource Type	Operator	Capacity [a/] (Peak MW)	Firm Energy (aMW)
Non-Hydro Resources					
1. Columbia Generating Station	1984	Nuclear	ENW	1,120	916
2. Condon Wind Project	2002	Wind	Condon Wind Project, LLC	0	9.65
3. Foote Creek 1	1999	Wind	Foote Creek 1, LLC	0	3.98
4. Foote Creek 4	2000	Wind	Foote Creek 4, LLC	0	4.4
5. Stateline Wind Project	2001	Wind	PPM, FLP	0	20.7
6. Klondike Phase I	2001	Wind	NW Wind Power	0	6.8
7. Klondike Phase III	2007	Wind	NW Wind Power	0	14.2
8. Fourmile Hill Geothermal [b/]	Not in Service	Geo.	Calpine	0	0
9. Ashland Solar Project	2000	Solar	City of Ashland, OR	0	0
10. White Bluffs Solar	2002	Solar	Energy Northwest	0	0
11. Total Federal System Non-Hydro Resources ***(sum lines 1 through 10)***				**1,120**	**976**
Contract Purchases					
18. Canadian Entitlement for Canada (non-Federal)				239	137
19. Canadian Imports				1	1
20. Pacific Southwest Imports				75	89
21. Intra-Regional Transfers In (Pacific Northwest Purchases)				242	141
22. Slice Transmission Loss Return				52	35
23. Total Federal System Contracted Purchases ***(sum lines 18 through 22)***				**1,117**	**402**
24. Total Federal System Non-Hydro Resources and Contract Purchases ***(line 11 + line 23)***				**2,237**	**1,378**

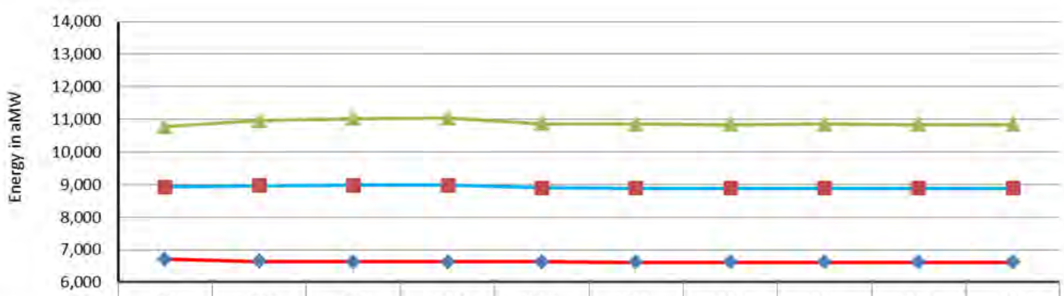
[a/] This is the maximum generation using optimum conditions for January 2017

[b/] Fourmile Hill is not assumed to be in operation within the study period

Federal System Hydro Resource Variability: The generating capability of Federal system hydroelectric projects depends on the amount of water flowing through the facilities, the physical capacity of the facilities, streamflow requirements pursuant to biological opinions, and other operating limitations. Table 2-7, below, shows the annual variability of the Federal system hydro generation under three streamflow scenarios: 1) 1937-critical water conditions, representing the firm energy capability; 2) 1958-water conditions, representing average streamflows; and 3) 1974-water conditions, representing high streamflows.

Table 2-7

Federal System
Variability of Annual Hydro Resource Generation
OY 2017 through 2026
Under Different Water Conditions

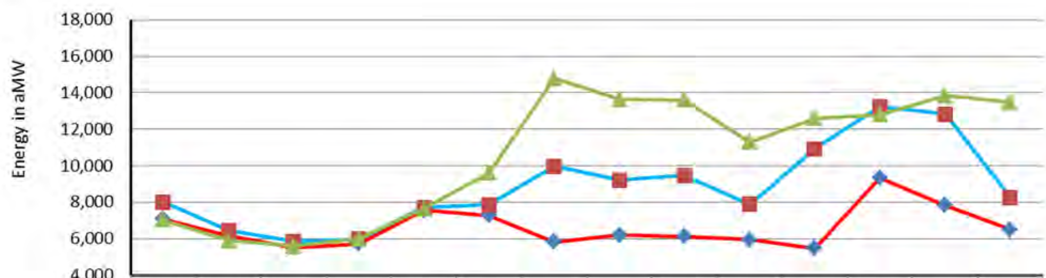


	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Critical Water (1937)	6,711	6,634	6,633	6,631	6,628	6,616	6,614	6,613	6,614	6,614
Average Water (1958)	8,920	8,971	8,977	8,977	8,896	8,882	8,879	8,880	8,879	8,879
High Water (1974)	10,777	10,965	11,027	11,034	10,865	10,848	10,846	10,856	10,845	10,845

In OY 2017, annual Federal system hydro energy generation, under 1937-critical water conditions, is forecasted to be 6,711 aMW. However, the generating potential from these same Federal system hydro resources can annually be as high as 10,777 aMW in high streamflows conditions as represented by 1974-water conditions. While Table 2-7, above, shows the annual variability of Federal system hydro generation, Table 2-8, page 24, shows the monthly variability of the Federal system hydro generation for OY 2017, under the same three streamflow scenarios. High generation levels in the December through mid-April period is largely due to drafting reservoirs for power production and flood control, which can vary widely due to rainfall and snowpack levels in the Columbia River Basin. Power production in late-April through July is variable due to the timing and amount of the Columbia River Basin snowmelt runoff. Power production decreases through the end of the summer and early fall as streamflows are reduced due to depleted snowpack and lower precipitation levels. There is little monthly water variability on the Federal system hydro resources August through December. The monthly hydro resource generating capability can vary by up to 8,700 aMW depending on project operations and the availability of water.

Table 2-8

Federal System
Variability of Monthly Hydro Resource Generation
OY 2017
Under Different Water Conditions



	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Critical Water (1937)	7,090	6,197	5,546	5,750	7,582	7,303	5,845	6,231	6,147	5,978	5,501	9,348	7,840	6,523
Average Water (1958)	8,028	6,463	5,873	5,982	7,715	7,867	9,974	9,222	9,475	7,906	10,927	13,225	12,840	8,269
High Water (1974)	7,051	5,923	5,612	6,022	7,661	9,591	14,775	13,644	13,608	11,304	12,600	12,808	13,847	13,492

Total Federal System Resources: Table 2-9, below, illustrates the monthly shape of the forecasted total Federal system resource for average energy and 120-Hour capacity for OY 2017, under 1937-critical water conditions. Total Federal system resources include all Federal system hydro, non-hydro and contract purchases contracts. The Federal system maintains similar shapes over the study period, with the highest generation forecasts being in late spring/early summer and early winter periods.

Table 2-9

Federal System
Monthly Energy and 120-Hour Capacity Resource Generation
OY 2017
Under 1937-Critical Water Conditions

	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Energy (aMW)	8,306	7,471	6,863	7,106	8,871	8,597	7,162	7,529	7,506	7,304	6,817	9,815	8,098	7,659
120 Hour Cap (MW)	10,933	8,963	8,761	9,075	11,272	11,260	9,934	9,975	10,498	9,090	8,372	12,233	11,202	10,134

Key Results

Annual Energy**:** This study shows that the Federal system has small annual energy surpluses in three of the first four years, and minimal annual energy deficits over the rest of the study period, under 1937-critical water conditions. Table 2-10, below, presents the Federal system annual energy surplus/deficits, under 1937-critical water conditions. The individual components of the Federal system annual energy loads and resources are shown in Exhibit 6-1, page 81 for OY 2017 through 2026. The Federal system monthly energy loads and resources are shown in Exhibit 6-2, page 85, for OY 2017 through 2026. The details of these components for OY 2017 through 2026 are presented in the 2015 White Book Technical Appendix, Volume 1: Energy Analysis.

Table 2-10

Federal System
Annual Energy Surplus/Deficit
OY 2017 through 2026
1937-Critical Water Conditions

Energy (aMW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Surplus/Deficit	16	102	-93	7	-167	-116	-268	-121	-298	-152

Table 2-11, below, compares the Federal system annual energy surplus/deficits results from the 2015 White Book to the 2014 White Book results. The annual energy deficits are smaller than the previous year's analysis mainly due to lower load obligation forecasts over the study period.

Table 2-11

Federal System
Annual Energy Surplus/Deficit Comparison
OY 2017 through 2026
1937-Critical Water Conditions

Energy (aMW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
2015 White Book	16	102	-93	7	-167	-116	-268	-121	-298	-152
2014 White Book	-157	-158	-317	-262	-443	-406	-576	-440	-675	n/a
Difference *(2015 WBK – 2014 WBK)*	*174*	*260*	*223*	*269*	*276*	*290*	*309*	*318*	*378*	*n/a*

<u>120-Hour Capacity</u>: Table 2-12, below, presents the January 120-Hour capacity forecast under 1937-critical water conditions. The detailed components of the Federal system January 120-Hour capacity loads and resources for OY 2017 through 2026 are shown in Exhibit 6-3, page 89. The monthly 120-Hour capacity for the Federal system loads and resources are shown in Exhibit 6-4, page 93, for OY 2017. The details of these components for OY 2017 through 2026 are presented in the 2015 White Book Technical Appendix, Volume 2: Capacity Analysis.

Table 2-12

Federal System
January 120-Hour Capacity Surplus/Deficit
OY 2017 through 2026
1937-Critical Water Conditions

January 120-Hour Capacity (MW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Surplus/Deficit	-1,018	-880	-1,039	-990	-1,020	-1,108	-1,188	-1,170	-1,188	-1,195

Table 2-13, below, compares the January 120-Hour capacity results from the 2015 White Book to the 2014 White Book results. This study shows larger January 120-Hour capacity deficits over the entire study period. This is mainly driven by reduced Federal system hydro capacity due to updated operations at Grand Coulee that shift generation from January to subsequent months under 1937-critical water conditions.

Table 2-13

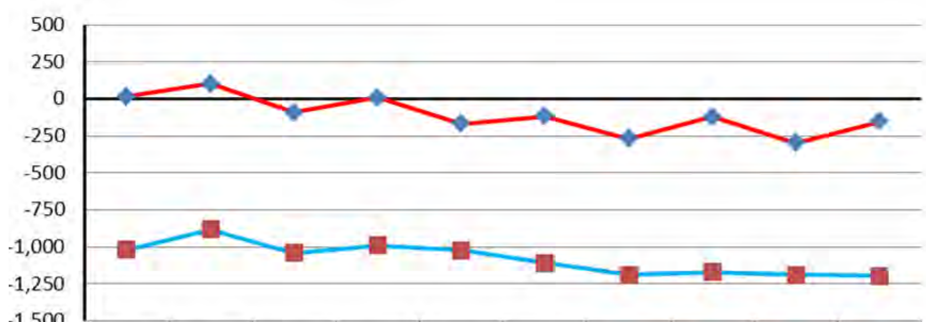
Federal System
January 120-Hour Capacity Surplus/Deficit Comparison
OY 2017 through 2026
1937-Critical Water Conditions

January 120-Hour Capacity (MW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
2015 White Book	-1,018	-880	-1,039	-990	-1,020	-1,108	-1,188	-1,170	-1,188	-1,195
2014 White Book	-485	-512	-548	-665	-800	-918	-1,012	-936	-1,122	n/a
Difference *(2015 WBK – 2014 WBK)*	*-533*	*-369*	*-491*	*-325*	*-220*	*-190*	*-176*	*-234*	*-66*	*n/a*

Federal System Annual Surplus/Deficits: Table 2-14, below, graphically presents the annual energy and January 120-Hour capacity surplus/deficits for the study period under 1937-critical water conditions. The Federal system is projected to have annual firm energy surplus/deficits ranging from a surplus as high as 102 aMW in OY 2018 to deficits up to -298 aMW in OY 2025. The January 120-Hour capacity projections show the Federal system is deficit throughout the study period, ranging from -880 MW in OY 2018 to -1,195 MW in OY 2026. Variations in the annual energy deficits between the odd and even OYs are mainly due to the biennial Columbia Generation Station (CGS) maintenance schedule.[3]

Table 2-14

Federal System
Annual Energy and January 120-Hour Capacity Surplus/Deficit
OY 2017 through 2026
1937-Critical Water Conditions



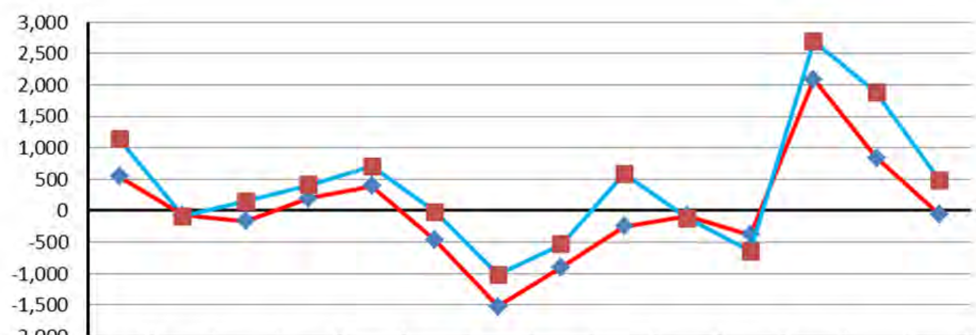
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Energy (aMW)	16	102	-93	7	-167	-116	-268	-121	-298	-152
January 120Hour Cap (MW)	-1,018	-880	-1,039	-990	-1,020	-1,108	-1,188	-1,170	-1,188	-1,195

[3] During the odd calendar years, CGS has scheduled maintenance in May and June and it is estimated to produce 916 aMW annually. In even calendar years, CGS does not have scheduled maintenance and is forecast to produce 1,075 aMW annually.

Federal System Monthly Surplus/Deficit: Table 2-13, below, graphically presents the monthly energy and 120-Hour capacity surplus/deficits for OY 2017, under 1937-critical water conditions. Forecasts for average energy and 120-Hour capacity maintain similar shapes over the study period. This monthly view shows that across the year the Federal system surplus/deficit position changes; January showing the largest monthly deficits, and the spring showing the largest surpluses.

Table 2-13

Federal System
Monthly Energy and 120-Hour Capacity Surplus/Deficit
OY 2017
1937-Critical Water Conditions



	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Energy (aMW)	542	-74	-169	199	393	-472	-1,524	-899	-250	-81	-388	2,091	841	-67
120 Hour Cap (MW)	1,129	-94	143	409	706	-25	-1,018	-537	588	-127	-650	2,698	1,874	471

Conclusion

The Federal system continues to remain close to load/resource balance, have minimal annual energy surpluses and deficits over the 10 year study horizon, under 1937-critical water conditions. These annual energy surplus/deficits range from a surplus of 102 aMW in OY 2018 to a deficit of -298 aMW in OY 2025. On a monthly energy basis, the Federal system shows large energy deficits in the winter and surpluses in the spring runoff season during May and June.

The Federal system capacity analysis shows annual January 120-Hour capacity deficits throughout the study horizon, under 1937-critical water conditions. However, under 1937-critical water conditions, monthly 120-Hour capacity shows surpluses and deficits throughout the year. Like the Federal system monthly energy analysis, the monthly 120-Hour capacity has larger capacity deficits in the winter and capacity surpluses during the spring runoff season during May and June.

Depending on water conditions, surplus/deficit projections can vary greatly, as much as 4,295 aMW for annual energy and 3,143 MW for January 120-Hour capacity. Similarly, on a monthly basis, water conditions can cause the surplus/deficit in the winter months to vary by up to 6,388 aMW.

Additionally, on a monthly basis the Federal system energy deficits tend to be greater than the 120-Hour capacity deficits under 1937-critical water conditions. This result shows that the Federal system is more energy constrained than capacity constrained across the study period. The range of Federal system monthly surplus/deficit projections under all 80-historical water conditions are presented in Exhibit 6-5, page 97.

Future Above Rate High Water Mark Load Service:

In December 2008, BPA executed PSCs with Federal agency, Public agency, and Tribal utility customers under which BPA is obligated to provide power deliveries from October 1, 2011, through September 30, 2028. The terms of these PSCs contain provisions for the Federal system to serve all or a portion of a customer's Above-Rate High Water Mark (A-RHWM) load at a specific rate. These contract provisions specify several election periods in which customers can place A-RHWM load on the Federal system. Unlike other BPA contract obligations, A-RHWM loads are not served from BPA's Tier 1 system. A-RHWM load service is priced and planned to be served through forward marketing purchases or potential resource acquisitions that are specifically designated to meet these loads. These purchases are incorporated in ratemaking and help set rates for customers electing this service.

Federal system resources in this study include signed market purchase contracts to meet A-RHWM load, placed on BPA through the 2019 election period. Post-2019 the study does not assume any market purchases, therefore the analysis assumes that the A-RHWM load is served from the Federal system including BPA's Tier 1 system. In the future, BPA may need to reevaluate the planning assumptions for service of A-RHWM load.

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Section 3: Pacific Northwest Regional Analysis

The PNW Regional Analysis is an operating year analysis that provides a deterministic projection of the PNW region's firm loads and resources over a 10-year period from OY 2017 through 2026. Firm load and resource forecasts are made for both energy and 120-Hour capacity based on regional retail loads, contract obligations, and resources. This White Book analysis assumes that all regional uncommitted Independent Power Producer (IPP) generation (energy and capacity) is available to meet regional firm load. Retail loads, regional contracts, and generating resource forecasts incorporate regional utility data submittals received by BPA.

Total Regional Loads

The regional analysis incorporates total regional load projections that consist of two separate components: 1) Total Retail Loads (TRL)—which is the sum of individual utilities' retail power consumption within the PNW region; and 2) Regional contract sales (Exports)—which is the sum of all reported long-term regional contract deliveries to entities outside the PNW. The regional analysis incorporates TRL forecasts were developed by BPA's ALF tool for all PNW Public Agencies, USBR, IOUs, and DSIs entities. TRL forecasts reflect normal weather conditions and do not include any adjustments for future climate change impacts. Export contracts are signed power contract obligations with delivery points outside the PNW region. All export contracts have specific terms and expiration dates and are not assumed to be renewed upon expiration. Total regional loads are comprised of about 94 percent retail loads and 6 percent export contracts.

Table 3-1, page 32, shows the forecasted composition of PNW regional load consumption and exports for OY 2017. For the PNW region, over 51 percent of the regional loads are represented by Investor-Owned Utility customers. Public and Federal agency, Cooperative, and USBR customers comprise about 40 percent of the regional loads. Marketers and DSI's regional loads are quite small and only make up approximately 3 percent of the total regional load, while export contracts make up approximately 6 percent of the total regional load.

Table 3-1

PNW Region
Total Regional Loads by Customer Class
OY 2017

Customer Class	Energy (aMW)	Percent of Firm Energy	January 120-Hour Capacity (MW)	Percent of Capacity
Federal Agency	128	1%	216	1%
USBR	184	1%	272	1%
Cooperative	1,968	8%	3,200	9%
Municipality	2,731	11%	4,475	12%
Public Utility District	4,546	19%	7,446	21%
Investor-Owned Utility	12,206	51%	18,176	50%
Marketer	252	1%	265	1%
Direct-Service Industry	445	2%	460	1%
Total Retail Load	**22,461**	**94%**	**34,511**	**96%**
Exports	1,333	6%	1,500	4%
Total Regional Load	**23,794**	**100%**	**36,011**	**100%**

Conservation in Total Retail Loads: The TRL forecasts developed by BPA using the ALF tool are based on historic retail load consumption. Since historic retail loads include actual historic conservation savings, these forecasts include embedded conservation. The Council's "BPA's and Utility Programs" historical conservation totals provide the regional perspective of historical conservation in the PNW region. Table 3-2, below, presents the estimated regional conservation embedded in BPA's TRL forecast, based on the Council's historical conservation totals.

Table 3-2

PNW Region
Conservation Embedded in Total Retail Load Forecast
Based on Historical Reported Conservation
OY 2017 through 2026

Energy (aMW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation in TRL Forecast	208	214	220	226	232	239	245	251	257	263

Regional Resources

Pacific Northwest resources and contract purchases are collectively called “regional resources” in this study. Like the Federal system, regional resources vary monthly by water condition, resource type, and seasonality of generating resource potential. These resources are classified as: 1) Hydro resources—regulated, independent, and small hydro projects; 2) Other regional resources—cogeneration, combustion turbines, large thermal (i.e. coal and nuclear), renewable resources (i.e. wind, solar and biomass), and small thermal & miscellaneous resources; and 3) Regional contract purchases (imports).

Regional resources vary by type of fuel and generation technology. Table 3-3, below, summarizes resources and contract purchases available to meet PNW load obligations. For OY 2017, regional firm energy resources are comprised of approximately 41 percent hydro, 21 percent large thermal, 20 percent combustion turbines, 8 percent cogeneration, 7 percent renewables—mainly comprised of wind—and 2 percent imports. New regional generating projects are added to the resource forecast when those resources begin operating or under construction with a firm on-line date. In a similar manner, retiring resources are removed from the forecasts, based on the announced retirement date. Resource forecasts for the region assume the retirement of the following coal projects over the study period: Centralia 1 (December 1, 2020), Centralia 2 (December 1, 2025), Boardman (January 1, 2021), Valmy 1 (January 1, 2022), and Valmy 2 (January 1, 2026).

Table 3-3

PNW Region
Resource Generation by Type
OY 2017
1937-Critical Water Conditions

Project Type	Annual Energy (aMW)	Percent of Energy	January 120-Hour Capacity (MW) [a/]	Percent of Capacity
Hydro	11,960	41.2%	21,085	53.4%
Large Thermal	6,004	20.7%	6,986	17.7%
Cogeneration	2,396	8.2%	2,821	7.1%
Combustion Turbines	5,885	20.3%	6,892	17.5%
Renewables	2,109	7.3%	399	1.0%
Small Thermal &Misc	36	0.1%	92	0.2%
Imports	664	2.3%	1,213	3.1%
Total Regional Resources	**29,053**	**100.0%**	**39,487**	**100.0%**

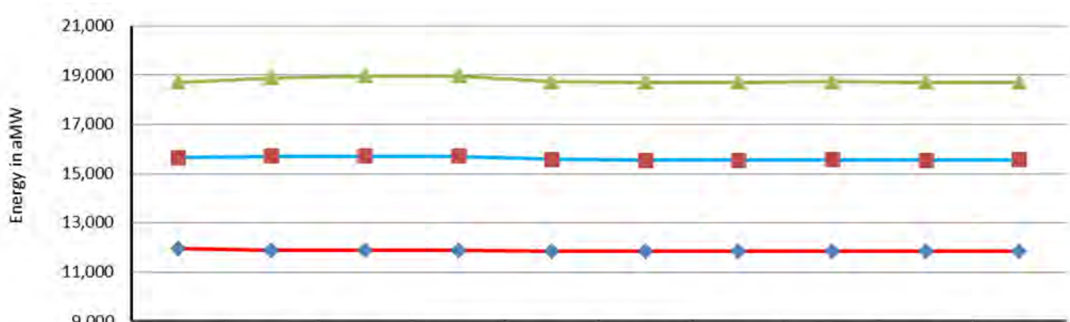
[a/] Federal resource estimates are before adjustments for reserves and transmission losses

Regional Hydro Generation Variability: The energy generating capability of the region's hydroelectric projects depends upon the amount of water flowing through the facilities, the physical capacity of the facilities, streamflow requirements pursuant to biological opinions, and other operating limitations. BPA utilizes an 80-year record of historic streamflows based on the historical period from 1929 through 2008 for planning purposes. To simplify the presentation of hydro generation variability, this study uses three water conditions to represent the magnitude of hydro variability.

Table 3-4, below, shows the annual variability of the regions hydro resources under the three streamflow scenarios: 1) 1937-critical water conditions—representing the firm energy capability; 2) 1958-water conditions—representing average streamflows; and 3) 1974-water conditions—representing high streamflows. In OY 2017, annual firm energy generation from regional hydro projects is estimated to be 11,960 aMW. This represents about 41 percent of region's firm resources. However, the generating potential from regional hydro projects can annually vary by up to 6,750 aMW depending on water conditions.

Figure 3-4

PNW Region
Variability of Annual Hydro Resource Generation
OY 2017 through 2026
Under Different Water Conditions

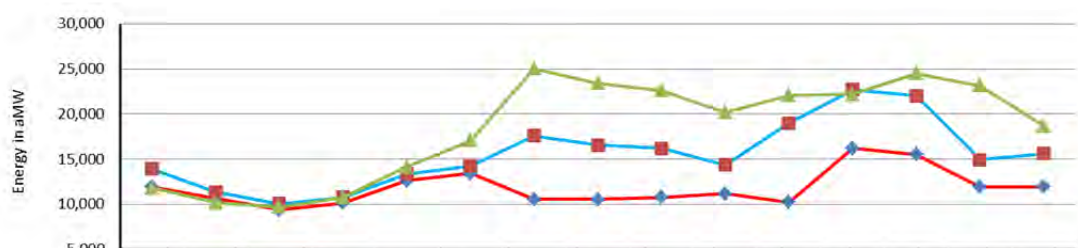


	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Critical Water (1937)	11,960	11,883	11,880	11,877	11,852	11,841	11,841	11,837	11,841	11,841
Average Water (1958)	15,648	15,699	15,703	15,706	15,575	15,551	15,551	15,554	15,551	15,551
High Water (1974)	18,710	18,897	18,957	18,970	18,728	18,708	18,708	18,724	18,708	18,708

Table 3-5, below, shows the monthly variability of the regions hydro resources under the same three water conditions. High generation levels in the December through mid-April period is largely due to drafting reservoirs for power production and flood control, which can vary widely due to rainfall and snowpack levels in the Columbia River Basin. Power production in late-April through July is variable due to the timing and amount of the Columbia River Basin snowmelt runoff. Power production decreases through the end of the summer and early fall as streamflows are reduced due to depleted snowpack and lower precipitation levels. There is little monthly water variability on the Federal system hydro resources August through December. Regional hydro generation capability can vary by more than 14,000 aMW depending on project operations and the availability of water.

Table 3-5

PNW Region
Variability of Monthly Hydro Resource Generation
OY 2017
Under Different Water Conditions



	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
Critical Water (1937)	11,947	10,655	9,433	10,192	12,653	13,441	10,577	10,581	10,805	11,205	10,262	16,216	15,548	11,942	11,960
Average Water (1958)	13,914	11,358	10,085	10,802	13,389	14,268	17,587	16,574	16,201	14,388	19,007	22,700	22,009	14,951	15,648
High Water (1974)	11,841	10,221	9,736	10,818	14,165	17,081	25,024	23,433	22,590	20,185	22,091	22,201	24,479	23,143	18,710

<u>Variability Due to IPP Generation Delivered to the PNW Region</u>: The PNW regional study includes uncommitted PNW IPP generation as regional resources. These resources or the share of these resources that are not committed to serving specific loads represent approximately 2,907 aMW of energy with an associated 3,135 MW of peak capacity in OY 2017. The inclusion of this uncommitted IPP generation is reasonable from a long-term planning stand point, specifically given the fact that the regional study does not include any reliance on market purchases. PNW utilities may have to compete with other western markets to secure this generation to meet electricity demand. Table 3-6, page 36, details the regions uncommitted IPP projects, the associated fuel types, and OY 2017 annual energy and January capacity generation forecast. As the generation from uncommitted IPP projects are purchased by load serving entities, those updates will be accounted for in future studies. Table 3-7, page 36, details the regions total uncommitted IPP annual energy and January capacity generation forecasts over the OY 2017 through 2026 study period.

Table 3-6

PNW Region
Uncommitted Independent Power Producer Projects
OY 2017

Project	Annual Energy (aMW)	January Capacity (MW)	Fuel Type
Centralia [a/, b/]	877	1,060	Coal
Cosmopolis Specialty Fibres	14	14	Wood Waste
Hermiston Power Project	567	630	Natural Gas
Juniper Canyon	39	0	Wind
Kittitas Valley Wind	26	0	Wind
Klamath Generation Facility	436	484	Natural Gas
Klamath Generation Peaking (CT) [c/]	90	100	Natural Gas
Leaning Juniper 2a & 2b	52	0	Wind
Longview Fibre Paper & Packaging	35	35	Wood Waste
Nippon Paper Cogen (Port Angeles)	12	13	Natural Gas
Satsop Combustion Turbine Project	584	650	Natural Gas
SDS Lumber	1	1	Wood Waste
SP Newsprint Cogen	104	104	Natural Gas
Stateline	8	0	Wind
Vansycle	26	0	Wind
Weyerhaeuser Longview	35	44	Wood Waste
Total Uncommitted IPP Generation	**2,907**	**3,135**	

a/ Centralia #1 (670 MW) is scheduled for retirement on Dec 1, 2020.
b/ Centralia #2 (670 MW) is scheduled for retirement on Dec 1, 2025
c/ Klamath Generation Peaking CT (100 MW) capacity is sold November through February through 2017, however, the project is uncommitted March through October.

Table 3-7

PNW Region
Annual Energy and January 120-Hour Capacity
Uncommitted Independent Power Producer Generation
OY 2017 through 2026

Regional Uncommitted IPP	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Annual Energy (aMW)	2,907	2,891	2,892	2,912	2,525	2,356	2,388	2,428	2,429	2,260
January Capacity (MW)	3,135	3,035	3,035	3,042	3,060	2,445	2,445	2,445	2,445	2,445

Key Results

Annual Energy: Table 3-8, below, shows significant annual energy surpluses for the PNW region throughout the study period under 1937-critical water conditions. This study assumes that 100 percent of PNW regional uncommitted IPP generation (2,907 aMW in OY 2017) is available to serve regional loads. The individual components of the PNW region's annual energy loads and resources for OY 2017 through 2026 are shown in Exhibit 7-1, page 103. The PNW region's monthly energy loads and resources for OY 2017 are shown in Exhibit 7-2, page 107. The details of these components for OY 2017 through 2026 are presented in the 2015 White Book Technical Appendix, Volume 1: Energy Analysis.

Table 3-8

PNW Region
Annual Energy Surplus/Deficit Comparison
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2017 through 2026
1937-Critical Water Conditions

Energy (aMW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Surplus/Deficit	4,397	4,293	3,792	3,669	2,659	1,964	1,486	1,493	1,032	481

Table 3-9, below, compares the PNW region's annual energy surplus/deficit results from the 2015 White Book to the 2014 White Book results. The annual energy deficits are smaller than the previous analysis mainly due to lower total retail load forecasts over the study period.

Table 3-9

PNW Region
Annual Energy Surplus/Deficit Comparison
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2017 through 2026
1937-Critical Water Conditions

Energy (aMW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
2015 White Book	4,397	4,293	3,792	3,669	2,659	1,964	1,486	1,493	1,032	481
2014 White Book	4,576	4,423	3,927	3,825	2,863	2,177	1,774	1,807	1,343	n/a
Difference *(2015 WBK – 2014 WBK)*	*-179*	*-130*	*-135*	*-156*	*-203*	*-213*	*-288*	*-314*	*-311*	*n/a*

Table 3-10, below, shows the significant variability in PNW regional surplus/deficit projections depending on the level of uncommitted IPP generation available to the region. IPP generation is detailed in Tables 3-6 and 3-7, page 36.

Table 3-10

PNW Region
Variability of Annual Energy Surplus/Deficit
Assuming Different Levels of Uncommitted IPP Generation
OY 2017 through 2026
1937-Critical Water Conditions

Energy (aMW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
100% IPP	4,397	4,293	3,792	3,669	2,659	1,964	1,486	1,493	1,032	481
50% IPP	2,944	2,847	2,346	2,213	1,397	786	292	279	-182	-649
0% IPP	1,490	1,401	900	757	134	-392	-903	-935	-1,397	-1,779

January 120-Hour Capacity**:** Table 3-11, below, shows the January 120-Hour capacity surplus/deficits for the PNW region under 1937-critical water conditions. The region is estimated to have January 120-Hour capacity surpluses through OY 2018 and deficits in the remainder of the forecast period. This assumes that 100 percent of PNW uncommitted IPP generation is available to serve regional loads. The individual components of the PNW regional January 120-Hour capacity loads and resources for OY 2017 through 2026 are shown in Exhibit 7-3, page111. The monthly PNW regional 120-Hour capacity loads and resources for OY 2017 are shown in Exhibit 7-4, page 115. The details of these components for OY 2017 through 2026 are presented in the 2015 White Book Technical Appendix, Volume 2: Capacity Analysis.

Table 3-11

PNW Region
January 120-Hour Capacity Surplus/Deficit
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2017 through 2026
1937-Critical Water Conditions

January 120-Hour Capacity (MW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Surplus/Deficit	511	105	-278	-582	-2,211	-2,758	-3,255	-3,665	-3,901	-5,107

Table 3-12, below, compares the January 120-Hour capacity results from the 2015 White Book to the 2014 White Book results. This study shows smaller January 120-Hour capacity surpluses through OY 2018, and larger deficits through the end of the study period. This is mainly driven by reduced hydro capacity due to updated operations at Grand Coulee that shift generation from January to subsequent months under 1937-critical water conditions.

Table 3-12

PNW Region
January 120-Hour Capacity Surplus/Deficit Comparison
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2017 through 2026
1937-Critical Water Conditions

January 120-Hour Capacity (MW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
2015 White Book	511	105	-278	-582	-2211	-2758	-3255	-3665	-3901	-5107
2014 White Book	1023	611	222	-97	-1796	-2352	-2735	-3064	-3376	n/a
Difference (2015 WBK – 2014 WBK)	*-512*	*-506*	*-500*	*-485*	*-415*	*-405*	*-520*	*-601*	*-525*	*n/a*

Table 3-13, below, shows the significant variability in PNW regional January 120-Hour capacity surplus/deficit projections depending on the level of uncommitted IPP generation available to the region. IPP generation is detailed in Tables 3-6 and 3-7, page 36.

Table 3-13

PNW Region
Variability of January 120-Hour Capacity Surplus/Deficit
Assuming Different Levels of Uncommitted IPP Generation
OY 2017 through 2026
1937-Critical Water Conditions

January 120-Hour Capacity (MW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
100% IPP	511	105	-278	-582	-2211	-2758	-3255	-3665	-3901	-5107
50% IPP	-1057	-1413	-1796	-2103	-3741	-3980	-4478	-4887	-5124	-6329
0% IPP	-2624	-2930	-3313	-3623	-5271	-5203	-5700	-6110	-6346	-7552

Regional Annual Surplus/Deficit: Table 3-14, below, graphically presents the annual energy and January 120-Hour capacity surplus/deficits projections for the PNW Region. These projections assume 1937-critical water conditions and 100 percent availability of PNW uncommitted IPP generation to serve regional loads. The regional annual energy and January 120-Hour capacity surpluses decline over the 10-year study period. By the end of the period, the study shows an annual energy surplus of 481 aMW, while January 120-Hour capacity becomes deficit in OY 2019 and finishes the study period with a deficit of -5,107 MW. The declines in both annual energy and January 120-Hour capacity surplus/deficit projections are primarily driven by steady regional load growth over the study period and the phased retirements of the Centralia, Boardman and Valmy coal plants beginning in December 2020.

Table 3-14

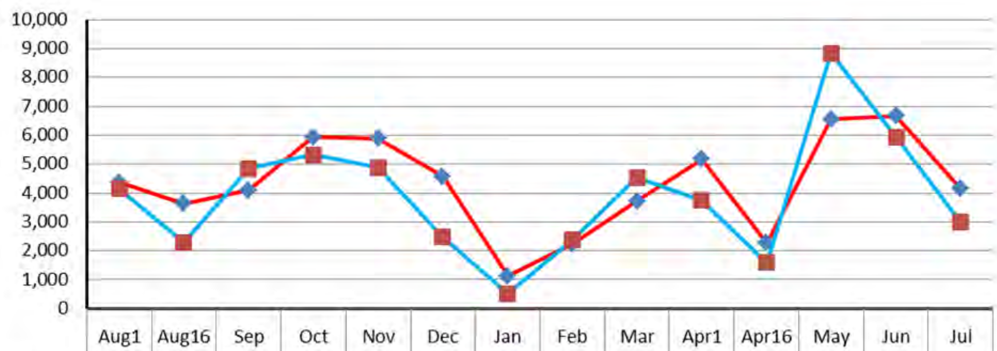
PNW Region
Annual Energy and January 120-Hour Capacity Surplus/Deficit
OY 2017 through 2026
1937-Critical Water Conditions

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Energy (aMW)	4,397	4,293	3,792	3,669	2,659	1,964	1,486	1,493	1,032	481
January 120 Hour Cap (MW)	511	105	-278	-582	-2,211	-2,758	-3,255	-3,665	-3,901	-5,107

Regional Monthly Surplus/Deficit**:** Table 3-15, below, graphically presents the monthly energy and 120-Hour capacity surplus/deficit projections for OY 2017 under 1937-critical water conditions and 100 percent availability of PNW uncommitted IPP generation to serve regional loads. Forecasts for monthly average energy and 120-Hour capacity maintain similar shaping over the study period. This monthly view shows the variability that the region experiences across the year, where January showing the lowest surpluses and the spring months show the largest.

Table 3-15

PNW Region
Monthly Energy and 120-Hour Capacity Surplus/Deficit
OY 2017
1937-Critical Water Conditions



	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Energy (aMW)	4,372	3,639	4,089	5,934	5,885	4,567	1,120	2,243	3,722	5,166	2,264	6,558	6,668	4,145
120-Hour Cap (MW)	4,138	2,282	4,852	5,322	4,874	2,481	511	2,369	4,543	3,736	1,590	8,832	5,935	2,988

Conclusion

Assuming modest load growth and 100 percent of PNW uncommitted IPP generation is available to serve regional loads, the PNW region is projected to have annual energy surpluses through the study period. However, using the same assumptions, the PNW region becomes January 120-Hour capacity deficit beginning in 2019. The study further shows that the PNW region is 120-Hour capacity constrained on a monthly basis. Since this analysis assumes that PNW uncommitted IPP generation is sold in power markets available to the region, the supply of power within the region can change dramatically if uncommitted IPP generation is committed to serve loads outside the region. The range of monthly surplus/deficit projections under the 80-year study are presented in Exhibit 7-5, page119. Additional monthly and annual details for OY 2017 through 2026 are presented in the 2015 White Book Technical Appendix, Volume 1: Energy Analysis and the 2015 White Book Technical Appendix, Volume 2: Capacity Analysis.

BPA provides this regional planning analysis as an information study. BPA's analysis offers its view of the region's loads and resources. Projected regional energy and capacity deficits identified in this and/or other analyses may be mitigated through options discussed in the Council's Seventh Power Plan.

Section 4: Federal System Needs Assessment

While the Federal System Analysis identifies the loads and resources surplus/deficit under critical water for informational and planning purposes, the Needs Assessment analysis examines five planning metrics that are used by BPA's Resource Program. The Needs Assessment measures the Federal system's expected generating resource capabilities to meet projected load obligations under a range of conditions and timeframes. The Needs Assessment does not discuss potential actions that BPA could take to meet any identified needs; those are evaluated and discussed in BPA's Resource Program. As part of the 2015 White Book, the Needs Assessment focused on the Federal system surplus/deficits for FY 2021 and 2024.

Federal System Needs Assessment Methodology

The Needs Assessment incorporates hourly forecasts of Federal system load obligations and resources, which are described as follows.

Load Obligations: Federal system load obligations include: Federal reserve power obligations to USBR and Regional Dialogue PSC obligations to Public and Federal agency customers; as well as other contract obligations, categorized as: 1) power sales; 2) power or energy exchanges; 3) capacity sales or capacity-for-energy exchanges; 4) power payments for services; and 5) power commitments under the Treaty.

Like the Federal system and PNW Regional Analyses, forecasts of the PSC obligations to Public and Federal agency customers and the USBR were produced by BPA's ALF system. These hourly forecasts are calculated as each utility customer's total retail load minus that utility's resources and contract purchases that are dedicated to serve those loads. This forecast is based on current customer load service elections placed on BPA. This includes both customer loads up to their Contract High Water Mark (CHWM) amount and the portion of each customer's Above Rate High Water Mark (A-RHWM) load that has been placed on BPA. The current level of customer elections has been set through FY 2019 and is assumed to continue through the study period. The total amount of A-RHWM load estimated to be placed on BPA is approximately 251 aMW in FY 2021 and 340 aMW in FY 2024.

In addition to the Load Following customers, Federal system load estimates also include hourly loads for customers who have purchased Slice/Block, and Block load service. Federal load obligation forecasts also include hourly contract sales and deliveries that include power and trading floor sales, U.S. deliveries to Canada under the Treaty, and DSI contracts. DSI contracts with Alcoa and Port Townsend are assumed to remain flat through the study period at 75 aMW and 16.1 aMW, respectively.

ALF's load obligation forecasting methodology automatically includes projections of programmatic conservation savings that are assumed to continue at levels established under current conservation programs. The 2015 Needs Assessment scenarios use the same embedded conservation savings as the Federal System Analysis, which was presented in 'Conservation in Load Forecast' and Table 2-3, page 18. These embedded conservation savings are estimated at 98 aMW in FY 2021 and 105 aMW in FY 2024. The Needs Assessment does not include additional incremental conservation needed to meet the Council's draft Seventh Power Plan targets.[4]

All adjustments made to the base Federal system load obligations for specific Needs Assessment scenarios are described in Federal System Needs Assessment Scenarios, page 45.

Resources: Federal system resources include: 1) Federal regulated, independent, and small hydro projects; 2) other non-Federal resources (renewable, cogeneration, large thermal, wind, and small non-utility generation projects); 3) Federal contract purchases; and 4) appropriate adjustments for reserves and transmission losses.

The Federal system resource capability is forecasted using two BPA computer models: 1) HYDSIM for monthly and annual energy; and 2) HOSS for hourly energy and capacity. The models assess the resource capability to meet loads under each scenario's specific set of conditions and inputs—over a range of possible water conditions while meeting non-power requirements. The base case HYDSIM study used for this Needs Assessment is the same study used for the rest of the 2015 White Book and the BP-16 Final Rate Proposal.

To incorporate the Federal system contract purchases and non-hydro generation in the study, the HOSS model operates to an hourly Federal Residual Hydro Load. The Federal Residual Hydro Load is the hourly Federal load obligations less the hourly contract purchases and non-hydro generation. Multiple hydro studies were produced for the Needs Assessment and are further discussed in the Federal System Needs Assessment Scenarios, page 45.

The Needs Assessment uses the same hydro planning models described in 'Hydro Resources Modeling' in Section 1, page 10. However, BPA has made specific changes to forecasts and certain model assumptions which are detailed below, including using stochastic load variability to simulate load uncertainty and stochastic unit performance for CGS generation to simulate unplanned outages. This assessment does not model any internal, or regional, transmission constraints that may limit the ability to deliver the modeled system generation to load.

Reserves for Ancillary Services were studied under two different forecasts of wind development in BPA's Balancing Authority Area (BAA). The wind development forecast for the Base Case Wind Development scenario was produced using the

[4] How additional incremental conservation needed to meet the Council's draft Seventh Power Plan targets is used to mitigate or eliminate the deficits identified in this Needs Assessment, will be discussed in BPA's 2016 Resource Program.

same methodology as the 2012 Needs Assessment, and includes significant wind development over the forecast horizon. The Low Wind Development scenario includes only projected wind development required for Renewable Portfolio Standard compliance, and includes very little wind development through the forecast horizon. This scenario serves as a sensitivity to evaluate the balancing reserve needs under a low wind development environment.

Federal System Needs Assessment Scenarios

The Needs Assessment focuses on five scenarios developed for FY 2021 and 2024. Depending on the scenario, up to five metrics—energy, capacity and ancillary service—were used to determine the ability of the Federal system generating capability to meet obligations. These metrics are detailed in Federal System Needs Assessment Metrics, page 46. The scenarios are as follows:

- Expected Base Case: Uses data that is consistent with the Federal System Analysis load forecast. The average annual load growth rate for this analysis is approximately 0.76 percent. This scenario analyzed FY 2021 and 2024.

- High Load Growth: Assumes a high load growth rate when compared to the base case. The average annual load growth rate is approximately 2.1 percent. This scenario analyzed FY 2021 and 2024.

- Low Load Growth: Assumes a low load growth rate when compared to the base case. The average annual load growth is assumed to be flat at 0.0 percent. This scenario analyzed FY 2021 and 2024.

- Product Switching: Assumes the 12 current Slice customers within BPA's BAA switch their Regional Dialogue contract product from Slice/Block to Load Following as of FY 2021. The remaining four current Slice customers—who are outside of the BPA's BAA—are assumed to remain Slice customers. As a result, the Federal Tier 1 System Slice percent is reduced to 7.51 percent. This study assumes that all customers that switch to Load Following service place their total A-RHWM load on BPA. No offsetting purchases to serve A-RHWM loads are assumed in this scenario. This scenario only analyzed FY 2021.

- Climate Change: Incorporates the Central Change Climate Model for 2020, which was one of the six climate change scenarios developed in the River Management Joint Operating Committee (RMJOC) Climate Change Report published jointly between BPA, the USBR, and USACE in 2011. The scenario assumes the climate is warmer by +1.0 centigrade and precipitation increases +3.8 inches in relation to the observed averages in the Columbia-Snake River basin from 1916 to 2006. The average January through July streamflows at The Dalles is assumed to increase by 6 million acre-feet (MAF) compared to the 2010 modified flows. Loads were also adjusted for anticipated temperature changes associated with climate change. This scenario only analyzed FY 2021.

Federal System Needs Assessment Metrics

The Needs Assessment used the following metrics to assess the ability of Federal resources to meet the Federal load obligations under the previously described scenarios. The five Federal system metrics used in this analysis are:

- Annual Energy: This metric focuses on Federal system annual average energy surplus/deficits—under 1937-critical water conditions—and was analyzed for all scenarios.

- Monthly P10 Heavy Load Hour Energy: This metric evaluates the lowest 10th percentile (P10) of Federal system surplus/deficit over heavy load hours (HLHs) by month. Each month is analyzed independently. Within each month, the largest driver of Federal system surplus/deficit is water supply, followed by load deviations and CGS outages. This metric was analyzed for the Expected Base Case, Product Switching, and Climate Change scenarios, but not the High or Low Load Growth scenarios.

- Monthly P10 Superpeak Energy: This metric evaluates the lowest 10th percentile of Federal system surplus/deficits over the six peak load hours per weekday by month. Each month is analyzed independently. This metric was analyzed for the Expected Base Case, Product Switching, and Climate Change scenarios, but not the High or Low Load Growth scenarios.

- 18-Hour Capacity: This metric analyzes the Federal system's ability to meet the six peak load hours per day over a three-day extreme weather event. This analysis uses the "expected" load case, with adjustments to simulate a three-day extreme weather event. Depending on the weather event, load obligations are adjusted for additional heating or cooling loads, and median water conditions are assumed for hydro generation. Additionally, load obligations assume that Canada requests maximum Canadian Entitlement energy deliveries available under terms of the Treaty.

  Generation forecasts for the winter analysis were based on the month of February. Hydro generation estimates for the winter incorporate a reduction in streamflows to account for icing effects. The generation forecasts for the summer analysis were based on the 2nd half of August. Summer CGS generation estimates were reduced to include the weather event heat impacts on CGS generating capabilities. Generating resource estimates for both analyses assume that wind generation is zero. This metric was analyzed for the Expected Base Case, Product Switching, and Climate Change scenarios, but not the High or Low Load Growth scenarios.

- Reserves for Ancillary Services: This metric analyzes the ability of the Federal system to meet forecasted BPA BAA balancing reserve needs. This is calculated as the difference between the amount of balancing reserves the Federal system can supply and the forecasted BPA BAA balancing reserve need. This metric was analyzed using two wind development scenarios in BPA's BAA for both FY 2021 and 2024.

Summary of Federal System Needs Assessment Results

The results of the 2015 Needs Assessment are summarized in Table 4-1, below. The results show that in FY 2021 and 2024, the Federal system has a wide range of potential deficits under the Annual Energy, Monthly P10 Heavy Load Hour Energy and Monthly P10 Superpeak Energy metrics under all scenarios. The Federal system is capacity surplus under the 18-Hour Capacity metric across all scenarios. Energy and capacity results have been rounded to the nearest 50 megawatts.

Trends in this analysis are similar to those presented in the 2012 Needs Assessment that was published as part of the 2012 White Book in February 2013. The 2012 Needs Assessment focused on FY 2016 and 2021 and showed similar deficits under the Annual Energy, Monthly P10 Heavy Load Hour Energy, and Monthly P10 Superpeak Energy metrics. One notable change in this year's analysis is in the 18-Hour Capacity metric, where the Federal system capacity surpluses increased when compared to the 2012 Needs Assessment.

Table 4-1

Federal System Needs Assessment
Results Summary
FY 2021 and 2024

Metric		Base Case FY 2021	Base Case FY 2024	Product Switching FY 2021	Climate Change FY 2021
Annual Energy		Expected: -150 aMW High: -750 aMW Low: 200 aMW	Expected: -50 aMW High: -1,150 aMW Low: 350 aMW	-350 aMW	150 aMW
Monthly P10 Heavy Load Hour Energy		Signficant deficits in January and February.	Signficant deficits in December and January.	Signficant deficits in December, January, February, 1st half of April, 2nd half of August, and September.	Significant deficits in 2nd half of August and September.
Monthly P10 Superpeak Energy		Signficant deficits in January and 2nd half of August.	Signficant deficits in January and 2nd half of August.	Signficant deficits in January, 1st half of April, and 2nd half of August.	Signficant deficits in 2nd half of August and September.
18-Hour Capacity		Winter: 1,150 MW Summer: 250 MW	Winter: 1,150 MW Summer: 250 MW	Winter: 1,650 MW Summer: 250 MW	Winter: 1,100 MW Summer: 250 MW
Reserves for Ancillary Services	Base Case Wind Development	Inc: -204 MW (-704 MW spring) Dec: -259 MW	Inc: -284 MW (-784 MW spring) Dec: -358 MW	n/a	n/a
	Low Wind Development	Inc: 116 MW (-384 MW spring) Dec: 140 MW	Inc: 116 MW (-384 MW spring) Dec: 140 MW	n/a	n/a

Details of the Needs Assessment results summarized in Table 4-1, above, are presented as follows.

Annual Energy Metric: The Annual Energy metric analyzes the ability of the Federal system to meet energy loads on an annual basis. Table 4-2, page 49, shows the results for the Annual Energy metric analyzed under 1937-critical water conditions for the following scenarios:

- Expected Base Case: Resulted in Federal system Annual Energy deficits of -150 aMW in FY 2021 and -50 aMW in FY 2024. Since FY 2021 is a refueling year for CGS, Federal system generation is significantly reduced. Therefore, FY 2021 shows larger energy deficits than FY 2024, because the loss of CGS generation is greater than the forecasted load growth between FY 2021 and 2024.

- Low Load Growth: Resulted in Federal system Annual Energy surpluses of 200 aMW in FY 2021 and 350 aMW in FY 2024 because no load growth is assumed between FY 2021 and 2024.

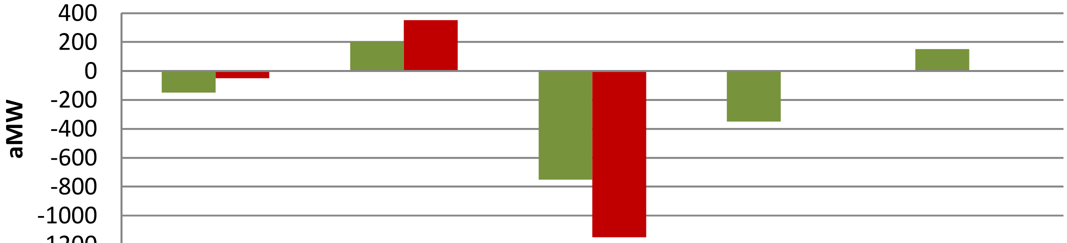
- High Load Growth: Resulted in Federal system Annual Energy deficits of -750 aMW in FY 2021 and -1,150 aMW in FY 2024. This is due to the assumption of dramatic load growth when compared to the Expected Base Case.

- Product Switching: Resulted in a Federal system Annual Energy deficit of -350 aMW in FY 2021. This deficit is larger than in the Expected Base Case, because forecasted Federal system load obligations are higher. This is due to BPA now serving the net requirement load obligations for those Slice customers who switched to Load Following service.

- Climate Change: Resulted in Federal system Annual Energy surplus of 150 aMW in FY 2021. The results show an inventory shift of about 300 aMW, causing the Federal system to become Annual Energy surplus, when compared to the Expected Base Case. This is due to increases in precipitation that result in additional hydro generation and reduced winter loads due to warmer temperatures.

Table 4-2

Federal System Needs Assessment
Annual Energy
FY 2021 and 2024
Under 1937-Critical Water Conditions



	Expected	Low	High	Product Switching	Climate Change
2021	-150	200	-750	-350	150
2024	-50	350	-1150		

Monthly P10 Heavy Load Hour Energy Metric: The Monthly P10 Heavy Load Hour Energy metric analyzes the ability of the Federal system to meet HLH loads on a monthly basis. Table 4-3, page 51, shows the results for the Monthly P10 Heavy Load Hour Energy metric for the following scenarios:

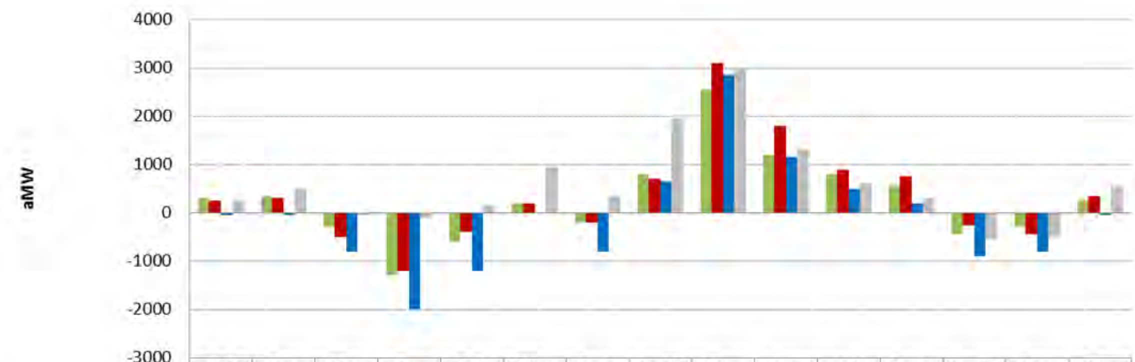
- Expected Base Case: Resulted in Federal system monthly HLH energy deficits in the winter and late summer. In that timeframe, the largest HLH energy deficits were -1,300 aMW in FY 2021 and -1,200 aMW in FY 2024. Large monthly HLH energy surpluses occur in the spring in both years, which coincide with the Columbia River Basin runoff.

- Product Switching: Resulted in Federal system monthly HLH energy deficits in the fall, winter, and late summer in FY 2021. In that timeframe, the largest HLH energy deficit was -2,000 aMW in January. Large monthly HLH energy surpluses occur through the spring, which coincides with the Columbia River Basin runoff. This scenario produced increased deficits in the fall, winter, and late summer when compared to the Expected Base Case. This is because forecasted Federal system load obligations are higher during these time periods, since BPA is now serving the net requirement load obligations for those Slice customers who switched to Load Following service. This scenario also produced increased HLH energy surpluses in the spring, because as Slice customers they received more Federal system generation under the Slice product during the spring Columbia River Basin runoff.

- Climate Change: Resulted in Federal system monthly HLH energy deficits in the winter and late summer in FY 2021. In that timeframe, the largest HLH energy deficit was -550 aMW in the 2nd half of August. Large monthly HLH energy surpluses occur in the spring, which coincides with the Columbia River Basin runoff. This scenario produced increased HLH energy deficits in the late summer and reduced deficits in the winter when compared to the Expected Base Case. This is due to increases in precipitation that result in additional hydro generation and reduced winter loads due to warmer temperatures.

Table 4-3

Federal System Needs Assessment
Monthly 10th Percentile HLH Energy
FY 2021 and 2024



	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Aug1	Aug16	Sep	Avg
Expected 2021	300	350	-300	-1300	-600	200	-200	800	2550	1200	800	550	-450	-300	250
Expected 2024	250	300	-500	-1200	-400	200	-200	700	3100	1800	900	750	-250	-450	350
Product Switching	-50	-50	-800	-2000	-1200	0	-800	650	2850	1150	500	200	-900	-800	-50
Climate Change	250	500	-50	-100	150	950	350	1950	3000	1300	600	300	-550	-500	550

Results from the Monthly P10 Heavy Load Hour Energy metric show, that in all scenarios, BPA faces HLH energy deficits in FY 2021 and 2024 during the winter and late summer months. This indicates that in low water conditions, or where the Federal system has reduced generation, the Federal system experiences HLH energy deficits in the winter and late summer. During the spring runoff months the Federal system usually experiences HLH energy surpluses. This is because the hydro system has a limited ability to store water from season-to-season, month-to-month, and day-to-day due to the amount of available storage and non-power operating requirements, such as flood control and fish operations.

Monthly P10 Superpeak Energy Metric: The Monthly P10 Superpeak Energy metric evaluates the ability of the Federal system to meet loads over the six peak load hours per weekday by month. Table 4-4, page 53, shows the results for the Monthly P10 Superpeak Energy metric for the following scenarios:

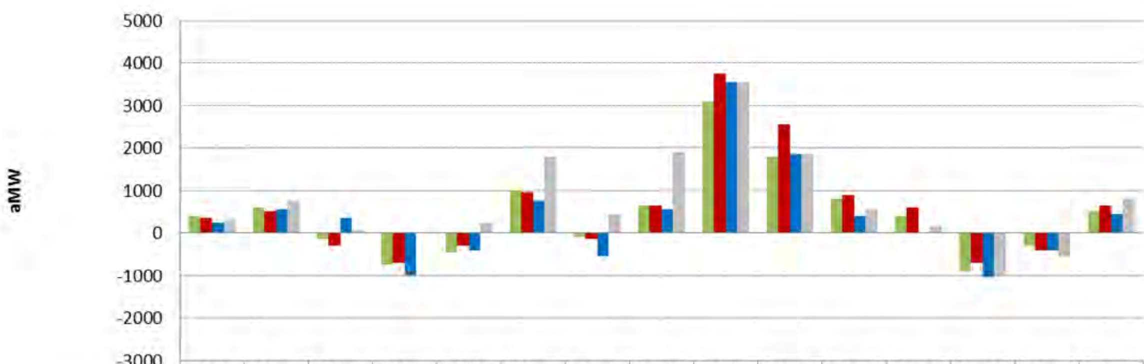
- Expected Base Case: Resulted in Federal system monthly Superpeak energy deficits in the winter and late summer for both FY 2021 and 2024. The January Superpeak energy deficits were -750 aMW in FY 2021 and -700 aMW in FY 2024. The 2nd half of August Superpeak energy deficits were -900 aMW in FY 2021 and -700 aMW in FY 2024. Large surpluses occur in the spring in both years, which coincide with the Columbia River Basin runoff.

- Product Switching: Resulted in Federal system monthly Superpeak energy deficits in the winter and late summer in FY 2021. In that timeframe, the largest Superpeak energy deficit was -1,050 aMW in the 2nd half of August. A similar deficit of -1,000 aMW occurred in January. Large surpluses occur in the spring, which coincide with the Columbia River Basin runoff. This scenario produced increased Federal system monthly Superpeak energy deficits in the winter and late summer when compared to the Expected Base Case. This is because forecasted Federal system load obligations are higher during these time periods, since BPA is now serving the net requirement load obligations for those Slice customers who switched to Load Following service. This scenario also produced larger Federal system surpluses in the spring, because net requirement load obligations are lower than the energy received by those same customers under the Slice contracts, during the spring Columbia River Basin runoff.

- Climate Change: Resulted in Federal system monthly Superpeak energy deficits in the late summer in FY 2021. In that timeframe, the largest Superpeak energy deficit was -1,000 aMW in the 2nd half of August. Large surpluses occur in the spring, which coincide with the Columbia River Basin runoff. This scenario produced increased Federal system monthly Superpeak energy deficits in the late summer and reduced deficits in the winter when compared to the Expected Base Case. This is due to increases in precipitation that result in additional hydro generation and reduced winter loads due to warmer temperatures.

Table 4-4

Federal System Needs Assessment
Monthly 10th Percentile Superpeak EnergyFY 2021 and 2024



	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Aug1	Aug16	Sep	Avg
Expected 2021	400	600	-150	-750	-450	1000	-100	650	3100	1800	800	400	-900	-300	500
Expected 2024	350	500	-300	-700	-300	950	-150	650	3750	2550	900	600	-700	-400	650
Product Switching	250	550	350	-1000	-400	750	-550	550	3550	1850	400	0	-1050	-400	450
Climate Change	300	750	50	0	250	1800	450	1900	3550	1850	550	150	-1000	-550	800

The Monthly P10 Superpeak Energy metric results show that the Federal system is deficit during the winter and late summer months, and surplus in the spring. Under the Product Switching scenario, BPA faces increased deficits in both the winter and late summer months. In the Climate Change scenario, Federal system winter deficits disappear, but the Federal system still shows late summer deficits. This indicates that in low water conditions, or where the Federal system has reduced generation, the system experiences Superpeak energy deficits in the winter and late summer. During the high water conditions of the spring runoff months the Federal system experiences Superpeak energy surpluses. This is because the hydro system has a limited ability to store water from season-to-season, month-to-month, and day-to-day due to the amount of available storage and non-power operating requirements, such as flood control and fish operations.

18-Hour Capacity Metric: The 18-Hour Capacity metric analyzes the ability of the Federal system to meet loads over the six peak load hours per day during a three-day extreme weather event—under median water conditions. Below are the 18-Hour Capacity metric results for each scenario:

- Expected Base Case: Tables 4-5 through 4-8, pages 55 through 56, show 18-Hour Capacity surplus/deficits for the Expected Base Case scenario for the winter and summer of FY 2021 and 2024. This scenario produced surpluses of 1,150 MW in the winter and 250 MW in the summer for both FY 2021 and 2024.

- Product Switching: Tables 4-9 and 4-10, page 57, show 18-Hour Capacity surplus/deficits for the Product Switching scenario for the winter and summer of FY 2021. This resulted in Federal system 18-Hour Capacity surpluses of 1,650 MW in the winter and 250 MW in the summer. This scenario produced increased surpluses in the winter and similar surpluses in the summer when compared to the Expected Base Case. The winter results are because under extreme temperatures and median hydro conditions, the net requirement load obligations for those Slice customers who switched to Load Following service are less than the energy and capacity they received under the Slice/Block product.

- Climate Change: Tables 4-11 and 4-12, page 58, show 18-Hour Capacity surplus/deficits for the Climate Change scenario for the winter and summer of FY 2021. This resulted in Federal system 18-Hour Capacity surpluses of 1,100 MW in the winter and 250 MW in the summer. This scenario produced marginally smaller surpluses in the winter, when compared to the FY 2021 Expected Base Case.

Table 4-5

Federal System Needs Assessment
Expected Base Case Scenario
18-Hour Capacity
Winter 2021
Under Extreme Weather—Median Water Conditions
(1 in 10 Load Scenario—50 Percent Hydro Scenario)

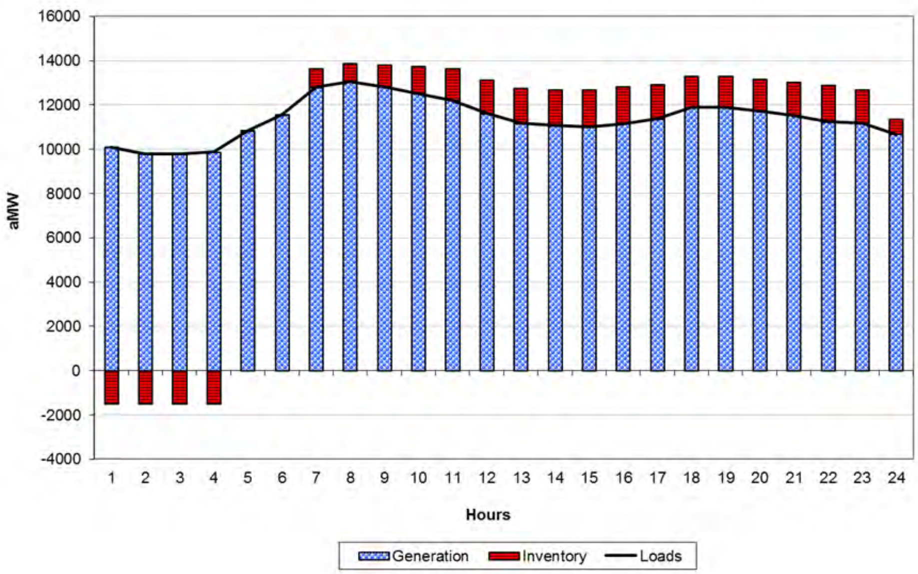


Table 4-6

Federal System Needs Assessment
Expected Base Case Scenario
18-Hour Capacity
Summer 2021
Under Extreme Weather—Median Water Conditions
(1 in 10 Load Scenario—50 Percent Hydro Scenario)

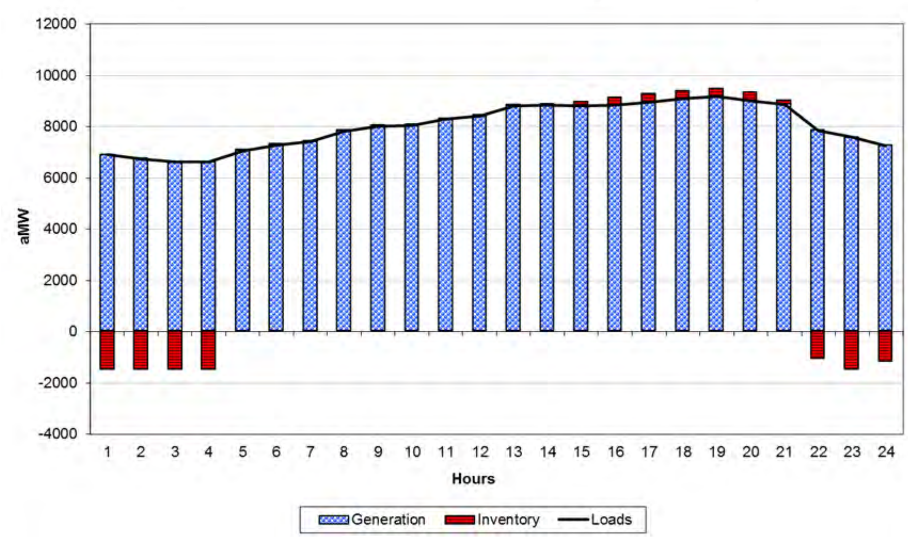


Table 4-7

Federal System Needs Assessment
Expected Base Case Scenario
18-Hour Capacity
Winter 2024
Under Extreme Weather—Median Water Conditions
(1 in 10 Load Scenario—50 Percent Hydro Scenario)

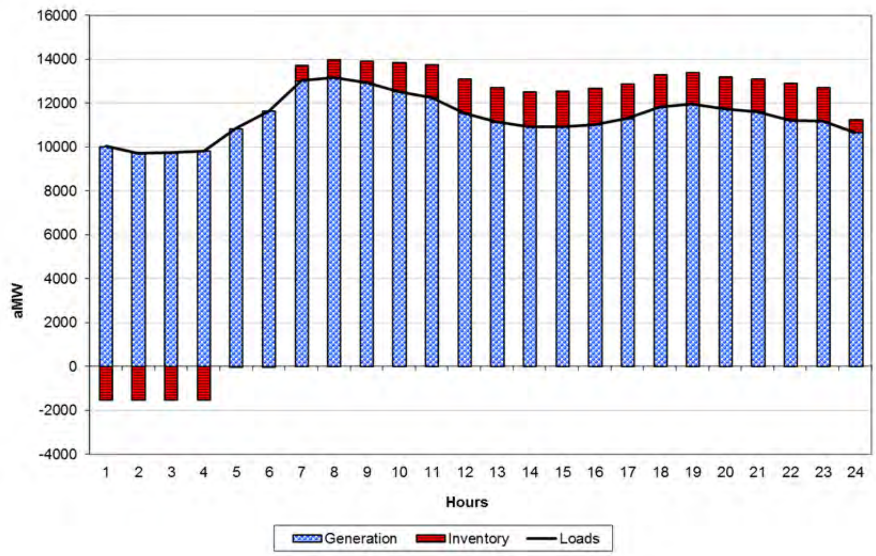


Table 4-8

Federal System Needs Assessment
Expected Base Case Scenario
18-Hour Capacity
Summer 2024
Under Extreme Weather—Median Water Conditions
(1 in 10 Load Scenario—50 Percent Hydro Scenario)

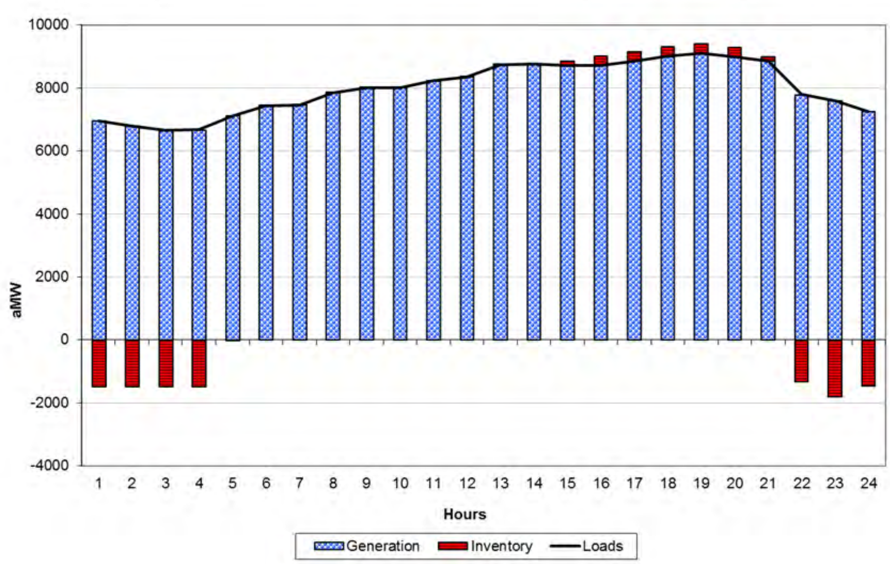


Table 4-9

Federal System Needs Assessment
Product Switching Scenario
18-Hour Capacity
Winter 2021
Under Extreme Weather—Median Water Conditions
(1 in 10 Load Scenario—50 Percent Hydro Scenario)

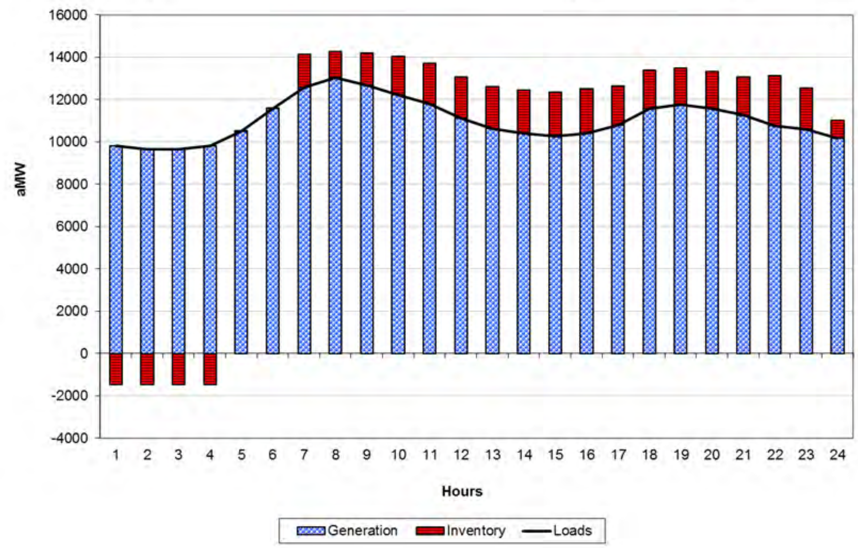


Table 4-10

Federal System Needs Assessment
Product Switching Scenario
18-Hour Capacity
Summer 2021
Under Extreme Weather—Median Water Conditions
(1 in 10 Load Scenario—50 Percent Hydro Scenario)

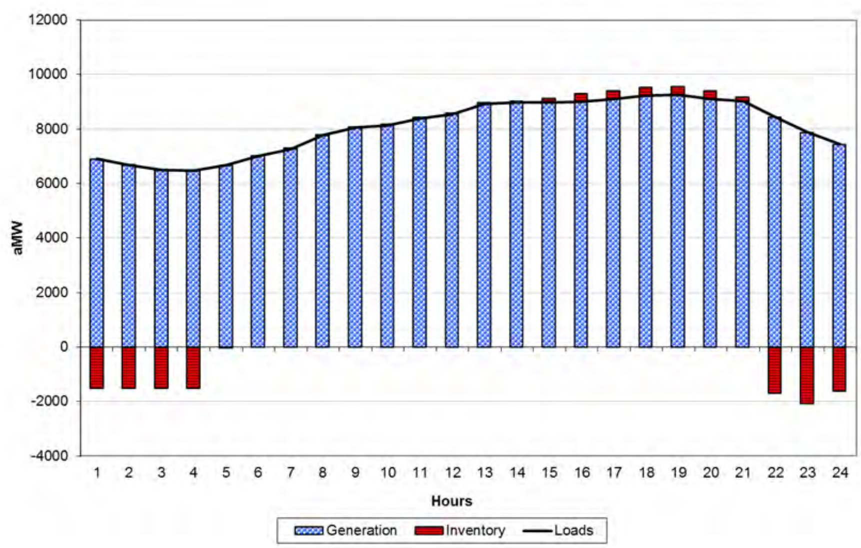


Table 4-11

Federal System Needs Assessment
Climate Change Scenario
18-Hour Capacity
Winter 2021
Under Extreme Weather—Median Water Conditions
(1 in 10 Load Scenario—50 Percent Hydro Scenario)

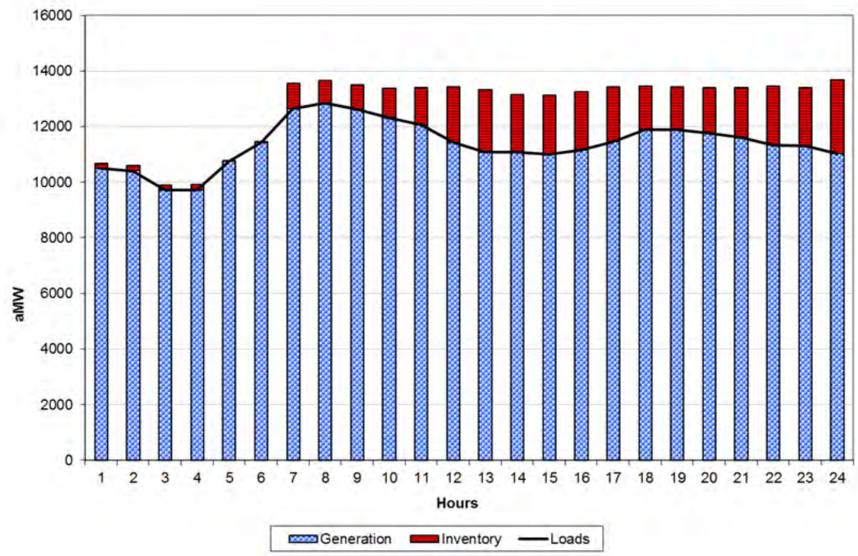
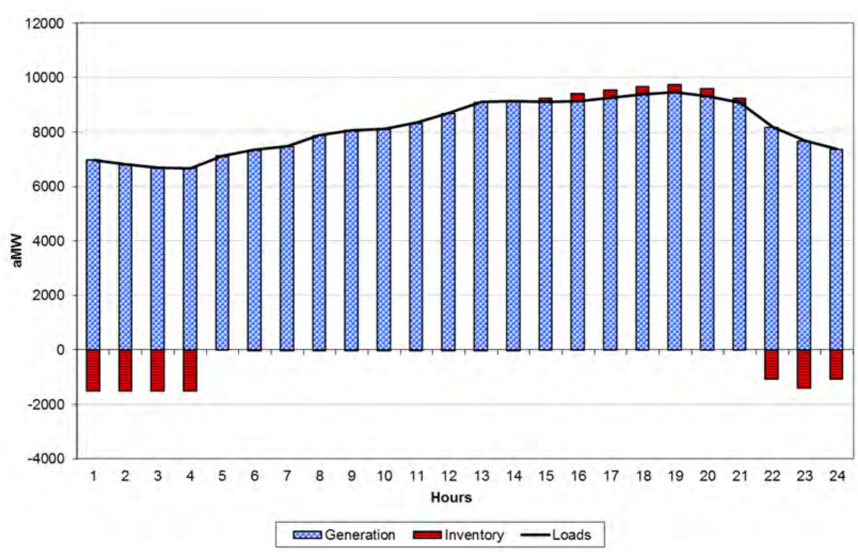


Table 4-12

Federal System Needs Assessment
Climate Change Scenario
18-Hour Capacity
Summer 2021
Under Extreme Weather—Median Water Conditions
(1 in 10 Load Scenario—50 Percent Hydro Scenario)



The results show that BPA anticipates 18-Hour Capacity surpluses during the winter and summer in both FY 2021 and 2024, under all these scenarios. While the Federal system can meet 18-Hour Capacity obligations under these scenarios, the water used to produce the power to meet these extreme load demands lowers the capability of the Federal system to serve load obligations over the remainder of the month and possibly subsequent months. Table 4-13, below, summarizes the 18-Hour Capacity results.

Table 4-13

Federal System Needs Assessment
18-Hour Capacity
Summary of Results
FY 2021 and 2024
Under Extreme Weather—Median Water Conditions

Season	Base Case FY 2021	Base Case FY 2024	Product Switching FY 2021	Climate Change FY 2021
Winter	1,150 MW	1,150 MW	1,650 MW	1,100 MW
Summer	250 MW	250 MW	250 MW	250 MW

Reserves for Ancillary Services Metric: The Reserves for Ancillary Services metric analyzes the ability of the Federal system to meet the forecasted BPA BAA balancing reserve needs. This metric was analyzed under two different scenarios for wind development in BPA's BAA. These wind development scenarios are unique and not associated with the other previously discussed Needs Assessment scenarios. Currently the Federal system can supply up to 900 MW of incremental (400 MW during spring) and 900 MW of decremental balancing reserves, which are the same reserve assumption in the 2015 White Book. The Reserves for Ancillary Services metric compared the forecast of balancing reserve needs for FY 2021 and 2024 to the Federal system supply. The results from the Base Case Wind Development scenario show that the balancing reserve needs exceed the Federal system supply in both FY 2021 and 2024. Under the Low Wind Development scenario, results show that the incremental balancing reserve needs only exceed the Federal system supply during the spring. In all other seasons the Low Wind Development scenario shows the Federal system can meet the incremental balancing reserve needs. Additionally, the results show that the decremental balancing reserve needs, in the Low Wind Development scenario, can be met by the Federal system across the entire year.

Forecasted balancing reserve needs for FY 2021 and 2024 can vary greatly due to many sources of uncertainty, including the amount of existing wind that may leave BPA's BAA, scheduling elections made for wind projects, and changes in market structure.

Federal System Needs Assessment Conclusions

The Needs Assessment results show that under a variety of conditions BPA may need to supplement existing Federal system generation in order to meet existing and projected load obligations.

Under expected load growth, the Federal system is projected to have modest annual energy deficits under critical water conditions. If BPA experiences lower than expected load growth, the Federal system would be annual energy surplus. Conversely, if BPA experiences higher than expected load growth, the Federal system will have larger annual energy deficits.

The Federal system is projected to have HLH and Superpeak energy deficits under expected load growth—most notably in the winter and late summer. Of the energy and capacity metrics analyzed, HLH energy is projected to have the largest deficits. Based on this analysis, HLH energy is the most limiting factor for the Federal system.

If a large portion of BPA's current Slice customers switch to Load Following service and assuming BPA serves the net requirement load of those customers, the Federal system is projected to have increased HLH energy deficits during the winter and summer. This is because forecasted Federal system load obligations would be higher during these time periods, since BPA is serving the net requirement for those former Slice customers.

Under current climate change expectations, the Federal system is projected to have lower HLH energy deficits or more energy surpluses during the winter period. This is due to higher winter streamflows and lower load obligations resulting from warmer temperatures. In the summer the Federal system is projected to have higher HLH energy deficits due to lower summer streamflows and increased load obligations due to warmer temperatures. These results are based on climate change conditions that include a 6 MAF average increase in January through July streamflows.

Section 5: Federal System Resource Adequacy

BPA continues to explore and advance its understanding of resource adequacy as it relates to the Federal system, consistent with its statutory purposes under section 2, of the Northwest Power Act.[5] System reliability is defined by the North American Electric Reliability Corporation (NERC) as the ability of a system to withstand sudden disturbances. The two components of system reliability are adequacy and security. Resource adequacy refers to the ability of a power system to meet its aggregate energy and capacity demand at any time. The Federal System Resource Adequacy analysis provides a stochastic simulation assessing the probability of the Federal system meeting firm load obligations under a variety of different combinations of supply and demand.

BPA introduced its first Federal System Resource Adequacy analysis in the 2011 White Book. The 2012 White Book further examined the Federal system's capability of meeting firm load obligations in FY 2016 and 2017. The 2015 White Book includes analyses for FY 2021 and 2024.

Federal System Resource Adequacy Assumptions

The Federal System Resource Adequacy modeling was performed using a Federal system version of the Council's regional GENESYS model. The Council created GENESYS to develop a consensus-based resource adequacy framework for the region, and to make annual assessments for the PNW. The Council's regional GENESYS model analyzes whether the PNW regional power system can meet firm load in a future year under many different combinations of future load and resource conditions. The Federal system version of GENESYS was developed based on the Council's model to complete an analysis focused on the Federal system. The Federal system GENESYS model incorporates the following future uncertainties:

Water Supply: The large variations in streamflow volume runoff impact the amount of hydroelectric power production in the Federal system. The January to July Columbia River runoff measured at The Dalles from 1929 through 2008 has varied from 53.5 MAF in 1977 to 158.2 MAF in 1997.

Load Obligations: Nearly half of the firm load obligations that BPA serves under the 2008 Regional Dialogue PSCs fluctuate with temperature. These fluctuations can result in approximately 400 aMW of monthly load differences in winter.

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[5] One of the purposes stated in Section of the Northwest Power Act, is to assure the Pacific Northwest of an adequate, efficient, economical, and reliable power supply. *[Northwest Power Act, §2(2), 94 Stat. 2697].*

Wind Generation: BPA has acquired the output of 248 MW of installed wind capacity to help meet its firm load obligations. In addition, Load Following customers—that contracted for BPA's Resource Support Services (RSS)—have dedicated 10 MW of installed wind capacity to serve their load. The generation output from these wind projects varies significantly from hour to hour.

Modeled Forced Outages of Thermal Resources: Forced outages are stochastically modeled for the Columbia Generating Station (CGS). Two studies were developed for this analysis: 1) FY 2021 Federal system study—when CGS is scheduled for refueling; and 2) FY 2024 Federal system study—when CGS is not scheduled for refueling. These studies incorporate the large uncertainties inherent in the Federal power system that are noted above, and include the following inputs that may differ from other Federal system analyses in the White Book:

Water Supply: Historical 2010 Level Modified Streamflows from the 1929 to 2008 record are selected sequentially for the stochastic analysis. Sequential water conditions are used because the operations of the Canadian Treaty projects are fixed to a sequential set of water years. Using sequential water conditions may provide a limited representation of potential future water supply variability as each year is always preceded by the same water year (e.g. 1929 always precedes 1930).

Load Obligations: To represent the impact of temperature variations, hourly loads for Load Following customers were forecast for 57 historical temperature years, which are based on actual hourly PNW temperatures. For the stochastic analysis, a temperature year is selected for each game to determine the specific hourly loads for that game.

Wind Generation: Wind generation is based on BPA's acquired output from 248 MW of installed wind capacity. An additional 10 MW of installed wind capacity, from Load Following customers who subscribe to BPA's RSS, is also included. To represent uncertainty in wind generation, hourly wind capacity factors were correlated to each of the 57 historical temperature years to create a set of synthetic wind years. These synthetic wind years are drawn in lockstep with the historical temperature year.

CGS: The 1,120 MW nuclear power plant is assumed to have a forced outage rate of 8.85 percent, which includes a mean repair time of 200 hours, to represent the likelihood and duration of unplanned outages. These assumptions are based on historical outage data and do not provide any indication of future performance. In 2021, CGS is assumed to have a two month refueling outage across May and June.

A-RHWM Resources: This study assumes no additional future resource acquisitions or contract purchases have been made to serve A-RHWM load obligations in FY 2021 and 2024. This is a different assumption than those made in the 2011 and 2012 Resource Adequacy studies. This change was made to be consistent with other White Book analyses. BPA's obligation forecasts include approximately 290 aMW in FY 2021 and 390 aMW in FY 2024 of A-RHWM load for BPA's Load Following customers.

Market Depth: The wholesale power market supply available to BPA to support resource adequacy requirements is assumed to be 1,000 MW in the winter and 500 MW in the summer.

The stochastic analysis incorporates 4,560 simulations that combine load years, wind years, water years, and CGS forced outages. These simulations are called games. The water and load years are selected sequentially in the analysis.

Federal System Resource Adequacy Metrics

BPA first discussed the concept of Federal System Resource Adequacy and the lack of a national industry standard in the 2011 White Book. While there is still no national industry standard on resource adequacy, most utilities and regional transmission organizations have adopted a standard of acceptable resource adequacy, as measured by having a loss-of-load event occurring no more than 1 day in 10 years. Although this standard is useful for capacity-limited power systems that are dominated by thermal generation, it is not appropriate for BPA's large hydro-based system, which has limited water storage capabilities and non-power requirements that constrain both the energy and capacity of the Federal system. For example, in low streamflow volume years there is the potential for prolonged periods of reduced energy production that results in load not being served which causes the system to exceed the 1 day in 10 years resource adequacy standard.

The metric adopted by the Council after recommendations from the Northwest Resource Adequacy Forum (now the Resource Adequacy Advisory Committee) is the Loss-of-Load Probability (LOLP)[6]. The Council uses LOLP to signal when PNW regional resource development is not keeping pace with regional load growth, and is defined as:

- Loss-of-Load Probability (LOLP): The number of yearly GENESYS simulations with significant Energy-Not-Served (ENS) events divided by the total number of simulations ran. Significant ENS events are defined as shortfalls—energy or capacity—that exceed the capability of standby resources and contractual load management actions.

North American Electric Reliability Corporation Metrics: BPA has looked at other efforts in the industry to define and assess resource adequacy, including NERC's pilot program of probabilistic assessments, which are published as addendums to their Long-Term Reliability Assessments.[7] The purpose of NERC's assessment is to provide a more comprehensive understanding of resource adequacy beyond the deterministic analysis found in their Long-Term Reliability Assessments.

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[6] *A New Resource Adequacy Standard for the Pacific Northwest.* Council Document Number 2011-14.

[7] The latest probabilistic assessment was issued in April 2015 for the 2014 Long-Term Reliability Assessment.

However, NERC has not set standards for any of these metrics. The three pilot metrics chosen by NERC for these studies are:

- Loss-of-Load Hours (LOLH): The average number of hours with unserved energy across all games—expressed in hours per year.

- Expected Unserved Energy (EUE): The average amount of unserved energy across all hours of all games—expressed in megawatt hours per year. EUE is equivalent to the expected amount of Energy-Not-Served (ENS).

- Normalized Expected Unserved Energy (Normalized EUE): The EUE divided by the total annual firm load obligation—expressed as a percent.

BPA Draft Metrics: Following Council recommendations, BPA is using the Annual LOLP metric in addition to the Conditional Value at Risk (CVaR) metric—which were first presented in the 2011 White Book—and has analyzed the three NERC metrics for comparison purposes.

The Annual LOLP metric measures the likelihood that the Federal system is unable to meet firm load obligations with its expected resources, under a variety of load and resource conditions and is defined as:

- Annual Loss-of-Load Probability (Annual LOLP): The number of games with significant annual energy ENS amounts, divided by the total number of games, expressed as a percent. As in the 2011 White Book, the significant ENS threshold is defined as annual ENS greater than 50 aMW.

The CVaR metric measures the magnitude of ENS for the Federal system under adverse load obligation and resource conditions and is defined as:

- Conditional Value at Risk (CVaR): The CVaR metric analyzes the 5 percent of games that have the highest annual ENS amounts. For this analysis 4,560 games were simulated, resulting in 228 games being analyzed as the 5 percent. The analysis includes both the average monthly ENS amount, and the probability of occurrence by month. BPA's 2011 and 2012 Resource Adequacy assessments examined the 2.5 percent of games with the highest amounts of annual ENS for the CVaR metric.

BPA continues to evaluate a possible standard for the Annual LOLP metric. The standard adopted by the Council to signal when regional resource development is not keeping pace with regional load growth is 5 percent. Using the most conservative LOLP standard of 0 percent may not meet the tradeoff between an adequate resource supply and an economical one. BPA is presently considering LOLP standards between 0 and 5 percent.

Federal System Resource Adequacy Results

NERC Draft Pilot Probabilistic Assessment Metrics: Table 5-1, below, summarizes the FY 2021 and 2024 results for NERC's three pilot probabilistic assessment metrics. NERC has not established standards for these metrics, which are shown for purposes of comparison only. For the Federal system the LOLH, EUE, and Normalized EUE values are considerably higher than those reported in the NERC 2014 Long-Term Reliability Assessment. These higher values are primarily a result of energy limitations on BPA's hydro-based system.

Table 5-1

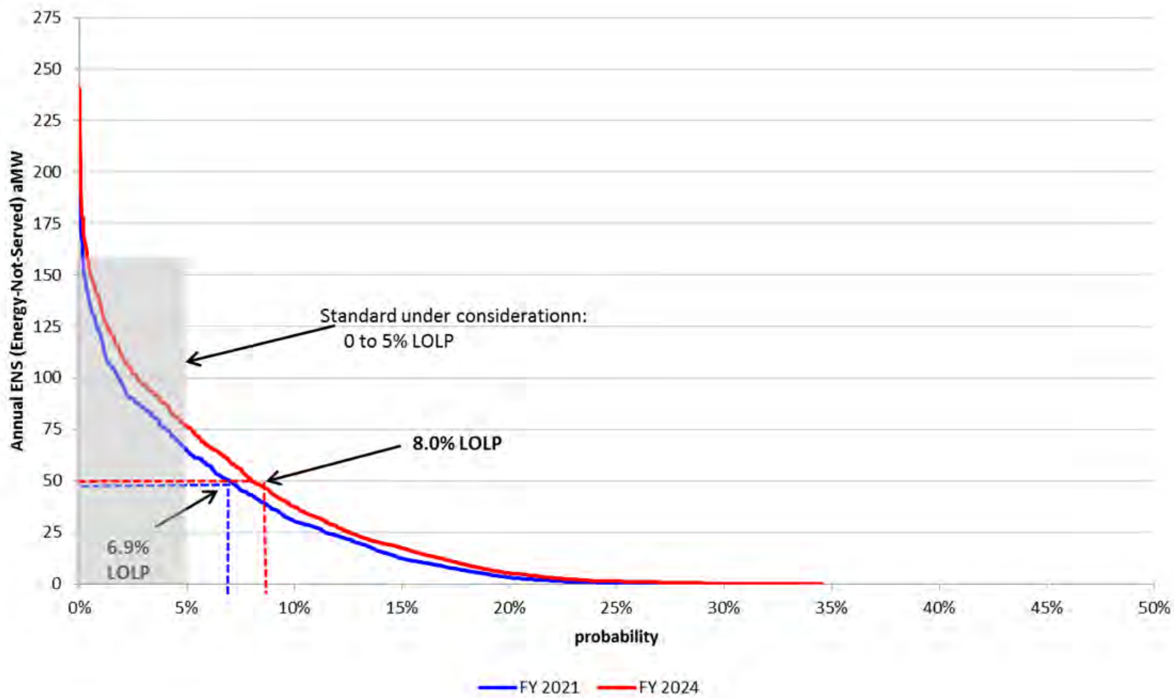
Federal System Resource Adequacy
NERC Pilot Probabilistic Assessment Metrics
FY 2021 and 2024

Metric	Units	FY 2021	FY 2024
LOLH	Hours/Year	138	155
EUE	MWhr/Year	76,709	90,615
Normalized EUE	%	0.1030%	0.1215%

Annual LOLP: Table 5-2, below, summarizes the annual ENS amounts and the associated probability of occurrence--across the 4,560 simulated games—for FY 2021 and 2024. In FY 2021, 314 of the simulated games had annual ENS amounts of 50 aMW or more—identifying them as significant—resulting in a calculated Annual LOLP of 6.9 percent. In FY 2024, 365 of the simulated games had significant annual ENS amounts that resulted in a calculated Annual LOLP of 8.0 percent.

Table 5-2

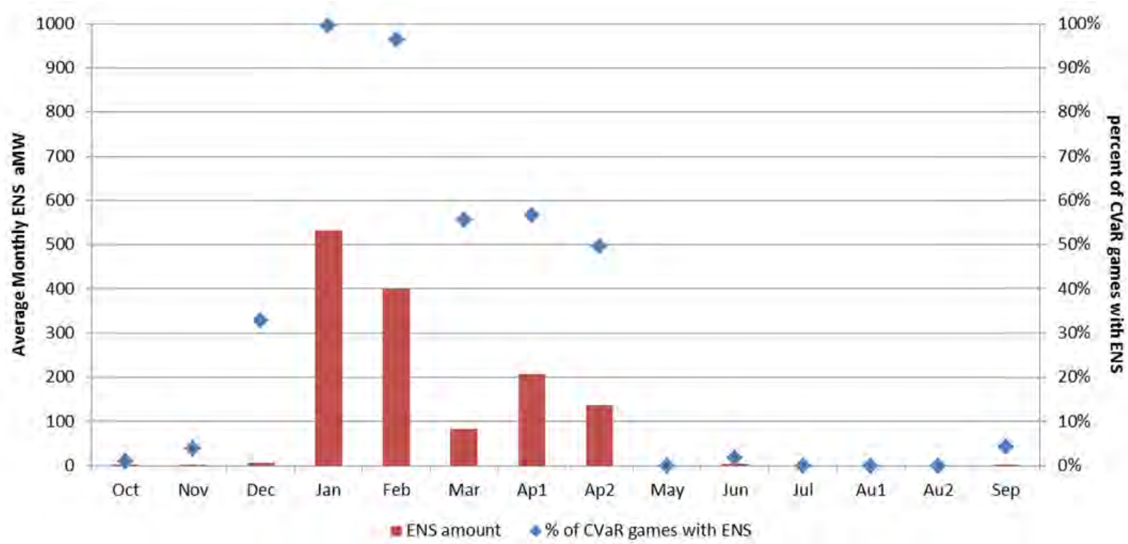
Federal System Resource Adequacy
Annual ENS events and Annual LOLP
FY 2021 and 2024



CVR Metric: The CVaR metric examines the 5 percent of the 4,560 simulated games that have the highest annual ENS amounts. Table 5-3, below, shows the average monthly ENS amount and the percent of games with ENS occurrences by month for FY 2021. For example, January 2021 on average has 531 aMW of ENS, and at least one ENS occurrence in all 228 games—worst 5 percent of all games. January and February have the largest average ENS amounts and the highest percentage of games with ENS occurrences.

Table 5-3

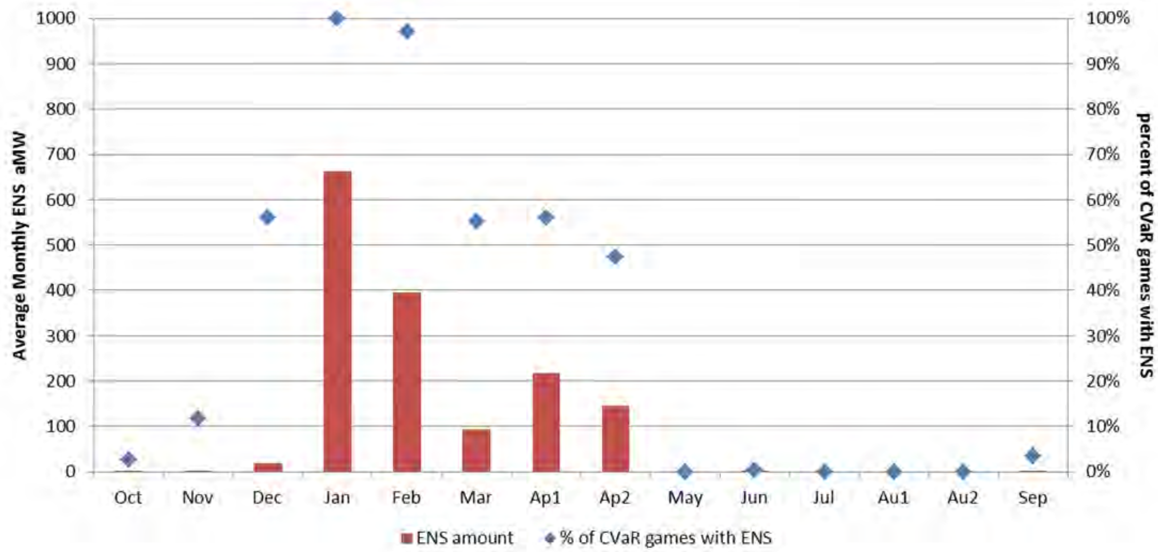
Federal System Resource Adequacy
Average Monthly ENS and Percentage of CVaR Games with ENS
FY 2021



For FY 2024, Table 5-4, below, shows the average monthly ENS amount and the percent of those games with ENS occurrences by month. For example, January 2024 on average has 662 aMW of ENS, and at least one ENS occurrence in all 228 games—worst 5 percent of all games. January and February have the largest average ENS amounts and the highest percentage of games with ENS occurrences

Table 5-4

Federal System Resource Adequacy
Average Monthly ENS and Percentage of CVaR games with ENS
FY 2024



Sensitivity of Results to Key Assumptions

The resource adequacy studies presented above for FY 2021 and 2024 reflect the most appropriate value for each assumption on a long-term planning basis. However, changes in key assumptions can produce significantly different results. Table 5-5, below, illustrates the FY 2021 Annual LOLP sensitivity to two key assumptions: 1) the value of the threshold for significant ENS amounts, and 2) the market depth available in the study.

The results show the impact of incorporating different annual ENS thresholds and market depth assumptions. Moving from left to right across the table shows reductions to the significant ENS threshold, while moving down the table shows reduction in the level of market depth available. As indicated by the range of Annual LOLP values, the study results are very sensitive to these key assumptions. While this shows variability in Annual LOLP results for FY 2021, an equivalent analysis would yield similar results for FY 2024.

Table 5-5

Federal System Resource Adequacy
Sensitivity of Annual LOLP Results to Key Assumptions
FY 2021

		Significant ENS Threshold		
		100 aMW	**50 aMW**	**0 aMW**
Market Depth	**1,000 MW Winter 500 MW Summer**	1.8%	**6.9%**	31.1%
	0 MW	8.7%	13.1%	52.0%

Federal System Resource Adequacy Conclusions

The Federal System Annual LOLP results of 6.9 percent and 8.0 percent for FY 2021 and 2024, are outside of the "acceptable" range of the Annual LOLP standards of 0 to 5 percent that BPA is presently considering. However, if BPA and its customers acquire resources to serve the A-RHWM load obligations assumed to be placed on BPA in these studies, the Annual LOLP drops to 3.5 percent in 2021 and 3.2 percent in FY 2024. These lower results are within the acceptable range of the Annual LOLP standards BPA is considering. Together with the CVaR metric, these lower results suggest that the months of January and February present the highest likelihood of the Federal system being unable to meet firm load obligations. The studies also include a market depth of 1,000 MW in the winter and 500 MW in the summer that is available in all hours. If this amount of market depth is not available, even on specific hours, the Annual LOLP would increase.

BPA's analyses suggest that the variability of water supply, load obligations, and available market depth are primary drivers of the Federal system's Annual LOLP. BPA continues to assess the most appropriate value for each assumption on a long-term planning basis. BPA also continues to investigate the draft resource adequacy metrics presented here as well as alternative metrics that may be more appropriate for its large hydro-based system. Additional analyses are required before establishing a metric, as well as a standard for the Federal system.

Overall, the 2015 White Book Federal System Resource Adequacy results are consistent with the resource adequacy results presented in the 2012 White Book.

Comparison of Federal System and Regional Resource Adequacy

The following analysis compares the Federal system's FY 2021 resource adequacy needs to the Council's FY 2021 regional resource adequacy needs that were presented in May 2015 as part of its *Resource Adequacy Assessment for 2020/21*. For FY 2021, the Federal system has an Annual LOLP of 6.9 percent compared to the Council's regional analysis of 8.1 percent; however, the methodology used to calculate LOLP is different between the two analyses. BPA's ENS threshold is 50 aMW on an annual basis, whereas the Council's regional method counts the ENS occurrences that remain after applying its regional standby resources. BPA's Federal system analysis is more conservative than the Council's in relation to available market purchases, specifically in the winter. In the winter, BPA assumes 1,000 MW is available from market purchases, while the Council's regional studies assume approximately 5,000 MW is available in the winter from a combination of imports and regional independent power producers.

The first comparison, presented in Table 5-6, 71, shows the average annual ENS for FY 2021. BPA's Federal system study has substantially higher annual average ENS then the Council's Regional study. Table 5-7, 71, shows that this is also the case for the month of January 2021, which has the highest monthly average ENS for both the Federal system and the Council's Regional study.

Table 5-6

Federal System Resource Adequacy
BPA's Federal System and Council's Regional Analyses
Annual Average ENS
FY 2021

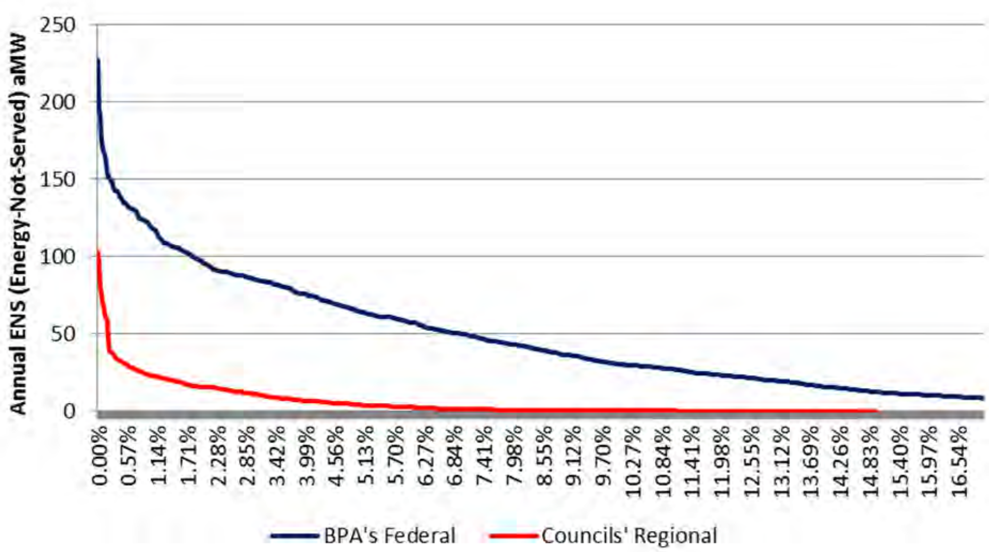
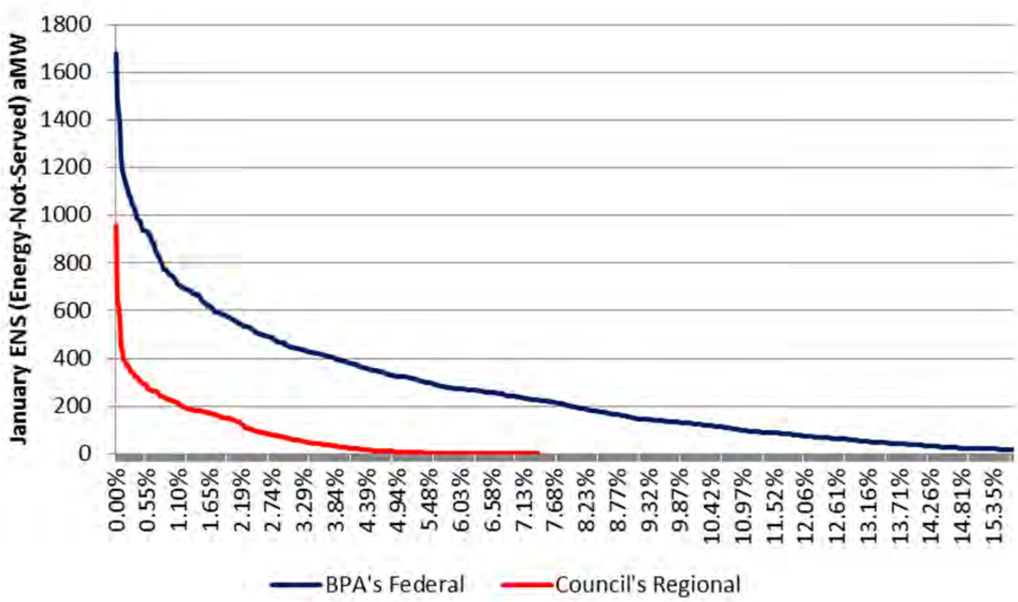


Table 5-7

Federal System Resource Adequacy
BPA's Federal System and Council's Regional Analyses
January ENS
FY 2021



These higher ENS amounts for the Federal system are primarily being driven by specific water years that are part of multiyear drought periods. Table 5-8, below, summarizes the 25 games for the Federal system with the highest annual average ENS, which were caused by 5 of the 80 water conditions simulated: 1931, 1932, 1937, 1945, and 1993. All of these water years, with the exception of 1937, are part of multiyear drought periods. For example, the 1931 and 1932 water years are part of a four year critical period that starts in 1929. The 1945 and 1993 water years are the last water years of two year drought periods. Table 5-8, below, also shows the January through July volume runoff at The Dalles for these games. While these years had low January through July volume runoff, they are typically preceded by a year with even lower runoff.

Table 5-8

Federal System Resource Adequacy
Water Year Details for the 25 Games with Highest Annual ENS
FY 2021

Water Year	2021 Occurrences	Jan-July Runoff at The Dalles (MAF)	Exceedance	Prior Water Year	Jan-July Runoff at The Dalles (MAF)	Exceedance
1931	10	64.3	64%	1930	70.9	92%
1932	5	108.2	41%	1931	64.3	97%
1937	2	69.2	95%	1936	90.3	71%
1945	1	83.4	79%	1944	60.2	98%
1993	7	89.1	77%	1992	72.7	90%

Table 5-9, below, summarizes the 25 games for the Council's Regional analysis with the highest annual average ENS. The regional results have a more dispersed set of water years, when compared to the Federal system, due to the region's more diverse resource portfolio. Most of the water conditions have low volume runoff, but are not necessarily part of multiyear drought periods.

Table 5-9

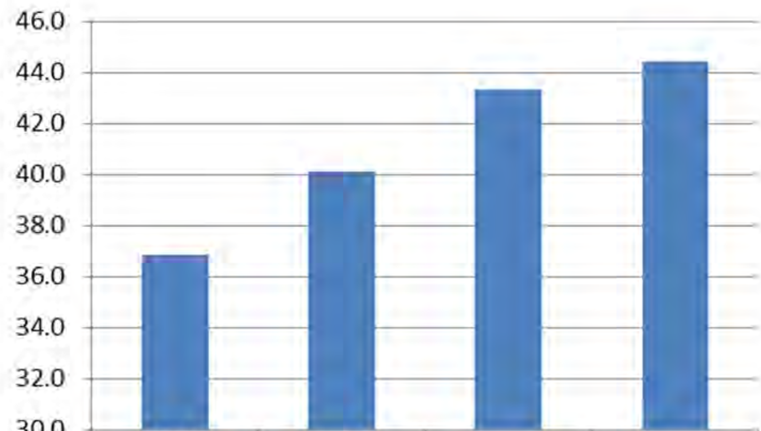
Council's Regional Analysis
Water Year details for the 25 Games with Highest Annual ENS
FY 2021

Water Year	2021 Occurrences	Jan-July Runoff at The Dalles (MAF)	Exceedance	Prior Water Year	Jan-July Runoff at The Dalles (MAF)	Exceedance
1930	1	70.9	92%	1929	69.5	94%
1931	2	64.3	97%	1930	70.9	92%
1932	3	108.2	41%	1931	64.2	97%
1936	3	90.3	71%	1935	91.9	70%
1937	2	69.2	95%	1936	90.3	71%
1941	1	69.8	93%	1940	81.9	84%
1945	1	83.4	79%	1944	60.2	98%
1977	1	53.9	100%	1976	122.1	20%
1988	1	76.9	87%	1987	78.3	86%
1989	1	92.9	67%	1988	76.9	87%
1993	3	89.1	77%	1992	72.7	90%
1994	2	76.4	88%	1993	89.1	77%
2001	1	59.9	99%	2000	100.2	57%
2002	1	106.1	47%	2001	59.9	99%
2004	2	83.2	80%	2003	89.6	74%

BPA's Federal system study begins, on average, with lower reservoir storage levels than the Council's Regional analysis for the 25 simulations with the highest annual average ENS. As previously discussed, this is because the worst simulations for the Federal system occur in water years that are part of multiyear drought periods. Table 5-10, below, shows that those 25 simulations for the Federal system study have initial reservoir storage levels 17 percent below the 80-water year median at 36.9 MAF. The 25 simulations for the Council's Regional study begin 10 percent below the median at 40.1 MAF.

Table 5-10

BPA's Federal System and Council's Regional Analyses
Comparison of Initial Storage Conditions
FY 2021



	BPA's Federal Highest ENS	Council's Regional Highest ENS	80-WY Mean	80-WY Median
Initial Storage (MAF)	36.9	40.1	43.3	44.4

The methodology used by the Council for resource adequacy studies considers both energy and capacity, any shortfall that exceeds the energy or capacity capability of the standby resources is considered as contributing to the LOLP, no matter how small the shortfall. Each shortfall that contributes to the LOLP can be classified as either energy or capacity depending on whether it exceeded the capacity or energy attributes of the standby resource(s). Shortfalls can be considered both energy and capacity if they exceed both capabilities of the standby resources. If the Council's standby resources' methodology is applied to the Federal system, the Banks Lake pumped storage facility is the only standby resource available, and it is considered a capacity-only resource. Table 5-11, below, shows the Federal system LOLP for energy and capacity, based on the energy and capacity attributes of the Federal system's only standby resource—Banks Lake. For FY 2021, the Federal system Energy LOLP is larger than the Capacity LOLP for all months. The larger Energy LOLP values show the Federal system is energy limited and adding capacity-only resources will not reduce the Federal system overall LOLP result.

Table 5-11

Federal System Resource Adequacy
LOLP Using Council's Standby Resource Methodology
Energy LOLP, Capacity LOLP, and Overall LOLP
FY 2021

Month	Energy LOLP	Capacity LOLP	Overall LOLP
Oct	13	1.5	13
Nov	3.9	1	3.9
Dec	17.3	11.1	17.3
Jan	25.5	22.3	25.5
Feb	25	21.9	25
Mar	12.6	9.8	12.6
Apr1	15.6	13	15.6
Apr16	10.2	8.8	10.2
May	1	0	1
Jun	3.7	3	3.7
Jul	1	0.2	1
Aug1	0.5	0.1	0.5
Aug16	3.8	1.3	3.8
Sep	7.1	2.6	7.1

Table 5-12, below, shows the Council's Regional LOLP for energy and capacity, which reflect the energy and capacity attributes of regional standby resources. The standby resources for the region includes a larger set of resources than for the Federal system, including demand response programs, Banks Lake pumped storage, load curtailment contracts, and small standby generators. Most of these regional standby resources are considered capacity-only. The results show that for FY 2021, the Capacity LOLP is larger than the Energy LOLP for all months. The larger Capacity LOLP values show that the region is capacity limited, and adding capacity-only resources will reduce the regional Overall LOLP results.

Table 5-12

Council's Regional LOLP
Using Council's Standby Resource Methodology
Capacity LOLP, Energy LOLP, and Overall LOLP
FY 2021

Month	Energy LOLP	Capacity LOLP	Overall LOLP
Oct	0	0	0
Nov	0	0	0
Dec	0	1	1
Jan	0.1	4.5	4.6
Feb	0	2.9	3
Mar	0	0	0
Apr1	0	0	0
Apr16	0	0	0
May	0	0	0
Jun	0	0	0.1
Jul	0	0	0
Aug1	0	0	0
Aug16	0	0.2	0.3
Sep	0	0.1	0.1

Table 5-13, below, compares the average monthly ENS from the 5 percent of games that have the highest annual ENS in BPA's Federal system study and the Council's Regional study. Though the Federal system is a subset of the region, the Federal system has higher monthly ENS amounts when compared to the region.

Table 5-13

Federal System Resource Adequacy
Comparison between BPA's Federal System
and Council's Regional Analyses
Average Monthly ENS for the 5 Percent of Games with Highest ENS
FY 2021

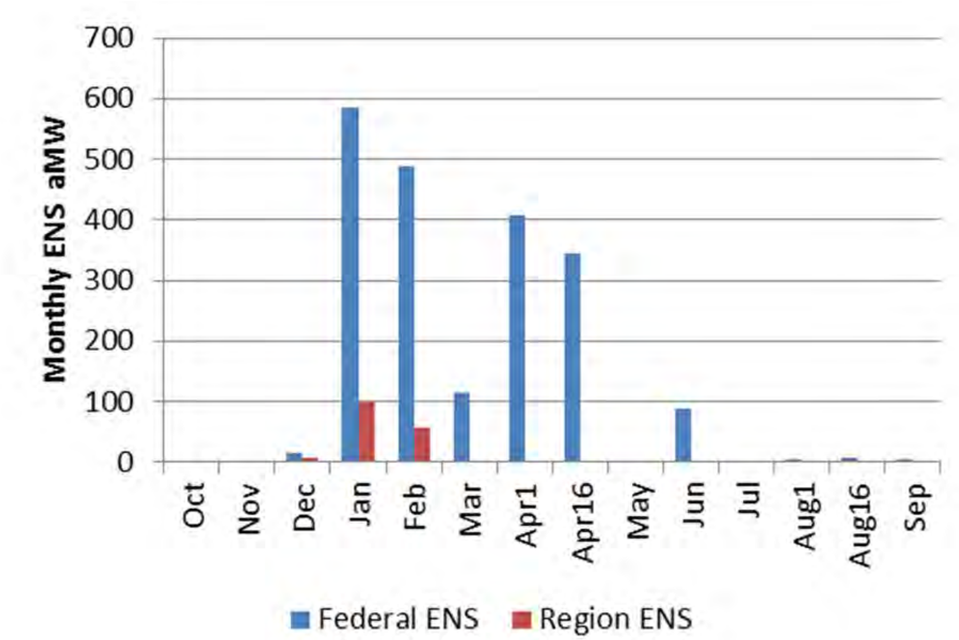
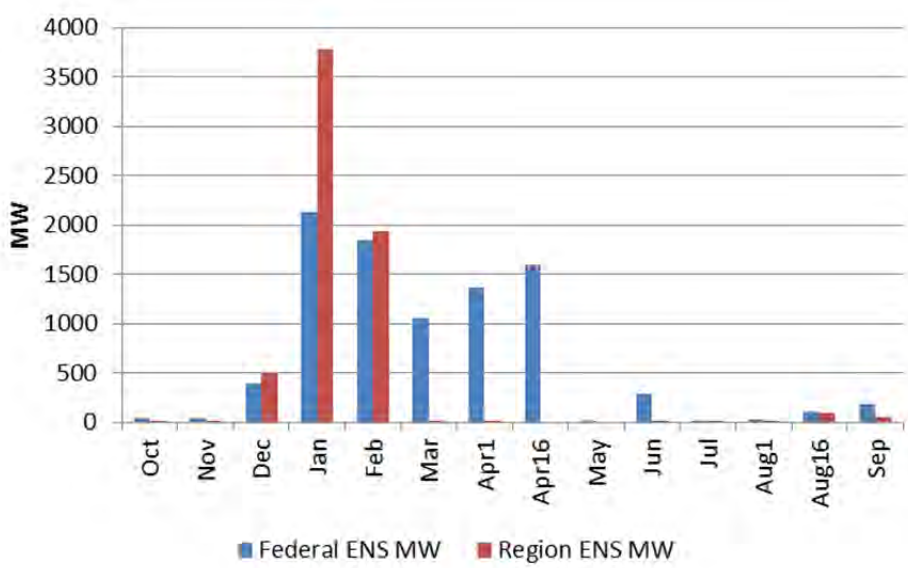


Table 5-14, below, compares the average monthly capacity ENS from the 5 percent of games that have the highest annual ENS in BPA's Federal system study and the Council's Regional study. This is calculated by averaging the single highest hour ENS amount from each month of each game by month for the 5 percent of games with the highest annual ENS amounts. For example, during the month of January 2021, the average of the highest single hour from each game for the region is 3,777 MW, while the average of the highest single hour from each game for the Federal system is 2,136 MW. It should be noted, however, that the region is larger than the Federal system.

Table 5-14

Federal System Resource Adequacy
Comparison between BPA's Federal System
and Council's Regional Analyses
Monthly Capacity ENS for the 5 Percent of Games with Highest ENS
FY 2021



Federal System and Regional Resource Adequacy Conclusions

The Federal system resource adequacy needs are more energy focused as the Federal system is less capacity constrained than the region. The Federal system is limited primarily during multiyear drought periods were the year starts with lower reservoir storage levels. This finding is consistent with the 2015 Federal System Needs Assessment which concluded that the most limiting metric for the Federal system is Monthly P10 Heavy Load Hour Energy, and is the most limited during the months of January and February. Using the Council's methodology of adding capacity-only resources would not lower the LOLP for the Federal system since the system is more energy limited. On the other hand, the regional resource adequacy needs are driven by capacity, which is influenced by the region's more diversified resource portfolio. As a result, capacity-only resources can lower the regional LOLP.

Section 6: Federal System Analysis Exhibits

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Exhibit 6-1: Annual Energy

Federal System Analysis Surplus Deficit
Operating Year 2017 to 2026
Using 1937-Water Conditions

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Loads and Resources - Federal System

Operating Year: 2017 to 2026 Water Year: 1937

2015 White Book Report Date: **6/30/2015**

S129-WB-20151029-154000 1

	Energy-aMW	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	Firm Obligations										
1	**Load Following**	3460	3485	3515	3514	3522	3524	3536	3546	3567	3581
2	Preference Customers	3158	3180	3193	3179	3186	3188	3199	3209	3230	3243
3	Federal Agencies	118	121	139	151	152	152	153	153	154	154
4	USBR	184	184	184	183	184	184	184	183	184	184
5	Federal Diversity	0	0	0	0	0	0	0	0	0	0
6	**Tier 1 Block**	23.1	25.5	25.5	26.3	25.7	26.0	26.5	25.7	25.6	25.3
7	Tier 1 Block	23.1	25.5	25.5	26.3	25.7	26.0	26.5	25.7	25.6	25.3
8	**Slice**	3635	3661	3638	3681	3674	3686	3674	3677	3682	3681
9	Slice Block	1812	1816	1835	1822	1856	1829	1858	1818	1864	1818
10	Slice Output from T1 System	1823	1845	1804	1859	1817	1857	1816	1859	1818	1863
11	**Direst Service Industries**	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1
12	DSI	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1	91.1
13	**Contract Deliveries**	624	573	548	486	478	472	467	463	459	456
14	Exports	519	513	489	471	466	461	456	452	449	445
15	Intra-Regional Transfers (Out)	105	59.9	59.9	15.1	11.9	10.7	10.7	10.7	10.7	10.7
16	**Total Firm Obligations**	**7833**	**7835**	**7819**	**7798**	**7790**	**7799**	**7795**	**7803**	**7825**	**7834**
	Net Resources										
17	**Hydro Resources**	6711	6634	6633	6631	6628	6616	6614	6613	6614	6614
18	Regulated Hydro - Net	6355	6278	6276	6275	6271	6271	6271	6271	6271	6271
19	Independent Hydro - Net	354	354	354	353	354	342	340	339	340	340
20	Small Hydro - Net	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88
21	**Other Resources**	976	1135	976	1135	972	1130	971	1130	971	1130
22	Cogeneration Resources	0	0	0	0	0	0	0	0	0	0
23	Combustion Turbines	0	0	0	0	0	0	0	0	0	0
24	Large Thermal Resources	916	1075	916	1075	916	1075	916	1075	916	1075
25	Renewable Resources	59.7	59.7	59.7	59.6	56.0	55.3	55.3	55.2	55.3	55.3
26	Small Thermal & Misc.	0	0	0	0	0	0	0	0	0	0
27	**Contract Purchases**	402	411	354	279	256	172	172	173	172	173
28	Imports	89.9	89.9	89.9	90.0	84.5	1.00	1.00	1.00	1.00	1.00
29	Intra-Regional Transfers (In)	141	149	92.8	17.4	0.73	0	0	0	0	0
30	Non-Federal CER	137	137	137	137	137	136	137	137	137	137
31	Slice Transmission Loss Return	34.6	35.1	34.3	35.3	34.5	35.3	34.5	35.3	34.6	35.4
32	Augmentation Purchases	0	0	0	0	0	0	0	0	0	0
33	**Reserves & Losses**	-240	-243	-236	-239	-233	-235	-230	-235	-230	-235
34	Contingency Reserves (Spinning)	0	0	0	0	0	0	0	0	0	0
35	Contingency Reserves (Non-Spinning)	0	0	0	0	0	0	0	0	0	0
36	Load Following Reserves	0	0	0	0	0	0	0	0	0	0
37	Generation Imbalance Reserves	0	0	0	0	0	0	0	0	0	0
38	Transmission Losses	-240	-243	-236	-239	-233	-235	-230	-235	-230	-235
39	**Total Net Resources**	**7849**	**7937**	**7726**	**7806**	**7623**	**7684**	**7527**	**7681**	**7527**	**7682**
40	**Total Surplus/Deficit**	**16**	**102**	**-93**	**7**	**-167**	**-116**	**-268**	**-121**	**-298**	**-152**

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Exhibit 6-2: Monthly Energy

Federal System Analysis Surplus Deficit
Operating Year 2017
Using 1937-Water Conditions

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Loads and Resources - Federal System

Operating Year: 2017 Water Year: 1937

2015 White Book Report Date: **6/30/2015**

S129-WB-20151029-154000 1

	Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
	Firm Obligations															
1	**Load Following**	3528	3530	3210	2975	3461	3905	3845	3668	3261	3311	3286	3278	3379	3710	3460
2	Preference Customers	3125	3128	2857	2762	3294	3720	3673	3500	3061	2943	2917	2845	2940	3203	3158
3	Federal Agencies	103	103	94.9	102	129	148	150	143	129	113	112	103	94.9	104	118
4	USBR	299	299	257	111	37.9	37.6	22.9	25.2	70.9	255	257	330	344	404	184
5	Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	**Tier 1 Block**	2.56	2.56	5.29	10.2	46.1	40.4	56.9	55.7	47.7	3.10	3.10	0	0	11.4	23.1
7	Tier 1 Block	2.56	2.56	5.29	10.2	46.1	40.4	56.9	55.7	47.7	3.10	3.10	0	0	11.4	23.1
8	**Slice**	3500	3275	3211	3318	4150	4306	3956	3880	3732	3323	3202	3822	3249	3354	3635
9	Slice Block	1573	1573	1643	1662	2048	2276	2305	2130	1982	1671	1671	1477	1385	1609	1812
10	Slice Output from T1 System	1927	1702	1568	1656	2102	2031	1651	1750	1750	1652	1531	2345	1864	1746	1823
11	**Direst Service Industries**	91.0	91.0	90.9	91.4	91.2	91.2	91.3	91.0	91.0	91.6	91.2	90.9	90.7	90.7	91.1
12	DSI	91.0	91.0	90.9	91.4	91.2	91.2	91.3	91.0	91.0	91.6	91.2	90.9	90.7	90.7	91.1
13	**Contract Deliveries**	642	646	516	512	730	726	736	733	624	656	623	533	538	559	624
14	Exports	627	631	502	498	493	491	502	499	505	534	501	519	523	544	519
15	Intra-Regional Transfers (Out)	14.8	14.8	13.7	13.8	236	235	234	234	119	122	122	14.5	14.4	15.8	105
16	**Total Firm Obligations**	**7764**	**7545**	**7033**	**6906**	**8478**	**9069**	**8686**	**8428**	**7756**	**7385**	**7205**	**7725**	**7257**	**7726**	**7833**
	Net Resources															
17	**Hydro Resources**	7090	6197	5546	5750	7582	7303	5845	6231	6147	5978	5501	9348	7840	6523	6711
18	Regulated Hydro - Net	6727	5836	5212	5426	7308	7121	5696	6076	5892	5541	5052	8627	7174	6117	6355
19	Independent Hydro - Net	361	358	332	321	271	179	145	152	251	434	445	718	664	403	354
20	Small Hydro - Net	2.63	2.63	2.63	2.67	2.84	3.19	3.21	3.05	3.10	3.09	3.09	2.83	2.72	2.63	2.88
21	**Other Resources**	1126	1163	1144	1138	1120	1125	1109	1104	1144	1148	1132	414	90.3	1032	976
22	Cogeneration Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Combustion Turbines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Large Thermal Resources	1075	1075	1075	1075	1075	1075	1075	1075	1075	1075	1075	347	0	971	916
25	Renewable Resources	51.2	87.5	69.4	62.9	45.5	50.3	34.2	29.4	69.4	73.1	56.7	67.2	90.3	60.9	59.7
26	Small Thermal & Misc.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	**Contract Purchases**	344	341	383	435	439	432	427	424	444	401	393	354	415	339	402
28	Imports	65.4	65.6	64.9	115	115	115	114	115	116	65.4	64.3	65.0	65.4	64.4	89.9
29	Intra-Regional Transfers (In)	103	103	149	154	147	140	147	138	157	166	172	105	176	107	141
30	Non-Federal CER	139	141	139	134	138	138	134	137	139	139	128	139	139	134	137
31	Slice Transmission Loss Return	36.6	32.3	29.8	31.5	39.9	38.6	31.4	33.3	33.3	31.4	29.1	44.6	35.4	33.2	34.6
32	Augmentation Purchases	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	**Reserves & Losses**	-254	-229	-210	-217	-272	-263	-219	-230	-230	-224	-209	-300	-248	-234	-240
34	Contingency Reserves (Spinning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Contingency Reserves (Non-Spinning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	Load Following Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	Generation Imbalance Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	Transmission Losses	-254	-229	-210	-217	-272	-263	-219	-230	-230	-224	-209	-300	-248	-234	-240
39	**Total Net Resources**	**8306**	**7471**	**6863**	**7106**	**8871**	**8597**	**7162**	**7529**	**7506**	**7304**	**6817**	**9815**	**8098**	**7659**	**7849**
40	**Total Surplus/Deficit**	**542**	**-74**	**-169**	**199**	**393**	**-472**	**-1,524**	**-899**	**-250**	**-81**	**-388**	**2,091**	**841**	**-67**	**16**

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Exhibit 6-3: Annual 120-Hour Capacity

Federal System Analysis Surplus Deficit
Operating Year 2017 to 2026
Using 1937-Water Conditions

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Loads and Resources - Federal System

Operating Year: 2017 to 2026 Water Year: 1937

2015 White Book Report Date: **6/30/2015**

S129-WB-20151029-154000 1

	120Hr-MW	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	Firm Obligations										
1	**Load Following**	4667	4678	4694	4700	4782	4792	4815	4824	4835	4856
2	Preference Customers	5357	5419	5434	5477	5495	5510	5523	5541	5566	5593
3	Federal Agencies	208	203	204	224	237	238	239	240	241	242
4	USBR	272	272	272	272	272	272	272	272	272	272
5	Federal Diversity	-1170	-1215	-1217	-1273	-1223	-1229	-1219	-1229	-1245	-1251
6	**Tier 1 Block**	57.1	57.0	57.0	59.1	57.4	58.4	59.3	57.3	57.1	56.7
7	Tier 1 Block	57.1	57.0	57.0	59.1	57.4	58.4	59.3	57.3	57.1	56.7
8	**Slice**	4461	4450	4486	4505	4587	4537	4587	4515	4607	4508
9	Slice Block	2313	2303	2331	2314	2362	2312	2364	2303	2375	2294
10	Slice Output from T1 System	2148	2148	2155	2191	2225	2225	2223	2211	2232	2214
11	**Direst Service Industries**	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.7
12	DSI	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.7
13	**Contract Deliveries**	1673	1537	1537	1358	1341	1341	1341	1341	1341	1341
14	Exports	1360	1363	1363	1324	1324	1324	1324	1324	1324	1324
15	Intra-Regional Transfers (Out)	313	173	173	33.2	16.4	16.4	16.4	16.4	16.4	16.4
16	**Total Firm Obligations**	**10952**	**10816**	**10867**	**10716**	**10861**	**10822**	**10896**	**10830**	**10934**	**10855**
	Net Resources										
17	**Hydro Resources**	10144	10142	10169	10161	10281	10277	10274	10225	10317	10208
18	Regulated Hydro - Net	9894	9892	9919	9911	10031	10049	10046	9997	10089	9980
19	Independent Hydro - Net	245	245	245	245	245	223	223	223	223	223
20	Small Hydro - Net	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59
21	**Other Resources**	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120
22	Cogeneration Resources	0	0	0	0	0	0	0	0	0	0
23	Combustion Turbines	0	0	0	0	0	0	0	0	0	0
24	Large Thermal Resources	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120
25	Renewable Resources	0.01	0.01	0.01	0.01	0	0	0	0	0	0
26	Small Thermal & Misc.	0	0	0	0	0	0	0	0	0	0
27	**Contract Purchases**	659	667	531	434	419	294	293	293	294	293
28	Imports	126	126	126	126	126	1.00	1.00	1.00	1.00	1.00
29	Intra-Regional Transfers (In)	242	249	113	16.8	0	0	0	0	0	0
30	Non-Federal CER	239	240	240	239	239	239	239	239	239	239
31	Slice Transmission Loss Return	51.7	51.6	51.8	52.7	53.5	53.5	53.5	53.2	53.7	53.2
32	Augmentation Purchases	0	0	0	0	0	0	0	0	0	0
33	**Reserves & Losses**	-1989	-1992	-1991	-1990	-1979	-1977	-1979	-1978	-1985	-1960
34	Contingency Reserves (Spinning)	-371	-372	-374	-375	-367	-369	-370	-370	-372	-361
35	Contingency Reserves (Non-Spinning)	-371	-372	-374	-375	-367	-369	-370	-370	-372	-361
36	Load Following Reserves	-586	-586	-586	-586	-586	-586	-586	-586	-586	-586
37	Generation Imbalance Reserves	-314	-314	-314	-314	-314	-314	-314	-314	-314	-314
38	Transmission Losses	-348	-348	-344	-340	-344	-340	-340	-338	-341	-338
39	**Total Net Resources**	**9934**	**9936**	**9828**	**9726**	**9841**	**9713**	**9709**	**9661**	**9746**	**9661**
40	**Total Surplus/Deficit**	**-1,018**	**-880**	**-1,039**	**-990**	**-1,020**	**-1,108**	**-1,188**	**-1,170**	**-1,188**	**-1,195**

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Exhibit 6-4: Monthly 120-Hour Capacity

Federal System Analysis Surplus Deficit
Operating Year 2017
Using 1937-Water Conditions

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Loads and Resources - Federal System

Operating Year: 2017 **Water Year: 1937**

2015 White Book Report Date: **6/30/2015**

S129-WB-20151029-154000 1

	120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
	Firm Obligations														
1	**Load Following**	4240	4016	3703	3640	4182	4708	4667	4401	3953	4048	4045	3830	4022	4368
2	Preference Customers	4164	4164	3900	4143	4777	5393	5357	5062	4571	4350	4350	3987	3979	4268
3	Federal Agencies	133	133	126	148	179	207	208	196	188	168	168	150	139	144
4	USBR	619	619	532	420	259	336	272	305	402	464	464	562	602	642
5	Federal Diversity	-676	-900	-856	-1072	-1032	-1228	-1170	-1162	-1209	-933	-937	-869	-698	-686
6	**Tier 1 Block**	2.56	2.56	5.29	10.2	46.2	40.6	57.1	55.9	47.8	3.10	3.10	0	0	11.4
7	Tier 1 Block	2.56	2.56	5.29	10.2	46.2	40.6	57.1	55.9	47.8	3.10	3.10	0	0	11.4
8	**Slice**	3873	3349	3391	3518	4563	4769	4461	4290	4266	3504	3312	4183	3765	3731
9	Slice Block	1570	1570	1638	1667	2053	2283	2313	2137	1988	1676	1676	1481	1390	1614
10	Slice Output from T1 System	2304	1780	1754	1851	2510	2486	2148	2153	2278	1828	1636	2702	2375	2117
11	**Direst Service Industries**	93.0	93.0	92.7	93.6	93.5	93.2	93.7	93.2	93.4	93.8	93.8	93.4	92.8	92.9
12	DSI	93.0	93.0	92.7	93.6	93.5	93.2	93.7	93.2	93.4	93.8	93.8	93.4	92.8	92.9
13	**Contract Deliveries**	1595	1595	1426	1405	1681	1674	1673	1672	1549	1568	1568	1427	1448	1460
14	Exports	1569	1569	1400	1379	1368	1361	1360	1359	1383	1402	1402	1401	1422	1434
15	Intra-Regional Transfers (Out)	26.2	26.2	26.2	26.2	313	313	313	313	166	166	166	26.2	26.2	26.2
16	**Total Firm Obligations**	**9804**	**9057**	**8618**	**8666**	**10566**	**11286**	**10952**	**10512**	**9909**	**9217**	**9022**	**9534**	**9328**	**9663**
	Net Resources														
17	**Hydro Resources**	11296	9209	8864	9167	11533	11554	10144	10177	10694	9210	8449	13828	12579	10459
18	Regulated Hydro - Net	10824	8742	8322	8747	11133	11273	9894	9953	10326	8600	7827	13064	11776	9939
19	Independent Hydro - Net	469	464	539	416	395	276	245	219	363	606	618	759	799	516
20	Small Hydro - Net	3.49	3.49	3.00	4.11	4.49	4.60	4.59	4.62	4.58	4.58	4.58	4.58	4.09	3.19
21	**Other Resources**	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120	0.01	0.01	1120
22	Cogeneration Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Combustion Turbines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Large Thermal Resources	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120	1120	0	0	1120
25	Renewable Resources	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
26	Small Thermal & Misc.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	**Contract Purchases**	496	484	602	656	668	661	659	651	672	621	616	498	643	488
28	Imports	76.0	76.0	76.0	126	126	126	126	126	126	76.0	76.0	76.0	76.0	76.0
29	Intra-Regional Transfers (In)	124	124	243	245	242	237	242	234	252	261	261	117	270	122
30	Non-Federal CER	241	241	241	241	240	238	239	239	239	240	240	240	240	240
31	Slice Transmission Loss Return	55.4	42.8	42.2	44.5	60.3	59.8	51.7	51.8	54.8	43.9	39.3	65.0	57.1	50.9
32	Augmentation Purchases	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	**Reserves & Losses**	-1980	-1850	-1825	-1868	-2049	-2074	-1989	-1973	-1988	-1861	-1813	-2094	-2020	-1933
34	Contingency Reserves (Spinning)	-349	-318	-309	-325	-377	-390	-371	-362	-360	-321	-310	-383	-364	-339
35	Contingency Reserves (Non-Spinning)	-349	-318	-309	-325	-377	-390	-371	-362	-360	-321	-310	-383	-364	-339
36	Load Following Reserves	-584	-584	-585	-586	-586	-586	-586	-586	-586	-586	-586	-586	-586	-586
37	Generation Imbalance Reserves	-316	-316	-315	-314	-314	-314	-314	-314	-314	-314	-314	-314	-314	-314
38	Transmission Losses	-382	-314	-306	-317	-394	-394	-348	-349	-367	-318	-293	-428	-392	-355
39	**Total Net Resources**	**10933**	**8963**	**8761**	**9075**	**11272**	**11260**	**9934**	**9975**	**10498**	**9090**	**8372**	**12233**	**11202**	**10134**
40	**Total Surplus/Deficit**	**1,129**	**-94**	**143**	**409**	**706**	**-25**	**-1,018**	**-537**	**588**	**-127**	**-650**	**2,698**	**1,874**	**471**

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Exhibit 6-5: 80-Year Monthly Energy

Federal System Analysis Surplus Deficit
Operating Year 2017

Federal Report Surplus Deficit By Water Year

Operating Year 2017

2015 White Book Report Date: **6/30/2015**

S129-WB-20151029-154000

	Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
1	1929 Federal Report Surplus Deficit	586	542	-29.6	340	180	-543	-616	-539	-23.3	-596	751	1032	1281	-427	110
2	1930 Federal Report Surplus Deficit	552	-1.51	180	383	310	-540	-1728	-427	-127	253	1689	1017	-521	667	39.4
3	1931 Federal Report Surplus Deficit	889	35.1	-45.9	380	403	-434	-1592	-1280	-425	-458	-957	2171	-263	856	-29.2
4	1932 Federal Report Surplus Deficit	418	-415	-296	269	-57.6	-498	-1396	-1596	1216	3060	4254	4605	4189	2136	1030
5	1933 Federal Report Surplus Deficit	661	1078	257	516	359	153	1711	2101	2227	909	1760	2912	5288	4164	1823
6	1934 Federal Report Surplus Deficit	2523	1557	175	895	2810	3657	4192	3799	4016	4205	4224	3602	2963	1025	2775
7	1935 Federal Report Surplus Deficit	395	-211	-289	465	0.59	-595	1818	1640	1969	-350	1848	2264	1981	2214	1024
8	1936 Federal Report Surplus Deficit	1892	257	-193	272	180	-550	-1449	-567	71.1	307	3504	4423	3813	828	820
9	1937 Federal Report Surplus Deficit	542	-74.0	-169	199	393	-472	-1524	-899	-250	-81.0	-388	2091	841	-66.9	16.3
10	1938 Federal Report Surplus Deficit	761	67.9	-85.1	436	-133	121	1463	1426	2398	2414	4824	4088	3012	2021	1564
11	1939 Federal Report Surplus Deficit	408	-197	176	526	77.9	-651	294	-57.2	392	1310	2853	2935	609	571	591
12	1940 Federal Report Surplus Deficit	632	-112	-52.9	613	793	-146	-108	-412	3362	1310	2258	2623	711	313	820
13	1941 Federal Report Surplus Deficit	204	-398	-94.5	332	282	-328	-690	-565	320	-446	872	2305	819	874	287
14	1942 Federal Report Surplus Deficit	452	-110	277	375	686	871	874	-228	1714	370	2112	2222	2302	2836	1122
15	1943 Federal Report Surplus Deficit	1324	675	641	248	53.3	-346	2226	1829	2171	4444	4851	3432	5267	4185	2108
16	1944 Federal Report Surplus Deficit	1051	373	-71.8	333	366	-586	-552	-427	-300	-435	578	599	-903	187	-44.4
17	1945 Federal Report Surplus Deficit	406	-399	-170	485	173	-486	-1541	-849	-238	-568	-1065	3167	3334	-199	242
18	1946 Federal Report Surplus Deficit	775	-198	-411	323	471	147	969	375	2526	2982	4929	4345	2700	2935	1559
19	1947 Federal Report Surplus Deficit	1842	1313	238	304	876	2343	2891	2596	2911	2083	2534	4080	3163	2340	2136
20	1948 Federal Report Surplus Deficit	1702	939	89.0	2210	2105	1035	2692	1582	1927	1535	3749	5096	5287	3577	2469
21	1949 Federal Report Surplus Deficit	2910	2147	516	541	705	-63.7	930	-81.7	3182	1967	4504	4791	3514	-41.6	1655
22	1950 Federal Report Surplus Deficit	-71.9	-580	-409	400	49.9	-22.8	2647	2435	3792	3154	3502	3854	5261	4617	2133
23	1951 Federal Report Surplus Deficit	2161	1366	277	1150	2390	2463	4024	3918	4496	3510	4083	4417	3260	3641	2963
24	1952 Federal Report Surplus Deficit	1974	850	128	1798	1517	1143	2540	2243	2202	3326	5156	5077	3543	2179	2334
25	1953 Federal Report Surplus Deficit	1680	808	-334	261	237	-517	-219	1698	1781	462	1820	3759	5485	2804	1439
26	1954 Federal Report Surplus Deficit	1153	683	187	483	990	590	1990	3015	3057	1643	2636	4147	4640	4706	2234
27	1955 Federal Report Surplus Deficit	3388	3047	1965	590	1550	557	-63.8	187	94.7	80.6	1235	2712	5314	4597	1788
28	1956 Federal Report Surplus Deficit	2764	1301	-38.1	741	2013	2441	3557	3837	3925	2950	4905	5062	5171	3772	3031
29	1957 Federal Report Surplus Deficit	2269	1695	219	690	659	754	1114	-156	2637	2931	2507	5387	5493	1967	1968
30	1958 Federal Report Surplus Deficit	1212	119	45.9	365	488	-69.2	1429	1240	2130	1298	3493	4864	4417	1182	1595
31	1959 Federal Report Surplus Deficit	543	102	-98.2	416	1373	1887	3164	3254	3230	2544	2427	3538	4701	4266	2373
32	1960 Federal Report Surplus Deficit	2762	1480	2178	2887	2895	1629	1792	1464	1997	4871	3698	2873	3996	2115	2517
33	1961 Federal Report Surplus Deficit	1310	208	-138	519	664	84.0	1588	1885	3597	1856	1863	4133	4837	1785	1795
34	1962 Federal Report Surplus Deficit	1238	438	-90.2	267	575	-170	1271	1278	452	3314	4849	3932	2765	1516	1388
35	1963 Federal Report Surplus Deficit	1130	662	-266	807	1621	1608	2044	1433	1645	232	1544	3049	3185	1868	1568
36	1964 Federal Report Surplus Deficit	1197	275	312	334	476	37.4	319	382	549	2130	1431	3305	5336	4439	1503
37	1965 Federal Report Surplus Deficit	2538	1841	765	1058	1302	2628	4589	4188	3963	1440	4862	4536	3997	1950	2854
38	1966 Federal Report Surplus Deficit	2181	1741	-187	655	829	312	976	938	728	3420	2461	2110	2553	2284	1342
39	1967 Federal Report Surplus Deficit	1272	304	6.08	259	422	423	3019	3065	2849	961	271	2726	5066	3953	1926
40	1968 Federal Report Surplus Deficit	1785	1255	237	529	1064	333	1624	2245	2454	-61.9	966	1693	3980	2771	1570
41	1969 Federal Report Surplus Deficit	1962	1848	1183	1149	2068	1171	3957	2893	2738	3495	4679	4971	3915	2449	2704
42	1970 Federal Report Surplus Deficit	1480	665	93.8	458	730	-347	1316	1181	1471	426	1314	3246	4664	1050	1314
43	1971 Federal Report Surplus Deficit	853	89.3	-132	308	437	63.8	3662	4049	4532	2968	4054	4953	5258	3574	2547
44	1972 Federal Report Surplus Deficit	2540	2539	410	745	878	629	3405	3982	5650	4553	3109	5001	5159	4384	3048
45	1973 Federal Report Surplus Deficit	3078	2760	595	658	897	264	1219	-33.9	519	-785	750	1813	272	246	789
46	1974 Federal Report Surplus Deficit	497	-288	-165	394	449	1164	4864	4403	5087	3728	4690	4566	5138	4918	2920
47	1975 Federal Report Surplus Deficit	2778	2692	533	255	386	-330	1840	1489	1962	452	1386	3882	5063	4139	1911
48	1976 Federal Report Surplus Deficit	2162	1813	591	1276	2314	3243	3429	3295	3676	3579	4125	4951	3948	3990	3047
49	1977 Federal Report Surplus Deficit	3555	3539	2642	737	520	-567	-458	-176	-82.0	-555	731	750	-1156	31.2	495
50	1978 Federal Report Surplus Deficit	414	-302	-577	-84.9	-25.4	955	1038	1265	1173	3172	2528	3879	2379	2205	1259
51	1979 Federal Report Surplus Deficit	801	149	1200	754	757	-461	-106	14.5	1816	283	1718	3687	1906	-67.6	918
52	1980 Federal Report Surplus Deficit	135	-203	-22.4	211	344	-820	593	-402	452	822	3429	5106	4147	864	1052
53	1981 Federal Report Surplus Deficit	378	-394	144	424	571	1586	2778	2412	2118	-552	1452	3241	5212	3480	1864
54	1982 Federal Report Surplus Deficit	2665	1663	228	437	1062	313	2212	4293	5034	3096	3099	4579	5362	4629	2774

Federal Report Surplus Deficit By Water Year

Operating Year 2017

2015 White Book Report Date: **6/30/2015** *Continued*

S129-WB-20151029-154000

	Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
55	1983 Federal Report Surplus Deficit	2450	2405	1150	1199	1162	799	2653	2896	4485	2239	2626	3953	4204	3261	2552
56	1984 Federal Report Surplus Deficit	2549	2097	524	567	2536	1089	2131	2395	2732	3464	4606	4077	4996	3229	2548
57	1985 Federal Report Surplus Deficit	1943	610	526	623	1158	245	831	602	600	1563	3599	4119	2272	-725	1174
58	1986 Federal Report Surplus Deficit	-334	-673	-65.0	568	1544	424	1699	2746	5088	3618	4546	2966	3249	1426	1925
59	1987 Federal Report Surplus Deficit	738	23.3	-176	249	687	326	164	-608	1694	24.1	1682	3103	1730	206	727
60	1988 Federal Report Surplus Deficit	262	-554	-245	288	154	-849	-908	-1296	-47.4	-312	1272	1658	444	783	34.1
61	1989 Federal Report Surplus Deficit	805	2.18	-99.3	298	360	-99.0	-448	-1038	1191	1338	4236	2929	1921	600	742
62	1990 Federal Report Surplus Deficit	379	-318	-116	376	815	785	1043	2914	2665	1172	3875	2900	4153	1824	1646
63	1991 Federal Report Surplus Deficit	1980	1102	-30.1	184	2274	1310	2822	2237	2288	2174	2160	3328	3578	4027	2144
64	1992 Federal Report Surplus Deficit	2503	1490	-54.1	281	462	-755	-245	-359	2058	-620	856	1949	-151	86.6	458
65	1993 Federal Report Surplus Deficit	366	-309	-309	346	346	-387	-1748	-1457	638	605	1161	3523	2322	1031	445
66	1994 Federal Report Surplus Deficit	956	235	299	385	592	-182	-1438	-811	-208	-116	1584	2752	1988	573	444
67	1995 Federal Report Surplus Deficit	713	-211	20.6	324	-101	-256	479	970	2292	715	1270	2904	4171	1414	1120
68	1996 Federal Report Surplus Deficit	656	127	364	1077	3164	4606	4548	4766	5546	3285	5062	4672	4326	4123	3473
69	1997 Federal Report Surplus Deficit	2371	1621	211	444	1054	1260	4862	4572	5199	3612	5088	4986	5322	4449	3218
70	1998 Federal Report Surplus Deficit	2468	2542	1117	2407	1959	227	820	1560	1387	277	2360	5117	4916	2074	2120
71	1999 Federal Report Surplus Deficit	2050	846	33.9	347	418	731	3286	3407	4568	2257	3836	3575	4772	4319	2491
72	2000 Federal Report Surplus Deficit	3282	2618	590	556	2589	1645	1652	1683	1964	3059	4626	4061	1397	1816	2064
73	2001 Federal Report Surplus Deficit	1328	-265	-240	427	198	-546	-588	-447	73.7	-288	852	1491	-1498	315	5.03
74	2002 Federal Report Surplus Deficit	420	-414	-589	-246	-139	-322	-552	-518	376	993	3982	2862	4875	3329	967
75	2003 Federal Report Surplus Deficit	304	49.9	-35.9	386	537	-427	-1137	-230	2140	967	1996	2782	3398	466	797
76	2004 Federal Report Surplus Deficit	289	-343	-287	472	1289	-196	0.16	-829	978	467	1462	2461	1812	610	611
77	2005 Federal Report Surplus Deficit	56.9	-230	656	705	772	505	816	956	524	-281	1146	2915	2042	1117	945
78	2006 Federal Report Surplus Deficit	683	-122	-29.6	258	730	333	1800	1828	2486	3269	4715	4571	4687	1755	1885
79	2007 Federal Report Surplus Deficit	1149	-398	-350	241	634	432	1749	1350	2920	2621	2170	3399	1593	2033	1399
80	2008 Federal Report Surplus Deficit	574	-340	-482	392	1018	-471	-10.7	22.0	619	572	408	4194	5472	2301	1141
	Ranked Averages															
81	**Bottom 10 pct**	**702**	**-42.9**	**-98.8**	**354**	**272**	**-557**	**-1131**	**-771**	**-167**	**-311**	**341**	**1653**	**339**	**264**	**46.7**
82	**Middle 80 pct**	**1349**	**666**	**201**	**560**	**844**	**333**	**1189**	**1174**	**2013**	**1585**	**2703**	**3522**	**3478**	**2131**	**1550**
83	**Top 10 pct**	**1961**	**1290**	**302**	**861**	**1695**	**2304**	**4160**	**4120**	**4693**	**3332**	**4491**	**4774**	**4540**	**3903**	**3069**

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Section 7: Pacific Northwest Regional Analysis Exhibits

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Exhibit 7-1: Annual Energy

Regional Analysis Surplus Deficit
Operating Year 2017 to 2026
Using 1937-Water Conditions

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Loads and Resources - Pacific Northwest Region

Operating Year: 2017 to 2026 Water Year: 1937

2015 White Book Report Date: **6/30/2015**

S129-WB-20151029-154000

	Energy-aMW	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	Regional Loads										
1	**Retail Loads**	22461	22793	23090	23363	23675	23951	24250	24502	24749	24990
2	Federal Agency	128	131	149	161	162	162	163	163	164	164
3	USBR	184	184	184	183	184	184	184	183	184	184
4	Cooperative	1968	1991	2015	2041	2078	2111	2144	2169	2190	2205
5	Municipality	2731	2767	2793	2812	2829	2842	2854	2864	2874	2886
6	Public Utility District	4546	4617	4663	4696	4734	4771	4804	4827	4855	4876
7	Investor-Owned Utility	12206	12406	12588	12772	12954	13139	13324	13512	13698	13890
8	Marketer	252	252	252	252	252	252	252	252	252	252
9	Direct-Service Industry	445	445	445	445	482	489	525	533	533	533
10	Federal Diversity	0	0	0	0	0	0	0	0	0	0
11	**Exports**	1333	1303	1269	1249	1245	1146	1109	1069	1064	1061
12	Canada	479	481	476	471	466	461	456	452	449	445
13	East Continental Divide	13.2	6.80	2.46	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	Inland Southwest	21.3	19.6	15.0	14.9	15.0	15.0	15.0	14.9	15.0	15.0
15	Pacific Southwest	819	795	776	762	763	669	636	601	600	600
16	Other	0	0	0	0	0	0	0	0	0	0
17	**Total Regional Loads**	**23794**	**24096**	**24359**	**24612**	**24919**	**25097**	**25359**	**25571**	**25813**	**26051**
	Regional Resources										
18	**Hydro Resources**	11960	11883	11880	11877	11852	11841	11841	11837	11841	11841
19	Regulated Hydro - Net	10662	10585	10584	10580	10579	10579	10579	10577	10579	10579
20	Independent Hydro - Net	1053	1053	1053	1052	1027	1017	1017	1016	1017	1017
21	Small Hydro - Net	245	245	244	244	245	245	245	245	245	245
22	**Other Resources**	16429	16707	16474	16608	15911	15468	15241	15467	15235	14908
23	Cogeneration Resources	2396	2403	2385	2398	2402	2384	2398	2404	2384	2398
24	Combustion Turbine Resources	5885	5882	5881	5883	5886	5884	5844	5842	5841	5840
25	Large Thermal Resources	6004	6270	6056	6176	5470	5047	4848	5071	4857	4518
26	Renewable Resources	2109	2115	2116	2115	2117	2116	2116	2115	2117	2116
27	Small Thermal & Miscellaneous	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9
28	**Imports**	664	667	658	662	660	580	584	588	591	595
29	Canada	38.9	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8
30	East of Continental Divide	0	0	0	0	0	0	0	0	0	0
31	Inland Southwest	476	480	484	487	491	494	498	502	506	509
32	Pacific Southwest	148	148	136	136	131	47.1	47.1	47.1	47.1	47.1
33	Other	0	0	0	0	0	0	0	0	0	0
34	**Reserves & Losses**	-863	-869	-862	-866	-844	-828	-822	-828	-822	-812
35	Contingency Reserves (Non-Spinning)	0	0	0	0	0	0	0	0	0	0
36	Contingency Reserves (Spinning)	0	0	0	0	0	0	0	0	0	0
37	Generation Imbalance Reserves	0	0	0	0	0	0	0	0	0	0
38	Load Following Reserves	0	0	0	0	0	0	0	0	0	0
39	Transmission Losses	-863	-869	-862	-866	-844	-828	-822	-828	-822	-812
40	**Total Regional Resources**	**28191**	**28389**	**28151**	**28281**	**27579**	**27061**	**26845**	**27064**	**26845**	**26532**
41	**Total Surplus/Deficit**	**4397**	**4293**	**3792**	**3669**	**2659**	**1964**	**1486**	**1493**	**1032**	**481**

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Exhibit 7-2: Monthly Energy

Regional Analysis Surplus Deficit
Operating Year 2017
Using 1937-Water Conditions

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Loads and Resources - Pacific Northwest Region

Operating Year: 2017 **Water Year: 1937**

2015 White Book Report Date: **6/30/2015**

S129-WB-20151029-154000

	Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
	Regional Loads															
1	**Retail Loads**	22656	22679	21021	20232	22680	24904	25152	23981	22021	21066	20909	20381	22033	23519	22461
2	Federal Agency	115	115	106	114	137	156	157	150	137	124	123	115	107	115	128
3	USBR	299	299	257	111	37.9	37.6	22.9	25.2	70.9	255	257	330	344	404	184
4	Cooperative	2056	2058	1818	1690	1970	2237	2195	2100	1845	1798	1784	1829	1944	2143	1968
5	Municipality	2474	2476	2394	2553	2990	3176	3240	3126	2815	2663	2635	2453	2432	2500	2731
6	Public Utility District	4263	4266	4088	4174	4872	5330	5311	5085	4544	4364	4333	4096	4140	4332	4546
7	Investor-Owned Utility	12762	12778	11711	10924	11982	13256	13515	12784	11906	11150	11066	10848	12357	13317	12206
8	Marketer	242	242	201	220	246	265	265	265	258	265	265	265	265	263	252
9	Direct-Service Industry	445	445	445	446	446	446	446	446	446	446	445	445	445	445	445
10	Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	**Exports**	1446	1705	1508	1378	1161	1081	993	975	1280	1496	1289	1284	1689	1651	1333
12	Canada	579	584	468	468	468	468	468	468	468	486	449	468	468	492	479
13	East Continental Divide	14.9	14.9	12.6	13.0	13.8	15.5	15.2	15.0	13.6	12.6	12.6	12.7	13.2	6.80	13.2
14	Inland Southwest	11.0	17.1	15.6	17.6	12.9	11.0	20.2	19.0	26.1	30.6	27.3	27.5	33.1	30.0	21.3
15	Pacific Southwest	841	1089	1012	880	667	587	490	474	772	967	800	776	1175	1123	819
16	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	**Total Regional Loads**	**24102**	**24383**	**22528**	**21610**	**23841**	**25985**	**26145**	**24956**	**23301**	**22562**	**22198**	**21665**	**23722**	**25170**	**23794**
	Regional Resources															
18	**Hydro Resources**	11947	10655	9433	10192	12653	13441	10577	10581	10805	11205	10262	16216	15548	11942	11960
19	Regulated Hydro - Net	10630	9344	8230	9120	11705	12465	9740	9680	9681	9610	8646	14206	13532	10394	10662
20	Independent Hydro - Net	991	988	959	910	817	854	723	779	969	1311	1330	1600	1574	1127	1053
21	Small Hydro - Net	325	323	243	162	131	123	115	121	155	284	286	410	442	421	245
22	**Other Resources**	16789	17615	17447	17624	17195	17147	16786	16717	16410	16864	14442	12326	15098	17552	16429
23	Cogeneration Resources	2506	2506	2511	2485	2530	2600	2563	2578	1797	2485	1930	2193	2321	2471	2396
24	Combustion Turbine Resources	6153	6160	6220	6275	6396	6467	6471	6413	6365	6251	5243	3532	4447	6156	5885
25	Large Thermal Resources	6445	6445	6445	6445	6445	6445	6445	6445	6000	5349	5047	4236	5175	6341	6004
26	Renewable Resources	1654	2473	2234	2381	1787	1596	1269	1244	2210	2746	2189	2327	3120	2548	2109
27	Small Thermal & Miscellaneous	30.3	30.4	35.9	37.6	36.5	38.1	37.9	36.3	37.9	33.8	33.6	37.7	33.2	35.3	35.9
28	**Imports**	610	610	552	570	789	899	736	733	636	508	506	545	675	718	664
29	Canada	25.8	25.8	16.0	17.3	37.5	53.1	66.4	72.6	64.8	30.6	30.6	27.5	36.5	21.5	38.9
30	East of Continental Divide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Inland Southwest	520	519	473	439	433	467	439	453	426	406	406	453	574	633	476
32	Pacific Southwest	64.4	64.6	63.9	114	318	379	231	208	145	70.6	69.5	64.0	64.4	63.4	148
33	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	**Reserves & Losses**	-872	-858	-815	-843	-910	-935	-835	-833	-827	-849	-749	-864	-930	-897	-863
35	Contingency Reserves (Non-Spinning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	Contingency Reserves (Spinning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	Generation Imbalance Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	Load Following Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	Transmission Losses	-872	-858	-815	-843	-910	-935	-835	-833	-827	-849	-749	-864	-930	-897	-863
40	**Total Regional Resources**	**28474**	**28022**	**26618**	**27544**	**29726**	**30551**	**27265**	**27198**	**27023**	**27728**	**24462**	**28223**	**30390**	**29315**	**28191**
41	**Total Surplus/Deficit**	**4372**	**3639**	**4089**	**5934**	**5885**	**4567**	**1120**	**2243**	**3722**	**5166**	**2264**	**6558**	**6668**	**4145**	**4397**

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Exhibit 7-3: Annual 120-Hour Capacity

Regional Analysis Surplus Deficit
Operating Year 2017 to 2026
Using 1937-Water Conditions

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Loads and Resources - Pacific Northwest Region

Operating Year: 2017 to 2026 Water Year: 1937

2015 White Book Report Date: **6/30/2015**

S129-WB-20151029-154000

	120Hr-MW	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
	Regional Loads										
1	**Retail Loads**	33341	33748	34112	34439	34925	35294	35726	36083	36414	36759
2	Federal Agency	216	211	212	232	245	246	247	248	249	250
3	USBR	272	272	272	272	272	272	272	272	272	272
4	Cooperative	3200	3233	3266	3304	3345	3388	3431	3470	3493	3516
5	Municipality	4475	4531	4557	4583	4609	4635	4662	4687	4713	4739
6	Public Utility District	7446	7535	7588	7634	7682	7733	7780	7821	7854	7883
7	Investor-Owned Utility	18176	18457	18708	18962	19223	19479	19738	19999	20262	20535
8	Marketer	265	265	265	265	265	265	265	265	265	265
9	Direct-Service Industry	460	460	460	460	505	505	550	550	550	550
10	Federal Diversity	-1170	-1215	-1217	-1273	-1223	-1229	-1219	-1229	-1245	-1251
11	**Exports**	1500	1487	1481	1442	1442	1385	1385	1385	1385	1385
12	Canada	1307	1324	1324	1324	1324	1324	1324	1324	1324	1324
13	East Continental Divide	20.4	6.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	Inland Southwest	0	0	0	0	0	0	0	0	0	0
15	Pacific Southwest	173	156	156	116	116	59.7	59.7	59.7	59.7	59.7
16	Other	0	0	0	0	0	0	0	0	0	0
17	**Total Regional Loads**	**34841**	**35235**	**35593**	**35881**	**36367**	**36680**	**37111**	**37468**	**37799**	**38145**
	Regional Resources										
18	**Hydro Resources**	21085	21082	21109	21102	21142	21159	21156	21108	21200	21090
19	Regulated Hydro - Net	19590	19588	19615	19607	19727	19745	19742	19693	19785	19676
20	Independent Hydro - Net	1338	1338	1338	1338	1258	1258	1258	1258	1258	1258
21	Small Hydro - Net	157	157	157	157	157	157	157	157	157	157
22	**Other Resources**	17190	17190	17190	17190	15940	15813	15757	15757	15757	14953
23	Cogeneration Resources	2821	2821	2821	2821	2821	2821	2821	2821	2821	2821
24	Combustion Turbine Resources	6892	6892	6892	6892	6892	6892	6836	6836	6836	6836
25	Large Thermal Resources	6986	6986	6986	6986	5736	5609	5609	5609	5609	4805
26	Renewable Resources	399	399	399	399	399	399	399	399	399	399
27	Small Thermal & Miscellaneous	92.1	92.1	92.1	92.1	92.1	92.1	92.1	92.1	92.1	92.1
28	**Imports**	1213	1216	1174	1177	1180	1059	1062	1065	1068	1071
29	Canada	155	155	155	155	155	155	155	155	155	155
30	East of Continental Divide	0	0	0	0	0	0	0	0	0	0
31	Inland Southwest	587	590	594	597	600	604	607	610	613	616
32	Pacific Southwest	471	471	425	425	425	300	300	300	300	300
33	Other	0	0	0	0	0	0	0	0	0	0
34	**Reserves & Losses**	-4135	-4148	-4159	-4169	-4106	-4109	-4119	-4126	-4127	-4077
35	Contingency Reserves (Non-Spinning)	-999	-1006	-1012	-1017	-1005	-1011	-1017	-1022	-1021	-1011
36	Contingency Reserves (Spinning)	-999	-1006	-1012	-1017	-1005	-1011	-1017	-1022	-1021	-1011
37	Generation Imbalance Reserves	-314	-314	-314	-314	-314	-314	-314	-314	-314	-314
38	Load Following Reserves	-586	-586	-586	-586	-586	-586	-586	-586	-586	-586
39	Transmission Losses	-1237	-1236	-1235	-1235	-1195	-1187	-1184	-1183	-1186	-1156
40	**Total Regional Resources**	**35352**	**35340**	**35314**	**35299**	**34155**	**33922**	**33856**	**33803**	**33897**	**33038**
41	**Total Surplus/Deficit**	**511**	**105**	**-278**	**-582**	**-2211**	**-2758**	**-3255**	**-3665**	**-3901**	**-5107**

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Exhibit 7-4: Monthly 120-Hour Capacity

Regional Analysis Surplus Deficit
Operating Year 2017
Using 1937-Water Conditions

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Loads and Resources - Pacific Northwest Region

Operating Year: 2017 **Water Year: 1937**

2015 White Book Report Date: **6/30/2015**

S129-WB-20151029-154000

	120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
	Regional Loads														
1	**Retail Loads**	29684	29460	26319	26712	30045	32812	33341	31202	28660	27109	27105	25433	28470	30659
2	Federal Agency	145	145	138	160	187	215	216	204	196	180	180	162	151	156
3	USBR	619	619	532	420	259	336	272	305	402	464	464	562	602	642
4	Cooperative	2713	2713	2499	2513	2862	3240	3200	3017	2720	2657	2657	2576	2633	2811
5	Municipality	3293	3293	3125	3609	4131	4393	4475	4242	3893	3625	3625	3104	3139	3382
6	Public Utility District	5566	5566	5321	5888	6752	7345	7446	6996	6493	6106	6106	5506	5391	5657
7	Investor-Owned Utility	17301	17301	14835	14469	16161	17786	18176	16875	15439	14286	14286	13666	16528	17973
8	Marketer	265	265	265	265	265	265	265	265	265	265	265	265	265	265
9	Direct-Service Industry	459	459	459	459	460	460	460	460	460	460	460	459	459	459
10	Federal Diversity	-676	-900	-856	-1072	-1032	-1228	-1170	-1162	-1209	-933	-937	-869	-698	-686
11	**Exports**	2092	2092	1922	1560	1512	1502	1500	1500	1527	1546	1554	1493	1944	1956
12	Canada	1445	1445	1307	1307	1307	1307	1307	1307	1307	1307	1307	1307	1307	1331
13	East Continental Divide	22.2	22.2	17.5	16.9	18.4	19.7	20.4	19.7	19.1	17.6	17.6	16.6	18.7	6.80
14	Inland Southwest	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Pacific Southwest	625	625	598	236	186	175	173	173	201	221	229	170	619	619
16	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	**Total Regional Loads**	**31775**	**31552**	**28241**	**28272**	**31556**	**34314**	**34841**	**32701**	**30186**	**28655**	**28659**	**26926**	**30415**	**32616**
	Regional Resources														
18	**Hydro Resources**	22404	20186	19350	19775	22434	22596	21085	20742	21301	19651	18901	25020	24432	21850
19	Regulated Hydro - Net	20512	18297	17457	18034	20792	21040	19590	19328	19587	17534	16766	22579	21929	19769
20	Independent Hydro - Net	1509	1508	1582	1514	1467	1394	1338	1246	1507	1792	1808	1993	2039	1627
21	Small Hydro - Net	384	382	311	227	174	162	157	169	207	325	327	448	464	455
22	**Other Resources**	16613	16614	16683	16823	16991	17177	17190	17136	16444	15754	14219	13915	14996	16715
23	Cogeneration Resources	2708	2708	2722	2784	2801	2818	2821	2813	2172	2714	2234	2453	2703	2708
24	Combustion Turbine Resources	6530	6530	6586	6664	6814	6882	6892	6846	6798	6754	5699	5840	6092	6533
25	Large Thermal Resources	6986	6986	6986	6986	6986	6986	6986	6986	6986	5798	5798	5132	5712	6986
26	Renewable Resources	299	299	299	299	299	399	399	399	398	399	398	398	399	399
27	Small Thermal & Miscellaneous	90.8	91.1	90.2	90.3	90.6	91.7	92.1	91.8	90.4	90.5	90.2	92.4	90.2	89.5
28	**Imports**	960	960	845	837	1115	1238	1213	1245	946	767	767	796	1029	1105
29	Canada	146	146	146	147	102	124	155	188	213	147	147	147	146	146
30	East of Continental Divide	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Inland Southwest	739	739	624	565	563	643	587	586	562	533	533	574	808	884
32	Pacific Southwest	75.0	75.0	75.0	125	450	471	471	471	171	87.0	87.0	75.0	75.0	75.0
33	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	**Reserves & Losses**	-4064	-3926	-3785	-3841	-4109	-4215	-4135	-4052	-3962	-3782	-3639	-3973	-4107	-4067
35	Contingency Reserves (Non-Spinning)	-954	-921	-863	-883	-967	-1014	-999	-963	-924	-874	-840	-911	-968	-961
36	Contingency Reserves (Spinning)	-954	-921	-863	-883	-967	-1014	-999	-963	-924	-874	-840	-911	-968	-961
37	Generation Imbalance Reserves	-316	-316	-315	-314	-314	-314	-314	-314	-314	-314	-314	-314	-314	-314
38	Load Following Reserves	-584	-584	-585	-586	-586	-586	-586	-586	-586	-586	-586	-586	-586	-586
39	Transmission Losses	-1256	-1184	-1158	-1175	-1274	-1287	-1237	-1227	-1215	-1133	-1058	-1251	-1272	-1245
40	**Total Regional Resources**	**35913**	**33834**	**33094**	**33594**	**36431**	**36795**	**35352**	**35071**	**34729**	**32391**	**30249**	**35758**	**36350**	**35603**
41	**Total Surplus/Deficit**	**4138**	**2282**	**4852**	**5322**	**4874**	**2481**	**511**	**2369**	**4543**	**3736**	**1590**	**8832**	**5935**	**2988**

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Exhibit 7-5: 80-Year Monthly Energy

Regional Analysis Surplus Deficit
Operating Year 2017

Regional Report Surplus Deficit By Water Year

Operating Year 2017

2015 White Book Report Date: **6/30/2015**

S129-WB-20151029-154000

	Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
1	1929 Regional Report Surplus Deficit	5307	4979	4637	6846	6340	4708	2720	3224	4155	4007	5642	5193	6923	3633	4866
2	1930 Regional Report Surplus Deficit	4318	3754	4712	6255	5855	4413	876	3993	3940	5236	7077	4859	3142	5339	4463
3	1931 Regional Report Surplus Deficit	4881	3737	4367	6294	6165	4392	1346	1819	3491	3430	1425	6732	3158	5294	4169
4	1932 Regional Report Surplus Deficit	3864	2661	3895	6177	5439	4415	1950	1729	6972	11385	12322	11681	12623	8848	6588
5	1933 Regional Report Surplus Deficit	5260	5816	5031	6683	7345	5772	8144	8732	8959	7052	7151	8697	14733	13445	8344
6	1934 Regional Report Surplus Deficit	8734	7215	5437	8506	12205	13004	13676	12685	12621	14041	11789	10169	9789	6132	10409
7	1935 Regional Report Surplus Deficit	4004	3380	3900	6666	6981	4397	8342	8375	8256	4305	6937	7830	8922	8886	6814
8	1936 Regional Report Surplus Deficit	6931	4422	4206	6157	5806	4340	1324	3328	4585	5809	10302	11532	12155	6290	6125
9	1937 Regional Report Surplus Deficit	4372	3639	4089	5934	5885	4567	1120	2243	3722	5166	2264	6558	6668	4145	4397
10	1938 Regional Report Surplus Deficit	5245	4043	4376	6547	6145	5780	7671	7621	9174	10032	13644	11651	10156	8582	7845
11	1939 Regional Report Surplus Deficit	4634	3634	4862	6664	5803	4593	5158	4738	5335	7636	9580	8594	5769	5483	5814
12	1940 Regional Report Surplus Deficit	4548	3574	4382	6782	6931	4927	4241	4263	11325	7530	7729	7997	5341	4574	6050
13	1941 Regional Report Surplus Deficit	3331	2769	4172	6202	6008	4295	2887	3663	4722	3639	4441	6577	5367	5438	4707
14	1942 Regional Report Surplus Deficit	3767	3258	4909	6480	7076	6952	5998	4360	7537	5476	7995	7210	8788	10014	6646
15	1943 Regional Report Surplus Deficit	5875	5151	5787	6174	6273	5001	9031	8845	9097	15272	13905	10175	14674	13566	9047
16	1944 Regional Report Surplus Deficit	6025	5089	4706	6581	6451	4916	2894	3809	3576	4042	5280	3817	2236	4388	4470
17	1945 Regional Report Surplus Deficit	3773	2802	4042	6261	5650	4326	1884	3185	3934	4019	1924	9040	10829	4103	4963
18	1946 Regional Report Surplus Deficit	5011	3421	3800	6480	7110	5951	7148	5917	9794	11446	13777	12203	10245	10704	8025
19	1947 Regional Report Surplus Deficit	7072	6605	5255	6517	7979	10561	10375	10703	10720	9927	9510	10750	10648	9162	9096
20	1948 Regional Report Surplus Deficit	6747	6401	4909	11120	10633	7509	9957	8074	8295	8360	11244	13254	14963	11767	9748
21	1949 Regional Report Surplus Deficit	9407	8509	6023	7141	7570	5031	6105	4908	11041	9501	13003	12707	11811	5072	8149
22	1950 Regional Report Surplus Deficit	3841	3054	4023	6684	6751	5467	10262	10358	12637	12483	11615	10872	15071	14584	9339
23	1951 Regional Report Surplus Deficit	8480	7432	5609	9014	11851	11468	13053	13858	13770	13313	12605	12147	11060	12122	11225
24	1952 Regional Report Surplus Deficit	7637	6056	5437	10449	9445	7965	9611	9604	9159	11932	14265	13489	11818	8955	9652
25	1953 Regional Report Surplus Deficit	6728	6149	4105	6251	5949	4703	4690	8727	8198	6371	7262	10820	15078	10623	7687
26	1954 Regional Report Surplus Deficit	6119	5630	5213	7052	8342	7086	9268	11351	11017	9265	9520	11127	13524	14605	9475
27	1955 Regional Report Surplus Deficit	10438	10348	9137	7358	9715	6532	4644	5528	4666	5871	5693	7939	14717	14128	8386
28	1956 Regional Report Surplus Deficit	9145	6722	4859	8334	10958	10892	12423	12570	12712	12171	14250	13278	15134	12543	11225
29	1957 Regional Report Surplus Deficit	8251	7662	5475	7800	7669	7407	6997	5225	10050	11502	8956	13833	14905	8237	8835
30	1958 Regional Report Surplus Deficit	6281	4321	4722	6525	6600	5369	7922	8057	8958	8255	10749	12849	12937	7065	7975
31	1959 Regional Report Surplus Deficit	4659	4316	4479	6792	9281	9637	11334	11433	11070	11057	9186	10388	13322	13159	9613
32	1960 Regional Report Surplus Deficit	8794	7015	9810	12865	12531	8851	8061	8312	8678	15711	11341	8849	11908	8850	10003
33	1961 Regional Report Surplus Deficit	6245	5057	4531	6838	7764	5531	8160	9352	11648	9243	7347	10941	13481	7921	8330
34	1962 Regional Report Surplus Deficit	6225	4531	4413	6412	6904	5024	7291	7346	5312	12499	13754	10724	9822	7549	7428
35	1963 Regional Report Surplus Deficit	5979	5441	4402	7673	9767	8874	8432	8724	7867	5769	6740	8998	10900	8237	7982
36	1964 Regional Report Surplus Deficit	5691	4522	5423	6586	7312	5464	5672	5829	5741	9842	6516	9609	15271	13793	7834
37	1965 Regional Report Surplus Deficit	8780	7839	6649	8230	8640	11157	13982	13659	12663	8851	13903	12344	12126	8744	10641
38	1966 Regional Report Surplus Deficit	8051	7746	4806	7353	7776	5900	6664	6593	6313	12840	8942	7397	9633	9004	7518
39	1967 Regional Report Surplus Deficit	5792	4748	4813	6308	6881	6686	10916	11305	10357	7628	4727	8864	14850	12560	8732
40	1968 Regional Report Surplus Deficit	7098	6498	5266	7521	8476	6157	8426	10137	10106	5030	5255	6545	12618	10153	8097
41	1969 Regional Report Surplus Deficit	7294	7950	7696	8877	10692	8040	12535	10794	10051	13344	13731	13281	12294	9463	10398
42	1970 Regional Report Surplus Deficit	6795	5476	4999	6872	7273	4763	7683	7590	7582	5986	5911	9694	13453	6743	7385
43	1971 Regional Report Surplus Deficit	5693	4232	4483	6432	6815	5756	12494	13719	13945	11996	12463	13093	15388	12682	10139
44	1972 Regional Report Surplus Deficit	9060	9106	5821	7748	8111	6778	11965	13642	16858	16163	11146	13008	15326	13921	11313
45	1973 Regional Report Surplus Deficit	10012	9676	6387	7569	7797	6512	7288	4954	5470	4038	4854	6379	4996	4892	6394
46	1974 Regional Report Surplus Deficit	4270	3218	4383	6542	7353	8099	15138	14713	15157	13880	13741	12365	15334	15013	10946
47	1975 Regional Report Surplus Deficit	9527	9535	6042	6540	6825	5623	8532	8299	8647	6562	6531	11203	14561	13508	8829
48	1976 Regional Report Surplus Deficit	8044	8100	6249	9116	11409	12836	12186	11757	12019	12975	12318	12931	12333	12977	11213
49	1977 Regional Report Surplus Deficit	10938	11301	10416	7371	6691	4681	3213	4034	4094	4353	4596	4075	1161	3695	5428
50	1978 Regional Report Surplus Deficit	3685	2919	3069	5714	5465	7466	6809	7262	6952	12166	9413	11157	9055	9169	7183
51	1979 Regional Report Surplus Deficit	5628	4749	7570	7340	7193	4374	3892	5182	8504	5337	6921	9925	8277	4335	6493
52	1980 Regional Report Surplus Deficit	3518	3516	4617	6200	5996	4282	5524	4600	5625	7021	10829	13153	12566	6632	6808
53	1981 Regional Report Surplus Deficit	4226	3256	5054	6525	7196	9468	10288	10234	8713	3970	6628	9183	13878	11130	8382
54	1982 Regional Report Surplus Deficit	8367	7053	5207	6889	8114	6269	9081	14105	14798	12001	10198	12153	14653	14202	10330

Regional Report Surplus Deficit By Water Year

Operating Year 2017

2015 White Book Report Date: **6/30/2015** *Continued*

S129-WB-20151029-154000

	Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
55	1983 Regional Report Surplus Deficit	8509	8695	7251	8548	8394	7476	10838	11396	13800	10144	9460	11098	12786	11640	10131
56	1984 Regional Report Surplus Deficit	8862	8373	5928	7213	11789	7774	9897	10050	9985	12197	12585	10802	14263	11133	9974
57	1985 Regional Report Surplus Deficit	7642	5482	6064	7342	8841	5782	6168	5976	5956	8618	11277	11291	9201	2936	7165
58	1986 Regional Report Surplus Deficit	2837	2573	4839	7383	9725	5961	8532	10562	15100	13335	13021	9213	10837	7047	8731
59	1987 Regional Report Surplus Deficit	5126	4105	4482	6485	7552	6035	4921	4074	8504	5084	7132	8974	7459	4464	6152
60	1988 Regional Report Surplus Deficit	3592	2592	4090	6058	5581	4040	2761	1821	4277	4547	6292	6017	5225	5425	4498
61	1989 Regional Report Surplus Deficit	4750	3754	4083	6165	6919	4839	3785	2559	6895	8061	12561	9033	8546	5784	6110
62	1990 Regional Report Surplus Deficit	4296	3540	4407	6339	8179	7305	7634	10527	9933	8063	11307	8849	12420	8543	8118
63	1991 Regional Report Surplus Deficit	7303	6219	4706	6366	11605	7974	10163	9917	9304	10241	8260	9597	11473	12848	9155
64	1992 Regional Report Surplus Deficit	8502	7082	4567	6116	6665	4158	3776	4138	8351	4369	4768	5977	3296	3745	5275
65	1993 Regional Report Surplus Deficit	3478	2734	3701	6099	6222	3871	1374	1504	5715	6378	5967	9822	9051	6520	5282
66	1994 Regional Report Surplus Deficit	5771	4367	5041	6322	6406	4554	2022	2831	4138	4710	6944	8055	7924	5021	5275
67	1995 Regional Report Surplus Deficit	4303	3012	4397	6184	5493	5089	5468	7310	9536	6701	5892	8917	12671	7509	6868
68	1996 Regional Report Surplus Deficit	5256	4421	5232	8066	13292	14916	14468	15613	16174	13066	14620	12438	12858	12704	12014
69	1997 Regional Report Surplus Deficit	8219	7309	5325	6849	8346	8132	14920	14743	15406	13853	14571	13246	15222	14001	11493
70	1998 Regional Report Surplus Deficit	8842	9218	7697	11860	10469	6224	6923	8384	7828	6130	8539	13078	14073	8835	9313
71	1999 Regional Report Surplus Deficit	7337	6093	4865	6464	6925	7392	11868	12153	13861	10513	12067	10556	14360	13928	10019
72	2000 Regional Report Surplus Deficit	10504	9510	6093	6978	11949	9060	8190	8208	8464	11846	13409	10978	7634	7948	9011
73	2001 Regional Report Surplus Deficit	6033	3788	4258	6509	5829	4478	2516	3260	4084	4762	4823	5464	786	4363	4280
74	2002 Regional Report Surplus Deficit	3602	2603	3665	4818	4786	4926	3540	3881	5216	7100	11387	8645	13623	11409	6408
75	2003 Regional Report Surplus Deficit	4637	4118	4356	6160	6319	4582	2310	4049	8560	6682	7498	8076	10473	5110	5958
76	2004 Regional Report Surplus Deficit	3714	2897	3878	6861	8227	4697	4574	3115	6223	5678	6573	7561	7861	5604	5680
77	2005 Regional Report Surplus Deficit	3363	3802	6190	7130	7432	6185	6253	6450	5170	4263	5723	8159	8359	6181	6336
78	2006 Regional Report Surplus Deficit	4683	3423	4253	6154	7037	5719	9064	8731	9461	11819	13183	12098	13540	7794	8352
79	2007 Regional Report Surplus Deficit	5922	3076	3867	5932	8043	6324	8166	7673	10972	10929	8256	9497	7911	8054	7541
80	2008 Regional Report Surplus Deficit	4597	3121	4207	6217	6910	4122	4521	4494	5723	6197	4051	10887	15090	9751	6747
	Ranked Averages															
81	**Bottom 10 pct**	**4732**	**3793**	**4379**	**6335**	**6014**	**4476**	**2140**	**2979**	**3996**	**4354**	**4655**	**5652**	**4188**	**4753**	**4481**
82	**Middle 80 pct**	**6203**	**5335**	**5171**	**7036**	**7751**	**6195**	**7136**	**7408**	**8633**	**8639**	**9135**	**10019**	**11319**	**8817**	**7843**
83	**Top 10 pct**	**7657**	**6768**	**5516**	**7987**	**9995**	**10535**	**13517**	**13819**	**14345**	**13034**	**13394**	**12720**	**13674**	**12753**	**11259**

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BONNEVILLE POWER ADMINISTRATION
DOE/BP-4739 ▪ January 2016