

2018 Pacific Northwest Loads and Resources Study

April 2019





Department of Energy

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

April 2, 2019

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 2018 White Book presents Federal system and the region’s load obligations, contracts, and resources as of December 2018 for operating years (OY) 2020 through 2029. The 2018 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 in the first year of the study, 79 aMW, with annual energy deficits, as large as -438 aMW, over the rest of the study period. These annual energy deficits projections are similar to those projected in the 2017 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 -969 MW to -1,406 MW. These 120-Hour capacity deficits are similar to those projected in the 2017 White Book. 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. 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 4,058 aMW in OY 2020, slowly decreasing to 403 aMW by OY 2029. These annual energy projections are similar to those presented in the 2017 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 January 120-Hour capacity deficits over the study period,

ranging from -246 MW to -4,891 MW. These deficit projections are larger than those shown in the 2017 White Book. Under average water conditions; the PNW region has January 120-Hour capacity surpluses through the final year of this study.

The 2018 White Book is available on BPA's website: 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 2018 Technical Appendix available only in electronic format on BPA's website: www.bpa.gov/goto/whitebook

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

Sincerely,

A handwritten signature in blue ink, appearing to read "K.P. Connolly". The signature is fluid and cursive, with a large loop at the end.

Kieran P. Connolly
Vice President, Generation Asset Management

Enclosure

2018 PACIFIC NORTHWEST LOADS AND RESOURCES STUDY
The White Book

BONNEVILLE POWER ADMINISTRATION
April 2019

Cover Picture:

Palisades Dam is an earth-fill dam on the Snake River in Bonneville County, Idaho, owned and operated by the Bureau of Reclamation. The dam was completed in 1957 and provides irrigation water, flood control, hydropower, and recreation; it features a four-turbine hydroelectric power plant with a nameplate capacity of 176 MW.

ACKNOWLEDGMENTS

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

Bonneville Power Administration

Generation Asset Management:

Long Term Power Planning Group
Regional Coordination Group
Operational Planning Group

Customer Support Services:

Load Forecasting and Analysis Group

Bulk Marketing and Transmission Services:

Long Term Sales and Purchasing Group

NW Requirements Marketing:

Office of General Counsel

Power Services Business Operations

Pacific Northwest Utilities Conference Committee

Northwest Power & Conservation Council

Table of Contents

SECTION 1: SUMMARY	3
Planning Context	3
Load Obligations	4
Resource Types	4
Adjustments to Resources	6
Hydro Resources Modeling	6
Critical Water Planning.....	8
Variability of Hydro Generation	8
Hydro Capacity Modeling.....	8
Notable Updates	9
Sources of Uncertainty	10
SECTION 2: FEDERAL SYSTEM ANALYSIS	11
Load Obligations	11
USBR obligations	11
Regional Dialogue CHWM PSC obligations to Public & Federal agency customers	11
Table 2-1	12
IOU Load Service under Regional Dialogue PSCs	12
DSI contracts	12
Other Contract Obligations	12
Firm Loads	12
Table 2-2	13
Conservation	13
Resources	13
Federal System Resource Types	14
Table 2-3	14
Table 2-4	16
Table 2-5	17
Federal System Hydro Generation Variability.....	18
Table 2-6	18
Table 2-7	19
Table 2-8	19
Key Results	20
Annual Energy	20
Table 2-9	20
Table 2-10	20
120-Hour Capacity.....	21
Table 2-11	21
Table 2-12	21
Federal System Annual Surplus/Deficits	22
Table 2-13	22
Federal System Monthly Surplus/Deficit.....	23
Table 2-14	23
Conclusion	24

SECTION 3: PACIFIC NORTHWEST REGIONAL ANALYSIS	25
Regional Loads.....	25
Table 3-1	26
Conservation in Total Retail Loads	26
Regional Resources	26
Table 3-2	27
Regional Hydro Generation Variability.....	28
Table 3-3	28
Table 3-4	29
Variability Due to IPP Generation Delivered to the PNW Region.....	29
Table 3-5	29
Table 3-6	30
Key Results	31
Annual Energy	31
Table 3-7	31
Table 3-8	31
Table 3-9	32
January 120-Hour Capacity	32
Table 3-10	32
Table 3-11	33
Table 3-12	33
Regional Annual Surplus/Deficit.....	34
Table 3-13	34
Regional Monthly Surplus/Deficit	34
Table 3-14	35
Conclusion	35
SECTION 4: FEDERAL SYSTEM ANALYSIS EXHIBITS.....	37
Exhibit 4-1: Annual Energy	39
Exhibit 4-2: Monthly Energy.....	43
Exhibit 4-3: Annual 120-Hour Capacity	47
Exhibit 4-4: Monthly 120-Hour Capacity.....	51
Exhibit 4-5: 80-Water Conditions Monthly Energy	55
SECTION 5: PACIFIC NORTHWEST REGIONAL ANALYSIS EXHIBITS	59
Exhibit 5-1: Annual Energy	61
Exhibit 5-2: Monthly Energy.....	65
Exhibit 5-3: Annual 120-Hour Capacity	69
Exhibit 5-4: Monthly 120-Hour Capacity.....	73
Exhibit 5-5: 80-Water Conditions Monthly Energy	77

Section 1: Summary

Planning Context

The Pacific Northwest Loads and Resources Study (commonly referred to as the “White Book”) is a planning document produced by the Bonneville Power Administration (Bonneville) that presents its projection of load and resource conditions for the upcoming 10-year period (OY 2020 through 2029). The White Book includes analysis of Bonneville’s forecasts of expected power obligations and resource generation for both the Federal system and the Pacific Northwest (PNW) region as a whole. The information contained in the White Book is used for: 1) long-term planning throughout Bonneville; 2) in planning studies for the Columbia River Treaty (Treaty); and 3) as 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).

Bonneville’s White Book traditionally focuses on long-term deterministic power planning for the Federal system and the PNW region. Bonneville’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, Bonneville’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 (OY¹) to be consistent with Bonneville’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 11, and the Pacific Northwest Regional Analysis is presented in Section 3, page 25.

Bonneville, 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. Bonneville periodically incorporates into its planning additional studies that use different analytical methods and analyze different scenarios to meet load obligations, such as the Federal System Needs Assessment and Federal System Resource Adequacy studies. While a Federal System Needs Assessment was completed as part of the 2018 Resource Program, we have not included those results in this 2018 White Book. Those results can be seen in the 2018 Resource Program, at <http://www.bpa.gov/goto/ResourceProgram>.

This 2018 White Book is published in three documents: 1) this document, the 2018 Loads and Resources Summary (commonly referred to as the White Book), provides Bonneville’s deterministic Federal system and PNW regional loads and resources used for long-term planning; 2) the 2018 Loads and Resources Technical Appendix, Volume 1, Energy Analysis, which provides the detailed components of the annual and monthly energy for the

^{1/} Operating Year (OY) is the time frame August 1 through July 31. For example, OY 2020 is August 1, 2019 through July 31, 2020.

Federal system and PNW regional retail loads, contracts, and resources; and 3) the 2018 Loads and Resources Technical Appendix, Volume 2, Capacity Analysis, that presents the detailed components of the monthly 120-Hour and 1-Hour peak capacity for Federal system and PNW regional retail loads, contracts, and resources. The Technical Appendices are only available electronically, at www.bpa.gov/goto/whitebook

The total retail load, contract, and generation forecasts used in this study were updated as of December 1, 2018. This 2018 White Book supersedes the 2017 White Book.

Load Obligations

The load obligations for the Federal system and PNW region contain multiple components in this study, and 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 within the PNW region (Intra-Regional Transfers (*Out*)) and 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 stated under section 5 of the Northwest Electric Power Planning and Conservation Act (NW Power Act), 16 U.S.C. 839 et seq., (December 5, 1980).

Forecasts of the regional TRL and Federal system load obligations are produced by Bonneville's Agency Load Forecasting (ALF) system. ALF forecasts are completed for individual PNW entities under two approaches; 1) 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, 2) for a limited number of customers, statistically adjusted end-use models. The statistically adjusted end-use models include calculated indexes for heating equipment, cooling equipment, and other equipment. ALF forecasts also assume normal weather conditions and do not include any adjustments for the impacts of climate change. Contract obligations not associated with Bonneville'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 Bonneville 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. PNW resources (which include the Federal system) are predominately hydro based. Therefore, generation levels can vary greatly both from month-to-month and year-to-year. This analysis classifies resources as: 1) Hydro resources, which include Regulated, Independent, and Small Hydro projects; 2) Non-Hydro Renewable resources, which include wind, solar, and other projects; 3) Thermal resources, which include nuclear, coal, natural gas, petroleum, biofuel and cogeneration projects; and 4) 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 Bonneville models or the project owners and are described as follows:

Hydro resources

- Regulated Hydro: 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. Bonneville 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: 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: Small hydro project generation forecasts are either provided by individual project owners or are based on historical actual generation. These generation forecasts can vary month-to-month but are not assumed to vary by water condition.

Non-Hydro Renewable resources

- Wind: 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.
- Solar: Solar projects are utility scale solar facilities that are metered and the generation is being sent to the grid, and is not meant to include any behind the meter or net metered resources.
- Other: Other renewables include any other project identified as renewable, including geothermal and biomass/biogas waste projects. Generation forecasts for these resources are based on energy and capacity forecasts submitted by individual project owners.

The methodologies for calculating renewable resource energy and capacity are consistent with previous White Books.

Thermal resources

- Thermal resources include nuclear, coal, natural gas, petroleum, biofuel, 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 show actual operational capabilities and expectations, and not to reflect economic dispatch.

Contract purchases

- **Contract Purchases/Imports:** Contract purchases include signed Federal system purchases and reported regional contract purchases with power 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

This White Book assumes that resource generation and contract purchases must be reliably delivered to load centers. To take this into account, this study makes adjustments to generation forecasts for: 1) Operating and Balancing 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 and are defined below:

- **Operating and Balancing Reserves:** Operating reserves consist of both spinning and non-spinning contingency reserves 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. Balancing reserves consist of regulating, load following, and imbalance reserves 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 the Hydro Resources Modeling section below. The reserve forecasts included in this 2018 White Book are consistent with Bonneville's BP-20 Initial Rates 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 based on water conditions. The transmission loss factor is 2.97 percent for energy and 3.38 percent for peak deliveries. These loss factors are assumed to be the same for every month and do not vary from year to year.

Hydro Resources Modeling

The HYDSIM model forecasts the energy production from the regulated hydroelectric power projects in the PNW. This includes the 14 coordinated hydro 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.

The HYDSIM studies encompass power and non-power operating requirements, including those non-power requirements described in applicable biological opinions issued by the National Oceanic and Atmospheric Administration (NOAA) Fisheries and the U.S. Fish and Wildlife Service (USFWS); relevant operations described in the Northwest Power and Conservation Council's Fish and Wildlife Program published October 2014; and other mitigation measures such as those implemented under federal district court injunction during the spring of 2018. The HYDSIM studies incorporate spring spill up to applicable water quality standards for Total Dissolved Gas (TDG) and summer spill informed by the results of biological performance standard testing conducted over the last decade to measure dam passage survival for out-migrating juvenile fish ("performance standard spill"). Each hydro regulation study specifies particular hydroelectric project operations for fish, such as seasonal flow objectives, minimum flow levels for fish, spill for juvenile fish passage, reservoir target elevations, drawdown limitations, and turbine operation requirements.

The Pacific Northwest Coordination Agreement (PNCA) coordinates the planning and operation of the members' 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. Bonneville incorporates this data into HYDSIM to simulate the coordinated operation of the PNW hydro system. This coordination agreement terminates on September 15, 2024.

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 upon, in 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 2018 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 throughout the study period.

Bonneville has other operational agreements with Canada that are not part of the Treaty. One operational agreement is the Non-Treaty Storage Agreement (NTSA) that allows additional shaping of Columbia River flows for power and fish operations by utilizing storage not specified by the Treaty from Canadian reservoirs. The NTSA allows water to be released from Canadian project 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 would be met with a subsequent release of water in the summer. These operations have been included in this study based on the NTSA 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 operating and balancing reserves. Incremental reserves are not specifically reported in this study; however, they are incorporated by increasing the minimum flow of several projects modeled in Bonneville's Hourly Operating and Scheduling Simulator (HOSS) discussed in the Hydro Capacity Modeling section of this study.

Critical Water Planning: To ensure sufficient generation to meet load, Bonneville 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, Bonneville 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 (referred to as 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 hydro 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 cause hydro generation to vary greatly year to year depending on factors such as precipitation, snowpack, and temperature. Project-level generation forecasts are produced using HYDSIM for each of the 80 historical water year 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 historical water year reservoir storage and flows from HYDSIM. For each month, HOSS forecasts hourly Federal system hydro generation by maximizing heavy load hour 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 should not be interpreted as an indication of the Federal hydro system's ability to react to system distress or extreme 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: the average generation forecasts from the 6 highest heavy load hours per day, 5 days per week, for 4 weeks per month ($6 \times 5 \times 4 = 120$ hours); and
- 1-Hour Capacity: the highest single 1-Hour generation per month.

The 1-Hour hydro capacity forecasts do not present a sustainable generation, but a single hour peak, which does not consider the ability of the hydro system to sustain generation levels from hour-to-hour and/or day-to-day. The hydro system is unable to sustain full hydro generation at the 1-Hour 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 sustain a generating peak energy level 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.

Notable Updates

The 2018 White Book includes updated forecasts of Federal system power sales contract (PSC) obligations, PNW regional Total Retail Loads, contract purchases, and generation as of December 1, 2018, including:

- Change in Regulated hydro spill assumptions to include similar operations to those implemented under the federal court injunction during the spring of 2018, for all years of the study.
- A Bonneville capacity sale to PGE.
- Alcoa exercised an option to terminate its power purchase contract with Bonneville effective August 31, 2019, which results in reduced direct service industry (DSI) load obligations on Bonneville;
- Improved peak load forecasts that better approximate recent actual peak loads;

Sources of Uncertainty

The forecasts presented in this document represent the best information currently available under 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 streamflow runoff that influence 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 other changes to major industrial operations;
- Potential service to new loads such as new public utilities or the Department of Energy's Richland vitrification plant operations;
- Future policy requirements at local, state, and national levels regarding the amount and type of renewable resources, conservation standards, electric vehicle saturation, and/or carbon emissions;
- Fuel cost and availability, which may be affected by environmental factors or competing uses for industry, transportation, and import/export markets;
- Changes to operating limits on existing and future Thermal resources resulting from environmental or climate-change objectives;
- Failures of existing or contracted generating resources to operate at anticipated times and/or output levels;
- Changes to Treaty obligations and/or operations;
- PNW entities' ability to purchase power from new and existing uncommitted regional resources to serve retail load;
- PNW entities' 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

The Federal System Analysis provides a deterministic forecast of Federal system loads and resources over a 10-year period from OY 2020 through 2029. This analysis incorporates forecasts of the Federal system's firm requirements power sales contract (PSC) obligations, contract sales and purchases, and resource generation. This section presents firm Federal system load and resource forecasts for energy and 120-Hour capacity. The detailed components of the Federal system study are available electronically in the 2018 Loads and Resources Technical Appendix, Volume 1, Energy Analysis, which provides annual and monthly energy in aMW; and the 2018 Loads and Resources Technical Appendix, Volume 2, Capacity Analysis, which provides monthly 120-Hour and 1-Hour peak capacity.

Load Obligations

Bonneville'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) Bonneville's Regional Dialogue PSC obligations to public, cooperative, and tribal utilities, and Federal agency customers; 3) contract obligations to investor-owned utilities (IOUs); 4) contract obligations to DSI customers; and 5) other Bonneville 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. Bonneville's forecasts of these obligations are as follows:

USBR obligations: USBR is obligated by Federal statutes to provide reserve power to several irrigation facilities and districts associated with USBR projects in the PNW. USBR project authorizations include congressional authorization for irrigation districts to receive reserve power from specific FCRPS projects. Bonneville markets the remaining power from USBR projects.

Regional Dialogue CHWM PSC obligations to Public & Federal agency customers: In December 2008, Bonneville executed Regional Dialogue Contract High Water Mark (RD CHWM) PSCs with public, cooperative, and tribal utilities, and Federal agency customers; Bonneville 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 135 customers who have signed Regional Dialogue Contracts; 119 are currently Load Following, 13 are Slice/Block, and three are Block only customers.

Under these RD contracts, 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) acquiring power from sources other than Bonneville; and/or 3) requesting Bonneville to supply additional power. The current customer elections have been set through fiscal year (FY) 2024, so 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, page 12, presents the A-RHWM load included in Bonneville's obligations by FY, which are consistent with the BP-20 Initial Rate Proposal.

Table 2-1

**Federal System
Annual Above-Rate High Water Mark (A-RHWM) Obligations
FY 2020 through 2029**

Energy (aMW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
A-RHWM Obligations	64	74	81	89	103	123	143	163	180	197

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 Bonneville 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 Bonneville would serve any net requirements of an IOU at the New Resource Firm Power rate.

DSI contracts: Bonneville is currently making power sales and deliveries to Port Townsend Paper Corporation (Port Townsend). Port Townsend’s contract with Bonneville run through September 30, 2022. Federal system DSI deliveries are forecasted at 12 aMW and expected to remain at that level throughout the study period.

Other Contract Obligations: Bonneville provides Federal power under a variety of additional contract arrangements. 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).

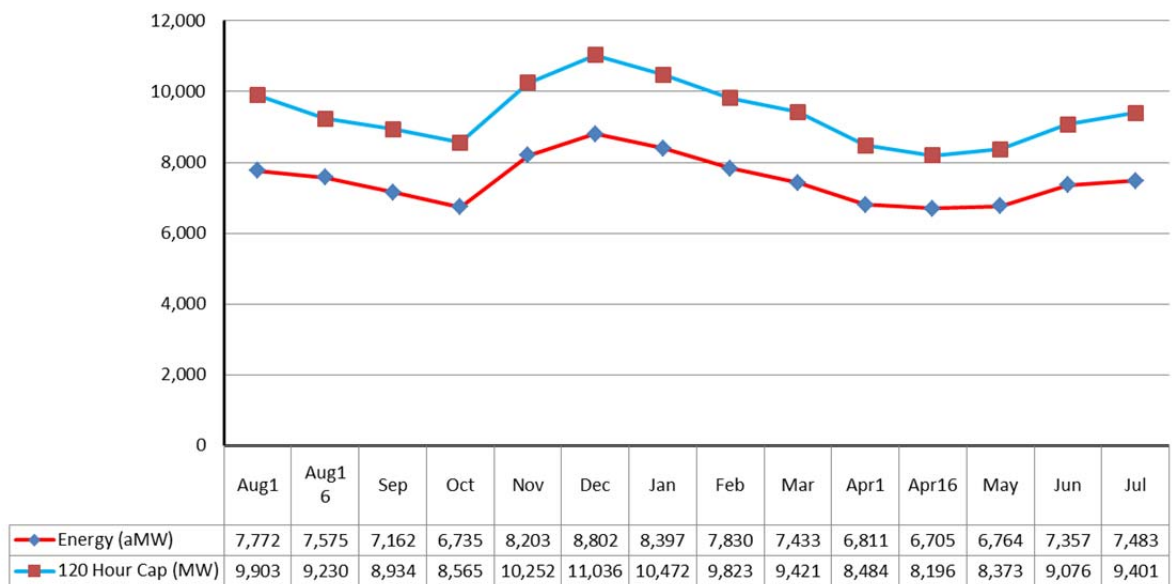
With the exception of Bonneville’s Treaty-related contracts and RD PSCs, forecasts of Bonneville’s contract deliveries follow individual contract terms and are not assumed to be renewed after expiration. Treaty and Regional Dialogue PSC power deliveries are assumed to remain in place through the study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

Firm Loads: The Federal system firm load forecasts show a modest average annual growth rate of approximately 0.2 percent over the study period. While Bonneville’s PSC requirements load increases over the study period, Bonneville 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, Federal system capacity sales, and wind energy shaping contracts. When all of these factors are considered, the total Federal system load obligations remain relatively flat on an annual basis over the study period.

Bonneville loads on a monthly basis can vary greatly throughout the year. At a high level, Bonneville forecasts represent higher loads in the winter (November through February) due to lower temperatures that increase heating loads, and lower loads during the spring, early 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 air conditioning loads. Table 2-2, below, illustrates the monthly shape of the forecasted Federal system firm load obligations for OY 2020. 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 2020**



Conservation: The PSC obligation forecasts developed by ALF are expected load forecasts, which include conservation identified by individual Bonneville customers.

Resources

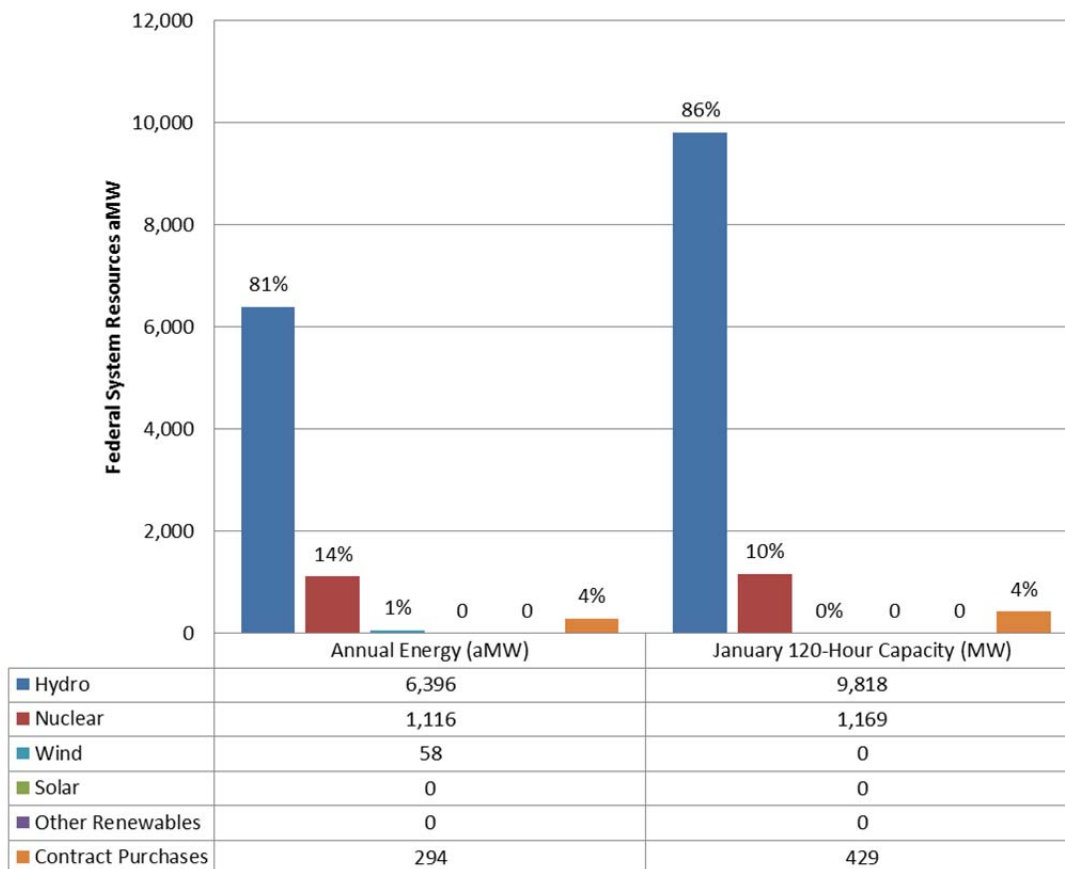
In the PNW, Bonneville is a Federal power marketing agency charged with marketing and transmitting power from Federal hydroelectric projects and acquired resources to serve the firm electrical load needs of its customers. Bonneville does not own generating resources, rather, Bonneville markets power from Federal resources and certain non-Federal generating resources whose output Bonneville has acquired under contracts to meet Bonneville’s load obligations. In addition, Bonneville 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) Non-Hydro Renewable resources, which include wind, solar, and other projects; 3) Thermal resources, which includes nuclear (Columbia Generating Station); and 4) 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 and Slice Transmission Loss Returns.

Federal System Resource Types: Table 2-3, below, summarizes Bonneville’s resources and contract purchases available to meet the Federal system load obligations. For OY 2020, Federal system resources are forecast to produce 7,864 annual aMW of generation under 1937-critical water conditions. Federal system energy resources are comprised of approximately 81.3 percent hydro, 14.2 percent nuclear (Columbia Generating Station), 3.7 percent contract purchases, 0.7 percent wind, and a very small amount of solar.

Table 2-3

**Federal System
Generation Forecast by Resource Type
OY 2020
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 16, shows the Federal system hydro resources from which Bonneville 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 above starting on page 8.
- Federal System Non-Hydro Resources: Federal system non-hydro resources are generating resources whose output have been purchased by Bonneville. Table 2-5, page 17, shows these generating resources, which include: 1) Columbia Generating Station; 2) wind projects (Non-Hydro Renewable); and 3) solar projects (Non-Hydro renewable). Forecasts for these resources are generally consistent from year to year, but may change annually based on scheduling for annual maintenance, refueling, and capital improvements.
- Federal System Contract Purchases: Bonneville 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 17, are made up of: 1) power purchases, 2) power or energy exchange purchases, 3) power assigned to Bonneville under Treaty-related agreements, and 4) transmission loss returns under Slice contracts. Bonneville'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 2020**

Project	Initial Service Date	Operator	Number of Units	Nameplate Rating (MW)	120-Hour Generating Capacity ^{a/} (Peak MW)	High Streamflows Energy (aMW)	Average Streamflows Energy (aMW)	Firm Energy ^{b/} (aMW)
Regulated Hydro								
1. Albeni Falls	1955	USACE	3	49	21.8	17.2	21.6	21.4
2. Bonneville ^{c/}	1938	USACE	18	1,195	980	610	552	380
3. Chief Joseph	1955	USACE	27	2,614	2,221	1,582	1,377	1,125
4. Dworshak	1974	USACE	3	465	384	278	216	140
5. Grand Coulee / GCL Pumping	1941	USBR	27	6,735	4,198	2,808	2,422	1,972
	1973		6	314				
6. Hungry Horse	1952	USBR	4	428	330	127	94	74
7. Ice Harbor	1961	USACE	6	693	508	306	227	111
8. John Day	1968	USACE	16	2,480	2,268	1,418	1,017	694
9. Libby	1975	USACE	5	605	484	254	227	182
10. Little Goose	1970	USACE	6	930	873	331	255	130
11. Lower Granite	1975	USACE	6	930	806	389	250	111
12. Lower Monumental	1969	USACE	6	930	878	396	300	145
13. McNary	1953	USACE	14	1,120	1,062	659	549	413
14. The Dalles	1957	USACE	22	2,052	1,697	972	805	545
15. Idled Federal Capacity	-	-	-	-	-7,094	-	-	-
16. Total Regulated Hydro Projects			169	21,540	9,615	10,148	8,314	6,044
Independent Hydro Projects								
17. Anderson Ranch	1950	USBR	2	40	4.3	19.6	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	18.0	19.9	18.9
23. Cowlitz Falls	1994	LCPD#1	2	70	10.0	40.3	27.7	26.2
24. Detroit	1953	USACE	2	115	96.0	61.9	49.0	41.2
25. Dexter	1955	USACE	1	17	3.4	11.3	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	27.3
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	17.7
30. Lookout Point	1954	USACE	3	138	7.8	45.7	41.1	35.6
31. Lost Creek	1975	USACE	2	56	18.5	43.4	45.4	30.0
32. Minidoka	1909	USBR	4	28	2.3	22.5	16.6	11.2
33. Palisades	1957	USBR	4	176	11.4	96.2	84.0	69.0
34. Roza	1958	USBR	1	13	2.6	8.7	7.6	6.9
35. Total Independent Hydro Projects (sum lines 17 through 34)			38	894	198	480	421	349
Small Non-Federally Owned Hydro Projects								
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
38. Total Non-Federally Owned Hydro Projects (line 36 + line 37)			2	7	4.6	2.9	2.9	2.9
39. Total Hydro Generation (line 16 + line 35 + line 38)			209	22,441	9,818	10,631	8,737	6,396

^{a/} This is the maximum 120-Hour hydro generation for January 2020 assuming 1937-critical water conditions

^{b/} Firm energy is the 12-month annual average for OY 2020 assuming 1937-critical water conditions

^{c/} Bonneville Dam generation totals include Bonneville Fishway

Table 2-5

**Federal System
Non-Hydro Project Generation and Contract Purchases
OY 2020**

Project	Initial Service Date	Resource Type	Operator	Capacity ^{a/} (Peak MW)	Firm Energy (aMW)
Non-Hydro Resources					
1. Columbia Generating Station	1984	Nuclear	ENW	1,169	1,116
2. Condon Wind Project	2002	Wind	Condon Wind Project, LLC	0	11.7
3. Foote Creek 1	1999	Wind	Foote Creek 1, LLC	0	3.6
4. Foote Creek 4	2000	Wind	Foote Creek 4, LLC	0	4.0
5. Stateline Wind Project	2001	Wind	PPM, FLP	0	21.2
6. Klondike Phase I	2001	Wind	NW Wind Power	0	5.6
7. Klondike Phase III	2007	Wind	NW Wind Power	0	11.8
8. Fourmile Hill Geothermal ^{b/}	Not in Service	Geo.	Calpine	0	0
9. Ashland Solar Project	2000	Solar	City of Ashland, OR	0	0
10. White Bluffs Solar	2002	Solar	Energy Northwest	0	0
11. Total Federal System Non-Hydro Resources (sum lines 1 through 10)				1,169	1,174
Contract Purchases					
12. Canadian Entitlement for Canada (non-Federal)				239	137
13. Canadian Imports				1	1
14. Pacific Southwest Imports				125	89
15. Intra-Regional Transfers In (Pacific Northwest Purchases)				17	38
16. Slice Transmission Loss Return				48	30
17. Total Federal System Contract Purchases (sum lines 12 through 16)				429	294
18. Total Federal System Non-Hydro Resources and Contract Purchases (line 11 + line 17)				1,598	1,468

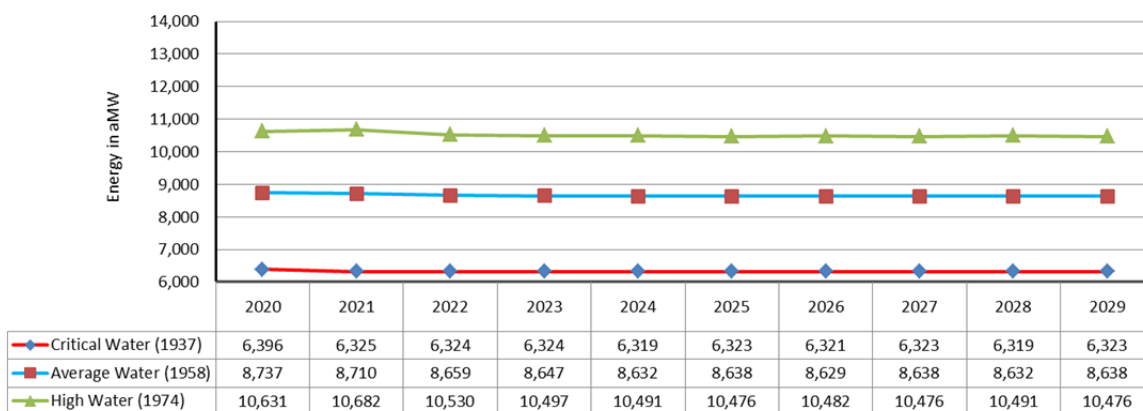
^{a/} This is the maximum generation for January 2020

^{b/} 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

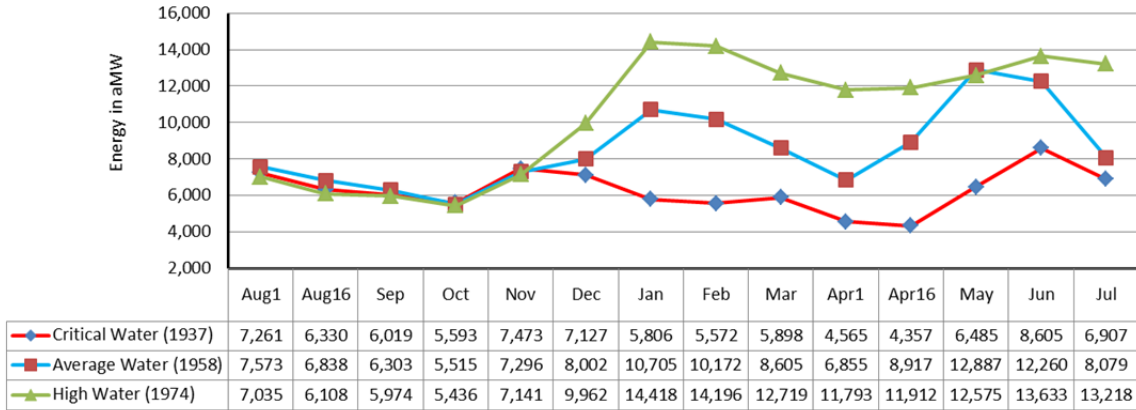
**Federal System
Variability of Annual Hydro Generation
OY 2020 through 2029
Under Different Water Conditions**



In OY 2020, annual Federal system hydro energy generation is forecasted to be 6,396 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 10,631 aMW. Table 2-6, above, 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 2020, 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 from 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 more than 8,500 aMW in a single month depending on project operations and the availability of water.

Table 2-7

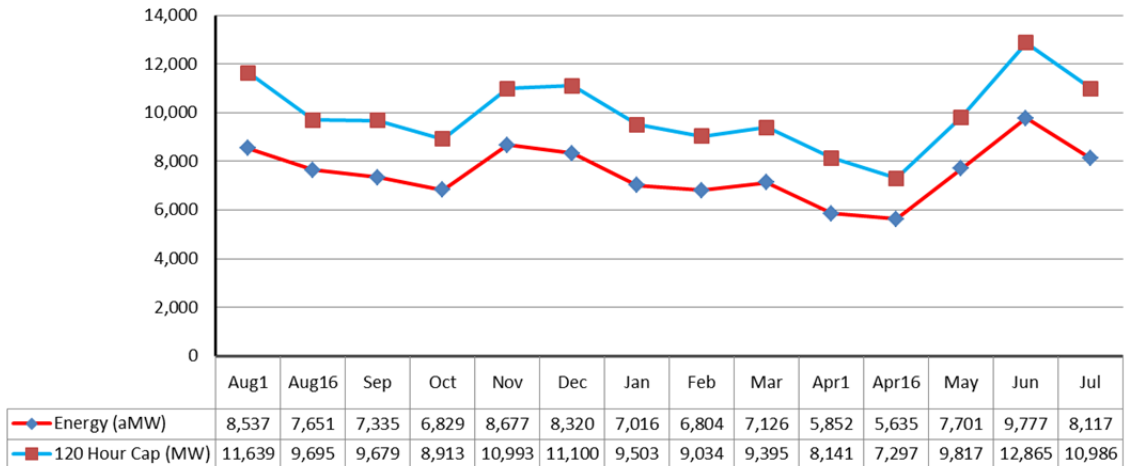
**Federal System
Variability of Monthly Hydro Generation
OY 2020
Under Different Water Conditions**



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 2020, 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
OY2020 Energy and 120-Hour Capacity
Under 1937-Critical Water Conditions**



Key Results

Annual Energy: Table 2-9, below, shows that the Federal system is forecasted to have small annual firm energy surpluses in the first year, and 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 39, for OY 2020 through 2029. The Federal system monthly energy loads and resources are shown in Exhibit 4-2, page 43, for OY 2020 through 2029. The details of each component are presented in the 2018 Loads and Resources Study Technical Appendix, Volume 1: Energy Analysis.

Table 2-9

**Federal System
Annual Energy Surplus/Deficit
OY 2020 through 2029
1937-Critical Water Conditions**

Energy (aMW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Surplus/Deficit	79	-123	-256	-414	-300	-438	-224	-275	-190	-308

Table 2-10, below, compares the 2018 White Book Federal system annual firm energy surplus/deficit results to those from the 2017 White Book. The 2018 White Book shows a smaller annual energy surplus in the first year and larger annual energy deficits over most of 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 2020 through 2029
1937-Critical Water Conditions**

Energy (aMW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
2018 White Book	79	-123	-256	-414	-300	-438	-224	-275	-190	-308
2017 White Book	169	-94	-60	-238	-105	-275	-142	-308	-180	n/a
<i>Difference (2018 WBK - 2017 WBK)</i>	<i>-90</i>	<i>-29</i>	<i>-196</i>	<i>-176</i>	<i>-195</i>	<i>-162</i>	<i>-83</i>	<i>33</i>	<i>-10</i>	n/a

120-Hour Capacity: Table 2-11, below, shows that the Federal system January 120-Hour capacity is 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 2020 through 2029 are shown in Exhibit 4-3, page 47. The Federal system monthly 120-Hour capacity loads and resources are shown in Exhibit 4-4, page 51, for OY 2020. The details of each component are presented in the 2018 Loads and Resources Study Technical Appendix, Volume 2: Capacity Analysis.

Table 2-11

**Federal System
January 120-Hour Capacity Surplus/Deficit
OY 2020 through 2029
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Surplus/Deficit	-969	-994	-1312	-1406	-1367	-1371	-1209	-1289	-1340	-1258

Table 2-12, below, compares the 2018 White Book January firm 120-Hour capacity surplus/deficit results to those from the 2017 White Book. This study shows larger January 120-Hour capacity deficits, due to changes in both load obligations and Federal system generation.

Table 2-12

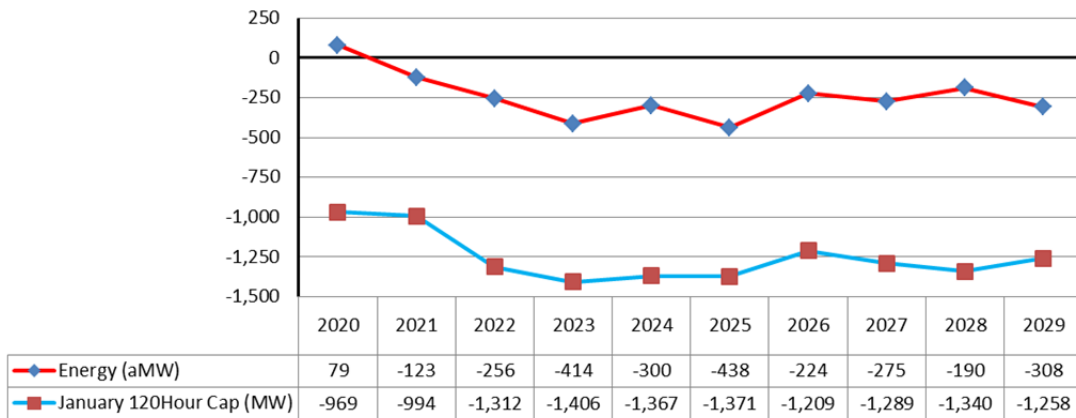
**Federal System
January 120-Hour Capacity Surplus/Deficit Comparison
OY 2020 through 2029
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
2018 White Book	-969	-994	-1312	-1406	-1367	-1371	-1209	-1289	-1340	-1258
2017 White Book	-884	-939	-1054	-1150	-1132	-1220	-1183	-1311	-1283	n/a
<i>Difference (2018 WBK – 2017 WBK)</i>	-85	-56	-258	-256	-235	-151	-26	22	-58	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 in the first year of 79 aMW (OY 2020), and annual deficits as high as -438 aMW over the study period. The January firm 120-Hour capacity forecasts show the Federal system is deficit throughout the study period, ranging from -969 MW in OY 2020, to as high as -1,406 in OY 2023, and ending the study period -1,258 MW in OY 2029. Variations in the annual energy deficits between the odd and even OYs are mainly due to the biennial Columbia Generation Station (CGS) maintenance schedule.²

Table 2-13

**Federal System
Annual Energy and January 120-Hour Capacity Surplus/Deficit
OY 2020 through 2029
1937-Critical Water Conditions**

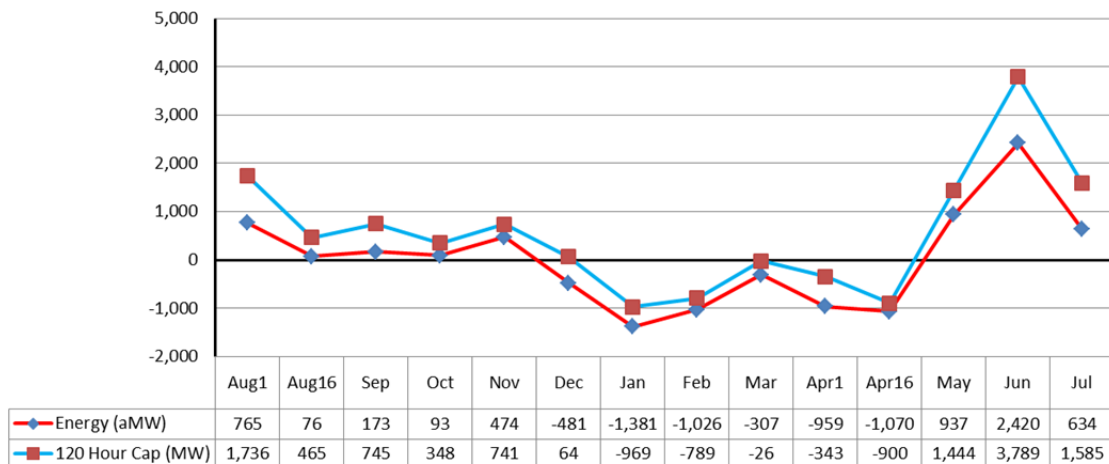


² In odd calendar years, CGS has scheduled maintenance in May and June, and is forecasted to produce 994 aMW annually. During even calendar years, CGS does not have scheduled maintenance and is forecast to produce 1,116 aMW annually.

Federal System Monthly Surplus/Deficit: Table 2-14, below, graphically presents the Federal system monthly firm energy and 120-Hour capacity surpluses and deficits for OY 2020. 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, February, and the second half of April show the largest monthly deficits and the spring (May through June) showing the largest surpluses.

Table 2-14

**Federal System
Monthly Energy and 120-Hour Capacity Surplus/Deficit
OY 2020
1937-Critical Water Conditions**



Conclusion

Under 1937 critical water conditions the Federal system continues to remain near annual firm energy load-resource balance. The Federal system is predicted to be surplus at the beginning of the study period, and then shows a growing deficit; with a reduction in that deficit as obligations expire in OY 2026. These annual energy surpluses and deficits range from a surplus of 79 aMW in OY 2020 to deficits as high as -438 aMW in OY 2025. 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. For example, the annual energy surpluses can increase by almost 3,200 aMW under better water conditions, while the monthly surplus/deficit position can vary by more than 8,600 aMW (January). Similarly, Federal system 120-Hour capacity surplus/deficits for OY 2020 can vary by more than 6,500 MW in January depending on water conditions.

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 surpluses and deficits forecasts under all 80-historical water conditions is presented in Exhibit 4-5, page 55.

Section 3: Pacific Northwest Regional Analysis

The PNW Regional Analysis is an OY analysis that provides Bonneville's deterministic forecast of the PNW region's loads and resources over a 10-year period from OY 2020 through 2029. 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 annual regional utility data submittals received by Bonneville.

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 Bonneville's ALF system. TRL forecasts reflect normal weather conditions and do not include 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 26, shows the forecasted composition of PNW regional load for OY 2020. For the PNW region, about 53 percent of the regional loads are represented by IOU customers. Public, cooperative, Tribal, Federal agency and USBR reserve power customers comprise about 40 percent of PNW regional loads. Marketer and DSI loads are quite small and make up approximately 2 percent of regional loads, while export contracts comprise approximately 5 percent of regional loads.

Table 3-1

**PNW Region
Firm Regional Loads by Customer Class
OY 2020**

Customer Class	Energy (aMW)	Percent of Energy	January 120-Hour Capacity (MW)	Percent of Capacity
Federal Agency	133	1%	212	1%
USBR	179	1%	281	1%
Cooperative	2,239	9%	3,540	10%
Municipality	2,629	11%	4,347	12%
Public Utility District	4,439	19%	7,399	20%
Investor-Owned Utility	12,672	53%	19,233	52%
Marketer	4	0%	4	0%
Direct-Service Industry ¹	401	2%	413	1%
Total Retail Load	22,696	95%	35,429	96%
Exports	1,210	5%	1,369	4%
Regional Load	23,906	100%	36,798	100%

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

Conservation in Total Retail Loads: The TRL forecasts are developed by Bonneville using the ALF system which includes historic conservation savings.

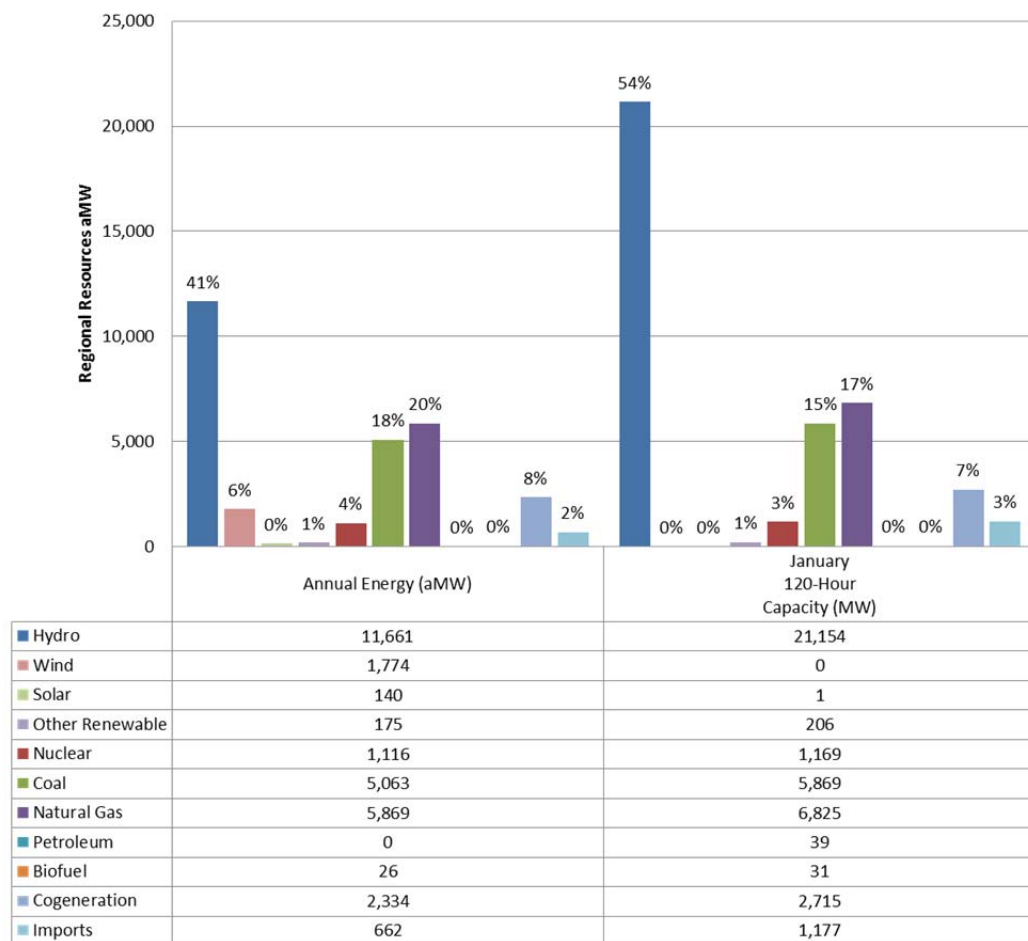
Regional Resources

PNW resources and contract purchases are collectively called “regional resources” in this study. Like the Federal system, regional resources vary monthly by water conditions, 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) Non-Hydro Renewable resources, which include wind, solar, and other projects; 3) Thermal resources, which include nuclear, coal, natural gas, petroleum, biofuel and cogeneration projects; and 4) Contract purchases, which are identified as Imports.

Table 3-2, below, summarizes the resource generation available to meet PNW regional loads. The generation forecasts for these resources are provided by Bonneville 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 individual utility, follow specific contract provisions and can have various delivery arrangements. For OY 2020, regional firm energy resources are comprised of approximately 40 percent hydro, 20 percent natural gas, 18 percent coal, 8 percent cogeneration, 6 percent wind, 4 percent nuclear, 2 percent imports, and about 1 percent solar and other renewables.

Table 3-2

**PNW Region
Generation by Resource Type
OY 2020
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 non-power requirements, and other operating limitations. Bonneville utilizes an 80-year record of historical 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 generation 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 2020, annual firm energy generation from regional hydro projects is forecasted to be 11,661 aMW. This represents about 41 percent of region’s resources. However, the generating potential from regional hydro projects can annually vary by almost 7,000 aMW depending on water conditions.

Table 3-3

**PNW Region
Variability of Annual Hydro Generation
OY 2020 through 2029
Under Different Water Conditions**

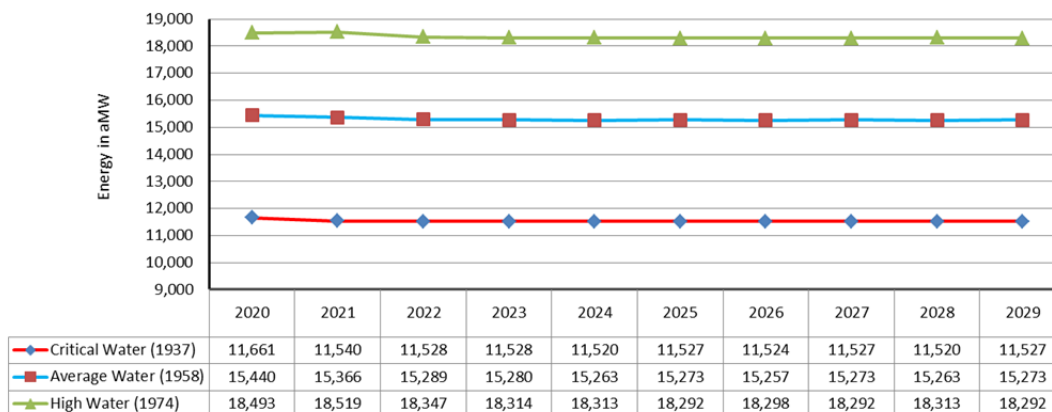
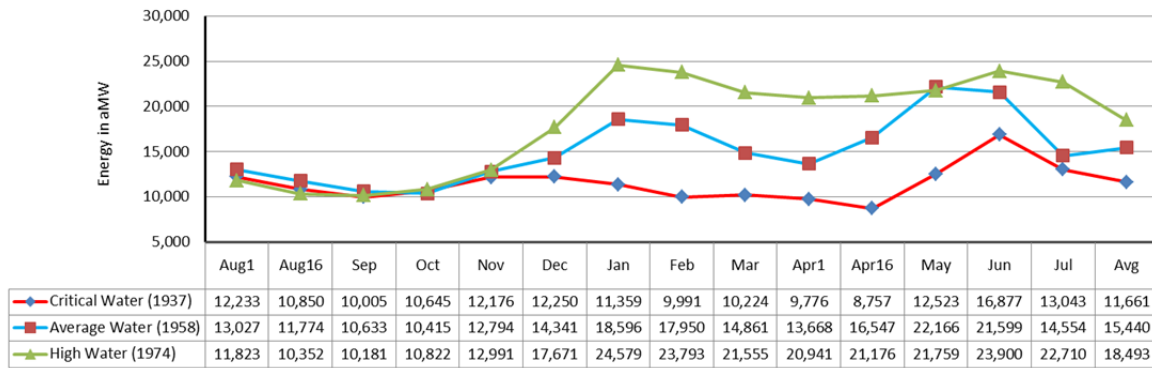


Table 3-4, page 29, shows the monthly variability of the region’s hydro generation under the same three water conditions. High generation levels in the December through mid-April period is largely due to drafting reservoirs for power production and flood control, which can vary widely due to rainfall and snowpack levels in the Columbia River Basin. Power production in late-April through July is variable due to the timing and amount of 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 14,000 aMW depending on project operations and the availability of water.

Table 3-4

**PNW Region
Variability of Monthly Hydro Generation
OY 2020
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 3,342 aMW of energy with an associated 4,012 MW of January 120-Hour capacity in OY 2020. The inclusion of this uncommitted IPP generation is reasonable from a long-term planning perspective given the fact that the PNW Regional Analysis 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, below, details the region’s total uncommitted IPP annual energy and January 120-Hour capacity generation forecasts over the OY 2020 through 2029 study period. Table 3-6, page 30, details the region’s uncommitted IPP projects and 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 3-5

**PNW Region
Uncommitted Independent Power Producer Generation
Annual Energy and January 120-Hour Capacity
OY 2020 through 2029**

Regional Uncommitted IPP	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Annual Energy (aMW)	3,342	2,926	2,732	2,702	2,700	2,700	2,531	2,457	2,489	2,497
January 120-Hour Capacity (MW)	4,012	3,342	3,308	3,130	3,130	3,130	2,840	2,840	2,840	2,840

Table 3-6

**PNW Region
Uncommitted Independent Power Producer Projects
OY 2020**

Project	Annual Energy (aMW)	January 120-Hour Capacity (MW)	Fuel Type
Centralia ^{a,b}	862	960	Coal
Cosmopolis Specialty Fibres	14	14	Wood Waste
Hermiston Power Project	567	630	Natural Gas
International Paper Energy Center	15	22	Wood Waste
Juniper Canyon Wind	36	0	Wind
Kittitas Valley Wind	24	0	Wind
Klamath Generation Facility	436	484	Natural Gas
Klamath Generation Peakings (CT)	90	100	Natural Gas
Leaning Juniper Wind	47	0	Wind
Longview Fibre Paper & Packaging	35	35	Wood Waste
Nippon Paper Cogen (Port Angeles)	11	12	Natural Gas
Pelton	13	41	Hydro
Priest Rapids	85	138	Hydro
Rock Island	138	235	Hydro
Rocky Reach	257	494	Hydro
Round Butte	29	99	Hydro
Satsop Combustion Turbine Project	584	650	Natural Gas
SDS Lumber	1	1	Wood Waste
Smith Creek (Idaho)	7	0	Hydro
Stateline Wind	8	0	Wind
Vansycle Wind	23	0	Wind
Wanapum	25	54	Hydro
Weyerhaeuser Longview	35	44	Wood Waste
Total Uncommitted IPP Generation	3,342	4,012	

^{a/} Centralia #1 (670 MW) is scheduled for retirement on Dec 1, 2020.

^{b/} Centralia #2 (670 MW) is scheduled for retirement on Dec 1, 2025

Key Results

Annual Energy: Table 3-7, below, shows significant annual energy surpluses for the PNW region throughout the study period, under 1937-water conditions. This study assumes that 100 percent of the PNW region’s uncommitted IPP generation (3,342 aMW in OY 2020) is available to serve the region’s loads. The individual components of the PNW regional annual energy loads and resources for OY 2020 through 2029 are shown in Exhibit 5-1, page 61. The PNW regional monthly energy loads and resources for OY 2020 are shown in Exhibit 5-2, page 65. The details of each component for OY 2020 through 2029 are presented in the 2018 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 2020 through 2029
1937-Critical Water Conditions**

Energy (aMW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Surplus/Deficit	4,058	3,141	2,303	1,637	1,750	1,416	965	614	579	403

Table 3-8, 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 29 and 30.

Table 3-8

**PNW Region
Variability of Annual Energy Surplus/Deficit
Assuming Different Levels of Uncommitted IPP Generation
OY 2020 through 2029
1937-Critical Water Conditions**

Energy (aMW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
100% IPP	4,058	3,141	2,303	1,637	1,750	1,416	965	614	579	403
50% IPP	2,387	1,678	937	286	400	66	-300	-615	-666	-845
0% IPP	715	215	-429	-1,066	-949	-1,285	-1,566	-1,843	-1,911	-2,094

Table 3-9, below, compares the 2018 White Book PNW regional annual firm energy surplus/deficit forecasts to the 2017 White Book results. The PNW region continues to have annual energy surpluses throughout the study period. When compared to the 2017 White Book, the 2018 study shows larger annual energy surpluses at the start and end of the study period with slightly decreased surpluses in the middle years. Over the study period this is mostly driven by changes in total retail load forecasts.

Table 3-9

**PNW Region
Annual Energy Surplus/Deficit Comparison
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2020 through 2029
1937-Critical Water Conditions**

Energy (aMW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
2018 White Book	4,058	3,141	2,303	1,637	1,750	1,416	965	614	579	403
2017 White Book	4,032	3,017	2,372	1,721	1,779	1,347	918	505	465	n/a
<i>Difference (2018 WBK – 2017 WBK)</i>	26	124	-69	-85	-28	69	47	109	114	n/a

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 January 120-Hour capacity deficits over the entire 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 2020 through 2029 are shown in Exhibit 5-3, page 69. The monthly PNW regional 120-Hour capacity loads and resources for OY 2020 are shown in Exhibit 5-4, page 73. The component details for OY 2020 through 2029 are presented in the 2018 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 2020 through 2029
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Surplus/Deficit	-246	-1,588	-2,456	-3,056	-3,337	-3,436	-4,482	-4,589	-4,866	-4,891

Table 3-11, 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 29 and 30.

Table 3-11

**PNW Region
Variability of January 120-Hour Capacity Surplus/Deficit
Assuming Different Levels of Uncommitted IPP Generation
OY 2020 through 2029
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
100% IPP	-246	-1,588	-2,456	-3,056	-3,337	-3,436	-4,482	-4,589	-4,866	-4,891
50% IPP	-2,251	-3,259	-4,110	-4,621	-4,902	-5,002	-5,902	-6,009	-6,286	-6,311
0% IPP	-4,257	-4,930	-5,764	-6,186	-6,468	-6,567	-7,322	-7,429	-7,706	-7,731

Table 3-12, below, compares the 2018 White Book January firm 120-Hour capacity forecast to the 2017 White Book results. Regional January 120-Hour capacity surplus/deficits show larger deficits over the study period. The increased January 120-Hour capacity deficits, compared to the 2017 White Book, are mainly the result of updated TRL forecasts from ALF.

Table 3-12

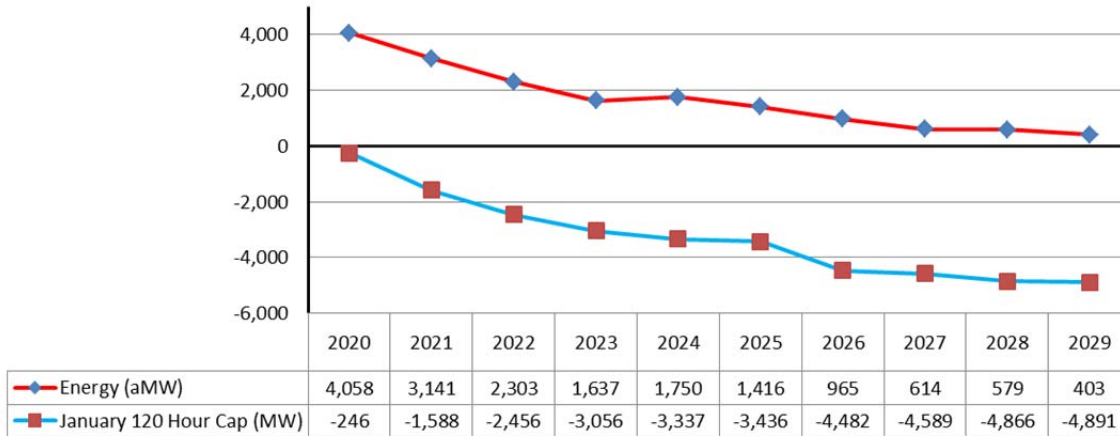
**PNW Region
January 120-Hour Capacity Surplus/Deficit Comparison
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2020 through 2029
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
2018 White Book	-246	-1,588	-2,456	-3,056	-3,337	-3,436	-4,482	-4,589	-4,866	-4,891
2017 White Book	308	-1,185	-1,666	-2,331	-2,599	-2,840	-3,765	-4,019	-4,175	n/a
<i>Difference (2018 WBK - 2017 WBK)</i>	<i>-553</i>	<i>-404</i>	<i>-791</i>	<i>-725</i>	<i>-738</i>	<i>-597</i>	<i>-717</i>	<i>-570</i>	<i>-692</i>	n/a

Regional Annual Surplus/Deficit: Table 3-13, below, graphically presents the annual firm energy and January 120-Hour capacity surplus/deficit 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 surplus/deficit declines over the 10-year study period. By the end of the period, the study shows an annual energy surplus of 403 aMW, while January 120-Hour capacity is deficit over the entire study period ending with a deficit of -4,891 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 region combined with the retirements of the Boardman, Centralia, Colstrip, and Valmy coal plants.

Table 3-13

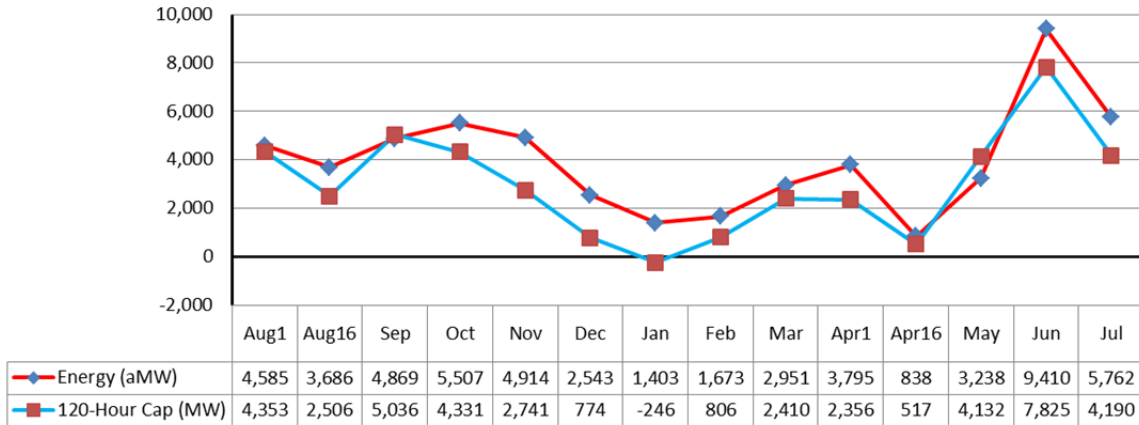
**PNW Region
Annual Energy and January 120-Hour Capacity Surplus/Deficit
OY 2020 through 2029
1937-Critical Water Conditions**



Regional Monthly Surplus/Deficit: Table 3-14, below, graphically presents the monthly energy and 120-Hour capacity surplus/deficit forecasts for OY 2020. 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 a deficit and the spring months showing 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 2020
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. 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 and deficit forecasts for all 80-historical water conditions are presented in Exhibit 5-5, page 77. Additional monthly and annual details for OY 2020 through 2029 are presented in the 2018 Loads and Resources Study Technical Appendix, Volume 1: Energy Analysis and the 2018 Loads and Resources Study Technical Appendix, Volume 2: Capacity Analysis.

Bonneville 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 Northwest Power and Conservation Council’s Seventh Power Plan.

Section 4: Federal System Analysis Exhibits

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Exhibit 4-1: Annual Energy

**Federal System Analysis Surplus Deficit
Operating Year 2020 to 2029
Using 1937-Water Conditions**

Loads and Resources - Federal System
Operating Year: 2020 to 2029 Water Year: 1937
2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

Energy-aMW	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Firm Obligations										
1 Load Following	3447	3445	3485	3513	3523	3541	3558	3573	3583	3596
² Preference Customers	3146	3136	3171	3199	3209	3225	3242	3256	3266	3278
³ Federal Agencies	123	130	135	135	135	137	137	138	138	139
⁴ USBR	179	179	179	179	179	179	179	179	179	179
⁵ Federal Diversity	0	0	0	0	0	0	0	0	0	0
6 Tier 1 Block	578	587	588	581	568	565	564	564	563	563
⁷ Tier 1 Block	578	587	588	581	568	565	564	564	563	563
8 Slice	2871	2866	2939	2944	2944	2935	2938	2929	2931	2921
⁹ Slice Block	1289	1314	1404	1442	1417	1437	1414	1434	1412	1427
¹⁰ Slice Output from T1 System	1582	1552	1535	1503	1528	1498	1524	1495	1519	1493
11 Direct Service Industries	18.4	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
¹² Direct Service Industry	18.4	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
13 Contract Deliveries	635	620	660	660	660	676	560	476	476	476
¹⁴ Exports	539	471	450	450	450	465	465	465	465	465
¹⁵ Intra-Regional Transfers (Out)	96.4	149	211	211	211	211	94.6	10.7	10.7	10.7
¹⁶ Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0
17 Total Firm Obligations	7550	7530	7685	7711	7708	7729	7632	7553	7565	7567
Net Resources										
18 Hydro	6396	6325	6324	6324	6319	6323	6321	6323	6319	6323
¹⁹ Regulated Hydro - Net	6044	5973	5971	5972	5967	5971	5969	5971	5967	5971
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

Loads and Resources - Federal System
Operating Year: 2020 to 2029 Water Year: 1937
2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

Energy-aMW	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
22 Non-Hydro Renewable	57.9	54.6	52.1	38.4	35.2	33.0	33.0	19.8	1.90	0
²³ Wind - Net	57.9	54.6	52.1	38.4	35.2	33.0	33.0	19.8	1.90	0
²⁴ Solar - Net	0	0	0	0	0	0	0	0	0	0
²⁵ Other - Net	0	0	0	0	0	0	0	0	0	0
26 Thermal	1116	994	1116	994	1116	994	1116	994	1116	994
²⁷ Nuclear - Net	1116	994	1116	994	1116	994	1116	994	1116	994
²⁸ Coal - Net	0	0	0	0	0	0	0	0	0	0
²⁹ Natural Gas - Net	0	0	0	0	0	0	0	0	0	0
³⁰ Petroleum - Net	0	0	0	0	0	0	0	0	0	0
³¹ Biofuel - Net	0	0	0	0	0	0	0	0	0	0
³² Cogeneration - Net	0	0	0	0	0	0	0	0	0	0
33 Contract Purchases	294	263	166	166	167	166	167	166	166	166
³⁴ Imports	90.0	84.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
³⁵ Intra-Regional Transfers (In)	37.6	12.4	0	0	0	0	0	0	0	0
³⁶ Non-Federal CER	137	137	136	137	137	137	137	137	136	137
³⁷ Slice Transmission Loss Return	30.1	29.5	29.2	28.6	29.1	28.5	29.0	28.4	28.9	28.4
³⁸ Augmentation Purchases	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-235	-229	-229	-225	-229	-225	-229	-225	-228	-224
⁴⁰ Operating Reserves	0	0	0	0	0	0	0	0	0	0
⁴¹ Balancing Reserves	0	0	0	0	0	0	0	0	0	0
⁴² Transmission Losses	-235	-229	-229	-225	-229	-225	-229	-225	-228	-224
43 Total Net Resources	7629	7407	7429	7297	7408	7291	7408	7278	7375	7258
44 Total Surplus/Deficit	79	-123	-256	-414	-300	-438	-224	-275	-190	-308

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Exhibit 4-2: Monthly Energy

**Federal System Analysis Surplus Deficit
Operating Year 2020
Using 1937-Water Conditions**

Loads and Resources - Federal System
Operating Year: 2020 Water Year: 1937
2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
Firm Obligations															
¹ Load Following	3624	3626	3253	2927	3410	3888	3831	3582	3206	3238	3238	3246	3444	3712	3447
² Preference Customers	3211	3215	2893	2711	3256	3709	3664	3422	3014	2882	2882	2811	2982	3190	3146
³ Federal Agencies	101	101	93.4	108	136	161	156	146	129	112	112	106	108	118	123
⁴ USBR	312	311	266	108	18.2	17.7	9.97	13.9	63.0	244	244	329	354	405	179
⁵ Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
⁶ Tier 1 Block	352	352	597	539	889	888	976	887	871	427	427	152	21.2	346	578
⁷ Tier 1 Block	352	352	597	539	889	888	976	887	871	427	427	152	21.2	346	578
⁸ Slice	2934	2730	2633	2545	3175	3299	3003	2775	2774	2562	2456	2782	3307	2817	2871
⁹ Slice Block	1222	1222	1169	1159	1356	1559	1553	1373	1312	1216	1216	1179	1155	1210	1289
¹⁰ Slice Output from T1 System	1712	1508	1464	1386	1819	1740	1451	1402	1463	1346	1240	1603	2152	1607	1582
¹¹ Direct Service Industries	87.0	87.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	18.4
¹² Direct Service Industry	87.0	87.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	18.4
¹³ Contract Deliveries	775	779	667	713	717	715	575	574	570	572	572	572	572	595	635
¹⁴ Exports	635	640	529	574	573	573	508	508	508	508	508	508	508	529	539
¹⁵ Intra-Regional Transfers (Out)	140	140	139	139	144	142	66.6	66.1	61.7	64.2	64.2	64.5	64.4	65.8	96.4
¹⁶ Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
¹⁷ Total Firm Obligations	7772	7575	7162	6735	8203	8802	8397	7830	7433	6811	6705	6764	7357	7483	7550
Net Resources															
¹⁸ Hydro	7261	6330	6019	5593	7473	7127	5806	5572	5898	4565	4357	6485	8605	6907	6396
¹⁹ Regulated Hydro - Net	6897	5969	5677	5284	7213	6952	5689	5441	5665	4127	3912	5763	7894	6498	6044
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	3.04	3.10	3.09	3.09	2.83	2.72	2.63	2.88

Loads and Resources - Federal System
Operating Year: 2020 Water Year: 1937
2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
22 Non-Hydro Renewable	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
23 Wind - Net	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
24 Solar - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Other - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Thermal	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116
27 Nuclear - Net	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116
28 Coal - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Natural Gas - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Petroleum - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Biofuel - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32 Cogeneration - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33 Contract Purchases	384	382	371	286	291	284	284	282	281	263	261	260	280	268	294
34 Imports	65.4	65.6	64.3	116	115	114	115	115	115	65.4	65.4	64.4	65.4	65.0	90.0
35 Intra-Regional Transfers (In)	148	148	146	5.11	3.80	3.24	2.50	2.40	4.58	34.1	34.1	31.7	35.4	33.3	37.6
36 Non-Federal CER	138	139	133	139	138	134	139	137	134	138	138	134	138	139	137
37 Slice Transmission Loss Return	32.6	28.7	27.8	26.4	34.6	33.1	27.6	26.7	27.8	25.6	23.6	30.5	40.9	30.6	30.1
38 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-264	-236	-226	-211	-267	-256	-216	-209	-219	-180	-174	-239	-303	-251	-235
40 Operating Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41 Balancing Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42 Transmission Losses	-264	-236	-226	-211	-267	-256	-216	-209	-219	-180	-174	-239	-303	-251	-235
43 Total Net Resources	8537	7651	7335	6829	8677	8320	7016	6804	7126	5852	5635	7701	9777	8117	7629
44 Total Surplus/Deficit	765	76	173	93	474	-481	-1,381	-1,026	-307	-959	-1,070	937	2,420	634	79

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Exhibit 4-3: Annual 120-Hour Capacity

**Federal System Analysis Surplus Deficit
Operating Year 2020 to 2029
Using 1937-Water Conditions**

Loads and Resources - Federal System
2020 to 2029 Water Year: 1937
2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

January 120Hr-MW	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Firm Obligations										
1 Load Following	4496	4603	4665	4699	4678	4696	4722	4785	4811	4801
² Preference Customers	5468	5493	5552	5582	5609	5638	5666	5694	5720	5745
³ Federal Agencies	204	218	223	221	222	224	225	226	227	227
⁴ USBR	281	281	281	281	281	281	281	281	281	281
⁵ Federal Diversity	-1457	-1388	-1390	-1385	-1433	-1446	-1449	-1416	-1416	-1451
6 Tier 1 Block	1039	1076	1077	1059	996	989	987	1024	1025	985
⁷ Tier 1 Block	1039	1076	1077	1059	996	989	987	1024	1025	985
8 Slice	3531	3638	3716	3787	3714	3779	3699	3773	3702	3764
⁹ Slice Block	1553	1591	1701	1731	1696	1725	1688	1722	1691	1712
¹⁰ Slice Output from T1 System	1978	2047	2015	2056	2018	2053	2010	2050	2012	2052
11 Direct Service Industries	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
¹² Direct Service Industry	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
13 Contract Deliveries	1395	1336	1336	1336	1336	1358	1158	1158	1158	1158
¹⁴ Exports	1312	1120	1120	1120	1120	1142	1142	1142	1142	1142
¹⁵ Intra-Regional Transfers (Out)	83.2	216	216	216	216	216	16.4	16.4	16.4	16.4
¹⁶ Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0
17 Total Firm Obligations	10472	10665	10807	10893	10736	10834	10578	10752	10709	10720
Net Resources										
18 Hydro	9818	10111	10085	10079	9956	10057	9940	10041	9943	10043
¹⁹ Regulated Hydro - Net	9615	9908	9882	9876	9753	9854	9737	9838	9741	9841
²⁰ Independent Hydro - Net	198	198	198	198	198	198	198	198	198	198
²¹ Small Hydro - Net	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59	4.59

Loads and Resources - Federal System
2020 to 2029 Water Year: 1937
2018 White Book Report Date: 12/1/2018
S166-WB-20190220-091000

January 120Hr-MW	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
22 Non-Hydro Renewable	0	0	0	0	0	0	0	0	0	0
23 Wind - Net	0	0	0	0	0	0	0	0	0	0
24 Solar - Net	0	0	0	0	0	0	0	0	0	0
25 Other - Net	0	0	0	0	0	0	0	0	0	0
26 Thermal	1169	1169	1169	1169	1169	1169	1169	1169	1169	1169
27 Nuclear - Net	1169	1169	1169	1169	1169	1169	1169	1169	1169	1169
28 Coal - Net	0	0	0	0	0	0	0	0	0	0
29 Natural Gas - Net	0	0	0	0	0	0	0	0	0	0
30 Petroleum - Net	0	0	0	0	0	0	0	0	0	0
31 Biofuel - Net	0	0	0	0	0	0	0	0	0	0
32 Cogeneration - Net	0	0	0	0	0	0	0	0	0	0
33 Contract Purchases	429	414	288	289	289	289	288	289	288	289
34 Imports	126	126	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
35 Intra-Regional Transfers (In)	16.8	0	0	0	0	0	0	0	0	0
36 Non-Federal CER	239	239	239	239	239	239	239	239	239	239
37 Slice Transmission Loss Return	47.6	49.3	48.5	49.5	48.6	49.4	48.4	49.4	48.4	49.4
38 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-1913	-2024	-2048	-2050	-2045	-2053	-2029	-2037	-2032	-2040
40 Operating Reserves	-747	-738	-751	-754	-753	-758	-737	-742	-740	-744
41 Balancing Reserves	-833	-946	-963	-963	-963	-963	-963	-963	-963	-963
42 Transmission Losses	-334	-340	-333	-333	-329	-332	-329	-332	-329	-332
43 Total Net Resources	9503	9671	9495	9487	9369	9462	9368	9462	9368	9462
44 Total Surplus/Deficit	-969	-994	-1,312	-1,406	-1,367	-1,371	-1,209	-1,289	-1,340	-1,258

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Exhibit 4-4: Monthly 120-Hour Capacity

**Federal System Analysis Surplus Deficit
Operating Year 2020
Using 1937-Water Conditions**

Loads and Resources - Federal System
Operating Year: 2020 Water Year: 1937
2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Firm Obligations														
1 Load Following	4203	3986	3687	3513	4065	4601	4496	4259	3868	3888	3781	3661	3894	4216
2 Preference Customers	4362	4362	4046	4195	4864	5512	5468	5163	4688	4420	4420	4085	4148	4402
3 Federal Agencies	134	134	128	142	175	208	204	186	167	142	142	136	135	144
4 USBR	615	615	539	406	238	316	281	282	381	453	453	541	587	621
5 Federal Diversity	-907	-1125	-1027	-1231	-1212	-1435	-1457	-1372	-1369	-1128	-1235	-1101	-976	-950
6 Tier 1 Block	352	352	597	555	954	979	1039	921	926	442	442	166	21.2	368
7 Tier 1 Block	352	352	597	555	954	979	1039	921	926	442	442	166	21.2	368
8 Slice	3575	3120	3098	2946	3674	3898	3531	3236	3227	2755	2574	3146	3761	3396
9 Slice Block	1222	1222	1169	1159	1356	1559	1553	1373	1311	1216	1216	1179	1155	1210
10 Slice Output from T1 System	2352	1898	1929	1787	2318	2338	1978	1862	1916	1539	1358	1967	2606	2186
11 Direct Service Industries	87.0	87.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
12 Direct Service Industry	87.0	87.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
13 Contract Deliveries	1686	1686	1540	1539	1546	1546	1395	1395	1388	1388	1388	1388	1388	1409
14 Exports	1535	1535	1389	1388	1388	1388	1312	1312	1312	1312	1312	1312	1312	1333
15 Intra-Regional Transfers (Out)	151	151	151	151	158	158	83.2	83.2	76.2	76.2	76.2	76.2	76.2	76.2
16 Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Total Firm Obligations	9903	9230	8934	8565	10252	11036	10472	9823	9421	8484	8196	8373	9076	9401
Net Resources														
18 Hydro	11638	9577	9547	9110	11355	11502	9818	9300	9663	8324	7429	10064	13360	11368
19 Regulated Hydro - Net	11065	9013	9022	8634	10933	11186	9615	9070	9273	7706	6795	9245	12516	10759
20 Independent Hydro - Net	569	560	522	472	417	311	198	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

Loads and Resources - Federal System
Operating Year: 2020 Water Year: 1937
2018 White Book Report Date: 12/1/2018
S166-WB-20190220-091000

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
22 Non-Hydro Renewable	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Wind - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Solar - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Other - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 Thermal	1163	1163	1179	1181	1179	1180	1169	1169	1169	1160	1160	1151	1154	1168
27 Nuclear - Net	1163	1163	1179	1181	1179	1180	1169	1169	1169	1160	1160	1151	1154	1168
28 Coal - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Natural Gas - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Petroleum - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Biofuel - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32 Cogeneration - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33 Contract Purchases	553	542	543	425	438	438	429	427	428	419	414	429	445	434
34 Imports	76.0	76.0	76.0	126	126	126	126	126	126	76.0	76.0	76.0	76.0	76.0
35 Intra-Regional Transfers (In)	182	182	182	16.8	16.8	16.8	16.8	16.8	16.8	66.8	66.8	66.8	66.8	66.8
36 Non-Federal CER	239	239	239	239	239	239	239	239	239	239	239	239	239	239
37 Slice Transmission Loss Return	56.6	45.7	46.4	43.0	55.8	56.3	47.6	44.8	46.1	37.0	32.7	47.3	62.7	52.6
38 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-1715	-1587	-1590	-1802	-1978	-2020	-1913	-1861	-1865	-1762	-1706	-1828	-2093	-1984
40 Operating Reserves	-727	-667	-648	-656	-759	-798	-747	-711	-702	-643	-617	-648	-761	-718
41 Balancing Reserves	-579	-579	-602	-833	-833	-833	-833	-833	-833	-833	-833	-833	-879	-879
42 Transmission Losses	-410	-341	-340	-314	-386	-390	-334	-317	-330	-286	-257	-347	-453	-387
43 Total Net Resources	11639	9695	9679	8913	10993	11100	9503	9034	9395	8141	7297	9817	12865	10986
44 Total Surplus/Deficit	1,736	465	745	348	741	64	-969	-789	-26	-343	-900	1,444	3,789	1,585

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Exhibit 4-5: 80-Water Conditions Monthly Energy

**Federal System Analysis Surplus Deficit
Operating Year 2020**

Federal Report Surplus Deficit By Water Year
Operating Year 2020
2018 White Book Report Date: 12/1/2018
S166-WB-20190220-091000

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	1447	1353	-83.4	39.3	243	-651	-476	-33.8	-18.4	-1097	-1148	411	3241	-12.0	243
2 1930 Federal Report Surplus Deficit	663	90.4	383	71.3	377	-638	-1252	-9.00	-63.4	-475	-752	557	1208	934	108
3 1931 Federal Report Surplus Deficit	976	167	215	83.1	349	-459	-1170	-73.1	-2.87	-643	-1250	744	992	866	96.8
4 1932 Federal Report Surplus Deficit	831	159	26.2	-163	-23.9	-558	-529	-1540	1691	2236	4017	5495	4767	2338	1267
5 1933 Federal Report Surplus Deficit	1246	1075	706	52.0	136	1004	2296	2786	1736	935	218	3301	6510	4443	2055
6 1934 Federal Report Surplus Deficit	2748	1946	504	635	2739	4110	4678	4950	4026	4807	4119	3850	3461	490	3012
7 1935 Federal Report Surplus Deficit	263	-110	55.2	-8.29	-333	-53.1	2152	2444	1883	-267	510	2688	2177	2414	1134
8 1936 Federal Report Surplus Deficit	2290	338	-148	-28.9	181	-611	-1172	-656	225	-433	2650	5656	4176	1484	963
9 1937 Federal Report Surplus Deficit	765	75.9	173	93.4	474	-481	-1381	-1026	-307	-959	-1070	937	2420	634	78.8
10 1938 Federal Report Surplus Deficit	764	-25.7	152	25.5	225	309	1507	1766	2755	2786	4236	5064	3503	2670	1820
11 1939 Federal Report Surplus Deficit	311	-129	458	62.7	79.1	-726	667	950	749	295	1148	2624	1588	1058	691
12 1940 Federal Report Surplus Deficit	677	-11.6	330	151	533	461	1000	496	2134	1419	375	2923	1663	-73.0	905
13 1941 Federal Report Surplus Deficit	200	-310	176	-112	546	121	-111	284	628	-752	-1229	555	1667	767	288
14 1942 Federal Report Surplus Deficit	923	163	378	-173	728	1584	1589	1681	-2.67	-402	-195	1483	4663	3214	1278
15 1943 Federal Report Surplus Deficit	1344	872	896	108	-5.81	-46.0	2638	2457	2409	5352	5140	3661	6165	4584	2427
16 1944 Federal Report Surplus Deficit	2116	804	68.4	-21.4	249	-637	95.8	-13.9	-497	-1321	-1423	262	1145	176	75.5
17 1945 Federal Report Surplus Deficit	931	-86.8	78.5	-103	205	-478	-968	-299	-130	-1178	-1261	2656	4478	343	413
18 1946 Federal Report Surplus Deficit	595	34.8	133	-57.6	414	422	1322	1858	1759	3897	4639	5343	3569	3282	1883
19 1947 Federal Report Surplus Deficit	1651	1068	541	-52.7	878	2609	3619	3297	2964	2320	1159	4679	4145	2934	2393
20 1948 Federal Report Surplus Deficit	1467	648	313	2327	2020	1463	3412	3122	1832	1551	2907	6534	6386	3408	2840
21 1949 Federal Report Surplus Deficit	3178	2332	867	325	566	240	1359	1570	2783	2517	3505	5433	3409	481	1899
22 1950 Federal Report Surplus Deficit	256	-460	79.2	-58.8	145	541	3259	3455	3389	3972	2148	4280	6229	5248	2455
23 1951 Federal Report Surplus Deficit	3148	2215	704	991	2313	2846	4463	5212	4267	4404	3429	5304	3870	4078	3383
24 1952 Federal Report Surplus Deficit	1900	679	376	1814	1386	1567	3254	3200	1860	3900	5176	6264	4211	2740	2705
25 1953 Federal Report Surplus Deficit	1376	324	-190	22.1	240	-604	303	4058	1120	-1096	-294	3450	6562	4341	1608
26 1954 Federal Report Surplus Deficit	1879	1137	490	267	867	974	2790	3638	2540	1529	1070	5030	5364	5067	2484
27 1955 Federal Report Surplus Deficit	3500	3251	2450	395	1457	917	438	872	-478	-736	-744	2579	6461	5091	1901
28 1956 Federal Report Surplus Deficit	2867	1347	248	542	1922	2700	4353	4512	4126	3743	5683	6353	6124	3751	3448
29 1957 Federal Report Surplus Deficit	2481	1844	502	493	508	1157	1564	922	2290	3507	1504	6731	6399	1821	2258
30 1958 Federal Report Surplus Deficit	1000	459	363	33.6	340	179	2323	2451	1738	689	2151	5846	5243	1521	1845
31 1959 Federal Report Surplus Deficit	1271	267	91.8	266	1436	2216	3914	4642	2315	2895	1190	4161	5559	4390	2642
32 1960 Federal Report Surplus Deficit	2910	2312	2801	3082	2838	2132	2744	2362	1957	4583	2898	2834	4569	2338	2829
33 1961 Federal Report Surplus Deficit	1614	308	51.6	208	809	392	2174	2761	3219	2540	500	4412	5747	1763	1995
34 1962 Federal Report Surplus Deficit	1392	505	142	-66.5	423	400	2152	2523	519	1298	4284	3916	3714	1642	1584
35 1963 Federal Report Surplus Deficit	1317	785	-12.1	742	1540	1976	2728	2548	652	-149	-570	2951	4732	2287	1734
36 1964 Federal Report Surplus Deficit	1300	494	636	-34.8	470	343	1100	1356	127	891	10.8	4017	6619	4801	1729
37 1965 Federal Report Surplus Deficit	2814	2012	1129	912	1213	2872	4667	5432	4078	1015	4692	5460	4734	2819	3210
38 1966 Federal Report Surplus Deficit	2423	1893	104	427	606	635	1867	2044	616	1534	537	2241	3511	2130	1445
39 1967 Federal Report Surplus Deficit	1976	352	114	-50.4	166	1144	3441	3708	2749	1141	-516	3822	5965	3851	2194
40 1968 Federal Report Surplus Deficit	1965	1398	510	314	923	672	2331	3044	2974	-791	-696	2097	4760	2579	1758
41 1969 Federal Report Surplus Deficit	2112	1243	1626	1035	2029	1571	3971	4693	2864	3840	4860	6158	4766	2838	3121
42 1970 Federal Report Surplus Deficit	1094	416	261	386	599	-72.6	2198	2790	1131	-593	-619	3424	5586	1545	1492
43 1971 Federal Report Surplus Deficit	1020	245	107	33.1	400	504	4057	5115	3953	3673	2978	6331	6444	4365	2930
44 1972 Federal Report Surplus Deficit	2729	2725	725	523	750	967	3957	4023	5788	5351	2311	6045	6077	4487	3326
45 1973 Federal Report Surplus Deficit	3261	2920	857	460	755	593	1777	2091	487	-1425	-1371	477	1731	523	952
46 1974 Federal Report Surplus Deficit	580	-107	97.7	-25.6	222	1662	5132	5496	4845	4609	4674	5588	6388	5407	3299

Federal Report Surplus Deficit By Water Year
Operating Year 2020
2018 White Book Report Date: 12/1/2018
S166-WB-20190220-091000

Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
47 1975 Federal Report Surplus Deficit	3073	2898	780	-125	209	71.0	2055	2299	2648	44.4	6.75	4528	6086	5030	2220
48 1976 Federal Report Surplus Deficit	1967	1660	922	1137	2238	3536	3913	4525	3400	4250	2945	6203	4722	4469	3372
49 1977 Federal Report Surplus Deficit	3747	3724	3301	527	289	-524	356	156	-483	-1295	-1309	431	614	122	603
50 1978 Federal Report Surplus Deficit	810	-79.2	-404	-398	278	642	1644	1820	1450	3815	1031	4371	3114	2804	1508
51 1979 Federal Report Surplus Deficit	1009	267	1760	551	638	-404	1019	478	1641	-381	363	4056	1943	235	1047
52 1980 Federal Report Surplus Deficit	610	33.8	342	65.7	256	-805	1097	483	-105	1009	1539	5820	4963	1742	1287
53 1981 Federal Report Surplus Deficit	489	51.6	388	32.1	721	1985	3485	3499	844	-1226	-430	4039	6126	3809	2027
54 1982 Federal Report Surplus Deficit	3059	2145	502	169	1006	678	2875	4413	5462	3704	1336	5597	6182	5303	3106
55 1983 Federal Report Surplus Deficit	2949	2598	1552	1068	1055	1174	3197	3688	3898	2488	841	4251	4412	4439	2765
56 1984 Federal Report Surplus Deficit	2783	1565	857	348	2516	1467	2946	3092	3142	2159	3512	4064	5968	4118	2788
57 1985 Federal Report Surplus Deficit	2494	947	840	406	1045	561	1371	1412	764	1914	2163	3399	1826	596	1328
58 1986 Federal Report Surplus Deficit	101	-568	261	630	1506	756	2338	3238	4491	3952	3211	3198	4441	1237	2109
59 1987 Federal Report Surplus Deficit	832	136	-46.4	-131	890	647	727	285	1261	-303	31.3	3514	1916	104	796
60 1988 Federal Report Surplus Deficit	218	-424	0.27	-60.5	167	-865	-1055	-201	-24.3	-1008	-380	734	1790	1231	74.6
61 1989 Federal Report Surplus Deficit	739	29.6	90.6	-65.0	445	129	-256	-913	1409	1542	4085	3272	2082	794	852
62 1990 Federal Report Surplus Deficit	404	-104	165	91.0	720	1194	1936	3193	2080	1298	3243	3217	4588	2265	1813
63 1991 Federal Report Surplus Deficit	2215	1573	101	-91.6	2429	1701	3370	3283	2362	1671	688	3455	4564	4195	2368
64 1992 Federal Report Surplus Deficit	2951	1643	78.3	-80.2	396	-800	313	410	542	-1014	-604	2467	1348	19.6	517
65 1993 Federal Report Surplus Deficit	445	-235	-144	-73.5	356	-405	-733	-1094	801	-42.6	-937	4604	3536	1371	660
66 1994 Federal Report Surplus Deficit	980	400	385	73.5	554	-263	-611	282	-53.8	-893	106	1756	1600	1011	418
67 1995 Federal Report Surplus Deficit	656	-108	194	-19.3	-11.5	-289	848	1846	2441	390	-873	3476	4733	2451	1306
68 1996 Federal Report Surplus Deficit	881	303	706	1016	3109	4707	4938	5170	5335	3951	5293	5419	5225	4284	3755
69 1997 Federal Report Surplus Deficit	2807	1656	492	225	935	1612	5022	5300	5251	4405	5376	6368	6221	4625	3591
70 1998 Federal Report Surplus Deficit	2691	2742	1517	2558	1891	588	1405	2973	1493	-277	-418	5695	5763	2581	2402
71 1999 Federal Report Surplus Deficit	1778	457	108	50.6	143	1468	3821	3690	4785	2045	2554	4231	5862	4757	2693
72 2000 Federal Report Surplus Deficit	3473	2807	891	199	2682	2030	2087	2405	2251	3355	4196	3791	1563	2186	2249
73 2001 Federal Report Surplus Deficit	1519	-103	-134	106	232	-600	54.8	-50.7	-264	-1354	-1336	674	481	351	18.4
74 2002 Federal Report Surplus Deficit	931	-132	-330	-479	175	89.9	-419	244	531	1053	2639	2725	5376	3591	1143
75 2003 Federal Report Surplus Deficit	1252	455	349	158	458	-506	-200	800	2191	563	274	1630	4693	935	976
76 2004 Federal Report Surplus Deficit	368	-391	-198	6.40	813	592	229	-86.4	636	300	-14.4	2102	3055	930	684
77 2005 Federal Report Surplus Deficit	750	350	1055	520	659	937	1537	2281	658	-1162	-773	2228	2575	1321	1109
78 2006 Federal Report Surplus Deficit	1014	-25.8	244	2.29	859	605	2824	3419	2059	4338	3926	5386	5343	1909	2261
79 2007 Federal Report Surplus Deficit	521	26.6	-112	-74.1	874	713	2143	1635	3340	1772	244	3982	3408	1990	1601
80 2008 Federal Report Surplus Deficit	718	-151	-260	141	698	-119	346	717	793	-105	-742	4377	6473	3380	1367
Ranked Averages															
81 Bottom 10 pct	988	207	99.9	25.0	330	-526	-662	-141	-68.6	-951	-1073	609	1618	618	123
82 Middle 80 pct	1548	808	483	296	794	639	1777	2080	1815	1371	1368	3876	4359	2487	1760
83 Top 10 pct	2224	1476	628	665	1588	2613	4556	4959	4636	3966	4300	5842	5420	4240	3423

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Section 5: Pacific Northwest Regional Analysis Exhibits

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Exhibit 5-1: Annual Energy

**Regional Analysis Surplus Deficit
Operating Year 2020 to 2029
Using 1937-Water Conditions**

Loads and Resources - Pacific Northwest Region
Operating Year: 2020 to 2029 Water Year: 1937
2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

Energy-aMW	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Regional Loads										
1 Retail Loads	22696	22959	23361	23641	23739	23869	23978	24075	24128	24220
² Federal Agency	133	139	145	145	145	147	147	148	148	149
³ USBR	179	179	179	179	179	179	179	179	179	179
⁴ Cooperative	2239	2362	2483	2574	2639	2670	2685	2699	2709	2726
⁵ Municipality	2629	2638	2659	2676	2683	2689	2695	2701	2706	2712
⁶ Public Utility District	4439	4498	4699	4817	4803	4832	4871	4900	4901	4910
⁷ Investor-Owned Utility	12672	12737	12790	12843	12884	12946	12995	13043	13079	13138
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	401	401	401	401	401	401	401	401	401	401
¹⁰ Federal Diversity	0	0	0	0	0	0	0	0	0	0
11 Exports	1210	1143	1028	998	968	983	983	983	983	981
¹² Canada	466	450	450	450	450	465	465	465	465	465
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	17.1	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
¹⁵ Pacific Southwest	726	679	563	534	504	503	503	503	503	501
¹⁶ Other	0	0	0	0	0	0	0	0	0	0
¹⁷ Total Regional Loads	23906	24102	24388	24639	24707	24852	24961	25058	25110	25200
Regional Resources										
¹⁸ Hydro	11661	11540	11528	11528	11520	11527	11524	11527	11520	11527
¹⁹ Regulated Hydro - Net	10356	10259	10258	10257	10251	10257	10254	10257	10251	10257
²⁰ Independent Hydro - Net	1059	1035	1024	1024	1023	1024	1024	1024	1023	1024
²¹ Small Hydro - Net	245	246	246	246	246	246	246	246	246	246

Loads and Resources - Pacific Northwest Region
Operating Year: 2020 to 2029 Water Year: 1937
2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

Energy-aMW	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
22 Hon-Hydro Renewable	2089	2099	2098	2098	2098	2099	2098	2098	2096	2092
²³ Wind - Net	1774	1782	1781	1781	1780	1781	1781	1781	1779	1775
²⁴ Solar - Net	140	143	143	143	143	143	143	143	143	143
²⁵ Other - Net	175	174	173	173	175	174	173	173	175	174
26 Thermal	14408	13778	13302	12870	13062	12854	12502	12235	12257	12162
²⁷ Nuclear - Net	1116	994	1116	994	1116	994	1116	994	1116	994
²⁸ Coal - Net	5063	4546	3958	3687	3751	3676	3201	3049	2955	2981
²⁹ Natural Gas - Net	5869	5871	5870	5830	5827	5827	5825	5825	5827	5827
³⁰ Petroleum - Net	0	0	0	0	0	0	0	0	0	0
³¹ Biofuel - Net	25.7	25.7	25.7	25.7	25.7	25.7	25.7	25.7	25.7	25.7
³² Cogeneration - Net	2334	2341	2332	2334	2342	2332	2334	2341	2333	2334
33 Imports	662	660	580	584	588	591	595	599	603	607
³⁴ Canada	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8
³⁵ East of Continental Divide	0	0	0	0	0	0	0	0	0	0
³⁶ Inland Southwest	487	491	494	498	502	506	509	513	517	521
³⁷ Pacific Southwest	136	131	47.1	47.1	47.1	47.1	47.1	47.1	47.1	47.1
³⁸ Other	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-856	-834	-817	-804	-810	-804	-794	-786	-786	-784
⁴⁰ Operating Reserves	0	0	0	0	0	0	0	0	0	0
⁴¹ Balancing Reserves	0	0	0	0	0	0	0	0	0	0
⁴² Transmission Losses	-856	-834	-817	-804	-810	-804	-794	-786	-786	-784
43 Total Regional Resources	27964	27243	26691	26276	26457	26267	25926	25672	25689	25604
44 Total Surplus/Deficit	4058	3141	2303	1637	1750	1416	965	614	579	403

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Exhibit 5-2: Monthly Energy

**Regional Analysis Surplus Deficit
Operating Year 2020
Using 1937-Water Conditions**

Loads and Resources - Pacific Northwest Region

Operating Year: 2020 Water Year: 1937

2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
Regional Loads															
1 Retail Loads	22581	22596	20639	20634	23423	25790	25484	24207	22272	21434	21434	20976	21592	23289	22696
2 Federal Agency	112	112	105	119	143	168	164	154	137	123	123	117	119	129	133
3 USBR	312	311	266	108	18.2	17.7	9.97	13.9	63.0	244	244	329	354	405	179
4 Cooperative	2282	2283	2014	1925	2214	2502	2472	2345	2112	2084	2084	2127	2316	2474	2239
5 Municipality	2386	2389	2292	2461	2840	3121	3139	3000	2719	2535	2535	2350	2329	2384	2629
6 Public Utility District	4185	4188	3896	4071	4706	5297	5266	4913	4499	4189	4189	3966	4026	4253	4439
7 Investor-Owned Utility	12898	12908	11661	11545	13097	14279	14027	13377	12338	11852	11852	11682	12042	13239	12672
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	401	401	401	402	402	402	402	401	401	402	402	401	401	401	401
10 Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Exports	1273	1473	1304	1064	1251	1103	816	983	1038	1423	1293	1338	1389	1505	1210
12 Canada	546	551	456	456	456	456	456	456	456	456	456	456	456	478	466
13 East Continental Divide	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14 Inland Southwest	9.27	13.9	12.9	24.9	28.8	24.8	6.07	10.0	11.5	20.6	17.4	18.6	18.4	18.0	17.1
15 Pacific Southwest	716	908	834	581	765	621	353	516	569	945	818	862	913	1008	726
16 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Total Regional Loads	23854	24070	21943	21698	24675	26894	26300	25190	23310	22857	22727	22314	22981	24794	23906
Regional Resources															
18 Hydro	12233	10850	10005	10645	12176	12250	11359	9991	10224	9776	8757	12523	16877	13043	11661
19 Regulated Hydro - Net	10905	9531	8786	9574	11228	11255	10521	9082	9098	8172	7136	10512	14826	11494	10356
20 Independent Hydro - Net	1000	995	976	907	817	867	712	775	961	1320	1336	1605	1625	1141	1059
21 Small Hydro - Net	328	324	243	163	130	129	127	135	165	284	285	406	425	408	245

Loads and Resources - Pacific Northwest Region

Operating Year: 2020 Water Year: 1937

2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
22 Hon-Hydro Renewable	1538	2131	1990	1676	2238	1762	1059	1610	1818	2992	2587	2779	2772	2740	2089
23 Wind - Net	1189	1782	1654	1363	1954	1498	815	1338	1517	2662	2258	2420	2424	2360	1774
24 Solar - Net	173	173	159	135	106	86.7	78.1	93.9	124	152	152	181	190	205	140
25 Other - Net	176	176	176	178	178	178	166	178	178	177	177	178	157	175	175
26 Thermal	14915	15003	15077	15132	15307	15453	15423	15376	14412	14192	12433	10477	13039	14964	14408
27 Nuclear - Net	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116
28 Coal - Net	5332	5333	5336	5337	5335	5339	5339	5338	5204	4423	4226	3410	5142	5335	5063
29 Natural Gas - Net	6018	6106	6170	6230	6360	6438	6444	6381	6327	6207	5198	3814	4402	6101	5869
30 Petroleum - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Biofuel - Net	23.7	23.7	25.5	26.8	27.1	24.7	24.4	24.5	27.1	25.5	25.5	27.3	25.1	25.9	25.7
32 Cogeneration - Net	2425	2425	2429	2422	2470	2536	2499	2517	1737	2421	1867	2110	2353	2385	2334
33 Imports	622	622	561	584	773	872	710	709	611	508	508	554	696	745	662
34 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
35 East of Continental Divide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36 Inland Southwest	536	536	482	448	440	474	446	461	434	414	414	462	592	654	487
37 Pacific Southwest	64.4	64.6	63.3	115	295	348	201	178	114	64.4	64.4	63.4	64.4	64.0	136
38 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-870	-850	-821	-833	-906	-901	-848	-822	-804	-816	-721	-782	-991	-935	-856
40 Operating Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41 Balancing Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42 Transmission Losses	-870	-850	-821	-833	-906	-901	-848	-822	-804	-816	-721	-782	-991	-935	-856
43 Total Regional Resources	28438	27756	26811	27204	29588	29437	27703	26863	26261	26652	23564	25552	32391	30556	27964
44 Total Surplus/Deficit	4585	3686	4869	5507	4914	2543	1403	1673	2951	3795	838	3238	9410	5762	4058

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Exhibit 5-3: Annual 120-Hour Capacity

**Regional Analysis Surplus Deficit
Operating Year 2020 to 2029
Using 1937-Water Conditions**

Loads and Resources - Pacific Northwest Region

Calendar Year: 2020 to 2029 Water Year: 1937

2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

120Hr-MW	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Regional Loads										
1 Retail Loads	33972	34430	35056	35295	35459	35644	35827	36028	36211	36328
² Federal Agency	212	226	231	229	230	232	233	234	235	236
³ USBR	281	281	281	281	281	281	281	281	281	281
⁴ Cooperative	3540	3685	3831	3924	4002	4039	4063	4085	4107	4128
⁵ Municipality	4347	4360	4399	4410	4422	4432	4443	4454	4489	4498
⁶ Public Utility District	7399	7517	7845	7869	7888	7943	8006	8051	8084	8110
⁷ Investor-Owned Utility	19233	19333	19442	19551	19653	19746	19834	19921	20015	20111
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	413	413	413	413	413	413	413	413	413	413
¹⁰ Federal Diversity	-1457	-1388	-1390	-1385	-1433	-1446	-1449	-1416	-1416	-1451
11 Exports	1369	1178	1121	1121	1121	1143	1143	1143	1143	1143
¹² Canada	1260	1120	1120	1120	1120	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	108	56.7	0	0	0	0	0	0	0	0
¹⁶ Other	0	0	0	0	0	0	0	0	0	0
¹⁷ Total Regional Loads	35342	35607	36177	36416	36580	36786	36970	37170	37354	37471
Regional Resources										
¹⁸ Hydro	21154	21367	21341	21334	21211	21313	21196	21297	21199	21299
¹⁹ Regulated Hydro - Net	19676	19969	19942	19936	19813	19914	19797	19898	19801	19901
²⁰ Independent Hydro - Net	1323	1243	1243	1243	1243	1243	1243	1243	1243	1243
²¹ Small Hydro - Net	156	156	156	156	156	156	156	156	156	156

Loads and Resources - Pacific Northwest Region

Calendar Year: 2020 to 2029 Water Year: 1937

2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

120Hr-MW	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
22 Hon-Hydro Renewable	207	207	207	207	207	207	207	207	207	207
²³ Wind - Net	0	0	0	0	0	0	0	0	0	0
²⁴ Solar - Net	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
²⁵ Other - Net	206	206	206	206	206	206	206	206	206	206
26 Thermal	16647	15407	15280	14917	14917	14917	14114	14114	14114	14114
²⁷ Nuclear - Net	1169	1169	1169	1169	1169	1169	1169	1169	1169	1169
²⁸ Coal - Net	5869	4629	4502	4195	4195	4195	3392	3392	3392	3392
²⁹ Natural Gas - Net	6825	6825	6825	6769	6769	6769	6769	6769	6769	6769
³⁰ Petroleum - Net	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5
³¹ Biofuel - Net	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7
³² Cogeneration - Net	2715	2715	2715	2715	2715	2715	2715	2715	2715	2715
33 Imports	1177	1180	1059	1062	1065	1068	1071	1075	1078	1081
³⁴ Canada	155	155	155	155	155	155	155	155	155	155
³⁵ East of Continental Divide	0	0	0	0	0	0	0	0	0	0
³⁶ Inland Southwest	597	600	604	607	610	613	616	620	623	626
³⁷ Pacific Southwest	425	425	300	300	300	300	300	300	300	300
³⁸ Other	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-4088	-4141	-4165	-4159	-4158	-4154	-4099	-4110	-4110	-4120
⁴⁰ Operating Reserves	-2028	-2005	-2022	-2029	-2032	-2025	-2000	-2007	-2010	-2018
⁴¹ Balancing Reserves	-833	-946	-963	-963	-963	-963	-963	-963	-963	-963
⁴² Transmission Losses	-1228	-1190	-1180	-1167	-1163	-1167	-1136	-1140	-1136	-1140
43 Total Regional Resources	35096	34019	33721	33361	33242	33350	32488	32581	32488	32580
44 Total Surplus/Deficit	-246	-1588	-2456	-3056	-3337	-3436	-4482	-4589	-4866	-4891

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Exhibit 5-4: Monthly 120-Hour Capacity

**Regional Analysis Surplus Deficit
Operating Year 2020
Using 1937-Water Conditions**

Loads and Resources - Pacific Northwest Region

Operating Year: 2020 Water Year: 1937

2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Regional Loads														
1 Retail Loads	30274	30056	27011	27709	31689	34274	33972	32085	29901	28359	28252	27228	28545	30664
2 Federal Agency	146	146	140	154	183	216	212	194	176	154	154	148	147	156
3 USBR	615	615	539	406	238	316	281	282	381	453	453	541	587	621
4 Cooperative	3018	3018	2771	2821	3182	3608	3540	3371	3107	3031	3031	2962	3079	3244
5 Municipality	3257	3257	3062	3448	3955	4359	4347	4135	3825	3495	3495	3078	3088	3274
6 Public Utility District	5540	5540	5148	5733	6674	7381	7399	6970	6477	5978	5978	5428	5323	5627
7 Investor-Owned Utility	18189	18189	15962	15961	18252	19413	19233	18088	16888	15959	15959	15755	16881	18277
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	412	412	412	413	412	412	413	412	412	413	413	412	412	412
10 Federal Diversity	-907	-1125	-1027	-1231	-1212	-1435	-1457	-1372	-1369	-1128	-1235	-1101	-976	-950
11 Exports														
12 Canada	1381	1381	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1282
13 East Continental Divide	1.00	1.00	1.00	1.00	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	25.0	25.0	25.0	0	0	0	0	0	0	0	0
15 Pacific Southwest	528	528	502	168	160	160	108	108	108	108	116	116	425	425
16 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Total Regional Loads	32184	31966	28775	29163	33135	35720	35342	33455	31270	29728	29629	28605	30231	32372
Regional Resources														
18 Hydro	22972	20770	20029	19839	22058	22612	21154	20210	20522	18967	17900	21261	25384	23156
19 Regulated Hydro - Net	20941	18751	18134	18045	20379	20979	19676	18754	18749	16798	15706	18739	22783	20964
20 Independent Hydro - Net	1664	1656	1614	1595	1512	1472	1323	1287	1565	1845	1869	2077	2139	1749
21 Small Hydro - Net	367	364	280	199	167	161	156	169	207	324	325	446	463	443

Loads and Resources - Pacific Northwest Region

Operating Year: 2020 Water Year: 1937

2018 White Book Report Date: 12/1/2018

S166-WB-20190220-091000

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
22 Hon-Hydro Renewable	218	218	218	219	218	218	207	219	218	218	218	219	217	217
23 Wind - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Solar - Net	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
25 Other - Net	217	217	217	218	217	217	206	218	217	217	217	218	216	216
26 Thermal	16177	16177	16270	16393	16564	16650	16647	16594	15905	15878	14861	14207	15581	16180
27 Nuclear - Net	1163	1163	1179	1181	1179	1180	1169	1169	1169	1160	1160	1151	1154	1168
28 Coal - Net	5868	5868	5867	5868	5868	5869	5869	5869	5868	5350	5868	4476	5714	5867
29 Natural Gas - Net	6463	6463	6523	6598	6749	6819	6825	6778	6730	6687	5632	6144	6025	6465
30 Petroleum - Net	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5
31 Biofuel - Net	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7
32 Cogeneration - Net	2614	2614	2632	2677	2699	2713	2715	2709	2069	2612	2133	2367	2618	2611
33 Imports	984	984	857	848	1099	1202	1177	1209	910	765	765	807	1056	1134
34 Canada	146	146	146	147	102	124	155	188	213	147	147	147	146	146
35 East of Continental Divide	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36 Inland Southwest	763	763	636	576	572	653	597	596	572	543	543	585	835	913
37 Pacific Southwest	75.0	75.0	75.0	125	425	425	425	425	125	75.0	75.0	75.0	75.0	75.0
38 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-3814	-3677	-3563	-3805	-4064	-4188	-4088	-3971	-3875	-3744	-3599	-3757	-4182	-4126
40 Operating Reserves	-1957	-1893	-1778	-1800	-1976	-2079	-2028	-1940	-1863	-1789	-1711	-1779	-1972	-1968
41 Balancing Reserves	-579	-579	-602	-833	-833	-833	-833	-833	-833	-833	-833	-833	-879	-879
42 Transmission Losses	-1278	-1206	-1183	-1172	-1255	-1277	-1228	-1199	-1178	-1122	-1055	-1145	-1331	-1279
43 Total Regional Resources	36537	34472	33811	33494	35876	36494	35096	34261	33680	32084	30146	32737	38056	36562
44 Total Surplus/Deficit	4353	2506	5036	4331	2741	774	-246	806	2410	2356	517	4132	7825	4190

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Exhibit 5-5: 80-Water Conditions Monthly Energy

**Regional Analysis Surplus Deficit
Operating Year 2020**

Regional Report Surplus Deficit By Water Year
Operating Year 2020
2018 White Book Report Date: 12/1/2018
S166-WB-20190220-091000

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	6086	6403	4929	5559	5723	2783	2468	3577	3666	4209	1662	2684	10370	4442	4607
2 1930 Regional Report Surplus Deficit	4373	3659	5279	5472	4869	2231	1787	4004	3543	4493	2354	2781	6269	5825	4116
3 1931 Regional Report Surplus Deficit	4704	3740	5074	5492	4852	2492	2039	3969	3658	3825	1334	2721	5413	5113	3962
4 1932 Regional Report Surplus Deficit	4171	3498	4612	5044	4356	2418	3308	1500	7131	9882	11489	11650	13102	8742	6371
5 1933 Regional Report Surplus Deficit	6152	5418	6026	5230	5973	6160	8179	8773	7357	7488	4394	8476	15725	13348	8072
6 1934 Regional Report Surplus Deficit	8918	7591	6208	7243	10875	12239	13054	13243	11833	14063	11138	9194	10005	4935	9954
7 1935 Regional Report Surplus Deficit	3703	3396	4702	5145	5461	4345	7904	8607	7382	4940	5017	7780	9025	9030	6485
8 1936 Regional Report Surplus Deficit	7499	4874	4395	4967	5009	2475	2310	2924	3946	4760	8916	11828	12362	7069	5858
9 1937 Regional Report Surplus Deficit	4585	3686	4869	5507	4914	2543	1403	1673	2951	3795	838	3238	9410	5762	4058
10 1938 Regional Report Surplus Deficit	4769	3539	4981	5157	5966	4988	6891	7258	9046	10682	12111	11709	10784	9334	7632
11 1939 Regional Report Surplus Deficit	4265	3521	5551	5176	5177	2883	5298	5809	5401	6358	6800	7253	7469	6069	5537
12 1940 Regional Report Surplus Deficit	4376	3496	5244	5373	5483	4875	5546	5143	8067	8058	4586	7638	7084	3598	5690
13 1941 Regional Report Surplus Deficit	3143	2735	4908	5177	5293	3873	3172	4431	4744	3742	266	2534	6973	4889	4237
14 1942 Regional Report Surplus Deficit	4286	3403	5211	4872	6215	7089	6435	7047	3627	4649	4023	4927	12785	10293	6377
15 1943 Regional Report Surplus Deficit	5584	5189	6410	5195	5590	4394	8657	8862	8837	15789	13481	9586	15264	13710	8859
16 1944 Regional Report Surplus Deficit	7718	5344	5219	5888	4952	2876	3656	3890	3567	3456	657	1770	6152	4071	4214
17 1945 Regional Report Surplus Deficit	4472	3201	4742	4919	4433	2427	2809	3539	3658	3322	1057	6960	12753	5095	4772
18 1946 Regional Report Surplus Deficit	4293	3476	5026	5636	5635	5270	6807	7691	7555	12799	12796	11989	11526	10912	7884
19 1947 Regional Report Surplus Deficit	6477	5781	5986	5319	7239	9826	10109	10773	10065	10357	7581	10450	12105	9798	8889
20 1948 Regional Report Surplus Deficit	6055	5552	5505	10324	9579	7061	10026	9664	7281	8762	9934	13512	15799	11068	9575
21 1949 Regional Report Surplus Deficit	9610	8477	6779	6040	6595	4496	5967	7084	9457	10732	11089	12008	11450	5726	7955
22 1950 Regional Report Surplus Deficit	4313	3091	5073	5647	5550	5324	10192	10966	11248	13468	9220	10163	15571	14942	9129
23 1951 Regional Report Surplus Deficit	9904	8629	6553	7950	10654	10809	12458	14700	12505	14281	11285	11776	11868	12383	11128
24 1952 Regional Report Surplus Deficit	7291	5371	6117	9572	8397	7553	9653	10190	7632	12601	13465	13523	12664	9526	9504
25 1953 Regional Report Surplus Deficit	5932	4958	4477	5739	4834	2504	5392	11850	6306	4004	3488	9285	15850	12785	7326
26 1954 Regional Report Surplus Deficit	7179	6095	5954	5959	7222	6615	9589	11182	9183	9489	6792	11110	14059	14638	9182
27 1955 Regional Report Surplus Deficit	10384	10286	9908	6238	8527	6033	4917	5947	3063	4949	1863	6596	15777	14313	7917
28 1956 Regional Report Surplus Deficit	9116	6450	5585	7139	9735	10173	12447	12388	12179	13143	14295	13343	15781	12063	11015
29 1957 Regional Report Surplus Deficit	8410	7568	6193	6694	6532	6960	6978	6402	8704	12427	7186	14041	15548	7843	8642
30 1958 Regional Report Surplus Deficit	5355	4583	5478	5284	5514	4571	8425	9396	7450	7573	8397	12594	13992	7228	7725
31 1959 Regional Report Surplus Deficit	5776	4339	4996	5764	8392	8996	11321	12510	8626	11598	7567	9876	14041	12844	9315
32 1960 Regional Report Surplus Deficit	8827	8168	10842	11946	11230	8455	8616	8926	7791	14395	10045	7973	12616	8920	9820
33 1961 Regional Report Surplus Deficit	6555	5009	5048	5559	7231	4953	8175	9871	10075	10549	4996	9977	14176	7480	7990
34 1962 Regional Report Surplus Deficit	6267	4313	5042	5270	5737	4899	7776	8536	4787	8861	12422	9608	11329	7369	7170
35 1963 Regional Report Surplus Deficit	6032	5296	5035	6700	8691	8327	8570	9833	5342	5625	2535	7742	13227	8507	7629
36 1964 Regional Report Surplus Deficit	5543	4644	6190	5287	6427	4866	6392	6769	4301	7937	4322	9763	16274	13794	7598
37 1965 Regional Report Surplus Deficit	9025	7805	7429	7192	7678	10365	12626	14427	12078	8258	13086	11993	12887	9850	10453
38 1966 Regional Report Surplus Deficit	8233	7651	5556	6238	6578	5324	7430	7631	5511	9438	5592	6844	11129	8450	7170
39 1967 Regional Report Surplus Deficit	6813	4485	5165	5219	5528	6753	10424	11114	9475	8244	3057	9530	15373	11965	8475
40 1968 Regional Report Surplus Deficit	7214	6379	5962	6394	7275	5632	8733	10434	10240	4181	1701	6475	13512	9448	7809
41 1969 Regional Report Surplus Deficit	7375	6506	8567	7834	9710	7550	11236	12431	9535	13396	13125	13284	13329	9787	10266
42 1970 Regional Report Surplus Deficit	5858	4699	5452	5953	6321	4138	8409	9570	6265	4654	2016	9006	14098	7496	7093
43 1971 Regional Report Surplus Deficit	5777	4271	5053	5779	5509	5191	11749	14270	12209	12999	10624	13295	16323	13600	9962
44 1972 Regional Report Surplus Deficit	9195	9050	6557	6621	7129	6250	11598	12360	16225	16449	9827	12873	16018	13522	10945
45 1973 Regional Report Surplus Deficit	10084	9570	7041	6430	6860	5961	7352	7852	4856	3279	302	2747	7547	5257	6120
46 1974 Regional Report Surplus Deficit	4186	3203	5039	5679	5705	7803	14231	15064	13946	14630	12888	12199	16225	15142	10687

Regional Report Surplus Deficit By Water Year
Operating Year 2020
2018 White Book Report Date: 12/1/2018
S166-WB-20190220-091000

Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
47 1975 Regional Report Surplus Deficit	9812	9513	6677	5256	5820	4915	8184	8742	9062	6370	4576	10841	15210	14478	8697
48 1976 Regional Report Surplus Deficit	7393	7423	7011	8074	10232	11922	11730	12609	10600	13656	10315	13030	13327	13219	10923
49 1977 Regional Report Surplus Deficit	11014	11150	11371	6169	5610	2997	4083	4075	3532	3006	369	2400	4406	3597	5083
50 1978 Regional Report Surplus Deficit	4186	3124	3706	4025	4945	5727	6869	7255	6823	12754	6906	10481	9959	9916	6927
51 1979 Regional Report Surplus Deficit	5404	4532	8892	6222	6290	3366	5324	5235	7463	4634	4312	9458	8059	4837	6212
52 1980 Regional Report Surplus Deficit	4176	3705	5434	5196	5176	2945	5887	5591	4039	7782	7934	12460	13590	7825	6652
53 1981 Regional Report Surplus Deficit	4344	3919	5666	5150	6599	8887	10287	11064	5662	3259	2936	9398	14635	11304	7978
54 1982 Regional Report Surplus Deficit	8861	7569	5882	5722	7207	5795	9170	13010	14610	12835	7137	12085	14985	14697	10102
55 1983 Regional Report Surplus Deficit	9134	8662	8063	7508	7465	6972	10575	11559	12071	10645	6229	10426	12804	13183	9826
56 1984 Regional Report Surplus Deficit	9054	7005	6701	6156	10737	7296	10360	10123	10245	9450	10065	9511	14788	12184	9643
57 1985 Regional Report Surplus Deficit	8382	5747	6811	6287	7838	5249	6285	6606	5550	9469	8242	9071	8076	5406	6913
58 1986 Regional Report Surplus Deficit	3561	2664	5634	6739	8692	5456	8736	10662	13366	13213	10435	8648	12505	6545	8467
59 1987 Regional Report Surplus Deficit	4958	4016	4894	5609	6660	5324	5110	4920	6938	5191	4485	8595	7288	4178	5738
60 1988 Regional Report Surplus Deficit	3459	2640	4724	5163	4415	1963	2322	3681	3660	3677	3524	3222	7427	6218	4112
61 1989 Regional Report Surplus Deficit	4302	3543	4652	5384	5662	4082	3440	2111	6548	8700	12077	8750	8469	6048	5791
62 1990 Regional Report Surplus Deficit	4255	3764	5149	5158	6964	6829	8188	9919	8113	8573	10176	8340	12788	8978	7797
63 1991 Regional Report Surplus Deficit	7516	6701	5048	5624	10446	7318	9902	10537	8721	9364	5919	8684	12717	12607	8852
64 1992 Regional Report Surplus Deficit	9030	7037	5032	4830	5813	2635	4338	4913	4903	3553	2020	6202	5682	3590	4895
65 1993 Regional Report Surplus Deficit	3563	2694	4209	4814	4931	2565	2666	1620	5263	5676	1932	10503	10511	6884	5084
66 1994 Regional Report Surplus Deficit	5641	4460	5492	5574	5147	3037	2394	5047	3787	3931	4936	5418	6656	5652	4798
67 1995 Regional Report Surplus Deficit	4132	3071	4928	5380	4450	3683	5463	7977	9070	6661	2069	8851	13347	8919	6659
68 1996 Regional Report Surplus Deficit	5461	4234	6049	7246	12000	13597	13829	15084	14916	13652	13978	11985	13852	12479	11623
69 1997 Regional Report Surplus Deficit	8729	7027	6041	5768	7263	7572	13759	14572	14759	14425	13952	13481	15798	13716	11216
70 1998 Regional Report Surplus Deficit	9037	9178	8509	11108	9357	5766	7238	9815	7378	5788	3377	12312	14883	9183	9097
71 1999 Regional Report Surplus Deficit	6584	5095	5176	5855	5227	7517	11434	11312	13409	10210	9471	10417	15244	14033	9604
72 2000 Regional Report Surplus Deficit	10573	9491	6777	5789	10912	8501	8021	8482	8179	12263	12203	9472	7699	8389	8700
73 2001 Regional Report Surplus Deficit	6117	3888	4620	5316	5099	2534	3168	3431	3591	3194	460	2791	4666	4207	3852
74 2002 Regional Report Surplus Deficit	4290	2947	3795	3711	4536	4090	3662	4498	4838	7515	9223	7681	13890	11407	6166
75 2003 Regional Report Surplus Deficit	5622	5035	5257	5101	5300	2705	3576	5500	7972	6538	4787	5147	12324	5639	5778
76 2004 Regional Report Surplus Deficit	3689	2534	4220	5337	5880	4673	4318	3766	4930	5898	4088	5901	9736	6088	5242
77 2005 Regional Report Surplus Deficit	4588	4373	7072	5997	6394	5839	6592	7661	4919	3196	1787	6044	8946	6604	6076
78 2006 Regional Report Surplus Deficit	5126	3432	4982	4882	5971	4916	9792	10253	7866	13356	11467	11837	14138	7657	8223
79 2007 Regional Report Surplus Deficit	4516	3688	4406	4785	7038	5517	7900	7189	10859	9385	4792	9335	10378	7746	7193
80 2008 Regional Report Surplus Deficit	4799	3294	4102	5357	5375	3581	4336	4927	5320	5335	2269	9984	15782	11144	6478
Ranked Averages															
81 Bottom 10 pct	5023	4012	4953	5447	5015	2662	2502	3582	3672	3799	1387	2718	7085	5066	4145
82 Middle 80 pct	6313	5307	5829	5935	6689	5465	7324	8093	7573	8388	6709	9323	12237	9119	7569
83 Top 10 pct	7876	6728	6283	6959	8799	9811	12835	13901	13401	13562	12453	12585	14469	12797	10999

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