

# 2017 Pacific Northwest Loads and Resources Study

December 2017







## Department of Energy

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

December 1, 2017

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) region’s 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 2017 White Book presents Federal system and the region’s load obligations, contracts, and resources as of June 1, 2017 for operating years (OY) 2019 through 2028. The 2017 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 two years of the study, up to 169 aMW, with annual energy deficits, as large as -308 aMW in 2027, over the rest of the study period. These annual energy deficits projections are similar to those projected in the 2016 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 -884 MW to -1,346 MW. These 120-Hour capacity deficits are larger than those presented in the 2016 White Book, mainly due to higher peak load obligation in this forecast. 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 existing resources to serve the region’s load. The decommissioning of existing resources, the availability of uncommitted PNW Independent Power Producer (IPP) generation, and new resource additions are key variables in the results of this analysis. The results are summarized below:
  - **Annual Energy Surplus/Deficits:** Under critical water conditions; the PNW region is projected to have annual energy surpluses as large as 4,088 aMW in OY 2019, slowly decreasing to 465 aMW by OY 2028. These annual energy projections show slightly larger surpluses than those presented in the 2016 White Book. Under average water conditions; the PNW region would see even larger energy surpluses over the study horizon.

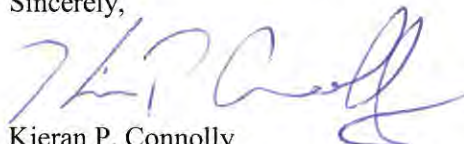
- January 120-Hour Capacity Surplus/Deficits: Under critical water conditions; the PNW region is projected to have a January 120-Hour capacity surplus of 41 MW in OY 2019, and with deficits over the rest of the study period, growing to a deficit of -4,175 MW by OY 2028. These projections show smaller January 120-Hour capacity deficits than those shown in the 2016 White Book. Under average water conditions; the PNW region has January 120-Hour capacity surpluses through the final year of this study.

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. These other studies were not updated and therefore are not included in the 2017 White Book.

The 2017 White Book is available on BPA's website: [www.bpa.gov/goto/whitebook](http://www.bpa.gov/goto/whitebook) or from BPA's Visitor Center, which you can reach toll-free at 800-622-4520 (or 503-230-4636). Details regarding regional loads, contracts, and generating resources are available in the 2017 Technical Appendix available only in electronic format on BPA's website: [www.bpa.gov/goto/whitebook](http://www.bpa.gov/goto/whitebook)

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

Sincerely,



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Enclosure

**2017 PACIFIC NORTHWEST LOADS AND RESOURCES STUDY**  
*The White Book*

**BONNEVILLE POWER ADMINISTRATION**  
December 2017

**Cover Picture:**

Hungry Horse Dam is on the South Fork of the Flathead River, 15 miles south of the west entrance to Glacier National Park and 20 miles northeast of Kalispell, Montana.

The dam site is a deep, narrow canyon about five miles southeast of the South Fork's confluence with the main Flathead River. The [Hungry Horse Project](#) is in the Flathead National Forest, Flathead County, Montana.

The 564-foot-high dam is a variable-thickness concrete arch structure with a crest length of 2,115 ft. The dam and appurtenant works contain 3,086,200 cubic yards of concrete. The spillway is the highest morning-glory structure in the world. Water cascading over the spillway rim drops a maximum distance of 490 feet. The capacity of the spillway is 50,000 cubic feet per second, and the reservoir has a total capacity of 3,468,000 acre-feet.

Power generating facilities are housed in a building with a structural steel framework surmounting a reinforced concrete substructure 394 feet long, 76 feet wide, and 157 feet high, constructed across the river channel at the downstream toe of the dam and four generators 107 MW each for a total plant capacity of 428 MW.

In 1995, a selective withdrawal system was installed on all four unit penstock intakes. This selective withdrawal system is used from the first of June to the end of September to increase the water discharge temperature to reduce the thermal shock for downstream fisheries and increasing aquatic insect communities for Bull Trout growth and reproduction.

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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:**

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### **Bulk Marketing and Transmission Services:**

Long Term Sales and Purchasing Group

### **NW Requirements Marketing:**

### **Office of General Counsel**

### **Power Services Business Operations**

## 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 2019 through 2028). 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).

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) (1-Hour peak megawatts are only presented 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 29.

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. 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. These studies have not been updated and, therefore, are not included in this document.

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<sup>1/</sup> Operating Year (OY) is the time frame August 1 through July 31. For example, OY 2019 is August 1, 2018 through July 31, 2019.

This 2017 White Book is published in three documents: 1) this document, the 2017 Loads and Resources Summary (commonly referred to as the White Book), provides BPA's deterministic Federal system and PNW regional loads and resources used for long-term planning; 2) the 2017 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 2017 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 not available in print, however are available electronically at:

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

The total retail load, contract, and generation forecasts used in this study were updated as of June 1, 2017. This document supersedes the 2016 White Book.

### **Load Obligations**

The load obligations for the Federal system and PNW region contain multiple components in this study, load obligation forecasts are categorized as follows: 1) Total Retail Loads (TRL), defined as each individual utility's retail electric power consumption on its system, 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 sales delivered to Northwest Federal agencies, Public bodies and cooperative agencies, and Tribal utility preference customers as directed under the Northwest Electric Power Planning and Conservation Act (Act), 16 U.S.C. 839 et seq., 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 the impacts of climate change. Contract obligations not associated with BPA's Regional Dialogue contracts follow individual contract terms through the life of the 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:

### Hydro resources

- 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.

### Other resources

- 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. Forecasts are adjusted to not reflect economic dispatch but to show actual operational capabilities and expectations.
- 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: 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 from 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 forecasts 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, below. The reserve forecasts included in this 2017 White Book are consistent with BPA's BP-18 Rate Proceeding Final 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 on a monthly basis, 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 over a year or 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, the 14-period results are referred to as "monthly" in this report.

HYDSIM studies incorporate current power and non-power operating requirements, including those described in the U.S. Fish and Wildlife Service (USFWS) 2000 FCRPS BiOp regarding bull trout and Kootenai River white sturgeon, published December 20, 2000; the USFWS 2006 Libby Dam BiOp regarding bull trout, Kootenai River white sturgeon, and Kootenai Sturgeon Critical Habitat, published February 18, 2006; National Oceanographic and Atmospheric Administration (NOAA) Fisheries FCRPS 2008 Biological Opinion (BiOp) regarding salmon and steelhead, published May 5, 2008; the NOAA Fisheries FCRPS 2010 Supplemental BiOp, published May 20, 2010; the NOAA Fisheries FCRPS 2014 Supplemental BiOp, published January 17, 2014; 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. This coordination agreement terminates on September 15, 2024 and is not expected to be extended; BPA will continue to use the most up to date operational information available for these power projects.

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 2017 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 of 10 years' notice. Neither Canada nor the United States have provided notice of termination; therefore, this study assumes the Treaty continues 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 10.

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 ( $6 \times 5 \times 4 = 120$  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 hydro system is unable to sustain full hydro capacity because there is often more hydro generating capability than available water supply. For this reason, the 120-Hour capacity analysis 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 2017 White Book includes updated forecasts of Federal system power sales contract (PSC) obligations, PNW regional Total Retail Loads, contracts, and generation as of June 1, 2017. Notable updates include:

- Regional Dialogue PSC product switch changes elected by customers were incorporated in this study:
  - Klickitat PUD from Slice/Block to Load Following (October 1, 2017),
  - Seattle City Light from Slice/Block to Block-only (October 1, 2017), and
  - Okanogan PUD from Slice/Block to Block-only (October 1, 2019).
- No changes have been made regarding possible future modifications to the Treaty or 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:

- Changes to hydro system operations in response to Endangered Species Act requirements or other environmental considerations;
- Natural variations in weather affecting 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 or 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 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.

## 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 2019 through 2028. 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 2017 Loads and Resources Technical Appendix, Volume 1, Energy Analysis, which provides annual and monthly energy in aMW; and the 2017 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 cooperative utilities, tribal utilities, 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 all considered 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 federal statutes to provide Federal Reserve Power to several irrigation facilities and districts associated with USBR projects in the PNW. These irrigation districts are congressionally authorized to receive reserve power from specific FCRPS projects as part of USBR project authorization.

Regional Dialogue CHWM PSC obligations to Public & Federal agency customers: In December 2008, BPA executed Regional Dialogue Contract High Water Mark (RD CHWM) PSCs with its Federal agency, Public agency and public cooperative, and Tribal utility customers under which BPA is obligated to provide firm power deliveries from October 1, 2011, through September 30, 2028. Three types of products were offered to customers: Load Following, Slice/Block, and Block. Of the 136 Public agency and public cooperative customers who have signed Regional Dialogue Contracts; 120 are currently Load Following, 14 are Slice/Block, and two are Block only customers.

Under these RD CHWM PSCs, customers must make periodic elections of how to serve their Above Rate Period 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 2024, this study assumes that the current elections continue through the study period. Based on this assumption, Federal system RD CHWM PSC obligation forecasts include elected and forecasted A-RHWM load for the study period. Table 2-1, below, presents the A-RHWM load included in BPA’s obligations by FY to be consistent with the BP-18 Rate Proceeding Final Proposal.

**Table 2-1**

**Federal System  
Annual Above-Rate High Water Mark (A-RHWM) Obligations  
FY 2019 through 2028**

Energy (aMW)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
A-RHWM Obligations	121	119	138	151	167	181	198	204	205	203

IOU Load Service under Regional Dialogue 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 RD PSCs for FY 2011 through 2028; however, no IOUs have chosen to take power service under these contracts and no net requirements power sales are assumed for the IOUs through the study period. If requested and based on the notice requirement, BPA would serve any net requirements of an IOU at the New Resource Firm Power rate.

DSI contracts: BPA is currently making direct federal 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 87.6 aMW and expected to remain at that level through the study period.

Other Contract Obligations: BPA provides Federal power under a variety of contract arrangements not included under its Regional Dialogue PSCs 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 determined 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).

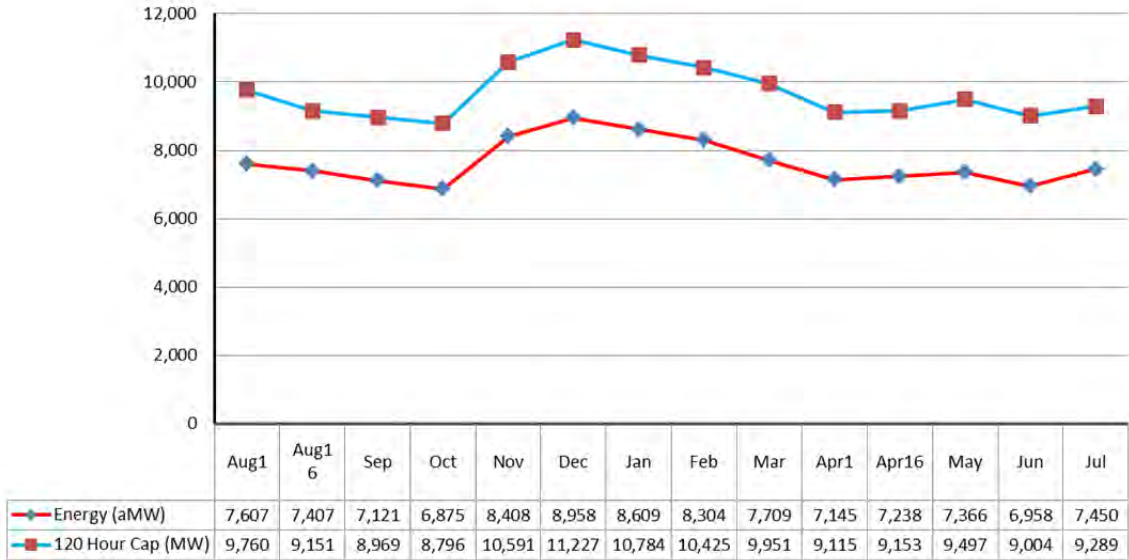
With the exception of BPA’s Treaty-related contracts and Regional Dialogue PSCs, forecasts of BPA’s contract deliveries follow individual contract terms and are not assumed to be renewed after expiration. Treaty and Regional Dialogue PSC power deliveries are assumed to remain in place through the study 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. At a high level BPA forecasts represent; higher loads in the winter (November through February), due to lower temperatures that increase residential heating loads; lower loads during the summer and early fall when temperatures are mild. July and August loads tend to be slightly higher than the rest of the summer due to increased PNW residential air conditioning loads. Table 2-2, page 16, illustrates the monthly shape of the forecasted Federal system firm load obligations for OY 2019. 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 2019**



**Conservation:** The PSC obligation forecasts developed by ALF are expected loads and are based on historic retail load consumption, adjusted for additional BPA-funded conservation identified by individual customers.



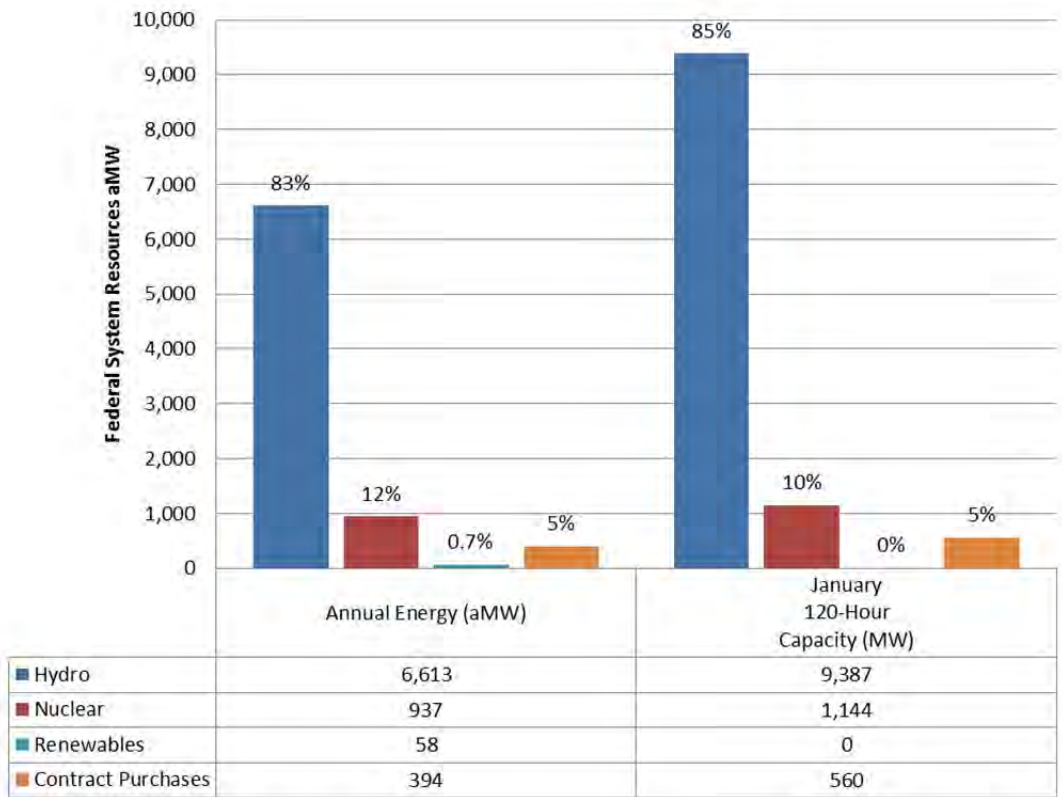
## **Resources**

In the PNW, BPA is a 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 resources and certain non-Federal generating resources whose output BPA has acquired under contracts 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, page 18, summarizes BPA's resources and contract purchases available to meet the Federal system load obligations. For OY 2019, the Federal system resources are forecast to produce 8,002 annual aMW of generation, under 1937-critical water conditions. Federal system energy resources are comprised of approximately 82.6 percent hydro, 11.7 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 2019  
1937-Critical Water Conditions**



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 20, 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 10.
- Federal System Non-Hydro Resources: Federal system non-hydro resources are generating resources whose output have been purchased by BPA. Table 2-5, page 21, 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 outside the PNW region (Imports), to meet Federal system load obligations. These contract purchases, presented in Table 2-5, page 21, 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, and these returns are also treated as Federal system resources. With the exception of deliveries 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 2019**

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	22.4	16.9	20.8	20.4
2. Bonneville <sup>c/</sup>	1938	USACE	18	1,195	943	610	556	390
3. Chief Joseph	1955	USACE	27	2,614	2,401	1,552	1,355	1,116
4. Dworshak	1974	USACE	3	465	164	290	216	140
5. Grand Coulee / GCL Pumping	1941	USBR	27	6,735	4,491	2,764	2,396	1,908
	1973		6	314				
6. Hungry Horse	1952	USBR	4	428	344	114	87	74
7. Ice Harbor	1961	USACE	6	693	583	315	212	109
8. John Day	1968	USACE	16	2,480	2,342	1,482	1,097	784
9. Libby	1975	USACE	5	605	487	266	227	187
10. Little Goose	1970	USACE	6	930	926	428	296	160
11. Lower Granite	1975	USACE	6	930	703	409	284	147
12. Lower Monumental	1969	USACE	6	930	922	446	308	149
13. McNary	1953	USACE	14	1,120	1,117	741	633	478
14. The Dalles	1957	USACE	22	2,052	1,673	1,054	823	599
15. Idled Federal Capacity	-	-	-	-	-7,550	-	-	-
<b>16. Total Regulated Hydro Projects</b>			<b>169</b>	<b>21,540</b>	<b>9,569</b>	<b>10,487</b>	<b>8,512</b>	<b>6,261</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	3.9	13.5	12.2	9.9
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	5.5	6.1	6.3	5.6
22. Cougar	1964	USACE	2	28	6.4	18.1	19.9	19.0
23. Cowlitz Falls	1994	LCPD#1	2	70	10.0	40.3	27.7	26.2
24. Detroit	1953	USACE	2	115	11.4	62.1	49.0	41.3
25. Dexter	1955	USACE	1	17	3.4	11.4	11.2	9.2
26. Foster	1968	USACE	2	23	4.2	14.7	11.9	12.3
27. Green Peter	1967	USACE	2	92	7.7	39.3	29.3	27.4
28. Green Springs	1960	USBR	1	18	6.9	7.3	7.3	7.3
29. Hills Creek	1962	USACE	2	34	3.8	21.7	22.5	17.8
30. Lookout Point	1954	USACE	3	138	7.8	45.8	41.1	35.7
31. Lost Creek	1975	USACE	2	56	18.5	43.5	45.4	30.1
32. Minidoka	1909	USBR	4	28	2.3	22.5	16.6	11.2
33. Palisades	1957	USBR	4	176	11.4	96.2	84.1	69.2
34. Roza	1958	USBR	1	13	2.6	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>113</b>	<b>480</b>	<b>420</b>	<b>349</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>209</b>	<b>22,441</b>	<b>9,687</b>	<b>10,970</b>	<b>8,935</b>	<b>6,613</b>

<sup>a/</sup> This is the maximum 120-Hour hydro generation for January 2019 assuming 1937-critical water conditions

<sup>b/</sup> Firm energy is the 12-month annual average for OY 2019 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 2019**

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	937
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	21.21095517
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	0.003421804
10. White Bluffs Solar	2002	Solar	Energy Northwest	0	0
<b>11. Total Federal System Non-Hydro Resources (sum lines 1 through 10)</b>				<b>1,144</b>	<b>995</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	122
16. Slice Transmission Loss Return				56	30
<b>17. Total Federal System Contract Purchases (sum lines 12 through 16)</b>				<b>676</b>	<b>379</b>
<b>18. Total Federal System Non-Hydro Resources and Contract Purchases (line 11 + line 17)</b>				<b>1,820</b>	<b>1,374</b>

<sup>a/</sup> This is the maximum generation for January 2019

<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**

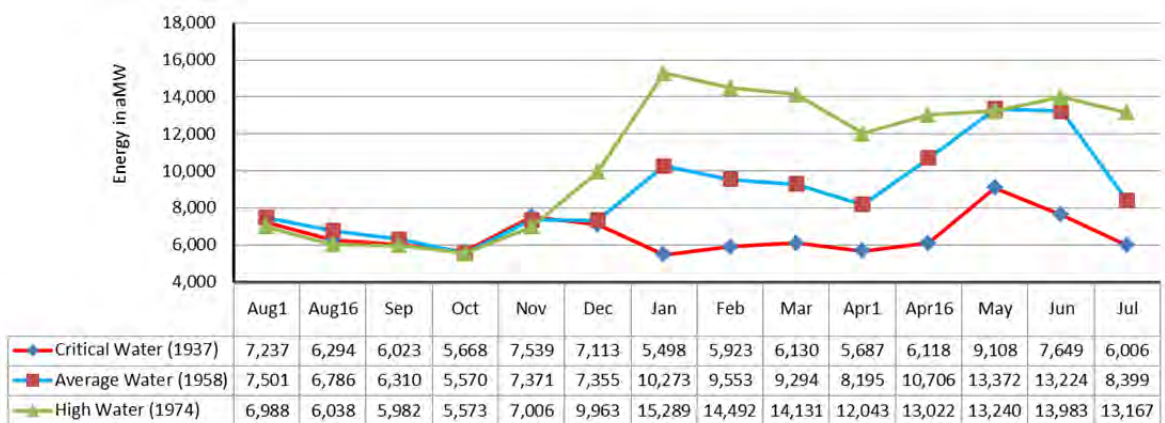
**Federal System  
Variability of Annual Hydro Generation  
OY 2019 through 2028  
Under Different Water Conditions**



In OY 2019, annual Federal system hydro energy generation is forecasted to be 6,613 aMW under 1937-critical water conditions. However, under the high streamflow condition (represented by 1974-water conditions), these same Federal system hydro resources would generate 10,971 aMW. Table 2-6, page 22, shows the annual variability of Federal system hydro generation, and Table 2-7, below, shows the monthly variability of the Federal system hydro generation for OY 2019, 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. Annual water volume variability does not have a substantial impact on generation from the Federal system hydro resources from August through November. Hydro generation can vary by up to almost 9,800 aMW in a single month depending on project operations and the availability of water.

**Table 2-7**

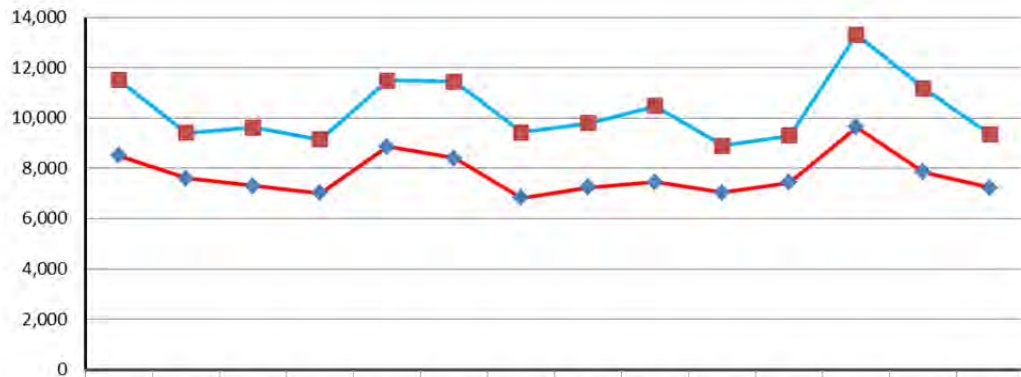
**Federal System  
Variability of Monthly Hydro Generation  
OY 2019  
Under Different Water Conditions**



**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 2019, 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 Federal System Generation  
OY2019 Energy and 120-Hour Capacity  
Under 1937-Critical Water Conditions**



	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Energy (aMW)	8,495	7,597	7,308	7,017	8,854	8,413	6,827	7,245	7,448	7,038	7,444	9,633	7,861	7,232
120 Hour Cap (MW)	11,496	9,416	9,621	9,154	11,495	11,451	9,438	9,798	10,477	8,893	9,303	13,313	11,174	9,329



## 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 two years, and modest but growing 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 45, for OY 2019 through 2028. The Federal system monthly energy loads and resources are shown in Exhibit 4-2, page 49, for OY 2019 through 2028. The details of these components for OY 2019 through 2028 are presented in the 2017 Loads and Resources Study Technical Appendix, Volume 1: Energy Analysis.

**Table 2-9**

**Federal System  
Annual Energy Surplus/Deficit  
OY 2019 through 2028  
1937-Critical Water Conditions**

Energy (aMW)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Surplus/Deficit	60	169	-94	-60	-238	-105	-275	-142	-308	-180

Table 2-10, below, compares the 2017 White Book Federal system annual firm energy surplus/deficits results to those from the 2016 White Book. The 2017 White Book shows larger annual energy surpluses in the first two years and larger annual energy deficits over the rest of the study period. These results reflect changes in both load obligations and Federal system generation.

**Table 2-10**

**Federal System  
Annual Energy Surplus/Deficit Comparison  
OY 2019 through 2028  
1937-Critical Water Conditions**

Energy (aMW)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
2017 White Book	60	169	-94	-60	-238	-105	-275	-142	-308	-180
2016 White Book	28	168	-75	-37	-203	-74	-241	-112	-267	n/a
<i>Difference (2017 WBK - 2016 WBK)</i>	32	0	-19	-23	-35	-31	-34	-30	-41	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, throughout the study period. The detailed components of the Federal system January 120-Hour capacity loads and resources for OY 2019 through 2028 are shown in Exhibit 4-3, page 53. The Federal system monthly 120-Hour capacity loads and resources are shown in Exhibit 4-4, page 57, for OY 2019. The details of these components for OY 2019 through 2028 are presented in the 2017 Loads and Resources Study Technical Appendix, Volume 2: Capacity Analysis.

**Table 2-11**

**Federal System  
January 120-Hour Capacity Surplus/Deficit  
OY 2019 through 2028  
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Surplus/Deficit	-1,346	-884	-939	-1054	-1150	-1132	-1220	-1183	-1311	-1283

Table 2-12, below, compares the 2017 White Book January firm 120-Hour capacity surplus/deficit results to those from the 2016 White Book. This study shows larger January 120-Hour capacity deficits, mainly due to increased peak load obligations that resulted from Regional Dialogue Product Switching.

**Table 2-12**

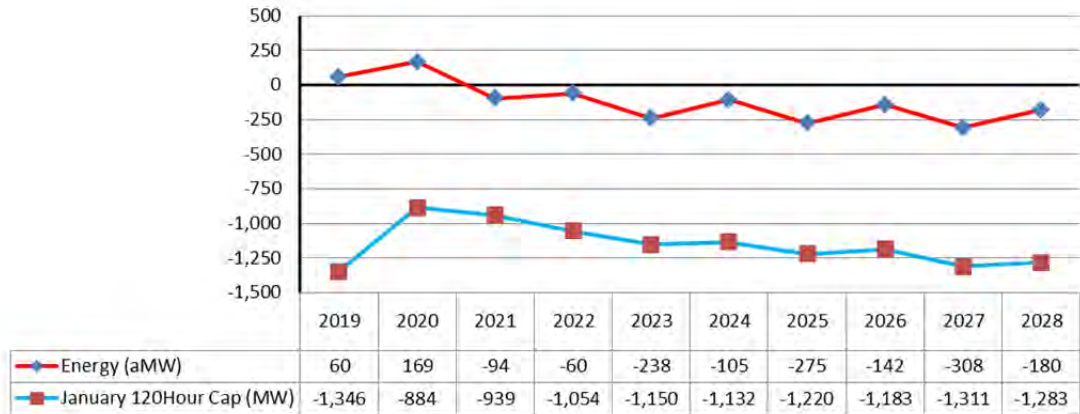
**Federal System  
January 120-Hour Capacity Surplus/Deficit Comparison  
OY 2019 through 2028  
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
2017 White Book	-1,346	-884	-939	-1054	-1150	-1132	-1220	-1183	-1311	-1283
2016 White Book	-736	-659	-665	-809	-812	-856	-800	-862	-863	n/a
<i>Difference</i> <i>(2017 WBK - 2016 WBK)</i>	-610	-225	-274	-245	-338	-276	-420	-321	-448	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, as high as 169 aMW in OY 2020, and annual deficits as high as -308 aMW in OY 2027. The January firm 120-Hour capacity forecasts show the Federal system is deficit throughout the study period, ranging from -1,346 MW in OY 2019, to -1,283 MW in OY 2028. 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 2019 through 2028  
1937-Critical Water Conditions**

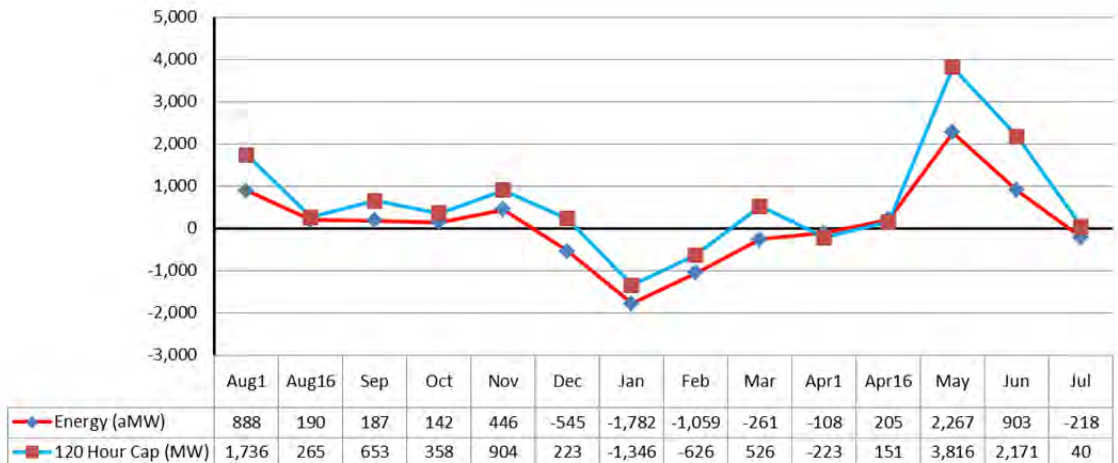


Federal System Monthly Surplus/Deficit: Table 2-14, below, graphically presents the Federal system monthly firm energy and 120-Hour capacity surplus/deficits for OY 2019. Forecasts for energy and 120-Hour capacity maintain similar monthly shapes over the study period. This shows that for each month the 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.

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

Table 2-14

**Federal System  
Monthly Energy and 120-Hour Capacity Surplus/Deficit  
OY 2019  
1937-Critical Water Conditions**



**Conclusion**

Under 1937 critical water conditions 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 62 aMW in OY 2019 to deficits as high as -303 aMW in OY 2027. The Federal system generally shows large monthly energy deficits in the winter and surpluses during the spring runoff in May and June.

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 energy analysis, the 120-Hour capacity analysis has large deficits during the winter and surpluses during the spring runoff (May and June), under 1937-water conditions.

As water conditions improve, the Federal system surplus/deficit forecasts can vary greatly. As an example, the annual energy surpluses can increase by almost 3,300 aMW under better water conditions, while the monthly surplus/deficits position can vary by more than 7,300 aMW (January). Similarly, Federal system 120-Hour capacity surplus/deficits for OY 2019 can vary by almost 5,900 MW in January depending on water condition.

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 61.

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

The PNW Regional Analysis is an operating year analysis that provides BPA's deterministic forecast of the PNW region's loads and resources over a 10-year period from OY 2019 through 2028. 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 30, shows the forecasted composition of PNW regional load for OY 2019. 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 2019**

Customer Class	Energy (aMW)	Percent of Energy	January 120-Hour Capacity (MW)	Percent of Capacity
Federal Agency	134	1%	221	1%
USBR	180	1%	300	1%
Cooperative	2,057	9%	3,318	9%
Municipality	2,627	11%	4,314	12%
Public Utility District	4,814	20%	7,667	21%
Investor-Owned Utility	12,481	52%	18,514	51%
Marketer	4	0%	4	0%
Direct-Service Industry <sup>1</sup>	411	2%	423	1%
<b>Total Retail Load</b>	<b>22,709</b>	<b>95%</b>	<b>34,760</b>	<b>96%</b>
Exports	1,159	5%	1,421	4%
<b>Regional Load</b>	<b>23,868</b>	<b>100%</b>	<b>36,181</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.

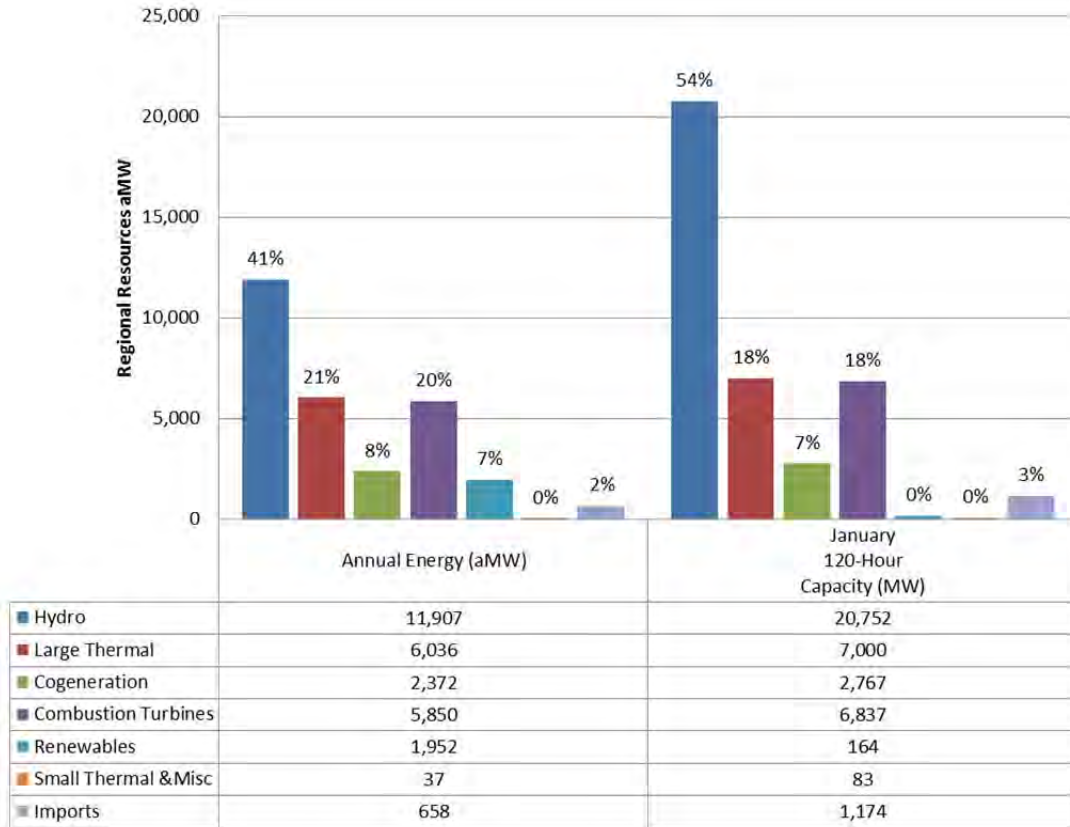
## **Regional Resources**

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, page 32, 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. New regional generating projects are included when those resources begin operating or are under construction and have a scheduled on-line date, similarly, 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 2019, regional firm energy resources are comprised of approximately 41 percent hydro, 21 percent large thermal, 20 percent combustion turbines, 8 percent cogeneration, 7 percent renewables (mainly comprised of wind), and 2 percent imports.

**Table 3-2**

**PNW Region  
Generation by Resource Type  
OY 2019  
1937-Critical Water Conditions**



**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 2019, annual firm energy generation from regional hydro projects is forecasted to be 11,907 aMW. This represents about 41 percent of region’s resources. However, the generating potential from regional hydro projects can annually vary by more than 7,000 aMW depending on water conditions.

**Table 3-3**

**PNW Region  
Variability of Annual Hydro Generation  
OY 2019 through 2028  
Under Different Water Conditions**

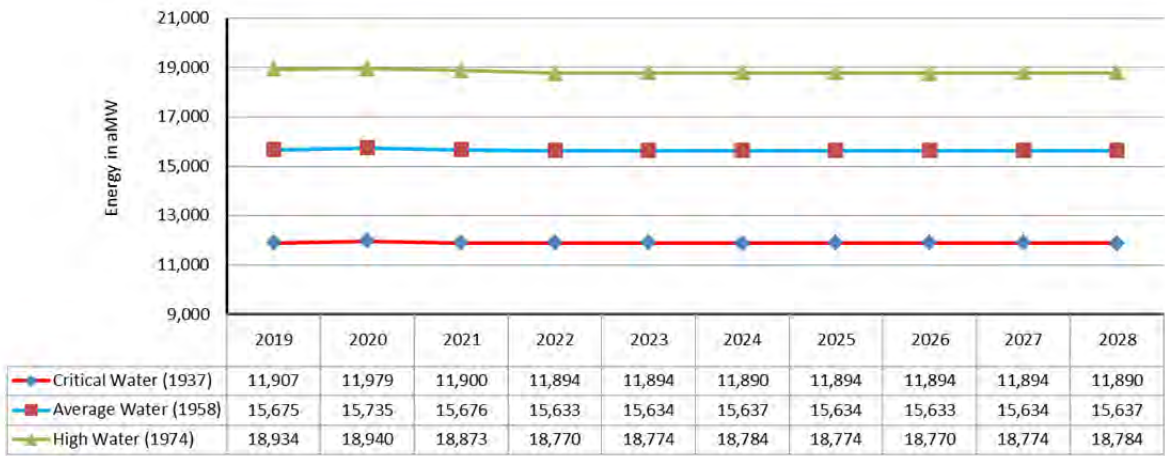
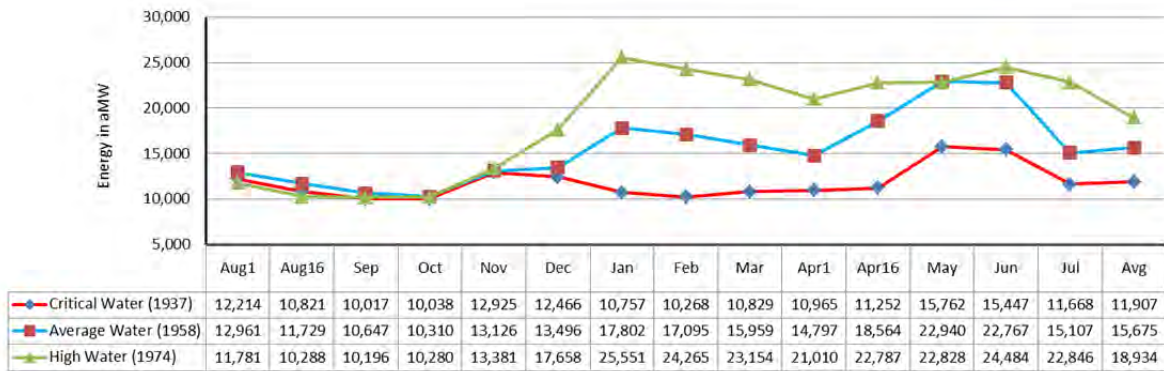


Table 3-4, below, shows the monthly variability of the region’s hydro generation under the same three water conditions. High generation levels in the December through mid-April period is largely due to drafting reservoirs for power production and flood control, which can vary widely due to rainfall and 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 almost 15,000 aMW depending on project operations and the availability of water.

**Table 3-4**

**PNW Region  
 Variability of Monthly Hydro Generation  
 OY 2019  
 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 2019. 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 35, details the region's uncommitted IPP projects, the associated fuel types. If uncommitted IPP generation is secured for long-term periods by load serving entities, within the region or outside the region, the IPP forecasts will be updated in future studies to reflect these changes. Table 3-6, page 36, details the regions total uncommitted IPP annual energy and January capacity generation forecasts over the OY 2019 through 2028 study period.

**Table 3-5**

**PNW Region  
Uncommitted Independent Power Producer Projects  
OY 2019**

<b>Project</b>	<b>Annual Energy (aMW)</b>	<b>January 120-Hour Capacity (MW)</b>	<b>Fuel Type</b>
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
Stateline	8	0	Wind
Vansycle	23	0	Wind
Weyerhaeuser Longview	35	44	Wood Waste
<b>Total Uncommitted IPP Generation</b>	<b>2,782</b>	<b>2,941</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 2019 through 2028**

Regional Uncommitted IPP	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Annual Energy (aMW)	2,782	2,789	2,398	2,230	2,272	2,307	2,308	2,138	2,065	2,097
January 120-Hour Capacity (MW)	2,941	2,952	2,282	2,337	2,337	2,337	2,337	2,047	2,047	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 2019) is available to serve the region's loads. The individual components of the PNW regional annual energy loads and resources for OY 2019 through 2028 are shown in Exhibit 5-1, page 67. The PNW regional monthly energy loads and resources for OY 2019 are shown in Exhibit 5-2, page 71. The details of these components for OY 2019 through 2028 are presented in the 2017 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 2019 through 2028  
1937-Critical Water Conditions**

Energy (aMW)	2019	2019	2020	2021	2022	2023	2024	2025	2026	2028
Surplus/Deficit	4,088	4,032	3,017	2,372	1,721	1,779	1,347	918	505	465

Table 3-8, below, compares the 2017 White Book PNW regional annual firm energy surplus/deficit forecasts to the 2016 White Book results. The PNW region continues to have annual energy surpluses through the study period. When compared to the 2016 White Book, the 2017 study shows larger annual energy surpluses. The larger annual energy surpluses are primarily driven by lower total retail load forecasts.

**Table 3-8**

**PNW Region  
Annual Energy Surplus/Deficit Comparison  
Assuming 100% of Uncommitted IPP Generation is Available to the Region  
OY 2019 through 2028  
1937-Critical Water Conditions**

Energy (aMW)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
2017 White Book	4088	4032	3017	2372	1721	1779	1347	918	505	465
2016 White Book	3839	3782	2707	2009	1323	1312	798	240	-293	n/a
<i>Difference (2017 WBK – 2016 WBK)</i>	<i>249</i>	<i>250</i>	<i>311</i>	<i>363</i>	<i>399</i>	<i>467</i>	<i>548</i>	<i>678</i>	<i>798</i>	<i>n/a</i>

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, pages 35 and 36.

**Table 3-9**

**PNW Region  
Variability of Annual Energy Surplus/Deficit  
Assuming Different Levels of Uncommitted IPP Generation  
OY 2019 through 2028  
1937-Critical Water Conditions**

Energy (aMW)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
100% IPP	4,088	4,032	3,017	2,372	1,721	1,779	1,347	918	505	465
50% IPP	2,697	2,638	1,819	1,257	585	625	193	-151	-527	-583
0% IPP	1,306	1,243	620	142	-551	-529	-961	-1,220	-1,560	-1,632

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 through OY 2020 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 2019 through 2028 are shown in Exhibit 5-3, page 75. The monthly PNW regional 120-Hour capacity loads and resources for OY 2019 are shown in Exhibit 5-4, page 79. The component details for OY 2019 through 2028 are presented in the 2017 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 2019 through 2028  
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Surplus/Deficit	41	308	-1,185	-1,666	-2,331	-2,599	-2,840	-3,765	-4,019	-4,175

Table 3-11, below, compares the 2017 White Book January firm 120-Hour capacity forecast to the 2016 White Book results. Regional January 120-Hour capacity surplus/deficits show a larger surplus in OY 2019 and smaller deficits through the rest of the study. This reduction, as compared to the 2016 White Book, is mainly the result of lower forecasted load growth rates in the newest TRL forecasts from ALF.

**Table 3-11**

**PNW Region  
January 120-Hour Capacity Surplus/Deficit Comparison  
Assuming 100% of Uncommitted IPP Generation is Available to the Region  
OY 2019 through 2028  
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
2017 White Book	41	308	-1185	-1666	-2331	-2599	-2840	-3765	-4019	-4175
2016 White Book	-198	-189	-1755	-2349	-3054	-3436	-3754	-4907	-5255	n/a
<i>Difference (2017 WBK - 2016 WBK)</i>	239	497	570	684	723	837	914	1,143	1,235	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, pages 35 and 36.

**Table 3-12**

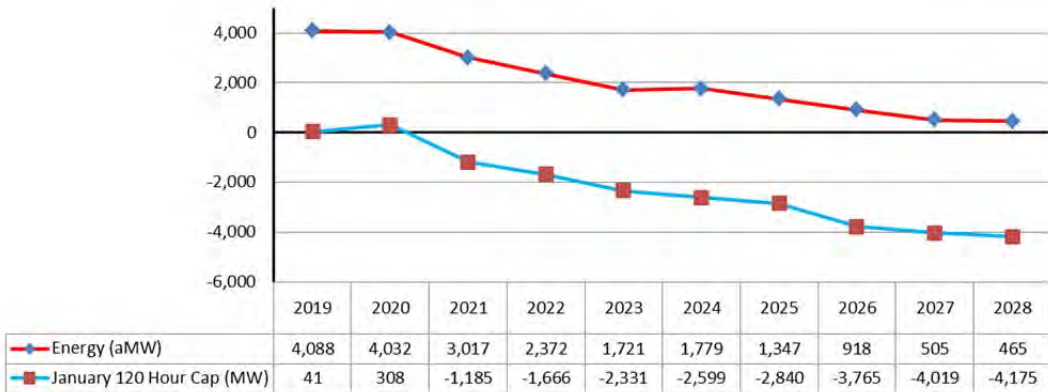
**PNW Region  
Variability of January 120-Hour Capacity Surplus/Deficit  
Assuming Different Levels of Uncommitted IPP Generation  
OY 2019 through 2028  
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
100% IPP	41	308	-1,185	-1,666	-2,331	-2,599	-2,840	-3,765	-4,019	-4,175
50% IPP	-1,430	-1,168	-2,326	-2,834	-3,499	-3,767	-4,008	-4,788	-5,043	-5,198
0% IPP	-2,900	-2,644	-3,467	-4,003	-4,668	-4,936	-5,177	-5,812	-6,066	-6,221

Regional Annual Surplus/Deficit: Table 3-13, below, 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 surplus of 465 aMW, while January 120-Hour capacity becomes deficit in OY 2021 and finishes the study period with a deficit of -4,175 MW. The declines over the study period in surplus/deficit position, for both annual energy and January 120-Hour capacity are primarily driven by the annual load growth across the regional combined with 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 2019 through 2028  
1937-Critical Water Conditions**

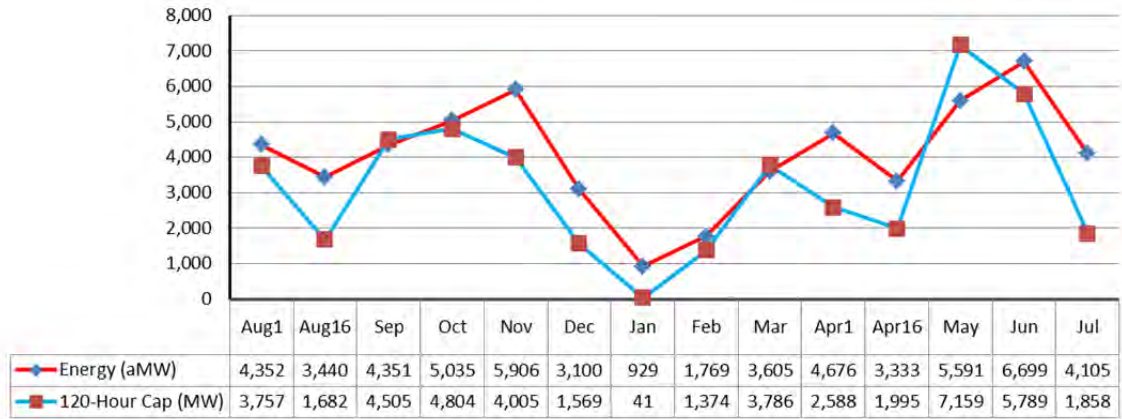




**Regional Monthly Surplus/Deficit:** Table 3-14, below, graphically presents the monthly energy and 120-Hour capacity surplus/deficit forecasts for OY 2019. These forecasts assume 100 percent availability of the PNW's uncommitted IPP generation to serve regional loads. This monthly view shows the variability 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 2019  
1937-Critical Water Conditions**



## **Conclusion**

The PNW region is projected to have annual firm energy surpluses through 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 2020. 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 83. Additional monthly and annual details for OY 2019 through 2028 are presented in the 2017 Loads and Resources Study Technical Appendix, Volume 1: Energy Analysis and the 2017 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 resource 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 2019 to 2028  
Using 1937-Water Conditions**

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**Loads and Resources - Federal System**  
**Operating Year: 2019 to 2028 Water Year: 1937**  
**2017 White Book Report Date: 6/1/2017**

S149-WB-20171215-145200

Energy-aMW	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
<b>Firm Obligations</b>										
<b>1 Load Following</b>	3481	3529	3575	3595	3609	3621	3638	3649	3653	3654
2 Preference Customers	3177	3214	3256	3277	3291	3304	3319	3329	3333	3334
3 Federal Agencies	125	135	138	138	138	138	139	140	140	141
4 USBR	180	179	180	180	180	179	180	180	180	179
5 Federal Diversity	0	0	0	0	0	0	0	0	0	0
<b>6 Tier 1 Block</b>	515	538	543	542	543	542	543	542	543	542
7 Tier 1 Block	515	538	543	542	543	542	543	542	543	542
<b>8 Slice</b>	3072	3077	3058	3070	3060	3072	3067	3081	3071	3082
9 Slice Block	1507	1472	1503	1480	1509	1485	1516	1494	1523	1500
10 Slice Output from T1 System	1565	1605	1554	1590	1551	1587	1551	1587	1548	1582
<b>11 Direct Service Industries</b>	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6
12 Direct Service Industry	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6	87.6
<b>13 Contract Deliveries</b>	547	479	478	477	477	477	477	477	477	477
14 Exports	486	464	466	466	466	466	466	466	466	466
15 Intra-Regional Transfers (Out)	61.5	15.1	11.9	10.7	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>7703</b>	<b>7710</b>	<b>7741</b>	<b>7772</b>	<b>7776</b>	<b>7799</b>	<b>7812</b>	<b>7837</b>	<b>7832</b>	<b>7843</b>
<b>Net Resources</b>										
<b>18 Hydro Resources</b>	6613	6669	6628	6632	6632	6631	6632	6632	6632	6631
19 Regulated Hydro - Net	6261	6318	6276	6280	6280	6279	6280	6280	6280	6279
20 Independent Hydro - Net	349	349	349	349	349	349	349	349	349	349
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>	995	1158	992	1151	972	1133	970	1133	957	1102
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	937	1100	937	1100	937	1100	937	1100	937	1100
26 Renewable Resources	57.9	57.9	54.6	50.6	34.8	33.0	33.0	33.0	19.8	1.90
27 Small Thermal & Misc.	0	0	0	0	0	0	0	0	0	0
<b>28 Contract Purchases</b>	394	295	263	167	167	168	167	168	167	167
29 Imports	89.9	90.0	84.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00
30 Intra-Regional Transfers (In)	138	37.6	12.4	0	0	0	0	0	0	0
31 Non-Federal CER	137	137	137	136	137	137	137	137	137	136
32 Slice Transmission Loss Return	29.8	30.5	29.6	30.2	29.5	30.2	29.5	30.2	29.4	30.1
33 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0
<b>34 Reserves &amp; Losses</b>	-239	-243	-236	-238	-233	-237	-233	-237	-232	-236
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: 2019 to 2028 Water Year: 1937**  
**2017 White Book Report Date: 6/1/2017 *Continued***

S149-WB-20171215-145200

Energy-aMW	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
<sup>39</sup> Transmission Losses	-239	-243	-236	-238	-233	-237	-233	-237	-232	-236
<sup>40</sup> <b>Total Net Resources</b>	<b>7763</b>	<b>7879</b>	<b>7647</b>	<b>7712</b>	<b>7538</b>	<b>7694</b>	<b>7537</b>	<b>7695</b>	<b>7524</b>	<b>7663</b>
<sup>41</sup> <b>Total Surplus/Deficit</b>	<b>60</b>	<b>169</b>	<b>-94</b>	<b>-60</b>	<b>-238</b>	<b>-105</b>	<b>-275</b>	<b>-142</b>	<b>-308</b>	<b>-180</b>



**Exhibit 4-2: Monthly Energy**

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**Federal System Analysis Surplus Deficit  
Operating Year 2019  
Using 1937-Water Conditions**

**Loads and Resources - Federal System**  
**Operating Year: 2019 Water Year: 1937**  
**2017 White Book Report Date: 6/1/2017**

S149-WB-20171215-145200

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>	3528	3531	3198	3003	3479	3918	3869	3666	3256	3317	3317	3322	3473	3748	3481
2 Preference Customers	3116	3119	2840	2783	3319	3732	3699	3503	3061	2950	2950	2885	3016	3229	3177
3 Federal Agencies	102	102	95.8	112	141	165	160	148	128	112	112	105	108	120	125
4 USBR	310	309	263	108	19.8	21.3	10.4	14.9	66.6	254	254	332	349	400	180
5 Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>6 Tier 1 Block</b>	343	343	578	485	795	782	849	799	765	382	382	121	0	291	515
7 Tier 1 Block	343	343	578	485	795	782	849	799	765	382	382	121	0	291	515
<b>8 Slice</b>	3040	2833	2749	2798	3431	3561	3195	3146	3068	2824	2917	3357	2919	2828	3072
9 Slice Block	1338	1338	1289	1379	1601	1829	1822	1676	1550	1439	1439	1386	1355	1422	1507
10 Slice Output from T1 System	1702	1495	1460	1419	1830	1732	1374	1470	1518	1385	1478	1971	1564	1406	1565
<b>11 Direct Service Industries</b>	87.5	87.5	87.4	88.0	87.8	87.7	87.9	87.5	87.6	87.9	87.9	87.4	87.3	87.2	87.6
12 Direct Service Industry	87.5	87.5	87.4	88.0	87.8	87.7	87.9	87.5	87.6	87.9	87.9	87.4	87.3	87.2	87.6
<b>13 Contract Deliveries</b>	609	612	508	501	614	608	608	605	532	534	534	479	478	495	547
14 Exports	594	598	494	487	483	479	478	476	464	464	464	464	464	480	486
15 Intra-Regional Transfers (Out)	14.8	14.8	13.7	13.9	131	130	130	129	67.4	70.0	70.0	14.5	14.4	15.8	61.5
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>7607</b>	<b>7407</b>	<b>7121</b>	<b>6875</b>	<b>8408</b>	<b>8958</b>	<b>8609</b>	<b>8304</b>	<b>7709</b>	<b>7145</b>	<b>7238</b>	<b>7366</b>	<b>6958</b>	<b>7450</b>	<b>7703</b>
<b>Net Resources</b>															
<b>18 Hydro Resources</b>	7237	6294	6023	5668	7539	7113	5498	5923	6130	5687	6118	9108	7649	6006	6613
19 Regulated Hydro - Net	6872	5933	5681	5359	7279	6937	5381	5791	5897	5249	5672	8386	6938	5597	6261
20 Independent Hydro - Net	362	358	340	307	257	172	113	128	230	435	442	719	708	407	349
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	434	78.5	1070	995
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	355	0	994	937
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>	381	379	355	421	423	410	414	402	398	379	381	389	377	379	394

**Loads and Resources - Federal System**  
**Operating Year: 2019 Water Year: 1937**  
**2017 White Book** Report Date: 6/1/2017 *Continued*

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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	64.3	116	115	114	115	115	115	65.4	65.4	65.0	64.9	65.0	89.9
<sup>30</sup> Intra-Regional Transfers (In)	145	146	131	141	136	129	134	122	120	149	149	148	149	148	138
<sup>31</sup> Non-Federal CER	138	139	132	138	138	134	139	137	134	138	138	139	133	139	137
<sup>32</sup> Slice Transmission Loss Return	32.4	28.4	27.8	27.0	34.8	32.9	26.1	27.9	28.9	26.3	28.1	37.5	29.7	26.7	29.8
<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>-262</b>	<b>-235</b>	<b>-225</b>	<b>-217</b>	<b>-272</b>	<b>-259</b>	<b>-210</b>	<b>-223</b>	<b>-229</b>	<b>-217</b>	<b>-229</b>	<b>-298</b>	<b>-244</b>	<b>-224</b>	<b>-239</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	-262	-235	-225	-217	-272	-259	-210	-223	-229	-217	-229	-298	-244	-224	-239
<b><sup>40</sup> Total Net Resources</b>	<b>8495</b>	<b>7597</b>	<b>7308</b>	<b>7017</b>	<b>8854</b>	<b>8413</b>	<b>6827</b>	<b>7245</b>	<b>7448</b>	<b>7038</b>	<b>7444</b>	<b>9633</b>	<b>7861</b>	<b>7232</b>	<b>7763</b>
<b><sup>41</sup> Total Surplus/Deficit</b>	<b>888</b>	<b>190</b>	<b>187</b>	<b>142</b>	<b>446</b>	<b>-545</b>	<b>-1,782</b>	<b>-1,059</b>	<b>-261</b>	<b>-108</b>	<b>205</b>	<b>2,267</b>	<b>903</b>	<b>-218</b>	<b>60</b>

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

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**Federal System Analysis Surplus Deficit  
Operating Year 2019 to 2028  
Using 1937-Water Conditions**

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**Loads and Resources - Federal System**  
**Operating Year: 2019 to 2028 Water Year: 1937**  
**2017 White Book Report Date: 6/1/2017**

S149-WB-20171215-145200

January 120Hr-MW	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
<b>Firm Obligations</b>										
<b>1 Load Following</b>	4641	4733	4872	4930	4965	4993	5026	5043	5111	5126
2 Preference Customers	5417	5493	5528	5553	5569	5583	5602	5629	5651	5668
3 Federal Agencies	213	225	226	227	225	226	229	231	232	233
4 USBR	300	300	300	300	300	300	300	300	300	300
5 Federal Diversity	-1288	-1284	-1182	-1149	-1128	-1116	-1104	-1118	-1072	-1075
<b>6 Tier 1 Block</b>	849	893	893	892	893	894	892	892	893	894
7 Tier 1 Block	849	893	893	892	893	894	892	892	893	894
<b>8 Slice</b>	3666	3749	3831	3798	3844	3812	3854	3815	3860	3829
9 Slice Block	1821	1758	1806	1764	1813	1777	1821	1783	1831	1796
10 Slice Output from T1 System	1845	1992	2026	2033	2031	2035	2032	2032	2029	2032
<b>11 Direct Service Industries</b>	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3
12 Direct Service Industry	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3	90.3
<b>13 Contract Deliveries</b>	1537	1175	1158	1158	1158	1158	1158	1158	1158	1158
14 Exports	1363	1142	1142	1142	1142	1142	1142	1142	1142	1142
15 Intra-Regional Transfers (Out)	173	33.2	16.4	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>10784</b>	<b>10640</b>	<b>10844</b>	<b>10868</b>	<b>10950</b>	<b>10947</b>	<b>11020</b>	<b>10997</b>	<b>11111</b>	<b>11097</b>
<b>Net Resources</b>										
<b>18 Hydro Resources</b>	9387	9852	10009	10045	10033	10052	10040	10037	10024	10040
19 Regulated Hydro - Net	9269	9734	9891	9927	9915	9934	9922	9919	9906	9922
20 Independent Hydro - Net	113	113	113	113	113	113	113	113	113	113
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>	560	430	414	289	289	289	289	289	289	289
29 Imports	126	126	126	1.00	1.00	1.00	1.00	1.00	1.00	1.00
30 Intra-Regional Transfers (In)	150	16.8	0	0	0	0	0	0	0	0
31 Non-Federal CER	240	239	239	239	239	239	239	239	239	239
32 Slice Transmission Loss Return	44.4	47.9	48.8	48.9	48.9	49.0	48.9	48.9	48.8	48.9
33 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0
<b>34 Reserves &amp; Losses</b>	-1653	-1669	-1662	-1664	-1666	-1671	-1673	-1656	-1657	-1659
35 Contingency Reserves (Spinning)	-351	-361	-355	-358	-359	-361	-363	-354	-354	-355
36 Contingency Reserves (Non-Spinning)	-351	-361	-355	-358	-359	-361	-363	-354	-354	-355
37 Load Following Reserves	-361	-346	-346	-346	-346	-346	-346	-346	-346	-346
38 Generation Imbalance Reserves	-258	-258	-258	-258	-258	-258	-258	-258	-258	-258

**Loads and Resources - Federal System**  
**Operating Year: 2019 to 2028 Water Year: 1937**  
**2017 White Book Report Date: 6/1/2017 *Continued***

S149-WB-20171215-145200

January 120Hr-MW	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
<sup>39</sup> Transmission Losses	-331	-343	-348	-345	-344	-345	-344	-345	-344	-345
<sup>40</sup> <b>Total Net Resources</b>	<b>9438</b>	<b>9756</b>	<b>9905</b>	<b>9814</b>	<b>9800</b>	<b>9814</b>	<b>9800</b>	<b>9814</b>	<b>9800</b>	<b>9814</b>
<sup>41</sup> <b>Total Surplus/Deficit</b>	<b>-1,346</b>	<b>-884</b>	<b>-939</b>	<b>-1,054</b>	<b>-1,150</b>	<b>-1,132</b>	<b>-1,220</b>	<b>-1,183</b>	<b>-1,311</b>	<b>-1,283</b>



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

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**Federal System Analysis Surplus Deficit  
Operating Year 2019  
Using 1937-Water Conditions**

**Loads and Resources - Federal System**  
**Operating Year: 2019 Water Year: 1937**  
**2017 White Book Report Date: 6/1/2017**

S149-WB-20171215-145200

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>	4158	4037	3713	3656	4227	4686	4641	4396	4030	4090	4032	3835	3994	4356
2 Preference Customers	4197	4197	3918	4158	4816	5422	5417	5124	4619	4413	4413	4067	4069	4329
3 Federal Agencies	132	132	128	150	188	212	213	196	177	148	148	137	141	149
4 USBR	611	611	534	409	252	369	300	301	390	455	455	541	584	624
5 Federal Diversity	-781	-903	-866	-1061	-1029	-1317	-1288	-1224	-1155	-926	-985	-910	-800	-747
<b>6 Tier 1 Block</b>	343	343	578	485	795	782	849	799	765	382	382	121	0	291
7 Tier 1 Block	343	343	578	485	795	782	849	799	765	382	382	121	0	291
<b>8 Slice</b>	3588	3102	3145	3151	3932	4130	3666	3603	3632	3131	3228	4099	3570	3187
9 Slice Block	1338	1338	1288	1379	1601	1829	1821	1676	1550	1439	1439	1386	1355	1422
10 Slice Output from T1 System	2250	1764	1856	1773	2331	2301	1845	1927	2082	1693	1789	2714	2215	1765
<b>11 Direct Service Industries</b>	89.5	89.5	89.2	90.1	90.1	89.8	90.3	89.7	90.0	90.3	90.3	90.0	89.4	89.4
12 Direct Service Industry	89.5	89.5	89.2	90.1	90.1	89.8	90.3	89.7	90.0	90.3	90.3	90.0	89.4	89.4
<b>13 Contract Deliveries</b>	1581	1581	1443	1412	1547	1539	1537	1537	1434	1421	1421	1351	1351	1366
14 Exports	1554	1554	1417	1386	1374	1366	1363	1363	1338	1324	1324	1324	1324	1340
15 Intra-Regional Transfers (Out)	26.2	26.2	26.2	26.2	173	173	173	173	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>9760</b>	<b>9151</b>	<b>8969</b>	<b>8796</b>	<b>10591</b>	<b>11227</b>	<b>10784</b>	<b>10425</b>	<b>9951</b>	<b>9115</b>	<b>9153</b>	<b>9497</b>	<b>9004</b>	<b>9289</b>
<b>Net Resources</b>														
<b>18 Hydro Resources</b>	11533	9328	9547	9030	11544	11532	9387	9763	10474	8786	9221	13427	12351	9242
19 Regulated Hydro - Net	10960	8764	9022	8554	11123	11197	9269	9533	10084	8168	8588	12608	11507	8633
20 Independent Hydro - Net	569	560	522	472	417	330	113	225	385	613	629	815	840	605
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	0	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	0	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>	556	545	526	560	571	566	560	555	548	538	540	562	550	539

**Loads and Resources - Federal System**  
**Operating Year: 2019    Water Year: 1937**  
**2017 White Book    Report Date: 6/1/2017    *Continued***

S149-WB-20171215-145200

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)	188	188	167	153	150	145	150	142	132	182	182	182	182	182
<sup>31</sup> Non-Federal CER	238	238	238	239	239	240	240	240	240	239	239	239	239	239
<sup>32</sup> Slice Transmission Loss Return	54.2	42.4	44.7	42.7	56.1	55.4	44.4	46.4	50.1	40.7	43.0	65.3	53.3	42.5
<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>-1721</b>	<b>-1584</b>	<b>-1586</b>	<b>-1573</b>	<b>-1760</b>	<b>-1785</b>	<b>-1653</b>	<b>-1661</b>	<b>-1688</b>	<b>-1569</b>	<b>-1596</b>	<b>-1816</b>	<b>-1727</b>	<b>-1582</b>
<sup>35</sup> Contingency Reserves (Spinning)	-348	-316	-314	-316	-369	-382	-351	-349	-351	-319	-325	-364	-357	-317
<sup>36</sup> Contingency Reserves (Non-Spinning)	-348	-316	-314	-316	-369	-382	-351	-349	-351	-319	-325	-364	-357	-317
<sup>37</sup> Load Following Reserves	-360	-360	-360	-361	-361	-361	-361	-361	-361	-361	-361	-361	-361	-361
<sup>38</sup> Generation Imbalance Reserves	-260	-260	-260	-257	-258	-258	-258	-258	-258	-258	-258	-258	-258	-258
<sup>39</sup> Transmission Losses	-405	-332	-338	-322	-403	-402	-331	-344	-368	-312	-327	-469	-394	-329
<b><sup>40</sup> Total Net Resources</b>	<b>11496</b>	<b>9416</b>	<b>9621</b>	<b>9154</b>	<b>11495</b>	<b>11451</b>	<b>9438</b>	<b>9798</b>	<b>10477</b>	<b>8893</b>	<b>9303</b>	<b>13313</b>	<b>11174</b>	<b>9329</b>
<b><sup>41</sup> Total Surplus/Deficit</b>	<b>1,736</b>	<b>265</b>	<b>653</b>	<b>358</b>	<b>904</b>	<b>223</b>	<b>-1,346</b>	<b>-626</b>	<b>526</b>	<b>-223</b>	<b>151</b>	<b>3,816</b>	<b>2,171</b>	<b>40</b>

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

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**Federal System Analysis Surplus Deficit  
Operating Year 2019**

**Federal Report Surplus Deficit By Water Year**

**Operating Year 2019**

**2017 White Book Report Date: 6/1/2017**

S149-WB-20171215-145200

Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
1 1929 Federal Report Surplus Deficit	1537	1452	-61.9	144	217	-516	-637	-704	-56.6	-429	1207	1603	1380	-511	233
2 1930 Federal Report Surplus Deficit	713	139	400	216	362	-481	-1490	-385	-185	552	2029	1084	-738	1015	128
3 1931 Federal Report Surplus Deficit	1094	267	229	141	389	-342	-1040	-1478	-519	294	-469	1955	-418	858	42.2
4 1932 Federal Report Surplus Deficit	1009	313	40.7	33.5	-0.06	-426	-1874	-1535	1246	4004	4883	5482	4614	2038	1237
5 1933 Federal Report Surplus Deficit	1357	1199	723	107	-207	886	2047	2313	2303	1786	2108	3490	6172	4275	2109
6 1934 Federal Report Surplus Deficit	2881	2079	525	834	2514	4513	4928	4490	4919	4955	4737	4007	3019	1364	3197
7 1935 Federal Report Surplus Deficit	423	30.8	70.2	43.5	-575	-515	1733	1824	2214	373	2348	2896	2308	2791	1197
8 1936 Federal Report Surplus Deficit	2436	471	-132	148	165	-824	-1478	-713	58.5	583	4053	5415	4103	1341	992
9 1937 Federal Report Surplus Deficit	888	190	187	142	446	-545	-1782	-1059	-261	-108	205	2267	903	-218	60.3
10 1938 Federal Report Surplus Deficit	909	100	169	152	299	334	1362	1838	2441	3340	5648	4946	3336	2295	1844
11 1939 Federal Report Surplus Deficit	399	-45.3	475	100	116	-629	286	126	545	1672	3374	3257	679	1050	727
12 1940 Federal Report Surplus Deficit	813	108	345	171	534	-305	483	28.3	3054	1886	2681	2955	569	830	957
13 1941 Federal Report Surplus Deficit	363	-183	190	-61.9	274	-0.25	-847	-533	12.6	-326	778	2333	664	811	268
14 1942 Federal Report Surplus Deficit	1022	272	395	-43.4	784	888	1691	1143	1433	614	2406	2804	2787	2815	1406
15 1943 Federal Report Surplus Deficit	1441	912	917	98.2	-287	-110	2366	2034	2693	5459	5872	4092	5761	4150	2374
16 1944 Federal Report Surplus Deficit	2202	892	89.3	54.4	285	-538	-546	-364	-330	-528	907	890	-785	83.0	50.7
17 1945 Federal Report Surplus Deficit	1032	13.1	92.9	44.8	248	-385	-1260	-817	-275	-425	-933	3719	3746	-34.0	414
18 1946 Federal Report Surplus Deficit	687	129	151	42.4	371	244	1140	1154	2212	3946	5673	5081	3422	3375	1869
19 1947 Federal Report Surplus Deficit	1712	1142	562	75.9	448	3036	3477	3102	3314	2732	3074	4946	3699	2885	2490
20 1948 Federal Report Surplus Deficit	1551	743	335	2411	1627	1635	3291	2098	2251	2058	4345	6025	5784	3794	2805
21 1949 Federal Report Surplus Deficit	3224	2394	888	456	136	403	1143	807	3139	2902	4915	5496	3602	416	1939
22 1950 Federal Report Surplus Deficit	353	-377	97.2	-14.4	81.9	-113	2967	3637	3436	4214	3934	4158	5812	5074	2421
23 1951 Federal Report Surplus Deficit	3232	2312	727	1133	1962	3176	4687	4858	5433	4609	4592	5103	3609	3915	3494
24 1952 Federal Report Surplus Deficit	2253	772	401	1931	954	1735	2926	2530	2354	4434	6024	6189	4079	2675	2709
25 1953 Federal Report Surplus Deficit	1466	423	-173	112	12.6	-742	588	1873	1534	772	1872	3612	6150	4489	1638
26 1954 Federal Report Surplus Deficit	2241	1196	508	396	443	1127	2787	2935	3313	2343	3080	4930	4915	5021	2567
27 1955 Federal Report Surplus Deficit	3539	3299	2475	522	1047	1059	229	339	-161	231	1622	3163	5905	4801	1984
28 1956 Federal Report Surplus Deficit	2932	1438	268	687	1550	3062	4488	4556	4502	3882	5822	6035	5599	4041	3479
29 1957 Federal Report Surplus Deficit	2840	1938	523	627	111	1276	1414	823	2112	3686	2850	6355	5909	2034	2245
30 1958 Federal Report Surplus Deficit	1086	561	379	67.7	319	-363	1812	1673	2120	1779	3658	5477	5100	1583	1806
31 1959 Federal Report Surplus Deficit	1361	371	108	284	1014	2523	3963	3764	3794	3285	2880	4120	5163	4364	2748
32 1960 Federal Report Surplus Deficit	2946	2348	2827	3148	2586	2360	2181	1720	2243	5917	4188	2999	4336	2800	2909
33 1961 Federal Report Surplus Deficit	1722	413	72.0	336	324	558	1895	2459	3851	2551	2530	4762	5142	1903	2071
34 1962 Federal Report Surplus Deficit	1498	601	160	-77.3	281	278	1523	1636	520	4271	5452	4142	3066	1971	1611
35 1963 Federal Report Surplus Deficit	1409	891	6.63	881	1119	2205	2432	1845	1537	605	1957	3501	3091	2563	1805
36 1964 Federal Report Surplus Deficit	1356	574	655	14.2	122	509	431	525	615	2880	1808	3827	5935	4618	1716
37 1965 Federal Report Surplus Deficit	2902	2073	1154	1040	780	3331	5141	5850	4846	1973	5712	5306	4075	2691	3367
38 1966 Federal Report Surplus Deficit	2511	2004	130	557	247	799	1136	1121	809	4356	2644	2294	2738	2714	1526

**Federal Report Surplus Deficit By Water Year**

**Operating Year 2019**

**2017 White Book** Report Date: **6/1/2017** *Continued*

S149-WB-20171215-145200

Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
39 1967 Federal Report Surplus Deficit	2071	441	133	24.8	27.2	1080	3298	3374	3405	1542	185	3514	5565	4183	2221
40 1968 Federal Report Surplus Deficit	2328	1499	528	453	508	820	2592	2367	2656	259	1310	2023	4505	3136	1854
41 1969 Federal Report Surplus Deficit	2194	1310	1652	1167	1630	1744	3967	4572	3632	4255	5428	5862	4355	2865	3158
42 1970 Federal Report Surplus Deficit	1163	498	281	450	384	-125	1693	1471	1700	935	1693	3644	5368	1039	1500
43 1971 Federal Report Surplus Deficit	1108	323	126	42.7	192	327	4278	5522	4612	4176	4682	5916	5808	4571	3027
44 1972 Federal Report Surplus Deficit	3049	2801	746	651	321	1127	4165	4931	6156	5552	3537	5722	5563	4549	3444
45 1973 Federal Report Surplus Deficit	3338	3007	879	590	322	758	1457	317	319	-1071	930	2289	24.3	780	914
46 1974 Federal Report Surplus Deficit	686	-18.7	115	70.5	43.8	1600	5589	5392	5761	4676	5402	5378	5671	5172	3336
47 1975 Federal Report Surplus Deficit	3134	2981	801	-42.1	245	-187	1845	1999	2480	766	1692	4619	5958	4895	2245
48 1976 Federal Report Surplus Deficit	2297	1762	948	1292	1885	4041	4011	3651	4574	4696	4450	5932	4555	4220	3479
49 1977 Federal Report Surplus Deficit	3813	3827	3325	654	305	-515	-380	-105	-122	-837	434	503	-918	136	547
50 1978 Federal Report Surplus Deficit	1003	73.0	-390	-324	322	715	1467	1580	1508	4119	3043	4452	2525	2782	1562
51 1979 Federal Report Surplus Deficit	1085	346	1786	677	321	-390	781	-178	1773	452	2149	4303	2021	-194	1082
52 1980 Federal Report Surplus Deficit	721	125	360	91.0	281	-812	336	-64.1	249	1814	3273	5626	4593	1732	1283
53 1981 Federal Report Surplus Deficit	583	143	410	43.3	229	2202	3467	3290	1567	-586	1874	3595	5612	3828	2098
54 1982 Federal Report Surplus Deficit	3112	2210	522	298	581	836	2670	5489	5700	3991	3623	5466	5720	5074	3221
55 1983 Federal Report Surplus Deficit	3043	2713	1574	1193	625	1350	3272	3650	4634	3073	2836	4538	4585	4295	2961
56 1984 Federal Report Surplus Deficit	3107	1632	879	469	2182	1642	2595	2924	2994	4566	5057	4710	5490	3769	2896
57 1985 Federal Report Surplus Deficit	2578	1034	860	532	616	726	905	850	815	2668	3707	3820	1838	799	1396
58 1986 Federal Report Surplus Deficit	192	-476	285	58.5	1609	914	2388	3159	5560	4575	5150	3401	3624	1766	2278
59 1987 Federal Report Surplus Deficit	938	235	-26.8	-125	492	809	519	-240	1335	124	1619	3692	1691	116	818
60 1988 Federal Report Surplus Deficit	354	-325	17.2	47.0	230	-799	-901	-1282	61.9	-81.5	1517	2042	418	1091	147
61 1989 Federal Report Surplus Deficit	905	168	103	-15.0	546	-62.5	-408	-700	1298	1877	5243	3549	2112	616	933
62 1990 Federal Report Surplus Deficit	536	7.84	186	172	436	1166	2014	2442	2780	1689	4710	2780	4323	2438	1843
63 1991 Federal Report Surplus Deficit	2294	1662	120	-46.8	1882	1930	3021	2828	3264	2777	2433	3759	4065	4167	2464
64 1992 Federal Report Surplus Deficit	3088	1769	97.1	210	296	-740	-13.9	105	1557	-743	852	1980	-13.7	147	515
65 1993 Federal Report Surplus Deficit	595	-112	-129	98.6	407	-342	-1182	-1392	669	906	2005	4161	2861	1051	669
66 1994 Federal Report Surplus Deficit	1001	433	408	164	572	-151	-1415	-796	-210	-133	1429	2899	1777	860	461
67 1995 Federal Report Surplus Deficit	758	-37.0	209	99.2	-102	-351	744	1450	2528	1083	1773	3301	4715	2105	1370
68 1996 Federal Report Surplus Deficit	937	377	726	951	2867	5263	5271	5556	5900	4200	5781	5498	4639	4250	3872
69 1997 Federal Report Surplus Deficit	2910	1764	513	354	509	1805	5547	5800	6037	4523	5835	5806	5655	4526	3660
70 1998 Federal Report Surplus Deficit	2788	2864	1542	2610	1481	729	1368	1414	1455	1489	2762	5689	5460	2664	2453
71 1999 Federal Report Surplus Deficit	1863	556	126	126	-96.7	1498	4012	4316	4854	2854	4211	4168	5448	4578	2806
72 2000 Federal Report Surplus Deficit	3577	2927	910	327	2376	2265	1936	2027	2178	3953	5232	4389	1618	2313	2350
73 2001 Federal Report Surplus Deficit	1613	-14.2	-117	137	175	-502	-590	-384	2.28	-613	654	1422	-1399	295	-7.26
74 2002 Federal Report Surplus Deficit	1062	-23.1	-318	-390	257	-231	-632	-374	605	1605	4127	3253	5084	3512	1182
75 2003 Federal Report Surplus Deficit	1337	546	367	231	484	-346	-621	-749	1763	1590	2358	3160	4171	759	1016
76 2004 Federal Report Surplus Deficit	473	-305	-184	44.0	667	189	270	-509	1069	940	1878	2920	1772	1100	743
77 2005 Federal Report Surplus Deficit	849	441	1081	649	238	1048	1174	1194	299	-503	1425	3470	2268	1523	1172

**Federal Report Surplus Deficit By Water Year**

**Operating Year 2019**

**2017 White Book** Report Date: **6/1/2017** *Continued*

S149-WB-20171215-145200

Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
78 2006 Federal Report Surplus Deficit	1057	17.1	263	-227	366	768	2310	2953	2424	4559	5270	5349	4891	2064	2206
79 2007 Federal Report Surplus Deficit	634	146	-96.3	218	596	275	1848	1538	2808	3246	2394	3485	2884	2399	1597
80 2008 Federal Report Surplus Deficit	852	-33.7	-247	227	617	-540	-11.1	308	690	1076	223	4650	6153	2893	1319
<b>Ranked Averages</b>															
81 <b>Bottom 10 pct</b>	<b>1096</b>	<b>302</b>	<b>117</b>	<b>103</b>	<b>297</b>	<b>-465</b>	<b>-979</b>	<b>-774</b>	<b>-159</b>	<b>-155</b>	<b>854</b>	<b>1699</b>	<b>3.32</b>	<b>428</b>	<b>115</b>
82 <b>Middle 80 pct</b>	<b>1667</b>	<b>903</b>	<b>502</b>	<b>378</b>	<b>574</b>	<b>640</b>	<b>1519</b>	<b>1575</b>	<b>2101</b>	<b>2192</b>	<b>3073</b>	<b>4048</b>	<b>3889</b>	<b>2512</b>	<b>1804</b>
83 <b>Top 10 pct</b>	<b>2368</b>	<b>1564</b>	<b>650</b>	<b>772</b>	<b>1240</b>	<b>2926</b>	<b>4862</b>	<b>5074</b>	<b>5401</b>	<b>4264</b>	<b>5141</b>	<b>5597</b>	<b>4921</b>	<b>4170</b>	<b>3516</b>



# **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 2019 to 2028  
Using 1937-Water Conditions**

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**Loads and Resources - Pacific Northwest Region**  
**Operating Year: 2019 to 2028 Water Year: 1937**  
**2017 White Book Report Date: 6/1/2017**

S149-WB-20171215-145200

Energy-aMW	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
<b>Regional Loads</b>										
<b>1 Retail Loads</b>	22709	22979	23260	23492	23717	23915	24115	24244	24362	24462
2 Federal Agency	134	145	148	148	148	148	149	150	150	151
3 USBR	180	179	180	180	180	179	180	180	180	179
4 Cooperative	2057	2143	2234	2322	2408	2490	2548	2561	2571	2579
5 Municipality	2627	2671	2699	2705	2711	2717	2727	2736	2745	2754
6 Public Utility District	4814	4856	4908	4956	5001	5037	5076	5107	5130	5147
7 Investor-Owned Utility	12481	12569	12676	12765	12854	12928	13020	13094	13170	13236
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	411	411	411	411	411	411	411	411	411	411
10 Federal Diversity	0	0	0	0	0	0	0	0	0	0
<b>11 Exports</b>	1159	1136	1138	1044	1015	985	984	984	984	984
12 Canada	473	464	466	466	466	466	466	466	466	466
13 East Continental Divide	2.46	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14 Inland Southwest	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
15 Pacific Southwest	670	657	658	563	534	504	503	503	503	503
16 Other	0	0	0	0	0	0	0	0	0	0
<b>17 Total Regional Loads</b>	<b>23868</b>	<b>24115</b>	<b>24399</b>	<b>24536</b>	<b>24732</b>	<b>24900</b>	<b>25100</b>	<b>25228</b>	<b>25346</b>	<b>25445</b>
<b>Regional Resources</b>										
<b>18 Hydro Resources</b>	11907	11979	11900	11894	11894	11890	11894	11894	11894	11890
19 Regulated Hydro - Net	10596	10668	10614	10618	10618	10616	10618	10618	10618	10616
20 Independent Hydro - Net	1062	1061	1037	1026	1026	1025	1026	1026	1026	1025
21 Small Hydro - Net	248	249	250	250	250	249	250	250	250	249
<b>22 Other Resources</b>	16246	16368	15695	15257	14786	15017	14771	14458	14150	14211
23 Cogeneration Resources	2372	2374	2381	2371	2374	2381	2372	2373	2381	2372
24 Combustion Turbine Resources	5850	5852	5855	5853	5813	5811	5810	5809	5809	5811
25 Large Thermal Resources	6036	6152	5473	5047	4614	4840	4603	4290	3975	4044
26 Renewable Resources	1952	1953	1950	1949	1949	1949	1950	1949	1949	1947
27 Small Thermal & Miscellaneous	36.6	36.6	36.6	36.6	36.6	36.6	36.6	36.6	36.6	36.6
<b>28 Imports</b>	658	662	660	580	584	588	591	595	599	603
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	484	487	491	494	498	502	506	509	513	517
32 Pacific Southwest	136	136	131	47.1	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>	-856	-862	-839	-824	-810	-817	-809	-800	-791	-793
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	-856	-862	-839	-824	-810	-817	-809	-800	-791	-793
<b>40 Total Regional Resources</b>	<b>27956</b>	<b>28147</b>	<b>27416</b>	<b>26908</b>	<b>26454</b>	<b>26679</b>	<b>26446</b>	<b>26146</b>	<b>25851</b>	<b>25911</b>
<b>41 Total Surplus/Deficit</b>	<b>4088</b>	<b>4032</b>	<b>3017</b>	<b>2372</b>	<b>1721</b>	<b>1779</b>	<b>1347</b>	<b>918</b>	<b>505</b>	<b>465</b>

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**Exhibit 5-2: Monthly Energy**

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**Regional Analysis Surplus Deficit  
Operating Year 2019  
Using 1937-Water Conditions**

**Loads and Resources - Pacific Northwest Region**  
**Operating Year: 2019 Water Year: 1937**  
**2017 White Book Report Date: 6/1/2017**

S149-WB-20171215-145200

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>	22760	22781	21098	20517	23195	25453	25325	24318	22112	21346	21346	21030	21960	23429	22709
2 Federal Agency	114	114	107	123	148	172	168	156	136	124	124	117	119	131	134
3 USBR	310	309	263	108	19.8	21.3	10.4	14.9	66.6	254	254	332	349	400	180
4 Cooperative	2090	2091	1855	1754	2041	2305	2277	2181	1926	1912	1912	1963	2109	2269	2057
5 Municipality	2379	2381	2304	2449	2829	3112	3117	2982	2731	2552	2552	2358	2341	2393	2627
6 Public Utility District	4591	4594	4367	4399	5070	5622	5595	5352	4851	4617	4617	4335	4409	4585	4814
7 Investor-Owned Utility	12861	12876	11787	11268	12671	13805	13743	13216	11986	11471	11471	11511	12218	13236	12481
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	411	411	411	412	412	412	412	411	411	412	412	411	411	411	411
10 Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>11 Exports</b>	1238	1437	1275	982	1161	1009	786	951	994	1379	1249	1294	1345	1456	1159
12 Canada	553	558	464	464	464	464	464	464	464	464	464	464	464	480	473
13 East Continental Divide	6.80	6.80	6.80	6.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.46
14 Inland Southwest	9.27	13.9	12.9	10.4	14.9	11.3	6.07	10.0	11.5	20.6	17.4	18.6	18.4	18.0	13.6
15 Pacific Southwest	668	859	792	501	681	532	315	476	518	893	766	810	862	957	670
16 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>17 Total Regional Loads</b>	<b>23997</b>	<b>24218</b>	<b>22373</b>	<b>21500</b>	<b>24356</b>	<b>26461</b>	<b>26112</b>	<b>25269</b>	<b>23106</b>	<b>22725</b>	<b>22595</b>	<b>22324</b>	<b>23305</b>	<b>24884</b>	<b>23868</b>
<b>Regional Resources</b>															
<b>18 Hydro Resources</b>	12214	10821	10017	10038	12925	12466	10757	10268	10829	10965	11252	15762	15447	11668	11907
19 Regulated Hydro - Net	10881	9495	8790	8963	11972	11471	9924	9363	9704	9362	9626	13740	13388	10100	10596
20 Independent Hydro - Net	1002	997	978	909	819	868	713	776	962	1322	1337	1608	1628	1143	1062
21 Small Hydro - Net	331	329	248	167	135	127	120	129	163	282	289	414	431	425	248
<b>22 Other Resources</b>	16386	17067	16968	16727	17492	17130	16404	16891	16091	16769	14963	12456	14787	17471	16246
23 Cogeneration Resources	2466	2466	2432	2468	2545	2575	2533	2555	1889	2090	1909	2161	2396	2459	2372
24 Combustion Turbine Resources	6030	6118	6182	6242	6372	6450	6456	6393	6339	6219	5210	3451	4444	6113	5850
25 Large Thermal Resources	6426	6426	6426	6426	6426	6426	6426	6426	6140	5562	5365	4206	5341	6319	6036
26 Renewable Resources	1434	2028	1893	1553	2113	1643	952	1481	1684	2863	2443	2598	2569	2543	1952
27 Small Thermal & Miscellaneous	30.4	30.5	36.1	38.3	36.1	37.5	37.7	36.8	38.1	36.0	35.8	40.7	36.6	35.3	36.6
<b>28 Imports</b>	616	616	558	581	771	870	707	706	608	506	506	552	689	738	658
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	531	531	479	445	438	472	444	458	432	411	411	459	586	647	484



**Loads and Resources - Pacific Northwest Region**

**Operating Year: 2019 Water Year: 1937**

**2017 White Book** Report Date: 6/1/2017 *Continued*

S149-WB-20171215-145200

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	63.3	115	295	348	201	178	114	64.4	64.4	64.0	63.9	64.0	136
<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>	-868	-847	-818	-812	-926	-905	-828	-828	-818	-839	-794	-854	-918	-887	-856
<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	-868	-847	-818	-812	-926	-905	-828	-828	-818	-839	-794	-854	-918	-887	-856
<sup>40</sup> <b>Total Regional Resources</b>	<b>28349</b>	<b>27658</b>	<b>26725</b>	<b>26535</b>	<b>30262</b>	<b>29562</b>	<b>27041</b>	<b>27038</b>	<b>26711</b>	<b>27401</b>	<b>25928</b>	<b>27915</b>	<b>30004</b>	<b>28989</b>	<b>27956</b>
<sup>41</sup> <b>Total Surplus/Deficit</b>	<b>4352</b>	<b>3440</b>	<b>4351</b>	<b>5035</b>	<b>5906</b>	<b>3100</b>	<b>929</b>	<b>1769</b>	<b>3605</b>	<b>4676</b>	<b>3333</b>	<b>5591</b>	<b>6699</b>	<b>4105</b>	<b>4088</b>

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

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**Regional Analysis Surplus Deficit  
Operating Year 2019 to 2028  
Using 1937-Water Conditions**

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**Loads and Resources - Pacific Northwest Region**  
**Operating Year: 2019 to 2028 Water Year: 1937**  
**2017 White Book Report Date: 6/1/2017**

S149-WB-20171215-145200

January 120Hr-MW	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
<b>Regional Loads</b>										
1 <b>Retail Loads</b>	33471	33868	34265	34589	34888	35169	35410	35580	35820	35990
2 Federal Agency	221	233	234	235	234	234	237	239	240	241
3 USBR	300	300	300	300	300	300	300	300	300	300
4 Cooperative	3318	3411	3507	3603	3686	3768	3831	3857	3880	3899
5 Municipality	4314	4386	4398	4407	4419	4431	4444	4458	4478	4492
6 Public Utility District	7667	7744	7805	7869	7936	7994	8045	8091	8137	8169
7 Investor-Owned Utility	18514	18652	18777	18898	19017	19132	19231	19326	19431	19537
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	423	423	423	423	423	423	423	423	423	423
10 Federal Diversity	-1288	-1284	-1182	-1149	-1128	-1116	-1104	-1118	-1072	-1075
11 <b>Exports</b>	1421	1199	1199	1143	1143	1143	1143	1143	1143	1143
12 Canada	1324	1142	1142	1142	1142	1142	1142	1142	1142	1142
13 East Continental Divide	1.00	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	56.7	56.7	0	0	0	0	0	0	0
16 Other	0	0	0	0	0	0	0	0	0	0
17 <b>Total Regional Loads</b>	<b>34892</b>	<b>35068</b>	<b>35465</b>	<b>35732</b>	<b>36031</b>	<b>36312</b>	<b>36553</b>	<b>36723</b>	<b>36963</b>	<b>37133</b>
<b>Regional Resources</b>										
18 <b>Hydro Resources</b>	20752	21217	21294	21330	21318	21337	21325	21322	21309	21325
19 Regulated Hydro - Net	19344	19809	19966	20002	19990	20009	19997	19994	19981	19997
20 Independent Hydro - Net	1239	1239	1159	1159	1159	1159	1159	1159	1159	1159
21 Small Hydro - Net	169	169	169	169	169	169	169	169	169	169
22 <b>Other Resources</b>	16851	16851	15611	15484	15121	15121	15121	14318	14318	14319
23 Cogeneration Resources	2767	2767	2767	2767	2767	2767	2767	2767	2767	2767
24 Combustion Turbine Resources	6837	6837	6837	6837	6781	6781	6781	6781	6781	6781
25 Large Thermal Resources	7000	7000	5760	5633	5326	5326	5326	4522	4522	4522
26 Renewable Resources	164	164	164	164	164	164	164	164	164	165
27 Small Thermal & Miscellaneous	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1
28 <b>Imports</b>	1174	1177	1180	1059	1062	1065	1068	1071	1075	1078
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	594	597	600	604	607	610	613	616	620	623
32 Pacific Southwest	425	425	425	300	300	300	300	300	300	300
33 Other	0	0	0	0	0	0	0	0	0	0
34 <b>Reserves &amp; Losses</b>	-3844	-3870	-3805	-3807	-3802	-3811	-3801	-3753	-3758	-3764
35 Contingency Reserves (Non-Spinning)	-1001	-1014	-1001	-1006	-1009	-1014	-1009	-998	-1001	-1003
36 Contingency Reserves (Spinning)	-1001	-1014	-1001	-1006	-1009	-1014	-1009	-998	-1001	-1003
37 Generation Imbalance Reserves	-258	-258	-258	-258	-258	-258	-258	-258	-258	-258
38 Load Following Reserves	-361	-346	-346	-346	-346	-346	-346	-346	-346	-346
39 Transmission Losses	-1222	-1238	-1199	-1192	-1179	-1179	-1179	-1153	-1152	-1153
40 <b>Total Regional Resources</b>	<b>34933</b>	<b>35376</b>	<b>34280</b>	<b>34066</b>	<b>33700</b>	<b>33713</b>	<b>33713</b>	<b>32958</b>	<b>32944</b>	<b>32958</b>
41 <b>Total Surplus/Deficit</b>	<b>40.7</b>	<b>308</b>	<b>-1185</b>	<b>-1666</b>	<b>-2331</b>	<b>-2599</b>	<b>-2840</b>	<b>-3765</b>	<b>-4019</b>	<b>-4175</b>

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

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**Regional Analysis Surplus Deficit  
Operating Year 2019  
Using 1937-Water Conditions**

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**Loads and Resources - Pacific Northwest Region**

**Operating Year: 2019 Water Year: 1937**

**2017 White Book Report Date: 6/1/2017**

S149-WB-20171215-145200

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>	30705	30583	27495	27451	31259	33814	33471	32094	29475	28173	28114	27375	29042	31170
2 Federal Agency	144	144	140	162	197	221	221	204	185	160	160	149	153	161
3 USBR	611	611	534	409	252	369	300	301	390	455	455	541	584	624
4 Cooperative	2795	2795	2578	2586	2955	3334	3318	3144	2855	2813	2813	2756	2812	2982
5 Municipality	3230	3230	3081	3430	3888	4296	4314	4125	3771	3494	3494	3127	3087	3246
6 Public Utility District	5917	5917	5575	6051	6928	7624	7667	7248	6781	6342	6342	5758	5641	5915
7 Investor-Owned Utility	18364	18364	16028	15447	17642	18860	18514	17870	16223	15408	15408	15526	17140	18563
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	422	422	422	423	422	422	423	422	422	423	423	422	422	422
10 Federal Diversity	-781	-903	-866	-1061	-1029	-1317	-1288	-1224	-1155	-926	-985	-910	-800	-747
<b>11 Exports</b>	1935	1935	1798	1458	1431	1423	1421	1421	1395	1382	1390	1390	1699	1715
12 Canada	1445	1445	1324	1324	1324	1324	1324	1324	1324	1324	1324	1324	1324	1340
13 East Continental Divide	6.80	6.80	6.80	6.80	1.00	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	0	0	0	0
15 Pacific Southwest	483	483	466	126	106	97.9	95.8	95.8	70.0	56.7	64.7	64.7	374	374
16 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>17 Total Regional Loads</b>	<b>32640</b>	<b>32518</b>	<b>29293</b>	<b>28909</b>	<b>32691</b>	<b>35237</b>	<b>34892</b>	<b>33515</b>	<b>30870</b>	<b>29555</b>	<b>29504</b>	<b>28765</b>	<b>30742</b>	<b>32885</b>
<b>Regional Resources</b>														
<b>18 Hydro Resources</b>	22892	20548	20068	19869	22719	22735	20752	20671	21367	19510	19886	24655	24523	20990
19 Regulated Hydro - Net	20836	18503	18135	18039	21019	21068	19344	19201	19578	17325	17670	22111	21904	18779
20 Independent Hydro - Net	1666	1658	1616	1596	1514	1492	1239	1289	1567	1847	1871	2080	2142	1751
21 Small Hydro - Net	390	388	317	234	186	174	169	181	222	337	345	464	477	459
<b>22 Other Resources</b>	16384	16385	16468	16593	16769	16850	16851	16810	16092	15402	14339	14216	14823	16383
23 Cogeneration Resources	2669	2669	2686	2730	2752	2766	2767	2763	2095	2193	2185	2418	2674	2665
24 Combustion Turbine Resources	6475	6475	6535	6613	6764	6831	6837	6791	6743	6699	5645	5785	6038	6478
25 Large Thermal Resources	6984	6984	6991	6992	6996	6994	7000	6998	6999	6254	6254	5755	5856	6986
26 Renewable Resources	175	175	175	176	176	176	164	176	174	174	174	175	174	174
27 Small Thermal & Miscellaneous	81.8	82.1	81.2	81.3	81.6	82.7	83.1	82.8	81.4	81.5	81.2	83.4	81.2	80.5
<b>28 Imports</b>	976	976	853	845	1096	1199	1174	1206	907	762	762	804	1047	1124
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	755	755	632	573	569	650	594	593	569	540	540	582	826	903

**Loads and Resources - Pacific Northwest Region**

**Operating Year: 2019 Water Year: 1937**

**2017 White Book** Report Date: 6/1/2017 *Continued*

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120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
<sup>32</sup> Pacific Southwest	75.0	75.0	75.0	125	425	425	425	425	125	75.0	75.0	75.0	75.0	75.0
<sup>33</sup> Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<sup>34</sup> <b>Reserves &amp; Losses</b>	-3855	-3710	-3592	-3594	-3889	-3977	-3844	-3798	-3710	-3531	-3488	-3751	-3862	-3754
<sup>35</sup> Contingency Reserves (Non-Spinning)	-981	-947	-895	-899	-993	-1035	-1001	-979	-939	-894	-883	-938	-982	-960
<sup>36</sup> Contingency Reserves (Spinning)	-981	-947	-895	-899	-993	-1035	-1001	-979	-939	-894	-883	-938	-982	-960
<sup>37</sup> Generation Imbalance Reserves	-260	-260	-260	-257	-258	-258	-258	-258	-258	-258	-258	-258	-258	-258
<sup>38</sup> Load Following Reserves	-360	-360	-360	-361	-361	-361	-361	-361	-361	-361	-361	-361	-361	-361
<sup>39</sup> Transmission Losses	-1273	-1196	-1182	-1179	-1284	-1288	-1222	-1220	-1212	-1124	-1102	-1257	-1278	-1215
<sup>40</sup> <b>Total Regional Resources</b>	<b>36397</b>	<b>34200</b>	<b>33797</b>	<b>33713</b>	<b>36695</b>	<b>36806</b>	<b>34933</b>	<b>34889</b>	<b>34656</b>	<b>32142</b>	<b>31499</b>	<b>35924</b>	<b>36531</b>	<b>34743</b>
<sup>41</sup> <b>Total Surplus/Deficit</b>	<b>3757</b>	<b>1682</b>	<b>4505</b>	<b>4804</b>	<b>4005</b>	<b>1569</b>	<b>40.7</b>	<b>1374</b>	<b>3786</b>	<b>2588</b>	<b>1995</b>	<b>7159</b>	<b>5789</b>	<b>1858</b>

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

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**Regional Analysis Surplus Deficit  
Operating Year 2019**

**Regional Report Surplus Deficit By Water Year**

**Operating Year 2019**

**2017 White Book Report Date: 6/1/2017**

S149-WB-20171215-145200

Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
1 1929 Regional Report Surplus Deficit	5813	6138	4422	5763	6236	3532	2366	2863	4056	4628	6286	5224	6637	3565	4679
2 1930 Regional Report Surplus Deficit	4046	3328	4764	5141	5715	3164	1253	3945	3895	5162	7310	3838	2829	5922	4193
3 1931 Regional Report Surplus Deficit	4465	3476	4557	5125	5997	3240	2511	1286	3290	4433	3071	5075	2870	5178	3920
4 1932 Regional Report Surplus Deficit	4010	3303	4095	4951	5471	3353	1088	1706	6984	12074	12953	11909	12750	8298	6410
5 1933 Regional Report Surplus Deficit	5906	5184	5513	5261	6030	6408	8039	8490	8700	7928	7290	8587	15143	13247	8207
6 1934 Regional Report Surplus Deficit	8699	7369	5700	7666	11240	13305	13862	12946	13554	14395	12372	9681	9409	6562	10428
7 1935 Regional Report Surplus Deficit	3520	3184	4185	5189	5669	4010	7487	8089	8255	5018	7469	7929	8956	9647	6575
8 1936 Regional Report Surplus Deficit	7297	4652	3881	5147	5689	2571	1119	2950	4632	5773	10910	12049	12218	6925	5962
9 1937 Regional Report Surplus Deficit	4352	3440	4351	5035	5906	3100	929	1769	3605	4676	3333	5591	6699	4105	4088
10 1938 Regional Report Surplus Deficit	4566	3308	4467	5301	6648	5507	6832	7775	8876	10741	14436	11925	10295	8726	7729
11 1939 Regional Report Surplus Deficit	3988	3235	5037	5190	5783	3540	4832	4832	5481	7712	9952	8131	5700	6138	5589
12 1940 Regional Report Surplus Deficit	4161	3256	4728	5232	6230	3967	4869	4723	10158	7805	7985	7468	4876	5319	5769
13 1941 Regional Report Surplus Deficit	2963	2505	4390	4812	5731	4241	2063	3406	4031	3449	5080	5649	4935	5028	4274
14 1942 Regional Report Surplus Deficit	4023	3149	4698	4946	6718	6245	6791	6490	6695	5279	8109	7087	9377	9653	6578
15 1943 Regional Report Surplus Deficit	5359	4846	5901	5114	5621	4749	8359	8559	9662	15914	14853	10209	14981	12922	8864
16 1944 Regional Report Surplus Deficit	7438	5065	4710	5402	6148	3760	2709	3752	4285	4019	5257	3215	2226	3947	4253
17 1945 Regional Report Surplus Deficit	4211	2936	4225	4676	5457	3025	2492	3100	3851	4549	1908	8553	11096	4446	4810
18 1946 Regional Report Surplus Deficit	4022	3204	4513	5285	6592	5471	6865	6892	8800	12165	14460	12149	11076	11064	7967
19 1947 Regional Report Surplus Deficit	6165	5483	5477	5448	7025	10867	10185	10757	10869	10177	10093	10984	11196	9756	9035
20 1948 Regional Report Surplus Deficit	5773	5282	4998	10568	9381	7800	10023	8321	8494	8567	11859	13291	15135	11767	9633
21 1949 Regional Report Surplus Deficit	9279	8164	6272	6277	6329	5252	5777	6169	10456	10318	13168	12502	11537	5675	8063
22 1950 Regional Report Surplus Deficit	4048	2804	4560	5259	6504	4654	9982	11637	11418	13361	11932	10205	15207	14798	9163
23 1951 Regional Report Surplus Deficit	9623	8361	6046	8232	10586	11733	13130	14403	14680	14197	13056	12043	11291	12164	11395
24 1952 Regional Report Surplus Deficit	7499	5097	5614	9827	8135	8284	9370	9386	9050	12719	15281	13649	12216	9465	9602
25 1953 Regional Report Surplus Deficit	5659	4693	3962	5231	5448	2995	6138	8507	7482	6374	6995	9468	15145	13058	7427
26 1954 Regional Report Surplus Deficit	7421	5779	5442	6186	6990	7349	9841	10453	10927	9733	9777	11260	13518	14618	9406
27 1955 Regional Report Surplus Deficit	10045	9954	9405	6461	8403	6682	4732	5400	4042	5584	6028	7535	15197	14022	8146
28 1956 Regional Report Surplus Deficit	8809	6184	5075	7542	9671	11091	12878	12790	12995	12758	15336	13329	15271	12601	11218
29 1957 Regional Report Surplus Deficit	8559	7296	5684	6968	6335	7625	6874	6721	8768	11853	9054	13796	15145	8346	8727
30 1958 Regional Report Surplus Deficit	5076	4321	4963	5299	6102	4099	7765	8393	8582	8394	10428	12556	13801	7442	7744
31 1959 Regional Report Surplus Deficit	5501	4079	4481	5842	8202	9892	11659	11457	11395	11470	9797	10132	13534	12979	9569
32 1960 Regional Report Surplus Deficit	8482	7822	10340	12264	11499	9205	8018	8166	8783	16385	11760	8040	12092	9649	10016
33 1961 Regional Report Surplus Deficit	6304	4751	4539	5781	6871	5718	7921	9716	11472	9689	8118	10790	13455	7820	8192
34 1962 Regional Report Surplus Deficit	6013	4042	4529	5154	6133	5204	6975	7427	5246	13162	14379	9906	9994	8053	7267
35 1963 Regional Report Surplus Deficit	5761	5039	4524	7048	8493	9085	8299	8943	7373	5768	6996	8643	10291	9112	7793
36 1964 Regional Report Surplus Deficit	5225	4353	5679	5339	6334	5638	5382	5744	5711	10291	6861	9430	15530	13664	7651
37 1965 Regional Report Surplus Deficit	8758	7491	6926	7424	7409	11459	13563	15289	13513	8993	14897	12306	11696	9733	10757
38 1966 Regional Report Surplus Deficit	7956	7401	5054	6466	6428	6087	6341	6479	6241	13428	8779	6631	9644	9446	7298

**Regional Report Surplus Deficit By Water Year**

**Operating Year 2019**

**2017 White Book** Report Date: 6/1/2017 *Continued*

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Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
39 1967 Regional Report Surplus Deficit	6545	4206	4655	5286	5910	7126	10478	11012	10807	7952	4309	9133	14986	12567	8606
40 1968 Regional Report Surplus Deficit	7431	6116	5450	6687	7094	6335	9312	9649	10010	5062	5533	6086	13030	10353	7994
41 1969 Regional Report Surplus Deficit	7090	6198	8066	8072	9500	8285	11442	12701	11073	13662	14524	13383	12594	9854	10449
42 1970 Regional Report Surplus Deficit	5557	4411	4942	6119	6447	4512	7637	7665	7746	6295	6181	9309	13981	6375	7149
43 1971 Regional Report Surplus Deficit	5500	3979	4541	5254	6302	5527	12332	15142	13415	13148	13083	13145	15577	13938	10213
44 1972 Regional Report Surplus Deficit	9287	8754	6049	6844	6869	7007	12137	14239	17046	16896	11413	12947	15427	13788	11275
45 1973 Regional Report Surplus Deficit	9791	9289	6534	6660	6589	6730	6924	5208	4973	3593	4896	6009	4354	5593	6128
46 1974 Regional Report Surplus Deficit	3931	2923	4526	5270	6349	8137	15283	15350	15563	14422	14524	12448	15467	14951	10906
47 1975 Regional Report Surplus Deficit	9500	9226	6169	5321	6429	4925	7986	8623	9239	6532	6828	11273	14993	14204	8770
48 1976 Regional Report Surplus Deficit	7570	7160	6509	8354	10166	13112	12120	11529	12822	13863	12480	13104	12903	12985	11180
49 1977 Regional Report Surplus Deficit	10709	10889	10867	6391	6157	3487	2960	4089	4702	3165	4004	2489	1708	3725	5083
50 1978 Regional Report Surplus Deficit	4043	2927	3188	4560	5878	6268	6828	7243	7347	12836	9831	10893	8704	9954	7136
51 1979 Regional Report Surplus Deficit	5112	4240	8390	6440	6275	3851	5040	4525	8138	4948	7192	9905	8216	3900	6288
52 1980 Regional Report Surplus Deficit	3928	3429	4921	5197	5806	3339	4718	5073	5135	8245	10255	12710	12885	7770	6703
53 1981 Regional Report Surplus Deficit	4075	3644	5159	5126	6280	9694	10529	10980	7380	4342	6861	8531	13850	11355	8177
54 1982 Regional Report Surplus Deficit	8540	7259	5371	5897	6963	6541	8986	15030	15216	12545	10582	12414	14543	14379	10368
55 1983 Regional Report Surplus Deficit	8865	8417	7555	7731	7205	7752	10838	11891	13374	10750	9238	10865	12963	12998	10143
56 1984 Regional Report Surplus Deficit	9151	6697	6193	6263	10716	8067	9890	10192	10076	13004	12713	10540	14262	11638	9867
57 1985 Regional Report Surplus Deficit	8099	5466	6302	6458	7591	6025	5667	6035	6116	9807	10741	9595	7791	5820	7032
58 1986 Regional Report Surplus Deficit	3287	2388	5130	5760	9388	6198	8957	10599	15135	13955	13356	8812	11058	7500	8724
59 1987 Regional Report Surplus Deficit	4704	3751	4383	5152	6954	6161	4960	4436	7521	4892	6790	8995	6841	4268	5820
60 1988 Regional Report Surplus Deficit	3243	2374	4210	4897	5553	2845	2446	1925	4532	4372	6413	5845	4801	6150	4294
61 1989 Regional Report Surplus Deficit	4127	3328	4133	4949	6842	4246	3440	3001	6836	8215	13823	9058	8219	5779	5943
62 1990 Regional Report Surplus Deficit	4035	3514	4640	5197	7162	7227	8631	9171	9627	8263	12394	7625	12385	9300	7903
63 1991 Regional Report Surplus Deficit	7228	6422	4537	5294	10519	8231	9585	10157	10465	10504	8279	9262	11864	12730	9062
64 1992 Regional Report Surplus Deficit	8817	6807	4521	5176	6209	3214	4059	4836	7092	3934	4569	5103	3196	3848	4945
65 1993 Regional Report Surplus Deficit	3367	2458	3693	4918	6140	3309	2150	1077	5651	6244	7161	9740	9422	6412	5195
66 1994 Regional Report Surplus Deficit	5277	4109	4986	5163	6205	3963	1760	2618	3956	4186	6564	7271	7026	5468	4880
67 1995 Regional Report Surplus Deficit	3874	2769	4411	5007	5408	4088	5498	7729	9568	6822	6441	8411	13190	8420	6791
68 1996 Regional Report Surplus Deficit	5143	3934	5539	7143	12301	14891	14659	15771	16164	13721	15368	12575	12981	12586	11948
69 1997 Regional Report Surplus Deficit	8471	6774	5532	5993	7009	8364	14744	15702	16090	14401	15379	13151	15149	13744	11471
70 1998 Regional Report Surplus Deficit	8771	8941	8005	11292	9168	6440	7344	7587	7706	7787	8839	12761	14514	9469	9295
71 1999 Regional Report Surplus Deficit	6302	4831	4663	5353	5887	8059	11933	12766	13635	10727	12114	10369	14966	13951	9861
72 2000 Regional Report Surplus Deficit	10317	9252	6266	5920	11131	9295	7983	8207	8497	12442	13999	10350	7674	8502	8900
73 2001 Regional Report Surplus Deficit	5848	3608	4106	5296	5604	3225	2207	3325	4384	3744	4511	4039	1088	4164	3861
74 2002 Regional Report Surplus Deficit	4069	2693	3276	4302	5427	4063	3481	3838	5487	7456	11218	8232	13444	11270	6296
75 2003 Regional Report Surplus Deficit	5341	4760	4745	5090	6190	3515	2956	3118	7632	7181	7756	7609	11374	5426	5852
76 2004 Regional Report Surplus Deficit	3434	2251	3703	5413	6698	4740	4585	3490	6178	5809	6844	7204	7182	6475	5411
77 2005 Regional Report Surplus Deficit	4326	4097	6570	6277	6183	6483	6287	6359	4625	3261	5906	7947	8144	6777	6201

**Regional Report Surplus Deficit By Water Year**

**Operating Year 2019**

**2017 White Book** Report Date: **6/1/2017** *Continued*

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Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
78 2006 Regional Report Surplus Deficit	4791	3094	4470	4679	6129	5862	9239	9966	8903	13083	13576	12116	13498	8033	8320
79 2007 Regional Report Surplus Deficit	4272	3449	3890	5083	7743	5382	7641	7441	10279	11182	8214	8521	9448	8481	7282
80 2008 Regional Report Surplus Deficit	4582	3052	3584	5316	6398	3609	3982	4704	5644	6431	3555	10444	15379	10405	6524
<b>Ranked Averages</b>															
81 <b>Bottom 10 pct</b>	<b>4771</b>	<b>3742</b>	<b>4439</b>	<b>5184</b>	<b>5861</b>	<b>3388</b>	<b>2060</b>	<b>2784</b>	<b>4010</b>	<b>4310</b>	<b>5157</b>	<b>4809</b>	<b>4011</b>	<b>4757</b>	<b>4195</b>
82 <b>Middle 80 pct</b>	<b>6084</b>	<b>5037</b>	<b>5318</b>	<b>5972</b>	<b>7011</b>	<b>5955</b>	<b>7093</b>	<b>7600</b>	<b>8455</b>	<b>8983</b>	<b>9409</b>	<b>9697</b>	<b>11434</b>	<b>9212</b>	<b>7702</b>
83 <b>Top 10 pct</b>	<b>7699</b>	<b>6448</b>	<b>5775</b>	<b>7100</b>	<b>8795</b>	<b>10724</b>	<b>13564</b>	<b>14384</b>	<b>14859</b>	<b>13656</b>	<b>14057</b>	<b>12738</b>	<b>13773</b>	<b>12819</b>	<b>11269</b>

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