

# 2016 Pacific Northwest Loads and Resources Study

December 2016







## Department of Energy

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

December 22, 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 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 2016 White Book presents Federal system and the region’s load obligations, contracts, and resources as of September 8, 2016 for operating years (OY) 2018 through 2027. The 2016 White Book includes two 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 over the first three years of the study, up to 220 aMW, reducing to an annual energy deficit of -267 aMW in 2027. These annual energy deficits projections are smaller than those projected in the 2015 White Book. Under 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 -509 MW to -863 MW. These 120-Hour capacity deficits are smaller than those presented in the 2015 White Book, mainly driven by lower peak load obligation forecasts. Under 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 minimal 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 starting at 4,258 aMW in OY 2018, slowly decreasing to 220 aMW by OY 2026. For OY 2027, the region shows an annual energy deficit of -293 aMW. These annual energy projections are slightly smaller than those presented in the 2015 White Book. Under 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 a small January 120-Hour capacity surplus of 160 MW in OY 2018, and growing deficits up to -5,255 MW in OY 2027. These projections show smaller January 120-Hour capacity deficits than those shown in the 2015 White Book. Under average water conditions; the PNW region has January 120-Hour capacity surpluses through the final year of this study.

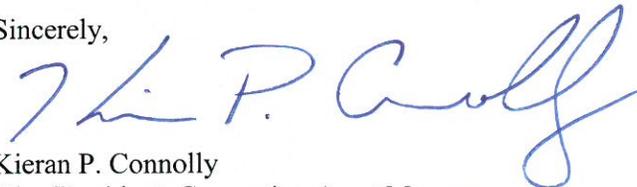
BPA continues to work with other regional entities, particularly the Council and the Pacific Northwest Utilities Conference Committee, to coordinate loads, contracts, and resource information used in loads and resources planning. Deficits identified in these studies could be mitigated through the options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

BPA, like the rest of the electric power industry, continues to explore ways to more comprehensively assess the ability of the power system to meet long-term load obligations. As a result, the 2015 White Book included additional studies that use different analytical methods and metrics to analyze different scenarios to meet load obligations. This analysis was not updated and therefore not included in the 2016 White Book.

The 2016 White Book is available on BPA's website: [www.bpa.gov/power/whitebook](http://www.bpa.gov/power/whitebook) or from BPA's Visitor Center, which you can reach toll-free at 8010-622-4520 (or 503-230-4636). Details regarding regional loads, contracts, and generating resources are available in the 2016 Technical Appendix available only in electronic format on BPA's website: [www.bpa.gov/power/whitebook](http://www.bpa.gov/power/whitebook).

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

Sincerely,



Kieran P. Connolly  
Vice President, Generation Asset Management

Enclosure

**2016 PACIFIC NORTHWEST LOADS AND RESOURCES STUDY**  
*The White Book*

**BONNEVILLE POWER ADMINISTRATION**  
December 2016

**Cover Picture:**

Keys Pumping Station penstocks, Grand Coulee Dam, and Lake Roosevelt located at Coulee Dam, Washington.

Source: Tim Miskey, taken August 2016

Grand Coulee Power facilities are among the largest in the world; with a nameplate rating of 6,735 megawatts. The John W. Keys III Pump-Generating Plant has a total generating capacity of 314 megawatts and was completed in 1973. It contains 12 pumps that can lift water from the Columbia River up the hillside to a canal that flows in to Banks Lake, which provides irrigation water to over 670,000 acres in the Columbia Basin Project. Six of the pumps can be reversed to generate hydroelectricity when demand exists.

Grand Coulee Dam forms Franklin D. Roosevelt Lake, extending 151 miles upstream to the Canadian border. It has a 600-mile shoreline and a surface area of 82,000 acres.

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# ACKNOWLEDGMENTS

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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.

## **Bonneville Power Administration**

### **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**

### ***Special thanks to Tim Misley***

*For his 36 years of trustworthy stewardship,  
steadfast involvement and commitment to excellence*

## **Pacific Northwest Utilities Conference Committee**

## **Northwest Power & Conservation Council**



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# Section 1: Summary

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## *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 10 year period (OY 2018 through 2027). The White Book includes analysis of BPA's forecasts of expected power obligations and resource generation for both the Federal system and the Pacific Northwest (PNW) region. The information contained in the White Book 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 long-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 forecasted Federal system resource generation and contract purchases. In the same manner, BPA's PNW regional analysis calculates the PNW Regional load and resource balance by comparing expected regional retail loads and contract obligations to forecasted regional resource generation and contract purchases. Hydro resources for the Federal system and PNW region include variability by incorporating a variety of generation forecasts, associated with streamflows from the 80-historical water conditions. These deterministic analyses are modeled by operating year (OY<sup>1</sup>) 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, presented in 120-Hour peak megawatts (MW) (and 1-Hour peak megawatts in the Appendix). The Federal System Analysis is presented in Section 2, page 13, and the Pacific Northwest Regional Analysis is presented in Section 3, page 27.

BPA, like the rest of the electric power industry, continues to explore ways to more comprehensively assess the ability of the power system to meet long-term load obligations. This assessment takes into account the use of multiple sets of analytical metrics. As a result, BPA periodically incorporates additional studies that use different analytical methods and analyze different scenarios to meet load obligations. These studies were last presented in the 2015 White Book and included the following: 1) Federal System Needs Assessment, which modeled the Federal System's ability to meet obligations under a variety of load, contract, and weather events; and 2) Federal System Resource Adequacy, which stochastically modeled the Federal system's ability to meet load obligations under many combinations of resource supply and load demand conditions. The Federal System Needs Assessment and Federal System Resource Adequacy studies that were included in

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<sup>1/</sup> Operating Year (OY) is the time frame August 1 through July 31. For example, OY 2018 is August 1, 2017 through July 31, 2018.

the 2015 White Book have not been updated and, therefore, are not included in this document.

The 2016 White Book is published in three documents: 1) this document, the 2016 Loads and Resources Summary, which provides BPA's deterministic Federal system and PNW regional loads and resources used for long-term planning; 2) the 2016 Loads and Resources Technical Appendix, Volume 1, Energy Analysis, which provides the detailed components of the annual and monthly energy for the Federal system and PNW regional retail loads, contracts, and resources; and 3) the 2016 Loads and Resources Technical Appendix, Volume 2, Capacity Analysis, that presents the detailed components of the monthly 120-Hour and 1-Hour peak capacity for Federal system and PNW regional retail loads, contracts, and resources. The Technical Appendices are only available in electronic format at:

[www.bpa.gov/power/whitebook](http://www.bpa.gov/power/whitebook)

The total retail load, contract, and generation forecasts used in this study were updated September 8, 2016. This document supersedes the 2015 White Book.

### **Load Obligations**

The load obligations for the Federal system and PNW region contain multiple components. For this study, load obligation forecasts are categorized as follows: 1) Total Retail Loads (TRL), defined as each individual utilities' retail electric power consumption, including electrical system losses; and 2) Contract obligations, which include reported PNW utility long-term contract sales to entities within the PNW region (Intra-Regional Transfers (*Out*)) and to those outside the PNW region (Exports). Contract obligations also include Federal system power deliveries to Northwest Federal agency, Public agency, and Tribal utility preference customers as allowed for under the Northwest Electric Power Planning and Conservation Act (Act), enacted December 5, 1980.

Forecasts of the regional TRL and Federal system load obligations are produced by BPA's Agency Load Forecasting (ALF) system. ALF forecasts are completed for individual PNW entities using statistical approaches that are based on time-series-based regressions that follow the fundamental assumption that historical retail electricity consumption patterns will continue into the future. ALF forecasts also assume normal weather conditions and do not include any adjustments for future climate change impacts. Contracts obligations not associated with BPA's Regional Dialogue contracts follow individual contract terms through the life of that contract and are not assumed to be renewed. All Federal system load and contract obligations are assumed to be firm and served by BPA regardless of weather, water, or economic conditions.

## 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. Therefore, generation levels can vary greatly from month-to-month and season-to-season. This analysis classifies resources as: 1) Hydro resources, which include Regulated, Independent, and Small Hydro projects; 2) Other resources (non-hydro), which include Cogeneration, Combustion Turbines, Large Thermal (including coal and nuclear projects), Renewable Resources (including wind, solar, and biomass projects), and Small Thermal and Miscellaneous projects; and 3) Contract purchases, which include reported PNW utility long-term contract purchases from entities within the PNW region (Intra-Regional Transfers (*In*)) and from those outside the PNW region (Imports) The generation forecasts for these resources are provided by BPA models or the project owners and are described as follows:

- **Regulated Hydro Projects:** Regulated hydro projects mainly consist of PNW Columbia River Basin hydroelectric power projects for which the operation and generating capability is hydraulically coordinated to meet power and non-power requirements. BPA forecasts 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 forecasts for these projects incorporate the month-to-month power and non-power requirements under each of the 80-historical water conditions of record, 1929 through 2008 water years. The HYDSIM model is described in Hydro Resource Modeling, page 7.
- **Independent Hydro Projects:** Independent hydro projects include those hydro projects whose generation output typically varies by water condition (like Regulated Hydro projects) but are not operated as part of the coordinated Columbia River Basin system. Independent hydro generation forecasts vary month-to-month for energy and capacity, and are developed and provided by individual project owners/operators for the same 80-historical water conditions as the Regulated hydro projects.
- **Small Hydro Projects:** Small hydro project generation forecasts are either 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 condition.
- **Thermal and Cogeneration:** These projects include coal, nuclear, gas-fired, and cogeneration. Generation forecasts for these projects are based on energy and capacity capabilities submitted by project owners. These forecasts typically vary month-to-month, and total plant generation is reduced in order to account for scheduled maintenance.
- **Renewable Resources:** These projects are comprised of wind, solar, geothermal, biomass and biogas. 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. The firm wind year generation performance

determines each project's energy forecast. The Federal system and PNW regional capacity analyses assume no (zero) capacity contribution from wind resources. Generation forecasts for geothermal, solar, biomass and biogas resources are based on energy and capacity forecasts submitted by individual project owners. These methodologies are consistent with previous White Books.

- **Contract Purchases:** Contract purchases include signed Federal system and reported regional contract purchases whose power is delivered to PNW entities. These 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 contracts associated with the 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***

Resource generation and contract purchases must be reliably delivered to load centers. To take this into account, this study makes adjustments to generation forecast to account for: 1) Operating reserves, which are held to meet reliability standards; and 2) Transmission Losses, which are associated with power deliveries. These resource adjustments are reductions to both energy and capacity as 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, which are calculated by summing 3 percent of forecast load and 3 percent of forecast generation; and 2) Balancing reserves (regulating, load following, and imbalance) that are dedicated to maintaining within-hour load and resource balance, which include reserves for wind integration. The modeling of reserves, including those for wind integration, is described in Hydro Resources Modeling, page 7. The reserve forecasts included in this 2016 White Book are consistent with BPA's BP-18 Initial Rate Proposal.
- **Transmission Losses:** During the transmission of power to load centers some of the electrical energy is lost, usually in the form of heat, which is known as transmission losses. Transmission losses are calculated monthly based on the sum of all generation and contract purchase forecasts. Transmission losses vary year-to-year and by water condition. The transmission loss factor is 2.97 percent for energy and 3.38 percent for 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**

HYDSIM forecasts the energy production from the regulated hydroelectric power projects in the PNW. 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, for water years 1929 through 2008. Energy production is maximized by coordinating hydro operations while meeting power and non-power requirements. HYDSIM produces results for 14 periods; 10 complete months, plus two periods each for April and August. April and August are divided because natural streamflows and operations often change significantly during these months. Consequently, generation can differ significantly between the beginning and end of these months. For simplicity, these 14-period results are referred to as “monthly” 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 Kootenai River white sturgeon, published February 18, 2006; relevant operations described in the Northwest Power and Conservation Council (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, 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 hydroelectric power projects in the PNW. All PNCA project owners provide physical plant data as well as power and non-power constraints in an annual data submittal. BPA incorporates this data into HYDSIM to simulate the coordinated operation of the PNW hydro system.

The 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. Canadian operations included in this 2016 White Book are based on the official AOP studies available with modifications that reflect updates expected in the official DOP studies.

Both Canada and 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 notice. Neither Canada nor the United States have provided notice of

termination; therefore, this study assumes the Treaty continues with the same or similar agreement through the study period.

BPA has other operational agreements with Canada that are not part of the Treaty. One agreement is the Non-Treaty Storage Agreement (NTSA) that allows additional shaping of Columbia River flows for power and fish operations by utilizing additional storage not specified by the Treaty in Canadian reservoirs. 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.

Balancing reserves, both incremental and decremental, reduce the ability to shape Federal system generation. Incremental reserves are modeled by reducing the generation capability of several projects. In this study, the impacts of incremental reserves are shown as a reduction in the capacity analyses and are categorized as Load Following reserves and Generation Imbalance reserves. Decremental reserves are not specifically reported in this study, however, they are incorporated by increasing the minimum flow of several projects modeled in BPA's Hourly Operating and Scheduling Simulator (HOSS) discussed in Hydro Capacity Modeling, page 9.

Critical Water Planning: To ensure sufficient generation to meet load, BPA bases its resource planning on critical water conditions. Critical water conditions are defined as, 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 forecasts under 1937-critical water conditions determine the critical period firm energy for the regulated and independent hydro projects.

Variability of Hydro Generation: 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, any flow or operating requirements pursuant to biological opinions, and other operating limitations. Water conditions drive hydropower generation greatly year to year depending on weather factors such as precipitation, snowpack, and temperature. Project level generation forecasts are produced using HYDSIM for each of the 80-historical water conditions of record, which are based on the period from 1929 through 2008.

This study uses three streamflow scenarios to demonstrate the magnitude of hydro generation variability:

- Low water flows: 1937-critical water conditions represent the firm energy and capacity capability of the hydro system.
- Average water flows: 1958-water conditions represent the average energy and capacity capability of the hydro system.
- High water flows: 1974-water conditions represent high (better than average) energy and capacity capability of the hydro system.

Hydro Capacity Modeling: BPA uses its HOSS model to forecast usable hydro capacity for long-term planning purposes. The HOSS model is used to simulate the relationship of hydro energy to hydro peaking capability for Federal system regulated hydro resources. HOSS incorporates the monthly 80-year reservoir storage and flows from HYDSIM. For each month, HOSS forecasts hourly Federal system hydro generation by maximizing HLH generation while meeting non-power requirements. The forecasts take into account scheduled hydro maintenance as well as operating and balancing reserves. The hydro peaking capability from HOSS is not an indication of the Federal hydro system's ability to react to system distress or extreme load conditions.

The 120-Hour and 1-Hour capacity forecasts for hydro resources are created by evaluating hourly generation from the HOSS model, over a specific period of time. These capacity metrics are defined as follows:

- 120-Hour Capacity: is calculated by averaging the generation forecasts from the 6 highest heavy load hours per day, 5 days per week, for 4 weeks per a month ( $6 \times 5 \times 4 = 120 \text{ hours}$ ); and
- 1-Hour Capacity: is calculated using the highest single 1-Hour generation per month.

The 1-Hour hydro capacity forecasts, do not consider the ability of the hydro system to sustain generation levels needed to meet hour-to-hour and/or day-to-day hydro operations. The inability of the hydro system to sustain full hydro capacity is because there is often more hydro generating capability than available water supply. For this reason, the 120-Hour presented in this study better reflects the actual ability of the hydro system to generate peaking energy to meet load obligations throughout each month. The 1-Hour capacity forecasts are included in the Loads and Resources Technical Appendix, Volume 2: Capacity Analysis for informational purposes only. The capacity presented in this analysis can be expressed as either capacity in megawatts (MW) or energy over peak load hours in average megawatts.

## **Key Updates**

The 2016 White Book includes updated forecasts of Federal system power sales contract (PSC) obligations, PNW regional Total Retail Loads, contracts, and generation as of September 8, 2016. Notable updates include:

- Lower retail load forecasts due to slower than anticipated economic growth;
- Improved peak load forecasts that better approximate recent actual peak loads;
- BPA power service to the newly formed Kalispel Tribal Utility, which requested power service from BPA under the new public and tribe provisions of the Regional Dialogue Agreement;
- Expiration of BPA's acquisition of the Idaho Falls Bulb Turbine generation, effective September 30, 2016. With the end of this contract Federal system generation was reduced and the output of these resources now serves the City of Idaho Falls' load;
- Reduction of regional generation forecasts due to the announced retirement of Colstrip 1 and Colstrip 2 on June 30, 2022;

The following planned generating project retirements were incorporated in previous White Books studies:

- Centralia 1 (December 1, 2020)
- Centralia 2 (December 1, 2025)
- Boardman (January 1, 2021)
- Valmy 1 (January 1, 2022)
- Valmy 2 (January 1, 2026)
- Reduction in PNW regional Total Retail Loads, by almost 250 aMW, due to the idling of Alcoa's Wenatchee Works plant in Chelan County PUD's service area.
- Due to the timing associated with the product switch process, Regional Dialogue PSC's early product switch changes, which will start October 1, 2017, were not incorporated in this study. This assumption is the same as those presented in the BP-18 Initial Rate Proposal. The following product switch changes will be incorporated in future studies:
  - Klickitat PUD from Slice/Block to Load Following, and
  - Seattle City Light from Slice/Block to Block-only.
- No changes have been made in regard to possible future modifications to the Treaty or to climate change assumptions.

## ***Sources of Uncertainty***

The forecasts presented in this document represent the best information currently available under each of the defined metrics for loads and resources. However, almost all 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 the streamflow runoff that dictates hydroelectric power generation;
- Potential increases or decreases in retail and industrial loads due to changes in local, regional, and/or 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, and Department of Energy (DOE)-Richland vitrification plant operations;
- 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 projects 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 requirements or other environmental considerations;
- Changes to Treaty obligations and/or operations;
- Ability to purchase power from new and existing uncommitted regional resources to serve retail load;
- Ability to purchase and transmit power from extra-regional import/export markets; and
- Future climate change impacts to retail loads, streamflows, and resources.

The potential impacts of these and other sources of uncertainty are not quantified in this report.

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## Section 2: Federal System Analysis

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The Federal System Analysis provides a deterministic forecast of Federal system loads and resources over a 10-year period from OY 2018 through 2027. This analysis incorporates forecasts of Federal system's firm requirements power sales contract (PSC) obligations, contract sales and purchases, and resource generation. Firm Federal system load and resource forecasts for energy and 120-Hour capacity are presented in this section. Detailed components from the Federal system study are available electronically in the 2016 Loads and Resources Technical Appendix, Volume 1, Energy Analysis, which provides annual and monthly energy in aMW; and the 2016 Loads and Resources Technical Appendix, Volume 2, Capacity Analysis, which provides monthly 120-Hour and 1-Hour peak capacity.

### **Load Obligations**

BPA's ALF system is used to forecast Federal system load obligations, as described on page 4. The types of Federal system load obligation forecasts include: 1) Federal reserve power obligations to the U.S. Bureau of Reclamation (USBR); 2) BPA's Regional Dialogue PSC obligations to Public and Federal agency customers; 3) contract obligations to investor-owned utilities (IOUs); 4) contract obligations to Direct Service Industry (DSI) customers; and 5) other BPA contract obligations, which include contract sales to entities within the PNW region (Intra-Regional Transfers *Out*) and to those outside the PNW region (Exports). These load obligations are considered to be firm power deliveries and are assumed to be served by the Federal system regardless of weather, water, or economic conditions. BPA's forecasts of these obligations are as follows:

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 Reserve Power from specific FCRPS projects as part of USBR project authorization.

Regional Dialogue 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 136 Public agency customers who signed Regional Dialogue Contracts, including the newly formed Kalispel Tribal Utility; 119 are Load Following, 16 are Slice, and one is a Block customer. The Block customer is not receiving power from BPA at this time.

Under these PSCs, customers must make periodic elections to serve their 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 at the same levels 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 14, presents the A-RHWM load

included in BPA's obligations by FY to be consistent with the BP-18 Initial Rate Proposal.

**Table 2-1**

**Federal System  
Annual Above-Rate High Water Mark (A-RHWM) Obligations  
FY 2018 through 2027**

Energy (aMW)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
A-RHWM Obligations	106.4	118.8	94.9	108.3	117.2	132.6	145.7	162.1	178.3	182.1

IOU Load Service under PSCs: The six IOUs in the PNW region are Avista Corporation, Idaho Power Company, NorthWestern Energy Division of NorthWestern Corporation, 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 Alcoa and Port Townsend's contracts with BPA run through September 30, 2022. Federal system DSI deliveries are forecasted at 49.8 aMW for OY 2018, and 87.6 aMW through the remaining study period.

Other Contract Obligations: BPA provides Federal power 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. These contracts include power deliveries to entities within the PNW region (Intra-Regional Transfers (*Out*)) and to those outside the PNW region (Exports).

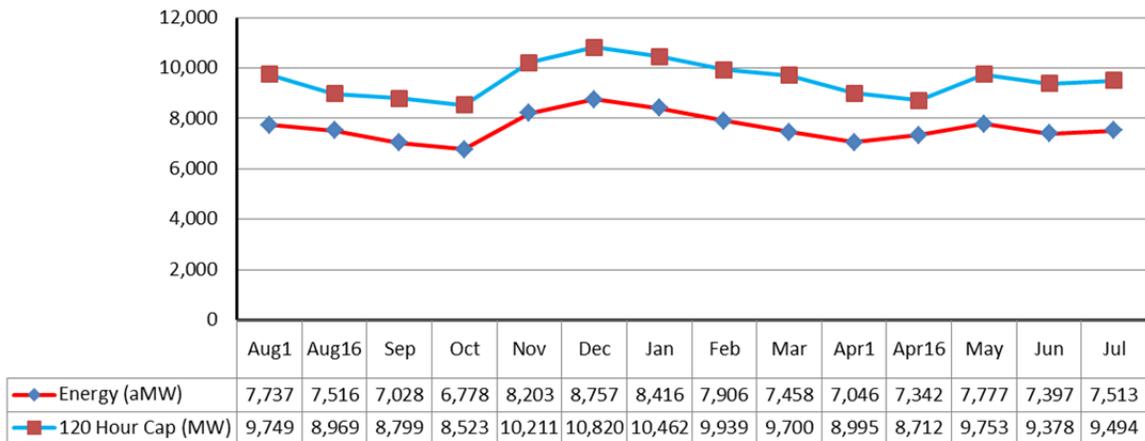
With the exception of BPA's Treaty related contracts and Regional Dialogue PSCs, forecasts of BPA's contract deliveries follow individual contract terms and are not assumed to be renewed after expiration. Treaty and Regional Dialogue PSC power deliveries are assumed to remain in place through the study horizon.

**Firm Loads:** The Federal system firm load forecasts show a modest average annual growth rate of approximately 0.3 percent over the study period. While BPA’s PSC requirements load increases over the study period, BPA Exports and Intra-Regional Transfers decrease due to the expiration of contracts and settlement agreements throughout the study period. Contracts that expire during the study period include Federal system power sales, wind energy shaping contracts with Pacific Gas and Electric (February 14, 2019) and PacifiCorp (October 31, 2020), and WNP-3 settlement deliveries to Avista Corporation (June 30, 2019). When all of these factors are considered, the total Federal system 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 for OY 2018. Monthly energy and 120-Hour capacity are projected to maintain a similar shape over the study period.

**Table 2-2**

**Federal System  
Monthly Energy and 120-Hour Capacity Load Obligations  
OY 2018**



**Conservation:** The PSC obligation forecasts developed by ALF are based on historic retail load consumption, and are adjusted for additional BPA-funded conservation identified by individual customers. Therefore, public power’s share of embedded conservation is included in these forecasts.

## Resources

In the PNW, BPA is the Federal power marketing agency charged with marketing and transmitting power from Federal hydroelectric projects and power generating facilities 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 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 currently comprised of: 1) Hydro resources, which include Regulated, Independent, and Small Hydro projects; 2) Other resources, which include Large Thermal (Columbia Generating Station) and Renewable Resources (including wind and solar projects); and 3) Contract purchases, which include contract purchases from entities within the PNW region (Intra-Regional Transfers (*In*)) and from those outside the PNW region (Imports), including Non-Federal Canadian Entitlement Return power (commonly known as Non-Federal CER), and Slice Transmission Loss Returns.

Federal System Resource Types: Table 2-3, below, summarizes BPA's resources and contract purchases available to meet the Federal system load obligations. For OY 2018, the Federal system resources are forecast to produce 8,136 annual aMW of generation, under 1937-critical water conditions. Federal system energy resources are comprised of approximately 80.5 percent hydro, 13.5 percent nuclear (Columbia Generating Station), 5 percent contract purchases, and 1 percent renewables. Federal system renewable resources are mainly comprised of wind with a small amount of solar.

**Table 2-3**

**Federal System  
Generation Forecast by Resource Type  
OY 2018  
1937-Critical Water Conditions**

Resource Type	Annual Energy (aMW)	Percent of Energy	January 120-Hour Capacity (MW) <sup>a/</sup>	Percent of Capacity
Hydro	6,550	80.5%	9,920	84.5%
Nuclear	1,100	13.5%	1,144	9.7%
Cogeneration	0	0.0%	0	0.0%
Renewables	58	0.7%	0	0.0%
Contract Purchases	427	5.2%	673	5.7%
<b>Total Federal Resources</b>	<b>8,135</b>	<b>100.0%</b>	<b>11,736</b>	<b>100.0%</b>

<sup>a/</sup> Federal resource forecasts are before adjustments for reserves and transmission losses.

The composition of the Federal system resources are detailed below.

- Federal System Hydro Resources: Table 2-4, page 18, shows the Federal system hydro resources from which BPA markets firm and non-firm power. Additionally, Table 2-4 shows the variability of individual Federal system hydro project generation for the three water conditions that represent critical, average and high water conditions. The variability of hydro generation is discussed starting on page 8.
- Federal System Non-Hydro Resources: Federal system non-hydro resources are generating resources whose output are either assigned to or have been purchased by BPA. Table 2-5, page 19, shows these generating resources, which include: 1) Columbia Generating Station (Large Thermal); and 2) wind projects, including wind projects that BPA shapes for other entities under contract, and several small solar projects (Renewables Resources). Forecasts for these resources are generally consistent from year to year, but may change annually based on annual maintenance, refueling, and capital improvements.
- Federal System Contract Purchases: BPA purchases or receives power under a variety of contract arrangements from entities within the PNW region (Intra-Regional Transfers (*In*)) and from those outside the PNW region (Imports), used to meet Federal system load obligations. These contract purchases, presented in Table 2-5, page 19, are made up of: 1) power purchases, 2) power or energy exchange purchases, 3) power assigned to BPA under Treaty related agreements, 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. Transmission loss returns capture the return of Slice transmission losses to the Federal system as specified in the Slice contracts, these returns are treated as Federal system resources. With the exception of delivers from Treaty related and Slice contracts, each contract purchase follows specific delivery terms and expiration dates and is not assumed to be renewed. Treaty related and Slice contracts are assumed to remain in place through the study horizon.

Table 2-4

**Federal System  
Hydro Project Generation by Various Streamflow Conditions  
OY 2018**

Project	Initial Service Date	Operator	Number of Units	Nameplate Rating (MW)	120-Hour Generating Capacity <sup>a/</sup> (Peak MW)	High Streamflows Energy (aMW)	Average Streamflows Energy (aMW)	Firm Energy <sup>b/</sup> (aMW)
<b>Regulated Hydro</b>								
1. Albeni Falls	1955	USACE	3	49	22.5	18.0	22.2	21.7
2. Bonneville <sup>c/</sup>	1938	USACE	20	1,195	960	631	566	387
3. Chief Joseph	1955	USACE	27	2,614	2,374	1,513	1,344	1,089
4. Dworshak	1974	USACE	3	465	434	292	217	141
5. Grand Coulee / GCL Pumping	1941	USBR	27	6,735	4,844	2,793	2,403	1,888
	1973		6	314				
6. Hungry Horse	1952	USBR	4	428	318	111	89	75
7. Ice Harbor	1961	USACE	6	693	586	287	203	111
8. John Day	1968	USACE	16	2,480	2,295	1,387	1,093	779
9. Libby	1975	USACE	5	605	483	263	229	189
10. Little Goose	1970	USACE	6	930	859	420	288	159
11. Lower Granite	1975	USACE	6	930	737	407	288	149
12. Lower Monumental	1969	USACE	6	930	810	437	299	150
13. McNary	1953	USACE	14	1,120	1,036	632	600	474
14. The Dalles	1957	USACE	24	2,052	1,830	978	815	595
15. Idled Federal Capacity	-	-	-	-	-7,898	-	-	-
<b>16. Total Regulated Hydro Projects</b>			<b>173</b>	<b>21,540</b>	<b>9,692</b>	<b>10,169</b>	<b>8,458</b>	<b>6,208</b>
<b>Independent Hydro Projects</b>								
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. Lookout Point	1954	USACE	3	138	7.5	47.2	40.7	35.3
31. Lost Creek	1975	USACE	2	56	43.7	43.4	45.4	30.0
32. Minidoka	1909	USBR	4	28	2.1	22.5	16.6	11.2
33. Palisades	1957	USBR	4	176	9.2	96.2	84.1	69.2
34. Roza	1958	USBR	1	13	1.9	8.7	7.6	6.9
<b>35. Total Independent Hydro Projects (sum lines 17 through 34)</b>			<b>38</b>	<b>894</b>	<b>223</b>	<b>471</b>	<b>415</b>	<b>340</b>
<b>Small Non-Federally Owned Hydro Projects</b>								
36. Dworshak/Clearwater Small Hydro	2000	ID DWR	1	5.4	3	2.6	2.6	2.6
37. Rocky Brook	1985	MCPD#1	1	1.6	1.6	0.3	0.3	0.3
<b>38. Total Non-Federally Owned Hydro Projects (line 36 + line 37)</b>			<b>2</b>	<b>7</b>	<b>4.6</b>	<b>2.9</b>	<b>2.9</b>	<b>2.9</b>
<b>39. Total Hydro Generation (line 16 + line 35 + line 38)</b>			<b>213</b>	<b>22,441</b>	<b>9,920</b>	<b>10,644</b>	<b>8,875</b>	<b>6,550</b>

<sup>a/</sup> This is the maximum 120-Hour hydro generation for January 2018 assuming 1937-critical water conditions

<sup>b/</sup> Firm energy is the 12-month annual average for OY 2018 assuming 1937-critical water conditions

<sup>c/</sup> Bonneville Dam generation totals include Bonneville Fishway

Table 2-5

**Federal System  
Non-Hydro Project Generation and Contract Purchases  
OY 2018**

Project	Initial Service Date	Resource Type	Operator	Capacity <sup>a/</sup> (Peak MW)	Firm Energy (aMW)
<b>Non-Hydro Resources</b>					
1. Columbia Generating Station	1984	Nuclear	ENW	1,144	1,100
2. Condon Wind Project	2002	Wind	Condon Wind Project, LLC	0	11.7
3. Foote Creek 1	1999	Wind	Foote Creek 1, LLC	0	3.6
4. Foote Creek 4	2000	Wind	Foote Creek 4, LLC	0	4.0
5. Stateline Wind Project	2001	Wind	PPM, FLP	0	21.2
6. Klondike Phase I	2001	Wind	NW Wind Power	0	5.7
7. Klondike Phase III	2007	Wind	NW Wind Power	0	11.8
8. Fourmile Hill Geothermal <sup>b/</sup>	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
<b>11. Total Federal System Non-Hydro Resources</b> <i>(sum lines 1 through 10)</i>				<b>1,144</b>	<b>1,158</b>
<b>Contract Purchases</b>					
12. Canadian Entitlement for Canada (non-Federal)				240	137
13. Canadian Imports				1	1
14. Pacific Southwest Imports				125	89
15. Intra-Regional Transfers In (Pacific Northwest Purchases)				254	165
16. Slice Transmission Loss Return				56	35
<b>17. Total Federal System Contract Purchases</b> <i>(sum lines 12 through 16)</i>				<b>676</b>	<b>427</b>
<b>18. Total Federal System Non-Hydro Resources and Contract Purchases</b> <i>(line 11 + line 17)</i>				<b>1,820</b>	<b>1,585</b>
<sup>a/</sup> This is the maximum generation for January 2018					
<sup>b/</sup> Fourmile Hill is not assumed to be in operation within the study period					

**Federal System Hydro Generation 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, flow requirements pursuant to biological opinions, and other operating limitations. Table 2-6, below, shows the annual variability of hydro generation under three streamflow conditions: 1) 1937-critical water conditions, representing the firm energy capability of the hydro system; 2) 1958-water conditions, representing the average energy capability of the hydro system; and 3) 1974-water conditions, representing the high energy capability of the hydro system.

**Table 2-6**

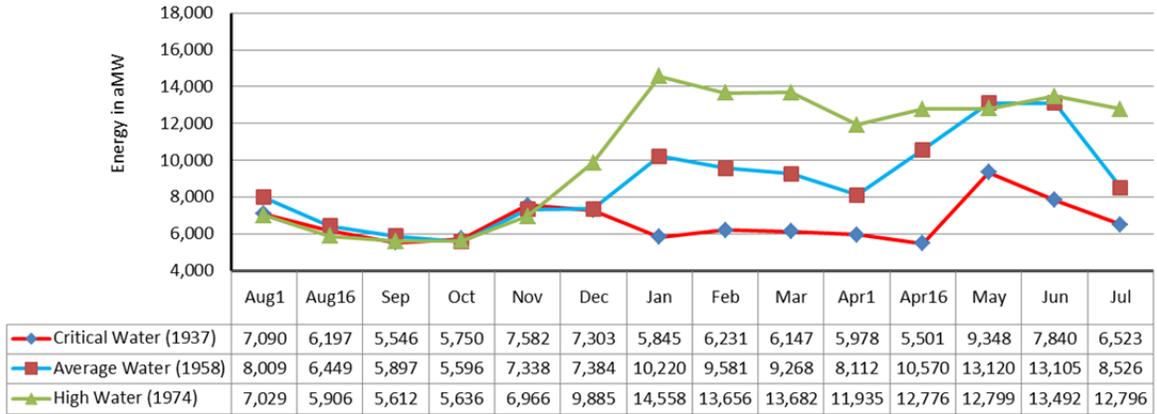
**Federal System  
Variability of Annual Hydro Generation  
OY 2018 through 2027  
Under Different Water Conditions**



In OY 2018, annual Federal system hydro energy generation, under 1937-critical water conditions, is forecasted to be 6,550 aMW. However, in the high streamflow condition, represented by 1974-water conditions, these same Federal system hydro resources generate annually 10,644 aMW. While Table 2-6, above, shows the annual variability of Federal system hydro generation, Table 2-7, page 21, shows the monthly variability of the Federal system hydro generation for OY 2018, 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. Water variability does not have a substantial impact on generation from the Federal system hydro resources from August through November. Monthly hydro generation can vary by up to 8,700 aMW depending on project operations and the availability of water.

**Table 2-7**

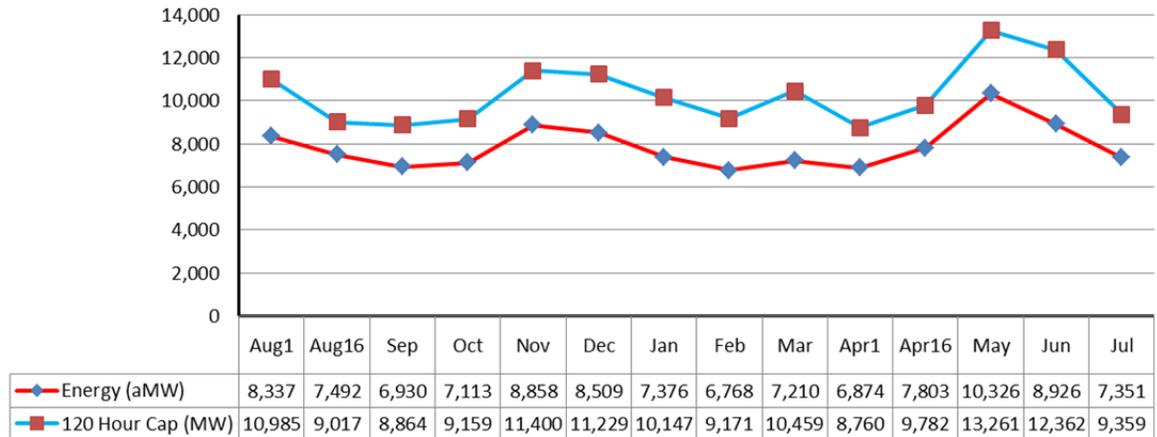
**Federal System  
Variability of Monthly Hydro Generation  
OY 2018  
Under Different Water Conditions**



Total Federal System Resources: Table 2-8, below, illustrates the monthly shape of the forecasted total Federal system generation for energy and 120-Hour capacity for OY 2018, under 1937-critical water conditions. This includes generation from all Federal system hydro and non-hydro resources and Federal system contract purchases. The Federal system maintains similar monthly shapes over the study period, with the highest generation forecasted in late spring/early summer and early winter periods.

**Table 2-8**

**Federal System  
Monthly Energy and 120-Hour Capacity  
OY 2018  
Under 1937-Critical Water Conditions**



## Key Results

Annual Energy: Table 2-9, below, shows that the Federal system is forecasted to have small annual firm energy surpluses in the first three years, and modest annual energy deficits over the rest of the study period. The individual components of the Federal system annual energy loads and resources are shown in Exhibit 4-1, page 41, for OY 2018 through 2027. The Federal system monthly energy loads and resources are shown in Exhibit 4-2, page 45, for OY 2018 through 2027. The details of these components for OY 2018 through 2027 are presented in the 2016 Loads and Resources Study Technical Appendix, Volume 1: Energy Analysis.

**Table 2-9**

**Federal System  
Annual Energy Surplus/Deficit  
OY 2018 through 2027  
1937-Critical Water Conditions**

Energy (aMW)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Surplus/Deficit	220	28	168	-75	-37	-203	-74	-241	-112	-267

Table 2-10, below, compares the 2016 White Book Federal system annual firm energy surplus/deficits projections to the 2015 White Book results. The 2016 White Book shows larger annual energy surpluses in the first three years and smaller annual energy deficits over the rest of the study period. These inventory improvements are a result of lower load obligations combined with small increases in Federal system generation.

**Table 2-10**

**Federal System  
Annual Energy Surplus/Deficit Comparison  
OY 2018 through 2027  
1937-Critical Water Conditions**

Energy (aMW)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
2016 White Book	220	28	168	-75	-37	-203	-74	-241	-112	-267
2015 White Book	102	-93	7	-167	-116	-268	-121	-298	-152	n/a
<i>Difference (2016 WBK - 2015 WBK)</i>	118	121	161	91	79	65	47	57	40	n/a

**120-Hour Capacity:** Table 2-11, below, shows that the Federal system is January 120-Hour capacity deficit under 1937-critical water conditions, through the study period. The detailed components of the Federal system January 120-Hour capacity loads and resources for OY 2018 through 2027 are shown in Exhibit 4-3, page 49. The Federal system monthly 120-Hour capacity loads and resources are shown in Exhibit 4-4, page 53, for OY 2018. The details of these components for OY 2018 through 2027 are presented in the 2016 Loads and Resources Study Technical Appendix, Volume 2: Capacity Analysis.

**Table 2-11**

**Federal System  
January 120-Hour Capacity Surplus/Deficit  
OY 2018 through 2027  
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2018	2019	2020	2021	2022	2023	2024	2025	2025	2027
Surplus/Deficit	-509	-736	-659	-665	-809	-812	-856	-800	-862	-863

Table 2-12, below, compares the 2016 White Book January firm 120-Hour capacity surplus/deficit forecasts to the 2015 White Book results. This study shows smaller January 120-Hour capacity deficits, which are mainly due to lower peak load obligation forecasts over the study period.

**Table 2-12**

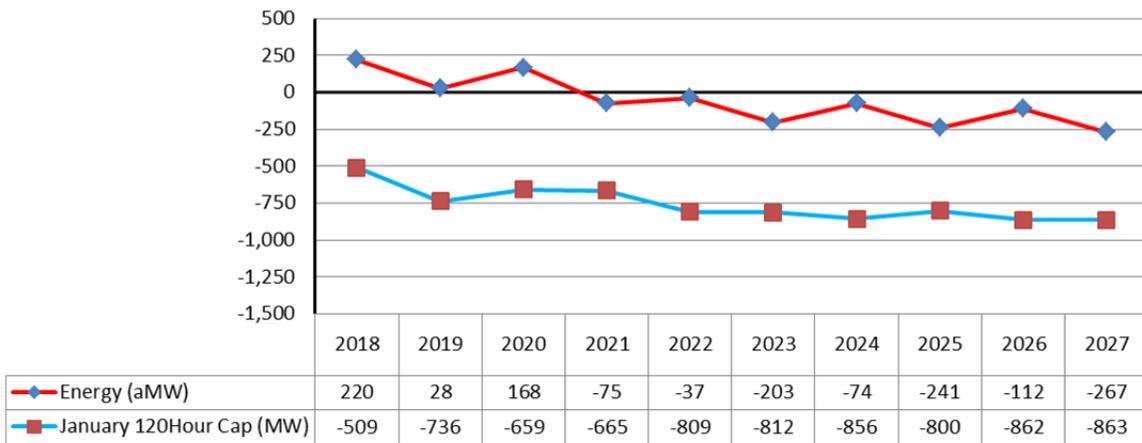
**Federal System  
January 120-Hour Capacity Surplus/Deficit Comparison  
OY 2018 through 2027  
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2018	2019	2020	2021	2022	2023	2024	2025	2025	2027
2016 White Book	-509	-736	-659	-665	-809	-812	-856	-800	-862	-863
2015 White Book	-880	-1,039	-990	-1,020	-1,108	-1,188	-1,170	-1,188	-1,195	n/a
<i>Difference (2016 WBK - 2015 WBK)</i>	371	303	331	355	299	376	313	388	332	n/a

Federal System Annual Surplus/Deficits: Table 2-13, below, graphically presents the annual firm energy and January 120-Hour capacity surplus/deficits. Over the study period, the Federal system is forecasted to have annual firm energy surpluses, up to 220 aMW in OY 2018, and annual deficits as high as -267 aMW in OY 2027. The January firm 120-Hour capacity forecasts show the Federal system is deficit throughout the study period, ranging from -509 MW in OY 2018, to -863 MW in OY 2027. Variations in the annual energy deficits between the odd and even OYs are mainly due to the biennial Columbia Generation Station (CGS) maintenance schedule.<sup>2</sup>

**Table 2-13**

**Federal System  
Annual Energy and January 120-Hour Capacity Surplus/Deficit  
OY 2018 through 2027  
1937-Critical Water Conditions**

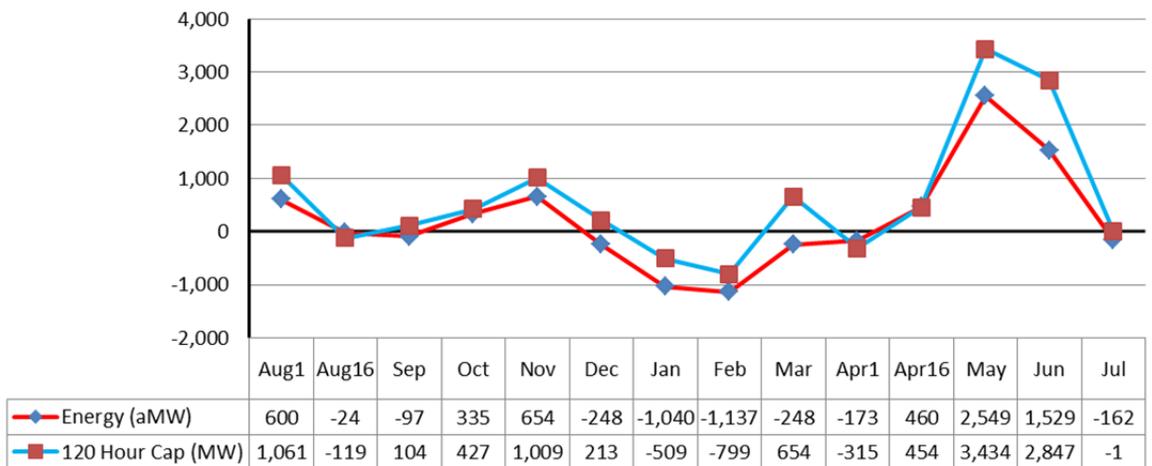


<sup>2</sup> During even calendar years, CGS does not have scheduled maintenance and is forecasted to produce 1,100 aMW annually. In odd calendar years, when CGS has scheduled maintenance in May and June, it is forecasted to produce 937 aMW annually.

Federal System Monthly Surplus/Deficit: Table 2-14, below, graphically presents the Federal system monthly firm energy and 120-Hour capacity surplus/deficits for OY 2018. Forecasts for energy and 120-Hour capacity maintain similar monthly shapes over the study period. This shows that for each month the Federal system energy and 120-Hour capacity surplus/deficit position changes across the year, with January and February showing the largest monthly deficits and the spring showing the largest surpluses.

**Table 2-14**

**Federal System  
Monthly Energy and 120-Hour Capacity Surplus/Deficit  
OY 2018  
1937-Critical Water Conditions**



**Conclusion**

The Federal system continues to remain near annual firm energy load-resource balance, having modest annual energy surpluses and deficits over the 10 year study period. These annual energy surplus/deficits range from a surplus of 220 aMW in OY 2018 to deficits up to -267 aMW in OY 2027. On a energy basis the Federal system generally shows large monthly energy deficits in the winter and surpluses in the spring runoff season during May and June, under 1937 water conditions.

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

Depending on water conditions, the Federal system surplus/deficit forecasts can vary greatly. For example, in OY 2018, Federal system annual energy surpluses can vary up to 3,000 aMW assuming high water conditions, while the monthly surplus/deficits can vary up to 5,550 aMW. Similarly, Federal system 120-Hour capacity surplus/deficits for OY 2018 can vary up to 4,800 MW in January.

Federal system monthly energy deficits tend to be greater than the 120-Hour capacity deficits under 1937-critical water conditions. This result indicates that the Federal system is more energy constrained than 120-Hour capacity constrained across the study period. The range of Federal system monthly surplus/deficit forecasts under all 80-historical water conditions is presented in Exhibit 4-5, page 57.

### ***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 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 firm 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 that was 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.

## **Section 3: Pacific Northwest Regional Analysis**

The PNW Regional Analysis is an operating year analysis that provides a deterministic forecast of the PNW region's loads and resources over a 10-year period from OY 2018 through 2027. 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 generation from all regional uncommitted Independent Power Producer (IPP) projects is available to meet regional load. Regional retail loads, contract sales and purchases, and generating resource forecasts incorporate regional utility data submittals received by BPA.

### ***Regional Loads***

The regional analysis incorporates regional load projections, which 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 are the sum of all reported long-term regional contract deliveries to entities outside the PNW region. The TRL forecasts for the regional analysis are developed by BPA's ALF system. TRL forecasts reflect normal weather conditions and do not include any adjustments for future climate change impacts. With the exception of power commitments under the Treaty, all Export contract deliveries follow individual contract terms and are not assumed to be renewed after their expiration. Treaty power deliveries are assumed to be in place through the study period. The sum of the forecasted TRL and Export contracts represent the regional loads for the PNW. Regional loads are comprised of about 95 percent retail loads and 5 percent exports.

Table 3-1, page 28, shows the forecasted composition of PNW regional load for OY 2018. For the PNW region, about 52 percent of the regional loads are represented by IOU customers. Public and Federal agency, Cooperative, and USBR customers comprise about 41 percent of the regional loads. Marketer and PNW Regional DSI loads are quite small and make up approximately 2 percent of the regional load, while export contracts comprise approximately 5 percent.

**Table 3-1**

**PNW Region  
Firm Regional Loads by Customer Class  
OY 2018**

Customer Class	Energy (aMW)	Percent of Energy	January 120-Hour Capacity (MW)	Percent of Capacity
Federal Agency	123	1%	205	1%
USBR	183	1%	336	1%
Cooperative	1,974	8%	3,242	9%
Municipality	2,668	11%	4,379	12%
Public Utility District	4,768	20%	7,596	21%
Investor-Owned Utility	12,406	52%	18,457	51%
Marketer	4	0%	4	0%
Direct-Service Industry <sup>1</sup>	421	2%	435	1%
<b>Total Retail Load</b>	<b>22,547</b>	<b>95%</b>	<b>34,654</b>	<b>96%</b>
<b>Exports</b>	<b>1,201</b>	<b>5%</b>	<b>1,427</b>	<b>4%</b>
<b>Regional Load</b>	<b>23,748</b>	<b>100%</b>	<b>36,081</b>	<b>100%</b>

<sup>1</sup> Direct-Service Industry (DSI) loads include regional loads currently served by BPA through DSI service contracts and former DSIs served by other energy suppliers.

Conservation in Total Retail Loads: The TRL forecasts are developed by BPA using the ALF system and are based on historic retail load consumption. Since historic retail loads include actual historic conservation savings, these forecasts include embedded conservation.

## Regional Resources

PNW 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. This analysis classifies resources as: 1) Hydro resources, which include Regulated, Independent, and Small Hydro projects; 2) Other resources, which include Cogeneration, Combustion Turbines, Large Thermal (such as coal and nuclear), Renewable Resources (such as wind, solar, and biomass), and Small Thermal and Miscellaneous generating projects; and 3) Contract purchases, identified as Imports.

Table 3-2, below, summarizes the resource generation available to meet PNW regional loads. The generation forecasts for these resources are provided by BPA models or the project owners. Forecasts for new regional generating projects are included when those resources begin operating or are under construction and have a scheduled on-line date. In a similar manner, retiring resources are removed from the forecasts based on the date of the announced retirement. Resource forecasts for the region assume the retirement of the following coal projects over the study period: Boardman (January 1, 2021), Centralia 1 (December 1, 2020), Centralia 2 (December 1, 2025), Colstrip 1 (June 30, 2022), Colstrip 2 (June 30, 2022), Valmy 1 (January 1, 2022), and Valmy 2 (January 1, 2026). Contract purchases are provided by each individual utility that follow specific provisions and can have various delivery arrangements. For OY 2018, regional firm energy resources are comprised of approximately 41 percent hydro, 22 percent large thermal, 20 percent combustion turbines, 8 percent cogeneration, 7 percent renewables (mainly comprised of wind), and 2 percent imports.

**Table 3-2**

**PNW Region  
Generation by Resource Type  
OY 2018  
1937-Critical Water Conditions**

Resource Type	Annual Energy (aMW)	Percent of Energy	January 120-Hour Capacity (MW) <sup>a/</sup>	Percent of Capacity
Hydro	11,826	41.0%	20,571	53.3%
Large Thermal	6,255	21.7%	7,000	18.1%
Cogeneration	2,300	8.0%	2,720	7.0%
Combustion Turbines	5,826	20.2%	6,837	17.7%
Renewables	1,953	6.8%	162	0.4%
Small Thermal & Misc.	36	0.1%	92	0.2%
Imports	667	2.3%	1,216	3.1%
<b>Total Regional Resources</b>	<b>28,863</b>	<b>100.0%</b>	<b>38,598</b>	<b>100.0%</b>

<sup>a/</sup> Regional resource forecasts are before adjustments for reserves and transmission losses

Regional Hydro Generation Variability: The generating capability of the region’s hydroelectric projects depends upon the amount of water flowing through the facilities, the physical capacity of the facilities, flow requirements pursuant to biological opinions, and other operating limitations. BPA utilizes an 80-year record of historic streamflows 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 3-3, below, shows the annual variability of the region’s hydro generation under the three streamflow scenarios: 1) 1937-critical water conditions, representing the firm generating capability of the hydro system; 2) 1958-water conditions, representing the average generating capability of the hydro system; and 3) 1974-water conditions, representing the high generating capability of the hydro system. In OY 2018, annual firm energy generation from regional hydro projects is forecasted to be 11,826 aMW. This represents about 41 percent of region’s resources. However, the generating potential from regional hydro projects can annually vary by up to 6,788 aMW depending on water conditions.

**Table 3-3**

**PNW Region  
Variability of Annual Hydro Generation  
OY 2018 through 2027  
Under Different Water Conditions**

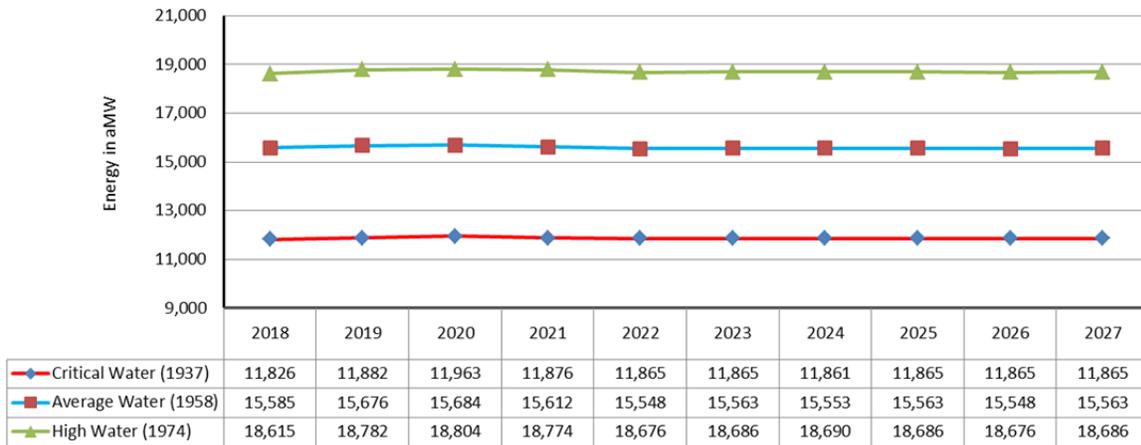
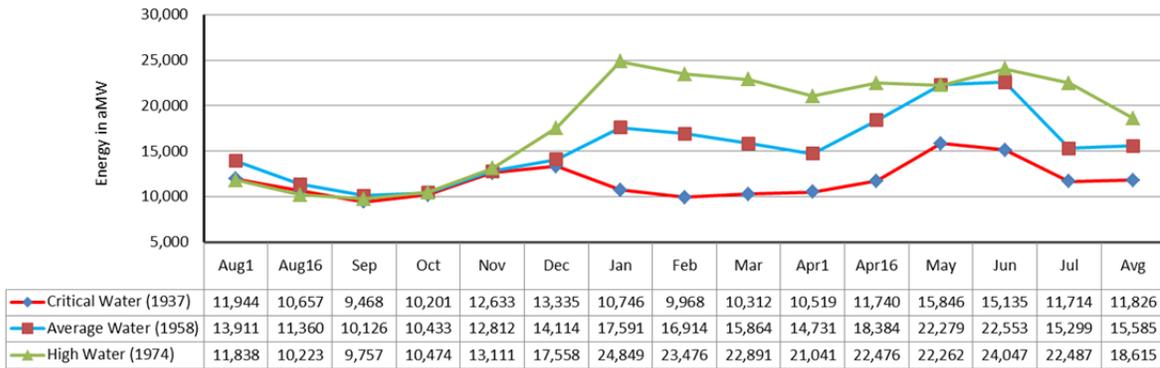


Table 3-4, below, shows the monthly variability of the region’s hydro generation under the same three water conditions. High generation levels in the December through mid-April period is largely due to drafting reservoirs for power production and flood control, which can vary widely due to rainfall and 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. Water variability does not have a substantial impact on regional hydro generation from August through November. Regional hydro generation capability can vary by about 14,000 aMW depending on project operations and the availability of water.

**Table 3-4**

**PNW Region  
Variability of Monthly Hydro Generation  
OY 2018  
Under Different Water Conditions**



Variability Due to IPP Generation Delivered to the PNW Region: 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 2,782 aMW of energy with an associated 2,941 MW of January 120-Hour capacity in OY 2018. The inclusion of this uncommitted IPP generation is reasonable from a long-term planning stand point given the fact that the regional study does not include any reliance on market purchases. However, PNW utilities may have to compete with other western markets to secure this generation to meet electricity demand. Table 3-5, page 32, details the region’s uncommitted IPP projects, the associated fuel types, and OY 2018’s annual energy and January 120-Hour capacity forecasts. If uncommitted IPP generation is secured for long-term periods by load serving entities, the IPP forecasts will be updated in future studies to reflect these changes. Table 3-6, page 33, details the regions total uncommitted IPP annual energy and January capacity generation forecasts over the OY 2018 through 2027 study period.

**Table 3-5**

**PNW Region  
Uncommitted Independent Power Producer Projects  
OY 2018**

Project	Annual Energy (aMW)	January 120-Hour Capacity (MW)	Fuel Type
Centralia <sup>a/, b/</sup>	862	960	Coal
Cosmopolis Specialty Fibres	14	14	Wood Waste
Hermiston Power Project	567	630	Natural Gas
International Paper Energy Center	8	11	Wood Waste
Juniper Canyon	36	0	Wind
Kittitas Valley Wind	24	0	Wind
Klamath Generation Facility	436	484	Natural Gas
Klamath Generation Peaking (CT)	90	100	Natural Gas
Leaning Juniper 2a & 2b	47	0	Wind
Longview Fibre Paper & Packaging	35	35	Wood Waste
Nippon Paper Cogen (Port Angeles)	11	12	Natural Gas
Satsop Combustion Turbine Project	584	650	Natural Gas
SDS Lumber	1	1	Wood Waste
SP Newsprint Cogen	0	0	Natural Gas
Stateline	8	0	Wind
Vansycle	23	0	Wind
Weyerhaeuser Longview	35	44	Wood Waste
<b>Total Uncommitted IPP Generation</b>	<b>2,773</b>	<b>2,930</b>	

<sup>a/</sup> Centralia #1 (670 MW) is scheduled for retirement on Dec 1, 2020.

<sup>b/</sup> Centralia #2 (670 MW) is scheduled for retirement on Dec 1, 2025

**Table 3-6**

**PNW Region  
Uncommitted Independent Power Producer Generation  
Annual Energy and January 120-Hour Capacity  
OY 2018 through 2027**

Regional Uncommitted IPP	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Annual Energy (aMW)	2,782	2,782	2,789	2,401	2,232	2,260	2,294	2,295	2,125	2,038
January 120-Hour Capacity (MW)	2,941	2,941	2,941	2,952	2,337	2,337	2,337	2,337	2,337	2,047

## Key Results

Annual Energy: Table 3-7, below, shows significant annual energy surpluses for the PNW region throughout most of the study period, under 1937-water conditions. This study assumes that 100 percent of PNW region's uncommitted IPP generation (2,782 aMW in OY 2018) is available to serve regional loads. The individual components of the PNW regional annual energy loads and resources for OY 2018 through 2027 are shown in Exhibit 5-1, page 63. The PNW regional monthly energy loads and resources for OY 2018 are shown in Exhibit 5-2, page 67. The details of these components for OY 2018 through 2027 are presented in the 2016 Loads and Resources Study Technical Appendix, Volume 1: Energy Analysis.

**Table 3-7**

**PNW Region  
Annual Energy Surplus/Deficit  
Assuming 100% of Uncommitted IPP Generation is Available to the Region  
OY 2018 through 2027  
1937-Critical Water Conditions**

Energy (aMW)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Surplus/Deficit	4,258	3,839	3,782	2,707	2,009	1,323	1,312	798	240	-293

Table 3-8, page 34, compares the 2016 White Book PNW regional annual firm energy surplus/deficit forecasts to the 2015 White Book results. The PNW region continues to have annual energy surpluses through OY 2026. When compared to the 2015 White Book, the 2016 study shows larger annual energy surpluses through OY 2022, followed by reduced surpluses from OY 2023 through OY 2026. The larger annual energy surpluses through OY 2022 are primarily driven by lower total retail load forecasts. Beginning in OY 2023 and running through OY 2026, this study shows smaller annual energy surpluses than the 2015 White Book, mainly due to lower regional generation forecasts, which include the retirement of the Colstrip 1 and 2 on June 30, 2022.

**Table 3-8**

**PNW Region  
Annual Energy Surplus/Deficit Comparison  
Assuming 100% of Uncommitted IPP Generation is Available to the Region  
OY 2018 through 2027  
1937-Critical Water Conditions**

Energy (aMW)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
2016 White Book	4,258	3,839	3,782	2,707	2,009	1,323	1,312	798	240	-293
2015 White Book	4,293	3,792	3,669	2,659	1,964	1,486	1,493	1,032	481	n/a
<i>Difference (2016 WBK - 2015 WBK)</i>	-34	46	112	47	44	-163	-181	-234	-241	n/a

Table 3-9, below, shows the significant variability in PNW regional annual firm energy surplus/deficit forecasts depending on the level of uncommitted IPP generation available to the region. IPP generation is detailed in Tables 3-5 and 3-6, page 32.

**Table 3-9**

**PNW Region  
Variability of Annual Energy Surplus/Deficit  
Assuming Different Levels of Uncommitted IPP Generation  
OY 2018 through 2027  
1937-Critical Water Conditions**

Energy (aMW)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
100% IPP	4,258	3,839	3,782	2,707	2,009	1,323	1,312	798	240	-293
50% IPP	2,867	2,448	2,387	1,506	893	193	165	-349	-823	-1,312
0% IPP	1,477	1,057	993	306	-223	-938	-982	-1,496	-1,885	-2,331

January 120-Hour Capacity: Table 3-10, below, shows the January firm 120-Hour capacity surplus/deficits for the PNW region. The region is forecasted to have a January 120-Hour capacity surplus in OY 2018 and deficits in the remainder of the study 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 2018 through 2027 are shown in Exhibit 5-3, page 71. The monthly PNW regional 120-Hour capacity loads and resources for OY 2018 are shown in Exhibit 5-4, page 75. The component details for OY 2018 through 2027 are presented in the 2016 Loads and Resources Study Technical Appendix, Volume 2: Capacity Analysis.

**Table 3-10**

**PNW Region  
January 120-Hour Capacity Surplus/Deficit  
Assuming 100% of Uncommitted IPP Generation is Available to the Region  
OY 2018 through 2027  
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Surplus/Deficit	160	-198	-189	-1,755	-2,349	-3,054	-3,436	-3,754	-4,907	-5,255

Table 3-11, below, compares the 2016 White Book January firm 120-Hour capacity forecast to the 2015 White Book results. Regional January 120-Hour capacity surplus/deficits show a larger surplus in OY 2018 and smaller deficits through the rest of the study. This is mainly driven by lower TRL forecasts across the study period.

**Table 3-11**

**PNW Region  
January 120-Hour Capacity Surplus/Deficit Comparison  
Assuming 100% of Uncommitted IPP Generation is Available to the Region  
OY 2018 through 2027  
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
2016 White Book	160	-198	-189	-1,755	-2,349	-3,054	-3,436	-3,754	-4,907	-5,255
2015 White Book	105	-278	-582	-2,211	-2,758	-3,255	-3,665	-3,901	-5,107	n/a
<i>Difference (2016 WBK - 2015 WBK)</i>	55	80	392	456	408	201	229	147	199	n/a

Table 3-12, below, shows the significant variability in PNW regional January firm 120-Hour capacity surplus/deficit forecasts depending on the level of uncommitted IPP generation available to the region. IPP generation is detailed in Tables 3-5 and 3-6, page 32.

**Table 3-12**

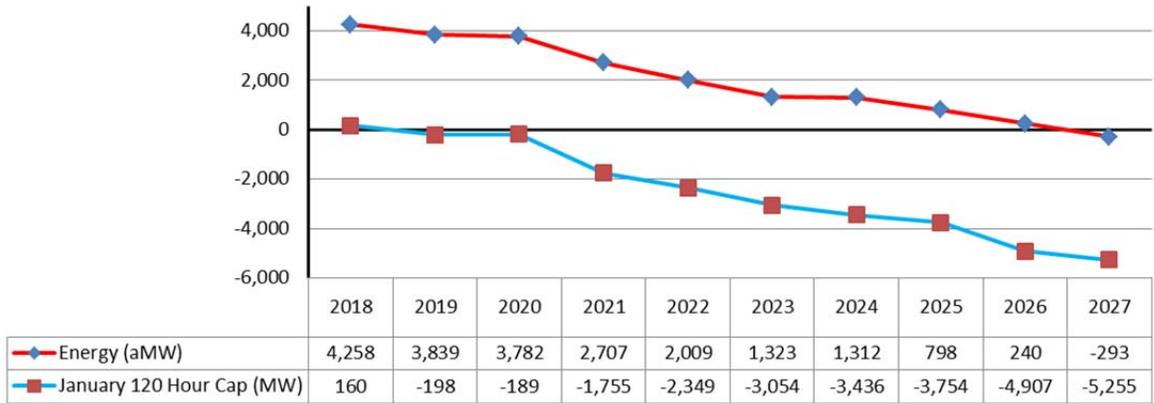
**PNW Region  
 Variability of January 120-Hour Capacity Surplus/Deficit  
 Assuming Different Levels of Uncommitted IPP Generation  
 OY 2018 through 2027  
 1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
100% IPP	160	-198	-189	-1755	-2349	-3054	-3436	-3754	-4907	-5255
50% IPP	-1310	-1668	-1660	-3231	-3518	-4223	-4604	-4922	-6076	-6278
0% IPP	-2781	-3139	-3131	-4707	-4686	-5391	-5773	-6091	-7244	-7302

Regional Annual Surplus/Deficit: Table 3-13, page 37, graphically presents the annual firm energy and January 120-Hour capacity surplus/deficits forecasts for the PNW Region. These forecasts assume 100 percent availability of the PNW's 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 deficit of -293 aMW, while January 120-Hour capacity becomes deficit in OY 2019 and finishes the study period with a deficit of -5,255 MW. The declines in both annual energy and January 120-Hour capacity surplus/deficit forecasts are primarily driven by steady regional load growth over the study period and the retirements of the Boardman, Centralia, Colstrip, and Valmy coal plants.

**Table 3-13**

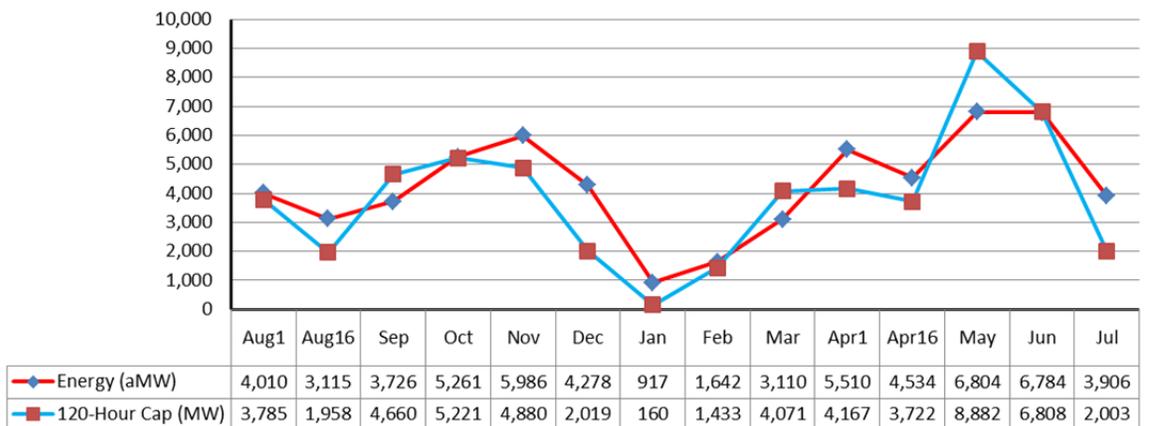
**PNW Region  
Annual Energy and January 120-Hour Capacity Surplus/Deficit  
OY 2018 through 2027  
1937-Critical Water Conditions**



Regional Monthly Surplus/Deficit: Table 3-14, below, graphically presents the monthly energy and 120-Hour capacity surplus/deficit forecasts for OY 2018. These forecasts assume 100 percent availability of the PNW's uncommitted IPP generation to serve regional loads. This monthly view shows the variability that the region experiences across the year, with January showing the lowest surpluses and the spring months experiencing the largest surpluses. Forecasts for monthly energy and 120-Hour capacity maintain similar shaping over the study period.

**Table 3-14**

**PNW Region  
Monthly Energy and 120-Hour Capacity Surplus/Deficit  
OY 2018  
1937-Critical Water Conditions**



## **Conclusion**

The PNW region is projected to have annual firm energy surpluses until the final year of the study period, assuming modest load growth and 100 percent of the PNW region's uncommitted IPP generation is available to the region. However, using the same assumptions, the PNW region is forecast to be January firm 120-Hour capacity deficit beginning in 2019. This study further shows that the PNW region is firm 120-Hour capacity constrained on a monthly basis. Since this analysis assumes that PNW uncommitted IPP generation is used to serve PNW regional load, the supply of power within the region can change dramatically if uncommitted IPP generation is committed to serve loads outside the PNW. The surplus/deficit forecasts for all 80-historic water conditions are presented in Exhibit 5-5, page 79. Additional monthly and annual details for OY 2018 through 2027 are presented in the 2016 Loads and Resources Study Technical Appendix, Volume 1: Energy Analysis and the 2016 Loads and Resources Study Technical Appendix, Volume 2: Capacity Analysis.

BPA provides this PNW regional planning analysis for informational purposes only. The regional energy and capacity deficits identified in this analysis may be mitigated through options discussed in the Council's Seventh Power Plan.

## **Section 4: Federal System Analysis Exhibits**

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**Exhibit 4-1: Annual Energy**

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**Federal System Analysis Surplus Deficit  
Operating Year 2018 to 2027  
Using 1937-Water Conditions**

**Loads and Resources - Federal System**  
**Operating Year: 2018 to 2027 Water Year: 1937**  
**2016 White Book Report Date: 9/20/2016**

S140-WB-20161121-220001

Energy-aMW	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
<b>Firm Obligations</b>										
<b>1 Load Following</b>	3402	3425	3446	3474	3485	3499	3512	3531	3546	3560
2 Preference Customers	3106	3117	3127	3151	3162	3176	3190	3206	3220	3233
3 Federal Agencies	113	125	137	140	140	140	140	142	143	144
4 USBR	183	183	182	183	183	183	182	183	183	183
5 Federal Diversity	0	0	0	0	0	0	0	0	0	0
<b>6 Tier 1 Block</b>	2.98	0	0	0	0	0	0	0	0	0
7 Tier 1 Block	2.98	0	0	0	0	0	0	0	0	0
<b>8 Slice</b>	3624	3631	3685	3669	3684	3678	3694	3685	3699	3681
9 Slice Block	1768	1804	1784	1825	1798	1835	1808	1842	1813	1838
10 Slice Output from T1 System	1856	1827	1900	1844	1886	1844	1886	1843	1886	1843
<b>11 Direct Service Industries</b>	49.8	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6
12 DSI	49.8	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6
<b>13 Contract Deliveries</b>	593	547	479	478	477	477	477	477	477	477
14 Exports	518	486	464	466	466	466	466	466	466	466
15 Intra-Regional Transfers (Out)	75.1	61.5	15.1	11.9	10.7	10.7	10.7	10.7	10.7	10.7
16 Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0
<b>17 Total Firm Obligations</b>	<b>7671</b>	<b>7692</b>	<b>7698</b>	<b>7708</b>	<b>7734</b>	<b>7742</b>	<b>7771</b>	<b>7781</b>	<b>7809</b>	<b>7806</b>
<b>Net Resources</b>										
<b>18 Hydro Resources</b>	6550	6595	6657	6608	6608	6608	6606	6608	6608	6608
19 Regulated Hydro - Net	6208	6252	6314	6265	6265	6265	6264	6265	6265	6265
20 Independent Hydro - Net	340	340	339	340	340	340	339	340	340	340
21 Small Hydro - Net	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88
<b>22 Other Resources</b>	1158	995	1158	992	1154	991	1154	991	1154	991
23 Cogeneration Resources	0	0	0	0	0	0	0	0	0	0
24 Combustion Turbines	0	0	0	0	0	0	0	0	0	0
25 Large Thermal Resources	1100	937	1100	937	1100	937	1100	937	1100	937
26 Renewable Resources	57.9	57.9	57.9	54.6	54.0	54.0	53.9	54.0	54.0	54.0
27 Small Thermal & Misc.	0	0	0	0	0	0	0	0	0	0
<b>28 Contract Purchases</b>	427	368	294	269	173	173	174	173	174	173
29 Imports	89.9	89.9	90.0	84.5	1.00	1.00	1.00	1.00	1.00	1.00
30 Intra-Regional Transfers (In)	165	107	31.4	12.4	0	0	0	0	0	0
31 Non-Federal CER	137	137	137	137	136	137	137	137	137	137
32 Slice Transmission Loss Return	35.3	34.7	36.1	35.0	35.8	35.0	35.8	35.0	35.8	35.0
33 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0
<b>34 Reserves &amp; Losses</b>	-243	-238	-243	-235	-237	-233	-237	-233	-237	-233
35 Contingency Reserves (Spinning)	0	0	0	0	0	0	0	0	0	0
36 Contingency Reserves (Non-Spinning)	0	0	0	0	0	0	0	0	0	0
37 Load Following Reserves	0	0	0	0	0	0	0	0	0	0
38 Generation Imbalance Reserves	0	0	0	0	0	0	0	0	0	0

**Loads and Resources - Federal System**  
**Operating Year: 2018 to 2027 Water Year: 1937**  
**2016 White Book** Report Date: **9/20/2016** *Continued*

S140-WB-20161121-220001

Energy-aMW	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
<sup>39</sup> Transmission Losses	-243	-238	-243	-235	-237	-233	-237	-233	-237	-233
<sup>40</sup> <b>Total Net Resources</b>	<b>7892</b>	<b>7720</b>	<b>7866</b>	<b>7633</b>	<b>7697</b>	<b>7539</b>	<b>7696</b>	<b>7539</b>	<b>7698</b>	<b>7539</b>
<sup>41</sup> <b>Total Surplus/Deficit</b>	<b>220</b>	<b>28</b>	<b>168</b>	<b>-75</b>	<b>-37</b>	<b>-203</b>	<b>-74</b>	<b>-241</b>	<b>-112</b>	<b>-267</b>

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**Exhibit 4-2: Monthly Energy**

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**Federal System Analysis Surplus Deficit  
Operating Year 2018  
Using 1937-Water Conditions**

**Loads and Resources - Federal System**  
**Operating Year: 2018 Water Year: 1937**  
**2016 White Book Report Date: 9/20/2016**  
S140-WB-20161121-220001

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
<b>Firm Obligations</b>															
<b>1 Load Following</b>	3472	3474	3152	2914	3391	3821	3773	3612	3195	3222	3244	3253	3355	3653	3402
2 Preference Customers	3055	3058	2791	2710	3243	3655	3618	3455	3006	2861	2886	2820	2912	3145	3106
3 Federal Agencies	101	101	94.2	96.6	126	145	144	141	120	102	103	94.8	91.2	102	113
4 USBR	316	315	266	108	21.7	21.3	11.2	16.3	69.4	259	255	338	352	406	183
5 Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>6 Tier 1 Block</b>	11.7	11.7	24.1	0	0	0	0	0	0	0	0	0	0	0	2.98
7 Tier 1 Block	11.7	11.7	24.1	0	0	0	0	0	0	0	0	0	0	0	2.98
<b>8 Slice</b>	3544	3317	3267	3283	4120	4250	3980	3647	3618	3181	3420	3919	3432	3232	3624
9 Slice Block	1603	1603	1673	1608	1984	2205	2233	2062	1919	1616	1616	1429	1338	1556	1768
10 Slice Output from T1 System	1941	1714	1594	1675	2136	2045	1747	1585	1699	1565	1804	2490	2094	1676	1856
<b>11 Direct Service Industries</b>	22.5	22.5	22.4	22.9	22.7	22.7	22.8	22.5	87.5	87.7	88.1	87.4	87.2	87.2	49.8
12 DSI	22.5	22.5	22.4	22.9	22.7	22.7	22.8	22.5	87.5	87.7	88.1	87.4	87.2	87.2	49.8
<b>13 Contract Deliveries</b>	687	691	562	557	670	663	640	624	556	555	590	518	523	541	593
14 Exports	647	651	523	518	513	509	485	482	489	485	520	504	508	525	518
15 Intra-Regional Transfers (Out)	39.8	39.8	38.7	38.8	156	155	155	142	67.4	69.9	70.0	14.5	14.4	15.8	75.1
16 Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>17 Total Firm Obligations</b>	<b>7737</b>	<b>7516</b>	<b>7028</b>	<b>6778</b>	<b>8203</b>	<b>8757</b>	<b>8416</b>	<b>7906</b>	<b>7458</b>	<b>7046</b>	<b>7342</b>	<b>7777</b>	<b>7397</b>	<b>7513</b>	<b>7671</b>
<b>Net Resources</b>															
<b>18 Hydro Resources</b>	7076	6187	5569	5727	7517	7183	6036	5403	5830	5468	6428	9076	7567	6032	6550
19 Regulated Hydro - Net	6722	5836	5245	5416	7260	7022	5910	5269	5590	5041	5989	8362	6910	5639	6208
20 Independent Hydro - Net	351	348	321	308	255	158	123	131	237	424	435	711	654	391	340
21 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
<b>22 Other Resources</b>	1140	1159	1155	1144	1164	1148	1126	1143	1149	1188	1174	1179	1178	1177	1158
23 Cogeneration Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Combustion Turbines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Large Thermal Resources	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100
26 Renewable Resources	39.6	59.4	55.2	44.4	63.6	48.5	25.9	42.9	49.3	88.2	74.2	79.4	78.5	76.7	57.9
27 Small Thermal & Misc.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>28 Contract Purchases</b>	379	377	420	461	450	439	441	430	453	429	441	390	456	370	427

**Loads and Resources - Federal System**  
**Operating Year: 2018    Water Year: 1937**  
**2016 White Book    Report Date: 9/20/2016    *Continued***

S140-WB-20161121-220001

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
<sup>29</sup> Imports	65.4	65.6	64.9	115	115	114	115	115	116	64.3	65.4	65.0	65.4	64.4	89.9
<sup>30</sup> Intra-Regional Transfers (In)	138	139	186	180	156	152	154	148	166	208	204	140	214	141	165
<sup>31</sup> Non-Federal CER	139	140	139	134	138	134	139	137	139	127	138	138	138	133	137
<sup>32</sup> Slice Transmission Loss Return	36.9	32.6	30.3	31.8	40.6	38.9	33.2	30.1	32.3	29.7	34.3	47.3	39.8	31.9	35.3
<sup>33</sup> Augmentation Purchases	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b><sup>34</sup> Reserves &amp; Losses</b>	<b>-258</b>	<b>-232</b>	<b>-214</b>	<b>-220</b>	<b>-272</b>	<b>-262</b>	<b>-227</b>	<b>-208</b>	<b>-222</b>	<b>-212</b>	<b>-240</b>	<b>-319</b>	<b>-277</b>	<b>-228</b>	<b>-243</b>
<sup>35</sup> Contingency Reserves (Spinning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<sup>36</sup> Contingency Reserves (Non-Spinning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<sup>37</sup> Load Following Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<sup>38</sup> Generation Imbalance Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<sup>39</sup> Transmission Losses	-258	-232	-214	-220	-272	-262	-227	-208	-222	-212	-240	-319	-277	-228	-243
<b><sup>40</sup> Total Net Resources</b>	<b>8337</b>	<b>7492</b>	<b>6930</b>	<b>7113</b>	<b>8858</b>	<b>8509</b>	<b>7376</b>	<b>6768</b>	<b>7210</b>	<b>6874</b>	<b>7803</b>	<b>10326</b>	<b>8926</b>	<b>7351</b>	<b>7892</b>
<b><sup>41</sup> Total Surplus/Deficit</b>	<b>600</b>	<b>-24</b>	<b>-97</b>	<b>335</b>	<b>654</b>	<b>-248</b>	<b>-1,040</b>	<b>-1,137</b>	<b>-248</b>	<b>-173</b>	<b>460</b>	<b>2,549</b>	<b>1,529</b>	<b>-162</b>	<b>220</b>

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**Exhibit 4-3: Annual 120-Hour Capacity**

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**Federal System Analysis Surplus Deficit  
Operating Year 2018 to 2027  
Using 1937-Water Conditions**

**Loads and Resources - Federal System**  
**Operating Year: 2018 to 2027 Water Year: 1937**  
**2016 White Book Report Date: 9/20/2016**

S140-WB-20161121-220001

January 120Hr-MW	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
<b>Firm Obligations</b>										
<b>1 Load Following</b>	4519	4518	4558	4635	4643	4655	4669	4669	4680	4727
2 Preference Customers	5348	5378	5447	5485	5508	5541	5568	5589	5614	5632
3 Federal Agencies	196	213	225	227	228	227	229	232	235	237
4 USBR	336	336	336	336	336	336	336	336	336	336
5 Federal Diversity	-1363	-1409	-1449	-1414	-1430	-1450	-1465	-1488	-1506	-1479
<b>6 Tier 1 Block</b>	0	0	0	0	0	0	0	0	0	0
7 Tier 1 Block	0	0	0	0	0	0	0	0	0	0
<b>8 Slice</b>	4551	4614	4639	4691	4665	4670	4686	4642	4681	4648
9 Slice Block	2233	2300	2265	2324	2274	2336	2294	2344	2292	2339
10 Slice Output from T1 System	2318	2314	2373	2367	2391	2333	2392	2298	2388	2309
<b>11 Direct Service Industries</b>	25.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2
12 DSI	25.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2	90.2
<b>13 Contract Deliveries</b>	1562	1537	1175	1158	1158	1158	1158	1158	1158	1158
14 Exports	1363	1363	1142	1142	1142	1142	1142	1142	1142	1142
15 Intra-Regional Transfers (Out)	198	173	33.2	16.4	16.4	16.4	16.4	16.4	16.4	16.4
16 Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0
<b>17 Total Firm Obligations</b>	<b>10657</b>	<b>10759</b>	<b>10462</b>	<b>10574</b>	<b>10555</b>	<b>10572</b>	<b>10602</b>	<b>10560</b>	<b>10609</b>	<b>10623</b>
<b>Net Resources</b>										
<b>18 Hydro Resources</b>	9920	9941	9809	9921	9878	9896	9883	9901	9867	9886
19 Regulated Hydro - Net	9692	9714	9581	9693	9650	9669	9655	9674	9640	9658
20 Independent Hydro - Net	223	223	223	223	223	223	223	223	223	223
21 Small Hydro - Net	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59
<b>22 Other Resources</b>	1144	1144	1144	1144	1144	1144	1144	1144	1144	1144
23 Cogeneration Resources	0	0	0	0	0	0	0	0	0	0
24 Combustion Turbines	0	0	0	0	0	0	0	0	0	0
25 Large Thermal Resources	1144	1144	1144	1144	1144	1144	1144	1144	1144	1144
26 Renewable Resources	0	0	0	0	0	0	0	0	0	0
27 Small Thermal & Misc.	0	0	0	0	0	0	0	0	0	0
<b>28 Contract Purchases</b>	676	534	439	422	297	296	298	295	297	296
29 Imports	126	126	126	126	1.00	1.00	1.00	1.00	1.00	1.00
30 Intra-Regional Transfers (In)	254	113	16.8	0	0	0	0	0	0	0
31 Non-Federal CER	240	240	239	239	239	239	239	239	239	239
32 Slice Transmission Loss Return	55.7	55.6	57.1	56.9	57.5	56.1	57.5	55.3	57.4	55.5
33 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0
<b>34 Reserves &amp; Losses</b>	-1592	-1597	-1589	-1577	-1573	-1576	-1578	-1581	-1562	-1565
35 Contingency Reserves (Spinning)	-365	-366	-366	-359	-359	-361	-362	-363	-354	-355
36 Contingency Reserves (Non-Spinning)	-365	-366	-366	-359	-359	-361	-362	-363	-354	-355
37 Load Following Reserves	-330	-335	-335	-335	-335	-335	-335	-335	-335	-335
38 Generation Imbalance Reserves	-175	-176	-176	-176	-176	-176	-176	-176	-176	-176

**Loads and Resources - Federal System**  
**Operating Year: 2018 to 2027 Water Year: 1937**  
**2016 White Book** Report Date: **9/20/2016** *Continued*

S140-WB-20161121-220001

January 120Hr-MW	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
<sup>39</sup> Transmission Losses	-357	-353	-345	-349	-343	-344	-343	-344	-343	-344
<sup>40</sup> <b>Total Net Resources</b>	<b>10147</b>	<b>10023</b>	<b>9803</b>	<b>9909</b>	<b>9746</b>	<b>9760</b>	<b>9746</b>	<b>9760</b>	<b>9746</b>	<b>9760</b>
<sup>41</sup> <b>Total Surplus/Deficit</b>	<b>-509</b>	<b>-736</b>	<b>-659</b>	<b>-665</b>	<b>-809</b>	<b>-812</b>	<b>-856</b>	<b>-800</b>	<b>-862</b>	<b>-863</b>

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**Exhibit 4-4: Monthly 120-Hour Capacity**

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**Federal System Analysis Surplus Deficit  
Operating Year 2018  
Using 1937-Water Conditions**

**Loads and Resources - Federal System**  
**Operating Year: 2018 Water Year: 1937**  
**2016 White Book Report Date: 9/20/2016**

S140-WB-20161121-220001

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
<b>Firm Obligations</b>														
<b>1 Load Following</b>	4145	3895	3617	3592	4116	4590	4519	4272	3918	3959	3932	3712	3768	4172
2 Preference Customers	4162	4162	3881	4108	4766	5399	5348	5107	4597	4353	4353	3976	3965	4251
3 Federal Agencies	133	133	128	139	175	192	196	188	171	145	145	133	125	135
4 USBR	614	614	532	415	279	368	336	334	405	472	472	556	598	632
5 Federal Diversity	-764	-1014	-924	-1070	-1105	-1370	-1363	-1357	-1255	-1011	-1038	-951	-920	-846
<b>6 Tier 1 Block</b>	11.7	11.7	24.2	0	0	0	0	0	0	0	0	0	0	0
7 Tier 1 Block	11.7	11.7	24.2	0	0	0	0	0	0	0	0	0	0	0
<b>8 Slice</b>	4096	3557	3606	3652	4653	4812	4551	4112	4314	3521	3800	4590	4204	3631
9 Slice Block	1608	1608	1678	1608	1984	2205	2233	2062	1919	1616	1616	1429	1338	1556
10 Slice Output from T1 System	2488	1949	1928	2044	2669	2607	2318	2049	2395	1905	2184	3161	2867	2075
<b>11 Direct Service Industries</b>	24.5	24.5	24.2	25.1	25.0	24.7	25.2	24.7	89.9	90.3	90.3	89.9	89.3	89.4
12 DSI	24.5	24.5	24.2	25.1	25.0	24.7	25.2	24.7	89.9	90.3	90.3	89.9	89.3	89.4
<b>13 Contract Deliveries</b>	1647	1647	1488	1462	1597	1589	1562	1562	1484	1505	1505	1435	1454	1467
14 Exports	1596	1596	1437	1411	1399	1391	1363	1363	1388	1409	1409	1409	1427	1441
15 Intra-Regional Transfers (Out)	51.2	51.2	51.2	51.2	198	198	198	198	96.2	96.2	96.2	26.2	26.2	26.2
16 Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>17 Total Firm Obligations</b>	<b>9924</b>	<b>9136</b>	<b>8760</b>	<b>8731</b>	<b>10391</b>	<b>11015</b>	<b>10657</b>	<b>9971</b>	<b>9805</b>	<b>9076</b>	<b>9328</b>	<b>9828</b>	<b>9515</b>	<b>9360</b>
<b>Net Resources</b>														
<b>18 Hydro Resources</b>	11273	9189	8882	8940	11255	11078	9920	8879	10206	8391	9473	13264	12172	9165
19 Regulated Hydro - Net	10811	8731	8351	8533	10873	10820	9692	8676	9853	7791	8860	12507	11378	8658
20 Independent Hydro - Net	459	454	528	403	378	254	223	199	349	596	608	753	789	504
21 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
<b>22 Other Resources</b>	1128	1128	1135	1136	1140	1138	1144	1142	1143	1138	1138	1139	1135	1130
23 Cogeneration Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Combustion Turbines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Large Thermal Resources	1128	1128	1135	1136	1140	1138	1144	1142	1143	1138	1138	1139	1135	1130
26 Renewable Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 Small Thermal & Misc.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>28 Contract Purchases</b>	557	544	667	689	683	677	676	662	688	683	689	564	715	542

**Loads and Resources - Federal System**  
**Operating Year: 2018    Water Year: 1937**  
**2016 White Book    Report Date: 9/20/2016    *Continued***

S140-WB-20161121-220001

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
<sup>29</sup> Imports	76.0	76.0	76.0	126	126	126	126	126	126	76.0	76.0	76.0	76.0	76.0
<sup>30</sup> Intra-Regional Transfers (In)	181	181	305	273	254	249	254	246	264	323	323	174	332	179
<sup>31</sup> Non-Federal CER	240	240	240	241	239	239	240	240	240	238	238	238	238	238
<sup>32</sup> Slice Transmission Loss Return	59.8	46.9	46.4	49.1	64.2	62.7	55.7	49.3	57.6	45.8	52.5	76.0	68.9	49.9
<sup>33</sup> Augmentation Purchases	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b><sup>34</sup> Reserves &amp; Losses</b>	<b>-1973</b>	<b>-1844</b>	<b>-1820</b>	<b>-1606</b>	<b>-1679</b>	<b>-1664</b>	<b>-1592</b>	<b>-1511</b>	<b>-1578</b>	<b>-1451</b>	<b>-1519</b>	<b>-1706</b>	<b>-1659</b>	<b>-1479</b>
<sup>35</sup> Contingency Reserves (Spinning)	-343	-313	-303	-319	-371	-382	-365	-342	-353	-318	-334	-367	-359	-322
<sup>36</sup> Contingency Reserves (Non-Spinning)	-343	-313	-303	-319	-371	-382	-365	-342	-353	-318	-334	-367	-359	-322
<sup>37</sup> Load Following Reserves	-586	-586	-586	-471	-405	-330	-330	-330	-330	-330	-330	-330	-330	-330
<sup>38</sup> Generation Imbalance Reserves	-314	-314	-314	-175	-132	-175	-175	-175	-175	-175	-175	-175	-175	-175
<sup>39</sup> Transmission Losses	-387	-318	-313	-322	-401	-396	-357	-322	-367	-310	-345	-467	-436	-330
<b><sup>40</sup> Total Net Resources</b>	<b>10985</b>	<b>9017</b>	<b>8864</b>	<b>9159</b>	<b>11400</b>	<b>11229</b>	<b>10147</b>	<b>9171</b>	<b>10459</b>	<b>8760</b>	<b>9782</b>	<b>13261</b>	<b>12362</b>	<b>9359</b>
<b><sup>41</sup> Total Surplus/Deficit</b>	<b>1,061</b>	<b>-119</b>	<b>104</b>	<b>427</b>	<b>1,009</b>	<b>213</b>	<b>-509</b>	<b>-799</b>	<b>654</b>	<b>-315</b>	<b>454</b>	<b>3,434</b>	<b>2,847</b>	<b>-1</b>

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**Exhibit 4-5: 80-Water Conditions Monthly Energy**

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**Federal System Analysis Surplus Deficit  
Operating Year 2018**

**Federal Report Surplus Deficit By Water Year  
Operating Year 2018**

**2016 White Book Report Date: 9/20/2016**

S140-WB-20161121-220001

Energy-aMW - Surplus Deficit	Aug1	Aug1 6	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
1 1929 Federal Report Surplus Deficit	642	587	55.4	299	420	-318	-338	-180	8.01	-507	1211	1830	2143	-448	370
2 1930 Federal Report Surplus Deficit	608	45.4	250	383	574	-294	-1113	-135	38.7	605	2029	1385	16.7	989	312
3 1931 Federal Report Surplus Deficit	955	88.8	32.1	332	585	-164	-829	-1172	-229	345	-535	2453	119	1033	226
4 1932 Federal Report Surplus Deficit	478	-363	-222	195	222	-233	-1522	-1391	1494	3539	4487	5323	4917	1997	1247
5 1933 Federal Report Surplus Deficit	715	1120	331	294	57.4	985	2478	2307	2140	1588	2019	3671	6043	3948	2080
6 1934 Federal Report Surplus Deficit	2580	1602	263	958	2520	4086	4554	4302	4558	4665	4385	4135	3798	1275	3081
7 1935 Federal Report Surplus Deficit	456	-158	-216	247	-359	-262	2192	1706	2135	415	2242	3132	2926	2658	1303
8 1936 Federal Report Surplus Deficit	1946	302	-127	327	356	-475	-1153	-555	319	697	3889	5182	4593	1120	1087
9 1937 Federal Report Surplus Deficit	600	-24.2	-97.1	335	654	-248	-1040	-1137	-248	-173	460	2549	1529	-162	220
10 1938 Federal Report Surplus Deficit	817	116	-17.5	324	492	157	1863	1891	2604	3130	5214	4859	3825	2193	1899
11 1939 Federal Report Surplus Deficit	464	-150	249	286	330	-411	624	303	634	1790	3240	3502	1354	1041	883
12 1940 Federal Report Surplus Deficit	690	-62.9	16.8	356	759	93.1	1096	-295	2950	1910	2607	3204	1194	815	1073
13 1941 Federal Report Surplus Deficit	266	-348	-21.5	132	471	247	-543	-220	228	-511	789	2597	1432	787	438
14 1942 Federal Report Surplus Deficit	516	-61.7	360	144	945	1079	1838	1144	1581	251	2341	3105	3433	2738	1493
15 1943 Federal Report Surplus Deficit	1379	720	711	298	-39.7	19.8	2695	2085	2566	5024	5448	4196	5952	4045	2396
16 1944 Federal Report Surplus Deficit	1108	416	2.10	213	508	-340	-253	-108	1.98	-394	748	1234	-75.2	144	191
17 1945 Federal Report Surplus Deficit	466	-351	-98.1	220	472	-197	-872	-544	-52.5	-304	-929	3908	4208	-5.81	543
18 1946 Federal Report Surplus Deficit	829	-153	-336	226	694	462	1231	1197	2253	3724	5315	5051	3860	3221	1894
19 1947 Federal Report Surplus Deficit	1900	1363	320	246	640	3041	3655	3026	3025	2579	2953	4845	4122	2756	2507
20 1948 Federal Report Surplus Deficit	1757	985	173	2391	1753	1774	3320	2307	2394	1982	4053	5835	5946	3858	2850
21 1949 Federal Report Surplus Deficit	2972	2195	604	598	337	657	1283	1245	2876	2713	4609	5471	4023	424	1983
22 1950 Federal Report Surplus Deficit	-15.3	-532	-333	170	324	106	3010	3351	3268	3990	3800	4241	5841	4602	2340
23 1951 Federal Report Surplus Deficit	2216	1408	355	1242	2074	3151	4407	4307	5155	4335	4254	5027	4018	3639	3287
24 1952 Federal Report Surplus Deficit	2028	894	201	1927	1116	1873	2690	2498	2885	4144	5533	5903	4484	2530	2701
25 1953 Federal Report Surplus Deficit	1732	848	-263	298	226	-401	575	2254	1547	794	1872	3909	6057	4198	1745
26 1954 Federal Report Surplus Deficit	1209	727	260	540	628	1305	2947	2970	3139	2282	2965	4885	5422	4506	2515
27 1955 Federal Report Surplus Deficit	3448	3096	2123	647	1199	1271	450	550	-9.98	425	1590	3396	6114	4423	2042
28 1956 Federal Report Surplus Deficit	2817	1340	48.3	820	1682	3113	4183	4155	4275	3671	5266	5802	5839	3823	3352
29 1957 Federal Report Surplus Deficit	2329	1742	299	759	348	1407	1575	968	2213	3562	2717	6111	6193	1928	2255
30 1958 Federal Report Surplus Deficit	1266	163	118	241	526	-105	1954	1851	2212	1719	3424	5444	5492	1623	1882
31 1959 Federal Report Surplus Deficit	1138	72.5	-18.4	420	1162	2566	3827	3529	3742	3140	2714	4219	5434	4078	2703
32 1960 Federal Report Surplus Deficit	2821	1526	2377	3096	2595	2381	2198	1784	2513	5529	3962	3244	4655	2677	2869
33 1961 Federal Report Surplus Deficit	1368	254	-59.1	481	514	803	1981	2803	3470	2498	2190	4837	5596	1953	2121
34 1962 Federal Report Surplus Deficit	1297	488	-12.9	69.9	507	511	1737	1629	697	4064	5060	4306	3557	1866	1688
35 1963 Federal Report Surplus Deficit	1188	711	-188	1002	1271	2268	2509	1962	1667	635	1910	3713	3627	2450	1878
36 1964 Federal Report Surplus Deficit	1255	324	391	207	305	752	613	690	832	2839	1723	3987	5781	4295	1746
37 1965 Federal Report Surplus Deficit	2588	1879	858	1144	945	3266	4926	4401	4570	1940	5240	5176	4402	2600	3172
38 1966 Federal Report Surplus Deficit	2235	1785	-97.4	711	433	1029	1284	1284	973	4177	2518	2551	3376	2563	1623
39 1967 Federal Report Surplus Deficit	1331	354	77.8	211	261	1186	3392	3201	3356	1633	184	3662	5769	3878	2224
40 1968 Federal Report Surplus Deficit	1837	1295	309	596	696	1051	2574	2455	2683	407	1295	2335	4690	2978	1896
41 1969 Federal Report Surplus Deficit	2010	1889	1288	1233	1756	1878	4165	3939	3486	4045	4995	5695	4679	2743	3104
42 1970 Federal Report Surplus Deficit	1538	714	171	575	604	146	2106	1739	1352	918	1646	3831	5646	1012	1627
43 1971 Federal Report Surplus Deficit	903	126	-54.1	222	407	527	4219	4580	4367	3804	4286	5799	5948	4320	2896
44 1972 Federal Report Surplus Deficit	2593	2578	491	796	514	1346	3895	4459	5740	5127	3205	5614	5766	4215	3295
45 1973 Federal Report Surplus Deficit	3133	2801	675	737	523	964	1603	515	526	-901	921	2479	781	783	1057
46 1974 Federal Report Surplus Deficit	550	-244	-109	270	259	1685	5058	4769	5372	4455	5003	5214	5770	4679	3145
47 1975 Federal Report Surplus Deficit	2829	2730	595	147	462	87.0	2065	2015	2467	827	1622	4624	5865	4621	2250
48 1976 Federal Report Surplus Deficit	2214	1853	659	1363	1999	3834	3866	3809	4089	4424	4153	5841	4752	3925	3372
49 1977 Federal Report Surplus Deficit	3611	3583	2840	795	524	-318	-45.9	113	56.3	-689	405	938	-246	255	701
50 1978 Federal Report Surplus Deficit	477	-251	-489	-197	515	635	1560	1592	1927	3854	2915	4529	3015	2783	1613
51 1979 Federal Report Surplus Deficit	849	185	1268	821	528	-101	959	-15.7	1961	503	2093	4332	2617	-129	1177
52 1980 Federal Report Surplus Deficit	193	-153	47.5	275	503	-582	620	146	389	1779	3194	5441	4864	1671	1325
53 1981 Federal Report Surplus Deficit	435	-346	218	242	444	2202	3487	3017	1751	-441	1824	3735	5888	3600	2105
54 1982 Federal Report Surplus Deficit	2723	1709	291	443	758	1031	2724	4736	5257	3770	3505	5291	5850	4720	3069

### Federal Report Surplus Deficit By Water Year

#### Operating Year 2018

**2016 White Book** Report Date: **9/20/2016** *Continued*

S140-WB-20161121-220001

Energy-aMW - Surplus Deficit	Aug1	Aug1 6	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
55 1983 Federal Report Surplus Deficit	2499	2439	1217	1283	802	1514	3205	3320	4354	2927	2711	4499	4820	4067	2865
56 1984 Federal Report Surplus Deficit	2600	2135	590	618	2272	1804	2650	2821	2955	4365	4754	4627	5683	3580	2873
57 1985 Federal Report Surplus Deficit	1991	647	589	675	796	964	1146	925	895	2597	3585	3974	2490	752	1468
58 1986 Federal Report Surplus Deficit	-285	-632	40.6	140	1733	1142	2411	3087	4930	4329	4800	3618	4022	1683	2231
59 1987 Federal Report Surplus Deficit	787	63.6	-113	53.2	658	1042	722	501	951	138	1542	3328	2613	490	961
60 1988 Federal Report Surplus Deficit	323	-502	-191	228	434	-587	-592	-990	279	-1.10	1471	2365	756	1299	312
61 1989 Federal Report Surplus Deficit	864	52.2	-38.2	162	732	220	-413	-326	1433	1912	4977	3715	2706	615	1062
62 1990 Federal Report Surplus Deficit	437	-271	-46.1	374	650	1218	2368	2459	2553	1693	4356	3411	4762	2309	1923
63 1991 Federal Report Surplus Deficit	2038	1148	17.6	106	1985	1996	3258	2823	3059	2231	2354	3904	4433	3891	2445
64 1992 Federal Report Surplus Deficit	2561	1536	-4.28	388	521	-525	303	243	1697	-521	587	2308	686	297	672
65 1993 Federal Report Surplus Deficit	425	-258	-214	266	577	-107	-959	-1088	844	937	2016	4126	3421	1027	796
66 1994 Federal Report Surplus Deficit	1012	279	378	347	774	66.1	-1093	-672	16.3	-81.8	1436	3146	2309	988	637
67 1995 Federal Report Surplus Deficit	771	-162	91.2	276	127	-70.1	744	1622	2770	1102	1712	3400	4908	2017	1462
68 1996 Federal Report Surplus Deficit	698	161	426	1039	2867	4711	4863	4544	5522	4082	5323	5300	4886	3969	3600
69 1997 Federal Report Surplus Deficit	2420	1661	279	496	693	1974	4779	4986	5592	4343	5355	5559	5828	4194	3430
70 1998 Federal Report Surplus Deficit	2520	2579	1208	2575	1618	942	1506	1581	1580	1508	2621	5690	5610	2571	2463
71 1999 Federal Report Surplus Deficit	2101	888	106	305	120	1616	3839	3951	4602	2724	3980	4172	5559	4205	2770
72 2000 Federal Report Surplus Deficit	3336	2659	664	491	2402	2332	2058	1979	2436	3763	4894	4439	2256	2198	2384
73 2001 Federal Report Surplus Deficit	1387	-215	-152	328	390	-307	-299	-128	250	-457	480	1726	-615	349	182
74 2002 Federal Report Surplus Deficit	480	-363	-518	-225	425	49.2	-359	-105	771	1590	3896	3475	5516	3409	1272
75 2003 Federal Report Surplus Deficit	361	95.1	45.6	403	672	-143	-569	-445	2105	1543	2337	3410	4480	781	1080
76 2004 Federal Report Surplus Deficit	349	-292	-208	226	881	474	409	-51.4	940	963	1817	3177	2400	1091	901
77 2005 Federal Report Surplus Deficit	114	-182	768	772	438	1200	2156	314	492	-409	1440	3659	2842	1506	1227
78 2006 Federal Report Surplus Deficit	738	-75.4	34.2	-56.6	536	955	2678	2652	2499	4273	4981	5289	5339	1994	2231
79 2007 Federal Report Surplus Deficit	1204	-352	-276	282	866	398	2006	1914	2639	3045	2321	3630	3450	2295	1689
80 2008 Federal Report Surplus Deficit	624	-298	-417	405	840	-323	148	539	866	1109	249	4585	6278	2768	1378
<b>Ranked Averages</b>															
81 <b>Bottom 10 pct</b>	<b>736</b>	<b>5.85</b>	<b>-15.3</b>	<b>281</b>	<b>505</b>	<b>-252</b>	<b>-626</b>	<b>-509</b>	<b>41.1</b>	<b>-137</b>	<b>832</b>	<b>2017</b>	<b>663</b>	<b>499</b>	<b>281</b>
82 <b>Middle 80 pct</b>	<b>1417</b>	<b>711</b>	<b>281</b>	<b>526</b>	<b>762</b>	<b>813</b>	<b>1692</b>	<b>1608</b>	<b>2119</b>	<b>2105</b>	<b>2908</b>	<b>4132</b>	<b>4278</b>	<b>2399</b>	<b>1848</b>
83 <b>Top 10 pct</b>	<b>2012</b>	<b>1329</b>	<b>376</b>	<b>896</b>	<b>1379</b>	<b>2885</b>	<b>4497</b>	<b>4429</b>	<b>5039</b>	<b>4047</b>	<b>4725</b>	<b>5442</b>	<b>5157</b>	<b>3881</b>	<b>3332</b>

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# **Section 5: Pacific Northwest Regional Analysis Exhibits**

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**Exhibit 5-1: Annual Energy**

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**Regional Analysis Surplus Deficit  
Operating Year 2018 to 2027  
Using 1937-Water Conditions**

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**Loads and Resources - Pacific Northwest Region**

**Operating Year: 2018 to 2027 Water Year: 1937**

**2016 White Book Report Date: 9/20/2016**

S140-WB-20161121-220001

Energy-aMW	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
<b>Regional Loads</b>										
<b>1 Retail Loads</b>	22547	22823	23114	23408	23679	23952	24214	24488	24758	24994
2 Federal Agency	123	135	147	150	150	150	150	152	153	154
3 USBR	183	183	182	183	183	183	182	183	183	183
4 Cooperative	1974	2009	2043	2081	2118	2155	2190	2229	2264	2285
5 Municipality	2668	2688	2713	2732	2740	2748	2756	2763	2770	2755
6 Public Utility District	4768	4795	4832	4883	4924	4967	4999	5037	5071	5104
7 Investor-Owned Utility	12406	12588	12772	12954	13139	13324	13512	13698	13890	14086
8 Marketer	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
9 Direct-Service Industry	421	421	421	421	421	421	421	421	421	421
10 Federal Diversity	0	0	0	0	0	0	0	0	0	0
<b>11 Exports</b>	1201	1159	1136	1138	1044	1015	985	984	984	984
12 Canada	480	473	464	466	466	466	466	466	466	466
13 East Continental Divide	6.80	2.46	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14 Inland Southwest	24.0	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
15 Pacific Southwest	690	670	657	658	563	534	504	503	503	503
16 Other	0	0	0	0	0	0	0	0	0	0
<b>17 Total Regional Loads</b>	<b>23748</b>	<b>23983</b>	<b>24250</b>	<b>24546</b>	<b>24723</b>	<b>24966</b>	<b>25199</b>	<b>25472</b>	<b>25742</b>	<b>25978</b>
<b>Regional Resources</b>										
<b>18 Hydro Resources</b>	11826	11882	11963	11876	11865	11865	11861	11865	11865	11865
19 Regulated Hydro - Net	10525	10582	10663	10600	10599	10599	10596	10599	10599	10599
20 Independent Hydro - Net	1053	1053	1052	1027	1017	1017	1016	1017	1017	1017
21 Small Hydro - Net	248	248	248	249	249	249	249	249	249	249
<b>22 Other Resources</b>	16370	16132	16264	15551	15104	14645	14874	14618	14316	14007
23 Cogeneration Resources	2300	2282	2295	2300	2282	2295	2301	2282	2295	2300
24 Combustion Turbine Resources	5826	5825	5827	5829	5828	5787	5785	5784	5783	5783
25 Large Thermal Resources	6255	6036	6152	5431	5005	4572	4799	4561	4249	3934
26 Renewable Resources	1953	1954	1954	1955	1954	1954	1954	1955	1954	1954
27 Small Thermal & Miscellaneous	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9	35.9
<b>28 Imports</b>	667	658	662	660	580	584	588	591	595	599
29 Canada	38.8	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	480	484	487	491	494	498	502	506	509	513
32 Pacific Southwest	148	136	136	131	47.1	47.1	47.1	47.1	47.1	47.1
33 Other	0	0	0	0	0	0	0	0	0	0
<b>34 Reserves &amp; Losses</b>	-857	-852	-858	-834	-818	-805	-811	-804	-795	-786
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	-857	-852	-858	-834	-818	-805	-811	-804	-795	-786
<b>40 Total Regional Resources</b>	<b>28006</b>	<b>27821</b>	<b>28032</b>	<b>27253</b>	<b>26732</b>	<b>26289</b>	<b>26511</b>	<b>26271</b>	<b>25982</b>	<b>25685</b>
<b>41 Total Surplus/Deficit</b>	<b>4258</b>	<b>3839</b>	<b>3782</b>	<b>2707</b>	<b>2009</b>	<b>1323</b>	<b>1312</b>	<b>798</b>	<b>240</b>	<b>-293</b>

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**Exhibit 5-2: Monthly Energy**

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**Regional Analysis Surplus Deficit  
Operating Year 2018  
Using 1937-Water Conditions**

**Loads and Resources - Pacific Northwest Region**

**Operating Year: 2018 Water Year: 1937**

**2016 White Book Report Date: 9/20/2016**

S140-WB-20161121-220001

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
<b>Regional Loads</b>															
<b>1 Retail Loads</b>	22768	22790	21082	20283	22701	24998	25235	24065	22105	20990	21145	20462	22175	23651	22547
2 Federal Agency	112	112	106	108	134	153	152	149	128	114	114	106	103	113	123
3 USBR	316	315	266	108	21.7	21.3	11.2	16.3	69.4	259	255	338	352	406	183
4 Cooperative	2031	2031	1800	1687	1968	2240	2191	2114	1843	1799	1813	1869	1977	2161	1974
5 Municipality	2391	2394	2316	2495	2956	3126	3171	3065	2734	2584	2611	2394	2367	2425	2668
6 Public Utility District	4468	4471	4241	4366	5034	5576	5562	5317	4823	4575	4606	4310	4383	4567	4768
7 Investor-Owned Utility	13025	13042	11928	11094	12163	13456	13722	12978	12083	11234	11319	11021	12569	13554	12406
8 Marketer	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
9 Direct-Service Industry	421	421	421	422	422	422	422	421	421	421	422	421	421	421	421
10 Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>11 Exports</b>	1311	1510	1335	1029	1197	1045	799	963	1025	1406	1310	1340	1395	1507	1201
12 Canada	582	586	469	469	469	469	469	469	469	451	488	469	469	485	480
13 East Continental Divide	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
14 Inland Southwest	34.3	38.9	37.9	35.4	39.9	36.3	6.07	10.0	11.5	20.6	17.4	18.6	18.4	18.0	24.0
15 Pacific Southwest	688	878	821	517	681	532	317	477	537	928	798	845	901	997	690
16 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>17 Total Regional Loads</b>	<b>24079</b>	<b>24300</b>	<b>22418</b>	<b>21311</b>	<b>23898</b>	<b>26043</b>	<b>26034</b>	<b>25028</b>	<b>23130</b>	<b>22396</b>	<b>22455</b>	<b>21802</b>	<b>23570</b>	<b>25158</b>	<b>23748</b>
<b>Regional Resources</b>															
<b>18 Hydro Resources</b>	11944	10657	9468	10201	12633	13335	10746	9968	10312	10519	11740	15846	15135	11714	11826
19 Regulated Hydro - Net	10626	9344	8264	9127	11684	12357	9904	9063	9184	8920	10121	13831	13115	10162	10525
20 Independent Hydro - Net	991	988	959	910	817	854	723	779	969	1311	1330	1600	1574	1127	1053
21 Small Hydro - Net	327	325	245	164	133	125	119	125	159	288	290	414	446	425	248
<b>22 Other Resources</b>	16394	16987	16920	16607	17373	17017	16296	16785	16096	17734	15565	13087	15465	17510	16370
23 Cogeneration Resources	2404	2404	2409	2382	2465	2498	2458	2476	1693	2379	1831	2107	2221	2401	2300
24 Combustion Turbine Resources	6097	6104	6164	6219	6340	6411	6415	6357	6309	6195	5186	3409	4428	6099	5826
25 Large Thermal Resources	6426	6426	6426	6426	6426	6426	6426	6426	6359	6255	6058	4924	6233	6426	6255
26 Renewable Resources	1437	2023	1886	1542	2106	1644	959	1490	1697	2872	2456	2609	2550	2548	1953
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
<b>28 Imports</b>	610	610	555	578	792	897	735	734	636	508	510	549	683	730	667
29 Canada	20.8	20.8	15.8	22.0	38.9	49.3	62.3	70.8	62.7	30.2	30.2	28.9	38.6	27.0	38.8
30 East of Continental Divide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Inland Southwest	525	525	476	442	435	469	441	455	429	408	409	456	580	640	480

**Loads and Resources - Pacific Northwest Region**  
**Operating Year: 2018 Water Year: 1937**  
**2016 White Book** Report Date: **9/20/2016** *Continued*

S140-WB-20161121-220001

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
<sup>32</sup> Pacific Southwest	64.4	64.6	63.9	114	318	378	231	208	145	69.5	70.6	64.0	64.4	63.4	148
<sup>33</sup> Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<sup>34</sup> <b>Reserves &amp; Losses</b>	-860	-839	-800	-813	-915	-928	-825	-816	-803	-854	-826	-876	-929	-890	-857
<sup>35</sup> Contingency Reserves (Non-Spinning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<sup>36</sup> Contingency Reserves (Spinning)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<sup>37</sup> Generation Imbalance Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<sup>38</sup> Load Following Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<sup>39</sup> Transmission Losses	-860	-839	-800	-813	-915	-928	-825	-816	-803	-854	-826	-876	-929	-890	-857
<sup>40</sup> <b>Total Regional Resources</b>	<b>28089</b>	<b>27415</b>	<b>26144</b>	<b>26572</b>	<b>29884</b>	<b>30321</b>	<b>26951</b>	<b>26670</b>	<b>26240</b>	<b>27907</b>	<b>26989</b>	<b>28606</b>	<b>30354</b>	<b>29064</b>	<b>28006</b>
<sup>41</sup> <b>Total Surplus/Deficit</b>	<b>4010</b>	<b>3115</b>	<b>3726</b>	<b>5261</b>	<b>5986</b>	<b>4278</b>	<b>917</b>	<b>1642</b>	<b>3110</b>	<b>5510</b>	<b>4534</b>	<b>6804</b>	<b>6784</b>	<b>3906</b>	<b>4258</b>

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**Exhibit 5-3: Annual 120-Hour Capacity**

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**Regional Analysis Surplus Deficit  
Operating Year 2018 to 2027  
Using 1937-Water Conditions**

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**Loads and Resources - Pacific Northwest Region**  
**Operating Year: 2018 to 2027 Water Year: 1937**  
**2016 White Book Report Date: 9/20/2016**

S140-WB-20161121-220001

January 120Hr-MW	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
<b>Regional Loads</b>										
<b>1 Retail Loads</b>	33291	33618	33998	34422	34782	35146	35507	35851	36214	36573
2 Federal Agency	205	221	233	235	236	236	237	240	243	245
3 USBR	336	336	336	336	336	336	336	336	336	336
4 Cooperative	3242	3290	3336	3382	3430	3482	3530	3572	3616	3634
5 Municipality	4379	4390	4425	4438	4450	4464	4476	4488	4500	4481
6 Public Utility District	7596	7643	7715	7782	7841	7902	7955	8000	8050	8104
7 Investor-Owned Utility	18457	18708	18962	19223	19479	19738	19999	20262	20535	20812
8 Marketer	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
9 Direct-Service Industry	435	435	435	435	435	435	435	435	435	435
10 Federal Diversity	-1363	-1409	-1449	-1414	-1430	-1450	-1465	-1488	-1506	-1479
<b>11 Exports</b>	1427	1421	1199	1199	1143	1143	1143	1143	1143	1143
12 Canada	1324	1324	1142	1142	1142	1142	1142	1142	1142	1142
13 East Continental Divide	6.80	1.00	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	95.8	95.8	56.7	56.7	0	0	0	0	0	0
16 Other	0	0	0	0	0	0	0	0	0	0
<b>17 Total Regional Loads</b>	<b>34718</b>	<b>35039</b>	<b>35197</b>	<b>35621</b>	<b>35925</b>	<b>36289</b>	<b>36650</b>	<b>36993</b>	<b>37357</b>	<b>37716</b>
<b>Regional Resources</b>										
<b>18 Hydro Resources</b>	20571	20593	20779	20811	20767	20786	20772	20791	20757	20776
19 Regulated Hydro - Net	19064	19086	19272	19384	19341	19360	19346	19365	19331	19349
20 Independent Hydro - Net	1338	1338	1338	1258	1258	1258	1258	1258	1258	1258
21 Small Hydro - Net	169	169	169	169	169	169	169	169	169	169
<b>22 Other Resources</b>	16811	16811	16811	15571	15444	15081	15081	15081	14278	14278
23 Cogeneration Resources	2720	2720	2720	2720	2720	2720	2720	2720	2720	2720
24 Combustion Turbine Resources	6837	6837	6837	6837	6837	6781	6781	6781	6781	6781
25 Large Thermal Resources	7000	7000	7000	5760	5633	5326	5326	5326	4522	4522
26 Renewable Resources	162	162	162	162	162	162	162	162	162	162
27 Small Thermal & Miscellaneous	92.1	92.1	92.1	92.1	92.1	92.1	92.1	92.1	92.1	92.1
<b>28 Imports</b>	1216	1174	1177	1180	1059	1062	1065	1068	1071	1075
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	590	594	597	600	604	607	610	613	616	620
32 Pacific Southwest	471	425	425	425	300	300	300	300	300	300
33 Other	0	0	0	0	0	0	0	0	0	0
<b>34 Reserves &amp; Losses</b>	-3720	-3736	-3760	-3695	-3695	-3695	-3704	-3701	-3656	-3667
35 Contingency Reserves (Non-Spinning)	-997	-1003	-1012	-1000	-1005	-1010	-1016	-1013	-1005	-1010
36 Contingency Reserves (Spinning)	-997	-1003	-1012	-1000	-1005	-1010	-1016	-1013	-1005	-1010
37 Generation Imbalance Reserves	-175	-176	-176	-176	-176	-176	-176	-176	-176	-176
38 Load Following Reserves	-330	-335	-335	-335	-335	-335	-335	-335	-335	-335
39 Transmission Losses	-1220	-1219	-1225	-1185	-1175	-1163	-1162	-1163	-1135	-1136
<b>40 Total Regional Resources</b>	<b>34878</b>	<b>34842</b>	<b>35007</b>	<b>33866</b>	<b>33576</b>	<b>33235</b>	<b>33214</b>	<b>33239</b>	<b>32449</b>	<b>32461</b>
<b>41 Total Surplus/Deficit</b>	<b>160</b>	<b>-198</b>	<b>-189</b>	<b>-1755</b>	<b>-2349</b>	<b>-3054</b>	<b>-3436</b>	<b>-3754</b>	<b>-4907</b>	<b>-5255</b>

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**Exhibit 5-4: Monthly 120-Hour Capacity**

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**Regional Analysis Surplus Deficit  
Operating Year 2018  
Using 1937-Water Conditions**

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**Loads and Resources - Pacific Northwest Region**

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

**2016 White Book Report Date: 9/20/2016**

S140-WB-20161121-220001

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
<b>Regional Loads</b>														
<b>1 Retail Loads</b>	29210	28992	25755	25925	29184	32195	32544	30495	28162	26601	26570	25284	28127	30240
2 Federal Agency	138	138	139	151	183	200	205	193	179	157	157	145	137	147
3 USBR	614	614	532	415	279	368	336	334	405	472	472	556	598	632
4 Cooperative	2688	2688	2461	2475	2857	3262	3188	3028	2736	2679	2679	2587	2644	2840
5 Municipality	3276	3276	3115	3403	3834	4304	4291	4105	3766	3481	3481	3117	3068	3233
6 Public Utility District	5495	5495	5144	5635	6536	7214	7247	6829	6460	6090	6090	5655	5536	5781
7 Investor-Owned Utility	17301	17301	14835	14469	16161	17786	18176	16875	15439	14286	14286	13666	16528	17973
8 Marketer	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
9 Direct-Service Industry	435	435	434	435	435	435	435	435	435	435	435	435	434	435
10 Federal Diversity	-741	-958	-910	-1063	-1106	-1379	-1337	-1309	-1262	-1004	-1034	-880	-823	-804
<b>11 Exports</b>	2032	2032	1863	1501	1452	1442	1466	1465	1492	1511	1519	1518	1909	1922
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	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
15 Pacific Southwest	565	565	538	177	126	116	114	114	141	161	170	170	559	559
16 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>17 Total Regional Loads</b>	<b>31242</b>	<b>31024</b>	<b>27618</b>	<b>27425</b>	<b>30636</b>	<b>33637</b>	<b>34010</b>	<b>31960</b>	<b>29654</b>	<b>28112</b>	<b>28089</b>	<b>26802</b>	<b>30036</b>	<b>32162</b>
<b>Regional Resources</b>														
<b>18 Hydro Resources</b>	22392	20174	19335	19756	22412	22578	21069	20729	21289	19140	18389	24515	23925	21339
19 Regulated Hydro - Net	20500	18284	17442	18014	20771	21022	19568	19308	19569	17016	16248	22068	21417	19256
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	163	175	213	331	333	454	470	457
<b>22 Other Resources</b>	16428	16429	16503	16637	16702	16785	16787	16746	16053	15368	14351	14665	14617	16327
23 Cogeneration Resources	2714	2714	2733	2788	2703	2717	2720	2714	2072	2619	2139	2363	2616	2613
24 Combustion Turbine Resources	6475	6475	6531	6609	6760	6827	6837	6791	6743	6699	5645	5785	6038	6478
25 Large Thermal Resources	6976	6976	6976	6976	6976	6976	6976	6976	6976	5788	6306	6252	5702	6976
26 Renewable Resources	173	173	173	174	173	174	162	174	172	172	172	173	171	172
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
<b>28 Imports</b>	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
<b>34 Reserves &amp; Losses</b>	-4044	-3906	-3762	-3809	-4071	-4183	-4098	-4018	-3931	-3251	-3126	-3507	-3583	-3540
35 Contingency Reserves (Non-Spinning)	-947	-914	-855	-870	-953	-1004	-987	-952	-914	-865	-831	-915	-962	-954
36 Contingency Reserves (Spinning)	-947	-914	-855	-870	-953	-1004	-987	-952	-914	-865	-831	-915	-962	-954
37 Generation Imbalance Reserves	-316	-316	-315	-314	-314	-314	-314	-314	-314	-182	-182	-182	-182	-182
38 Load Following Reserves	-584	-584	-585	-586	-586	-586	-586	-586	-586	-218	-218	-218	-218	-218
39 Transmission Losses	-1250	-1177	-1152	-1169	-1265	-1274	-1223	-1214	-1202	-1120	-1063	-1276	-1259	-1232
<b>40 Total Regional Resources</b>	<b>35736</b>	<b>33657</b>	<b>32922</b>	<b>33420</b>	<b>36157</b>	<b>36417</b>	<b>34971</b>	<b>34702</b>	<b>34358</b>	<b>32024</b>	<b>30382</b>	<b>36470</b>	<b>35989</b>	<b>35231</b>
<b>41 Total Surplus/Deficit</b>	<b>4495</b>	<b>2633</b>	<b>5304</b>	<b>5995</b>	<b>5522</b>	<b>2780</b>	<b>960</b>	<b>2742</b>	<b>4704</b>	<b>3912</b>	<b>2293</b>	<b>9667</b>	<b>5953</b>	<b>3069</b>

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**Exhibit 5-5: 80-Water Conditions Monthly Energy**

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**Regional Analysis Surplus Deficit  
Operating Year 2018**

**Regional Report Surplus Deficit By Water Year**

**Operating Year 2018**

**2016 White Book Report Date: 9/20/2016**

S140-WB-20161121-220001

Energy-aMW - Surplus Deficit	Aug1	Aug1 6	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
1 1929 Regional Report Surplus Deficit	4945	4450	4297	5868	6381	4422	2256	3326	3701	5359	6759	6106	7070	3286	4788
2 1930 Regional Report Surplus Deficit	3956	3230	4349	5326	5956	3633	1581	3940	3770	6497	8107	4710	3100	5620	4401
3 1931 Regional Report Surplus Deficit	4523	3212	4006	5347	6029	4170	1807	1373	3318	5754	2428	6927	2781	5282	4102
4 1932 Regional Report Surplus Deficit	3502	2136	3532	5177	5531	4180	690	1483	6985	12694	13366	12585	13015	8143	6444
5 1933 Regional Report Surplus Deficit	4898	5288	4673	5470	6240	6636	8522	8565	8272	8962	8018	9612	14934	12830	8273
6 1934 Regional Report Surplus Deficit	8371	6686	5095	7683	11247	13213	13375	13022	13159	15469	12767	10691	10070	6269	10436
7 1935 Regional Report Surplus Deficit	3642	2856	3537	5316	5923	4644	7830	7811	7991	6267	8153	8973	9350	9452	6767
8 1936 Regional Report Surplus Deficit	6569	3898	3841	5393	5779	3783	1007	2708	4466	7098	11528	12628	12632	6323	6097
9 1937 Regional Report Surplus Deficit	4010	3115	3726	5261	5986	4278	917	1642	3110	5510	4534	6804	6784	3906	4258
10 1938 Regional Report Surplus Deficit	4883	3519	4010	5432	6879	5146	7453	7830	8993	11876	14867	12663	10613	8467	7911
11 1939 Regional Report Surplus Deficit	4272	3110	4502	5401	5833	4329	4741	4771	5246	9170	10691	9133	6084	5923	5797
12 1940 Regional Report Surplus Deficit	4186	3050	4017	5437	6391	5153	5367	3625	9808	9140	8761	8473	5094	5086	5933
13 1941 Regional Report Surplus Deficit	2973	2244	3810	4968	5848	4640	2163	3637	4038	4207	5103	6726	5426	4769	4441
14 1942 Regional Report Surplus Deficit	3413	2734	4563	5281	6962	6637	6795	6324	6700	5803	8911	8227	9839	9454	6766
15 1943 Regional Report Surplus Deficit	5512	4627	5428	5379	5694	5113	8809	8520	9262	16860	15116	11161	14774	12864	8991
16 1944 Regional Report Surplus Deficit	5666	4560	4353	5537	6296	4662	2463	3792	4296	5054	5530	4279	2500	3759	4362
17 1945 Regional Report Surplus Deficit	3415	2278	3681	5024	5583	4046	2147	3120	3771	5716	2372	9593	11316	4165	4945
18 1946 Regional Report Surplus Deficit	4649	2896	3452	5480	6976	5828	6592	6861	8673	13312	14968	12932	11381	10945	8084
19 1947 Regional Report Surplus Deficit	6710	6080	4908	5633	7075	11173	10604	10769	10324	11337	10785	11702	11430	9557	9212
20 1948 Regional Report Surplus Deficit	6385	5876	4568	10605	9574	8188	10081	8668	8546	9749	12389	13830	15166	11971	9873
21 1949 Regional Report Surplus Deficit	9050	7981	5682	6332	6474	5680	5811	6771	9857	11430	13718	13091	11843	5479	8175
22 1950 Regional Report Surplus Deficit	3478	2530	3670	5460	6800	5058	9938	11433	10988	14490	12742	11096	15029	14234	9167
23 1951 Regional Report Surplus Deficit	8122	6908	5271	8256	10827	12104	12726	13972	14589	15326	13548	12784	11527	11792	11301
24 1952 Regional Report Surplus Deficit	7278	5531	5087	9699	8289	8630	8903	9451	9900	13802	15479	14136	12503	9165	9729
25 1953 Regional Report Surplus Deficit	6366	5620	3748	5475	5534	4196	5242	9070	7163	7577	7835	10666	14904	12709	7685
26 1954 Regional Report Surplus Deficit	5756	5101	4855	6231	7232	7734	9950	10705	10643	11010	10515	12042	13908	13961	9446
27 1955 Regional Report Surplus Deficit	10080	9823	8892	6540	8619	7175	4633	5543	3889	7066	6807	8617	15083	13562	8292
28 1956 Regional Report Surplus Deficit	8784	6193	4519	7567	9915	11516	12448	12623	12788	13892	15447	13883	15251	12466	11248
29 1957 Regional Report Surplus Deficit	7890	7133	5131	7015	6657	7931	6877	6757	8753	13156	9735	14296	15112	8047	8801
30 1958 Regional Report Surplus Deficit	5919	3797	4364	5486	6159	5034	7560	8382	8498	9598	10980	13046	13982	7384	7905
31 1959 Regional Report Surplus Deficit	5340	3638	4132	5871	8453	10284	11447	11321	11475	12750	10341	11069	13710	12690	9694
32 1960 Regional Report Surplus Deficit	8433	6487	9620	12110	11547	9573	7789	8327	9083	17444	12404	9094	12195	9520	10094
33 1961 Regional Report Surplus Deficit	5883	4528	4179	5884	7113	6194	7908	10471	10876	11002	8379	11694	13819	7834	8383
34 1962 Regional Report Surplus Deficit	5863	4007	4064	5302	6282	5538	7129	7277	5200	14365	14810	11008	10190	7736	7421
35 1963 Regional Report Surplus Deficit	5617	4916	4053	7098	8738	9454	8308	9069	7356	7069	7776	9720	10612	8830	7987
36 1964 Regional Report Surplus Deficit	5329	3998	5068	5520	6480	6089	5225	5796	5733	11682	7542	10450	15093	13313	7754
37 1965 Regional Report Surplus Deficit	8419	7310	6330	7459	7567	11712	13554	13482	13357	10350	15187	12997	11869	9508	10692
38 1966 Regional Report Surplus Deficit	7692	7223	4475	6538	6625	6548	6242	6626	6218	14679	9483	7691	10100	9183	7479
39 1967 Regional Report Surplus Deficit	5429	4223	4448	5485	6066	7382	10604	10953	10803	9424	4985	10092	15063	12288	8754
40 1968 Regional Report Surplus Deficit	6735	5969	4908	6726	7356	6801	9167	9813	10012	6511	6309	7169	13045	10216	8152
41 1969 Regional Report Surplus Deficit	6931	7428	7390	8086	9695	8689	11790	11980	10943	14898	14859	13805	12784	9622	10552
42 1970 Regional Report Surplus Deficit	6433	4952	4645	6224	6695	5036	8138	8002	6796	7515	6933	10385	13832	6117	7384
43 1971 Regional Report Surplus Deficit	5333	3703	4144	5513	6425	5843	12481	14163	13179	14050	13470	13851	15578	13787	10238
44 1972 Regional Report Surplus Deficit	8701	8577	5484	6929	7017	7426	11768	13916	16800	17785	11788	13517	15492	13412	11249
45 1973 Regional Report Surplus Deficit	9654	9149	6048	6802	6678	7136	6942	5317	4970	4956	5620	6986	4793	5354	6324
46 1974 Regional Report Surplus Deficit	3907	2694	4007	5526	6449	8375	14601	14750	15316	15720	14950	13029	15431	14359	10845
47 1975 Regional Report Surplus Deficit	9167	9006	5676	5527	6539	5433	8203	8594	9021	7852	7510	12104	14743	13945	8884
48 1976 Regional Report Surplus Deficit	7687	7576	5895	8344	10392	13296	11876	12158	12193	14978	13006	13620	12916	12746	11252
49 1977 Regional Report Surplus Deficit	10581	10777	10224	6548	6278	4426	3012	3971	4279	4407	4599	3885	1745	3608	5269
50 1978 Regional Report Surplus Deficit	3327	2394	2728	4520	6065	6121	6542	7184	7874	13936	10527	11835	8871	9925	7226
51 1979 Regional Report Surplus Deficit	5268	4221	7217	6586	6518	4897	4878	4344	8043	6253	7979	10491	8465	3686	6421
52 1980 Regional Report Surplus Deficit	3155	2992	4252	5417	5889	4012	4604	4994	4951	9468	10934	13371	12956	7377	6755
53 1981 Regional Report Surplus Deficit	3864	2732	4695	5415	6587	10002	10578	10768	7466	4719	7716	9668	14129	11166	8316
54 1982 Regional Report Surplus Deficit	8005	6525	4838	5978	7125	6930	9020	14365	14859	13682	11358	13057	14344	14064	10335

**Regional Report Surplus Deficit By Water Year**

**Operating Year 2018**

**2016 White Book** Report Date: **9/20/2016** *Continued*

S140-WB-20161121-220001

Energy-aMW - Surplus Deficit	Aug1	Aug1 6	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
55 1983 Regional Report Surplus Deficit	8150	8167	6895	7774	7315	8117	10816	11662	13073	11967	9924	11623	12976	12749	10169
56 1984 Regional Report Surplus Deficit	8502	7844	5569	6399	10896	8434	9818	10242	9918	14278	13246	11289	14031	11439	9983
57 1985 Regional Report Surplus Deficit	7280	4953	5702	6519	7745	6450	5688	5928	5960	11109	11670	10621	8493	5355	7158
58 1986 Regional Report Surplus Deficit	2475	2049	4531	5760	9507	6601	8884	10665	14331	15096	13915	9850	11235	7144	8744
59 1987 Regional Report Surplus Deficit	4764	3581	4112	5380	7011	6655	4988	5511	6526	6058	7529	9063	7753	4711	6055
60 1988 Regional Report Surplus Deficit	3230	2067	3699	5063	5660	3816	2398	1793	4380	5705	7126	6694	4470	6307	4459
61 1989 Regional Report Surplus Deficit	4388	3229	3705	5106	7076	4731	2847	3310	6800	9609	14394	10046	8659	5543	6139
62 1990 Regional Report Surplus Deficit	3938	3016	4044	5518	7270	7455	9039	9277	9153	9689	12771	9331	12578	9039	8099
63 1991 Regional Report Surplus Deficit	6940	5691	4313	5358	10742	8601	9952	10317	10231	10860	9038	10222	12064	12412	9195
64 1992 Regional Report Surplus Deficit	8141	6553	4174	5394	6374	3882	3846	4622	7146	5427	4798	6224	3767	3699	5137
65 1993 Regional Report Surplus Deficit	3116	2210	3369	5020	5794	3495	1685	1272	5665	7594	8046	10566	9911	6221	5306
66 1994 Regional Report Surplus Deficit	5413	3842	4693	5398	6266	4312	1216	2586	4155	5537	7410	8515	7289	5540	5096
67 1995 Regional Report Surplus Deficit	3941	2488	4033	5256	5485	4739	5049	7878	9914	8089	7141	9200	13118	8166	6956
68 1996 Regional Report Surplus Deficit	4884	3887	4872	7130	12426	14648	14122	14704	15879	15109	15703	13216	12978	12320	11820
69 1997 Regional Report Surplus Deficit	7857	6785	4969	6035	7243	8775	13796	14921	15795	15720	15619	13710	15250	13441	11386
70 1998 Regional Report Surplus Deficit	8484	8689	7373	11228	9431	6848	7238	7756	7652	9111	9493	13438	14469	9278	9389
71 1999 Regional Report Surplus Deficit	6975	5569	4515	5614	5989	8363	11824	12539	13408	11967	12758	11181	14684	13576	10011
72 2000 Regional Report Surplus Deficit	10143	8981	5741	6102	11233	9688	8005	8057	8776	13652	14487	11242	8166	8249	9073
73 2001 Regional Report Surplus Deficit	5670	3263	3915	5531	5720	4212	2075	3244	3911	5089	4846	5226	1426	3993	4061
74 2002 Regional Report Surplus Deficit	3240	2079	3299	4364	5523	4490	3521	3996	5418	8709	11800	9302	13832	11254	6493
75 2003 Regional Report Surplus Deficit	4275	3589	4007	5316	6250	3847	2642	3290	8021	8368	8579	8690	11434	5241	5931
76 2004 Regional Report Surplus Deficit	3352	2373	3525	5427	7030	5250	4344	3969	5606	7157	7611	8283	7578	6257	5630
77 2005 Regional Report Surplus Deficit	3001	3278	5881	6370	6405	6858	7707	4657	4613	4762	6671	8944	8467	6587	6289
78 2006 Regional Report Surplus Deficit	4320	2898	3886	5036	6094	6216	9741	9549	8902	14184	14195	12696	13773	7788	8434
79 2007 Regional Report Surplus Deficit	5559	2552	3509	5079	8119	5564	7693	8103	9873	12301	8941	9482	9931	8291	7512
80 2008 Regional Report Surplus Deficit	4235	2596	3836	5544	6640	4231	3648	4731	5490	7741	4275	11196	15341	10175	6688
<b>Ranked Averages</b>															
81 <b>Bottom 10 pct</b>	<b>4372</b>	<b>3268</b>	<b>4019</b>	<b>5362</b>	<b>5984</b>	<b>4229</b>	<b>1958</b>	<b>2843</b>	<b>3816</b>	<b>5397</b>	<b>5554</b>	<b>5934</b>	<b>4195</b>	<b>4615</b>	<b>4359</b>
82 <b>Middle 80 pct</b>	<b>5858</b>	<b>4807</b>	<b>4824</b>	<b>6110</b>	<b>7169</b>	<b>6418</b>	<b>7080</b>	<b>7585</b>	<b>8307</b>	<b>10180</b>	<b>10043</b>	<b>10588</b>	<b>11620</b>	<b>8984</b>	<b>7838</b>
83 <b>Top 10 pct</b>	<b>7295</b>	<b>6241</b>	<b>5168</b>	<b>7156</b>	<b>8980</b>	<b>10981</b>	<b>13111</b>	<b>13816</b>	<b>14590</b>	<b>14860</b>	<b>14406</b>	<b>13345</b>	<b>13839</b>	<b>12505</b>	<b>11224</b>

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