

2019 Pacific Northwest Loads and Resources Study

October 2020





Department of Energy

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

October 20, 2020

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 an information source for customers, as a published source of loads and resources information for regional interests, and as a data source for the Columbia River Treaty studies. 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 2019 White Book presents Federal system and the region’s load obligations, contracts, and resources as of December 2019 for operating years (OY) 2021 through 2030. Due to the timing of this study being completed and the decision making timing of the CRSO EIS, this White Book does not include all the assumptions and results presented in the EIS. The 2019 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 annual energy deficits across the study period, ranging from as low as -194 aMW, to as large as -354 aMW. These annual energy deficits projections are similar to those projected in the 2018 White Book, however the first two years are forecasts to have slightly greater deficits and rest of the study period has slightly smaller deficits. 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 as low as -950 MW to as high as -1,226 MW. While these 120-Hour capacity deficits are similar to those projected in the 2018 White Book, OY2021 is forecasted to have greater deficits and the rest of the study period is forecasted to have smaller deficits. 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 3,974 aMW in OY 2021, slowly decreasing to 698 aMW by OY 2030. These annual energy projections are similar to

those presented in the 2018 White Book, with the first two years forecasted for slightly less surplus, and the rest of the study period expected to be slightly larger surpluses. 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 -969 MW to -3,460 MW. These deficit projections are slightly smaller than those shown in the 2018 White Book. Under average water conditions; the PNW region has January 120-Hour capacity surpluses through the final year of this study.

The results of the 2019 White Book are similar to last year. However, the word ‘Uncertainty’ should be highlighted at this time as we are in a time of great uncertainty, both in terms of loads and resources. From resource retirements, to resource development, to resource adequacy, to carbon free resource requirements, ‘Uncertainty’ is a common theme. As with resources, there is also much uncertainty with loads. Some load forecasts associated with electrification of the transportation industry alone result in load growth rates of 38% by 2030, to 44% by 2035, to 60% by 2050. From low carbon electrification of new buildings, to refitting of old buildings, how loads will grow across the region also result in large amounts of ‘Uncertainty’.

The 2019 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 2019 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,

Kieran P. Connolly
Vice President, Generation Asset Management

Enclosure

2019 PACIFIC NORTHWEST LOADS AND RESOURCES STUDY
The White Book

BONNEVILLE POWER ADMINISTRATION

October 2020

Cover Picture:

John Day Dam is a concrete gravity run-of-the-river dam spanning the Columbia River between Sherman County in Oregon and Klickitat County in Washington, owned and operated by the US Army Corps of Engineers. The dam was completed in 1971 and creates Lake Umatilla, it includes 16 hydroelectric turbines with a nameplate capacity of 2,484 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

Pacific Northwest Utilities Conference Committee

Northwest Power & Conservation Council

Table of Contents

SECTION 1: SUMMARY.....	3
Planning Context.....	3
Load Obligations.....	4
Resource Types.....	5
Adjustments to Resources.....	7
Hydro Resources Modeling.....	7
Critical Water Planning.....	9
Variability of Hydro Generation.....	9
Hydro Capacity Modeling.....	9
Notable Updates.....	10
Sources of Uncertainty.....	10
Electrification Uncertainty.....	11
SECTION 2: FEDERAL SYSTEM ANALYSIS.....	13
Load Obligations.....	13
USBR obligations.....	13
Regional Dialogue CHWM PSC obligations to Public & Federal agency customers.....	13
Table 2-1.....	14
IOU Load Service under Regional Dialogue PSCs.....	14
DSI contracts.....	14
Other Contract Obligations.....	14
Firm Loads.....	14
Conservation.....	14
Table 2-2.....	15
Resources.....	15
Federal System Resource Types.....	16
Table 2-3.....	16
Table 2-4.....	18
Table 2-5.....	19
Federal System Hydro Generation Variability.....	20
Table 2-6.....	20
Table 2-7.....	21
Table 2-8.....	21
Key Results.....	22
Annual Energy.....	22
Table 2-9.....	22
Table 2-10.....	22
120-Hour Capacity.....	23
Table 2-11.....	23
Table 2-12.....	23
Federal System Annual Surplus/Deficits.....	24
Table 2-13.....	24
Federal System Monthly Surplus/Deficit.....	24
Table 2-14.....	25
Conclusion.....	25

SECTION 3: PACIFIC NORTHWEST REGIONAL ANALYSIS	27
Regional Loads.....	27
Table 3-1.....	28
Regional Resources.....	28
Table 3-2.....	29
Regional Hydro Generation Variability.....	29
Table 3-3.....	30
Table 3-4.....	31
Variability Due to IPP Generation Delivered to the PNW Region.....	31
Table 3-5.....	31
Table 3-6.....	32
Key Results.....	33
Annual Energy.....	33
Table 3-7.....	33
Table 3-8.....	33
Table 3-9.....	34
January 120-Hour Capacity.....	34
Table 3-10.....	34
Table 3-11.....	35
Table 3-12.....	35
Regional Annual Surplus/Deficit	36
Table 3-13.....	36
Regional Monthly Surplus/Deficit.....	36
Table 3-14.....	37
Conclusion.....	37

SECTION 4: FEDERAL SYSTEM ANALYSIS EXHIBITS.....	39
Exhibit 4-1: Annual Energy.....	41
Exhibit 4-2: Monthly Energy	45
Exhibit 4-3: Annual 120-Hour Capacity.....	49
Exhibit 4-4: Monthly 120-Hour Capacity.....	53
Exhibit 4-5: 80-Water Conditions Monthly Energy	57

SECTION 5: PACIFIC NORTHWEST REGIONAL ANALYSIS EXHIBITS	61
Exhibit 5-1: Annual Energy.....	63
Exhibit 5-2: Monthly Energy	67
Exhibit 5-3: Annual 120-Hour Capacity.....	71
Exhibit 5-4: Monthly 120-Hour Capacity.....	75
Exhibit 5-5: 80-Water Conditions Monthly Energy	79

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 2021 through 2030). 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 studies for 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 24.

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, and has been updated as part of the 2020 Resource Program (under development), we have not included those results in this 2019 White Book. The 2018 results can be seen in the 2018 Resource Program, at <http://www.bpa.gov/goto/ResourceProgram>. Once published, the 2020 Resource Program will be available in the same location.

^{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.

The 2019 White Book is published in three documents: 1) this document, the 2019 Loads and Resources Summary (commonly referred to as the White Book), which provides Bonneville's deterministic Federal system and PNW regional loads and resources used for long-term planning; 2) the 2019 Loads and Resources Technical Appendix, Volume 1, Energy Analysis, which provides the detailed components of the annual and monthly energy for the Federal system and PNW regional retail loads, contracts, and resources; and 3) the 2019 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, 2019. The 2019 White Book supersedes the 2018 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 Federal agencies, public bodies and cooperative, 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 explicit 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 (include the Federal system) and are predominately hydro based. Therefore, generation levels can vary greatly both from month-to-month and from 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 within the PNW region (Intra-Regional Transfers (*In*)) and from outside the PNW region (Imports). The generation forecasts for these resources are provided by Bonneville models or the project owners and are described below. The methodologies for calculating energy and capacity from these resources are consistent with previous White Books.

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 further in the Hydro Resource Modeling, page 7.
- Independent Hydro: Independent hydro projects include those hydro projects whose generation output typically varies by water condition 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 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 does not 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.

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 regional contract purchases with power delivered to PNW entities, report by utilities publically and in data submittals. 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. Treaty power deliveries are assumed to be in place through the study period.

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, held to meet reliability standards; and 2) Transmission Losses, associated with power deliveries. These resource adjustments are reductions to both energy and capacity and are described 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. The modeling of reserves, including those for wind integration, is described in the Hydro Resources Modeling section below. The reserve forecasts included in this 2019 White Book are consistent with Bonneville's BP-20 Final 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 hydro projects, and other major hydro projects in the PNW. Project level generation forecasts are produced for each of the 80-historical water conditions² 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 the 2019-2021 Spill Operation Agreement (December 2018). The HYDSIM studies incorporate spring and summer spill operations consistent with the 2019-2021 Spill Operation Agreement, which includes flexible spring spill to the 125% Total Dissolved Gas (TDG) cap, and summer spill cessation in August. At the time the White Book studies were completed, the CRSO was underway but a preferred alternative had not been finalized. Therefore this study

² Bonneville is working on updating the modified flow data set, which will add 10 more water years to the historic record. Once that is completed, Bonneville will incorporate the new 90 year modified flows historical record and review the critical water period based on that information.

does not necessarily include the CRSO Preferred Alternative measures. Each hydro regulation study specifies particular hydroelectric project operations for fish, such as seasonal flow objectives, minimum flow levels for fish, spill for juvenile fish passage, reservoir target elevations, 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. PNCA project owners provide physical plant data as well as power and non-power constraints in an annual data submittal to the Northwest Power Pool. Bonneville incorporates this data into HYDSIM to simulate the coordinated operation of the PNW hydro system. This coordination agreement expires on September 15, 2024.

The construction of three large storage projects in Canada under the Treaty between the United States and Canada enhanced the volume of storage in the Columbia River Basin. 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 2019 White Book are based on the official 2020 AOP studies, with additional modifications that reflect updates expected in the official DOP studies.

Both the United States and Canada 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. Decremental reserves are not specifically reported in this study; however, they are incorporated by increasing the minimum flow of modeled projects 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 currently represented by the historical streamflows from August 1936 through July 1937 (referred to as 1937-critical water conditions). Bonneville periodically reviews the critical period, and could change or adjust that period in the future if appropriate. 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 the 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 (or Super peak capability): the average generation forecasts from the 6 highest heavy load hours per day, 5 days per week, for 4 weeks per month ($6 \times 5 \times 4 = 120 \text{ hours}$); 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 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 120-Hour capacity presented in this analysis can be expressed as either capacity in megawatts (MW) or energy over super peak load hours in average megawatts.

Notable Updates

The 2019 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, 2019, including:

- Change in regulated hydro spill assumptions from the 2019-2021 Spill Operation Agreement (December 2018), for all years of the study.
- Updated retirement dates associated with announced Thermal (coal) generation retirements.
- Updated spill operations to incorporate spring and summer spill operations consistent with the 2019-2021 Spill Operation Agreement, which includes flexible spring spill to the 125% Total Dissolved Gas (TDG) cap, and summer spill cessation in August
- This study does not necessarily include the CRSO Preferred Alternative measures.

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;
- Changes to hydro system operations in response to CRSO EIS;
- 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;
- Changes to retirement dates associated with operating resources;
- 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.

Electrification Uncertainty

While specific forecasts of electrification are not included in this White Book, growing interest foreshadows a potential for significant load growth in the future. Many studies on the electrification of the transportation sector alone, point to a potential 60% increase in electrical load by 2050, and that by 2035 nearly 35% of all new vehicles produced will be electric. Northwest Power and Conservation Council 7th Power Plan studies assume 35% of new vehicles to be EV by 2035 and all new vehicles to be EV by 2050. When the EV penetration is combined with fuel switching in the residential and commercial sectors, the 7th Power Plan studies result in a projected 38% load growth in 2030 and a 44% regional load growth in 2035. Studies³ on electrifying all of British Columbia's vehicles predict a need for 60% more electric generation capability than existed in 2015. Additionally, studies produced by NREL predict a doubling of the 2017 US electricity usage by 2050, due to electrification efforts. Given the electrification efforts underway across the region, and a continued interest to reduce carbon emitting sources, electrification seems to be a likely process. Forecasting how, and when electrification occurs holds a lot of uncertainty at this time. BPA will continue to monitor electrification and future studies will incorporate continued development and knowledge gained relating to electrification and its impact to loads.

³ Electrification of road transportation with utility controlled charging: A case study for British Columbia with a 93% renewable electricity target, Science Direct November 2019

THIS PAGE INTENTIONALLY LEFT BLANK

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 2021 through 2030. 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 2019 Loads and Resources Technical Appendix, Volume 1, Energy Analysis, which provides annual and monthly energy in aMW; and the 2019 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. 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, in the PNW.

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 customers.

Under the 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 Final Rate Proposal.

Table 2-1

**Federal System
Annual Above-Rate High Water Mark (A-RHWM) Obligations
FY 2021 through 2030**

Energy (aMW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
A-RHWM Obligations	63	94	100	115	132	148	165	181	198	209

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).

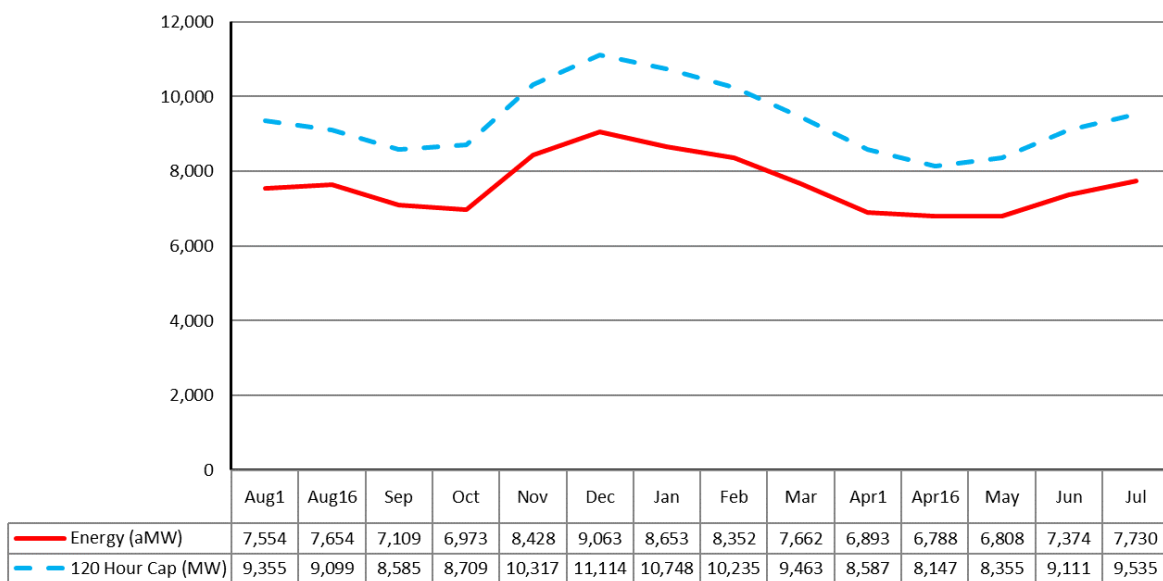
With the exception of Bonneville's Treaty-related contracts and RD PSCs, forecasts of Bonneville's contract deliveries follow individual contract terms and are not assumed to be renewed after expiration. Treaty and Regional Dialogue PSC power deliveries are assumed to remain in place through the study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

Firm Loads: The Federal system firm total load forecast shows a 0.2 percent per year average annual load reduction over the study period. While Bonneville's PSC requirements load increases (about 3 percent over the study period), Bonneville's Exports and Intra-Regional Transfers decrease due to the expiration of contracts 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. Overall, the total Federal system load obligations remain relatively flat on an annual basis over the study period.

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

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 2022. 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 2022



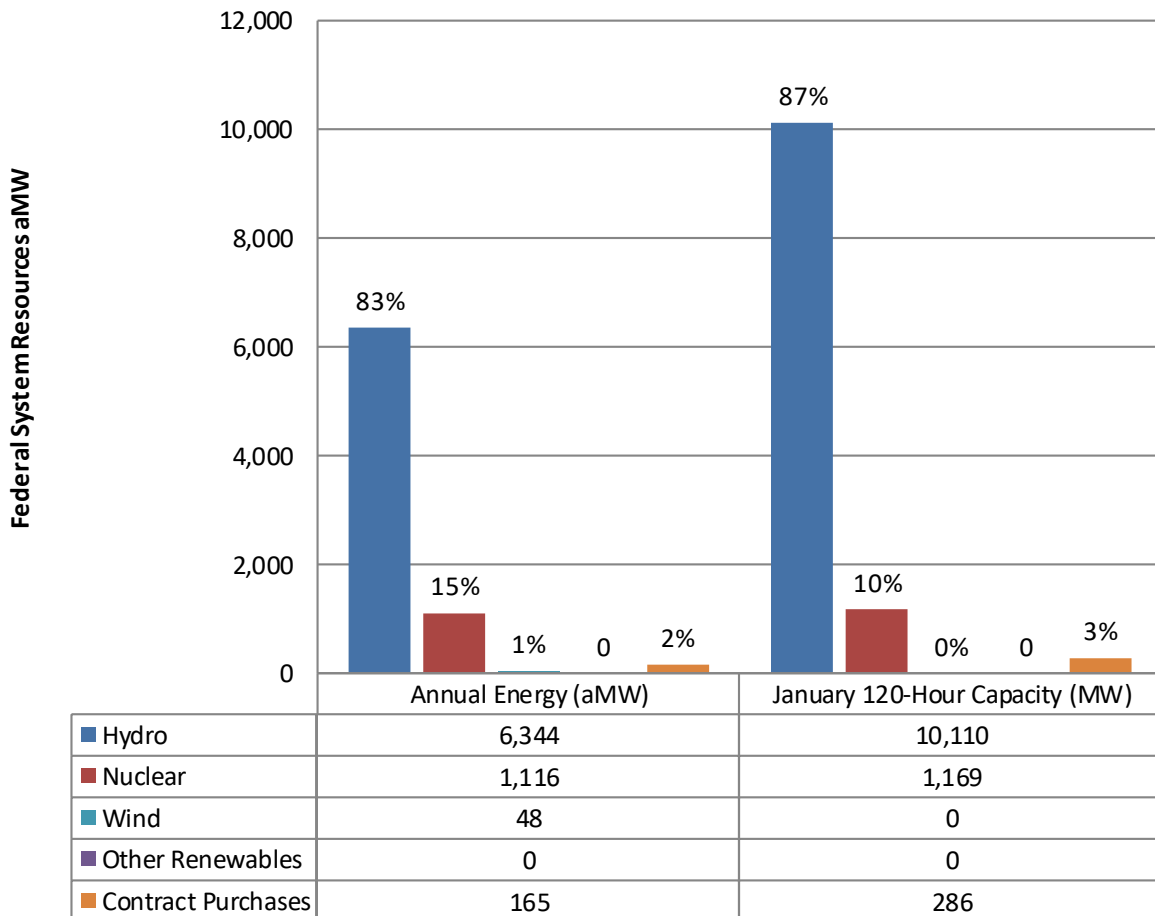
Resources

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. 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 transmission loss returns under Slice contracts.

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 2022, Federal system resources are forecast to produce 7,673 annual aMW of generation under 1937-critical water conditions. Federal system energy resources are comprised of approximately 83 percent hydro, 15 percent nuclear (Columbia Generating Station), 2 percent contract purchases, less than 1 percent wind.

Table 2-3

**Federal System
Generation Forecast by Resource Type
OY 2022
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 2022**

Project	Initial Service Date	Operator	Number of Units	Nameplate Rating (MW)	High Streamflows ^{c/} Energy (aMW)	Average Streamflows ^{c/} Energy (aMW)	Firm Energy ^{a/c/} (aMW)
Regulated Hydro							
1. Albeni Falls	1955	USACE	3	48	19.3	23.7	23.4
2. Bonneville ^{b/}	1938	USACE	18	1,242	599	543	366
3. Chief Joseph	1955	USACE	27	2,607	1,478	1,334	1,112
4. Dworshak	1974	USACE	3	465	277	211	140
5. Grand Coulee / GCL Pumping	1941	USBR	27	6,735	2,788	2,407	1,939
	1973		6	314			
6. Hungry Horse	1952	USBR	4	428	123	92	74
7. Ice Harbor	1961	USACE	6	693	300	196	108
8. John Day	1968	USACE	16	2,484	1,388	1,021	699
9. Libby	1975	USACE	5	605	256	222	177
10. Little Goose	1970	USACE	6	930	382	245	113
11. Lower Granite	1975	USACE	6	930	392	254	110
12. Lower Monumental	1969	USACE	6	930	391	238	112
13. McNary	1953	USACE	14	1,120	640	527	421
14. The Dalles	1957	USACE	22	2,182	984	826	598
15. Total Regulated Hydro Projects <i>(sum lines 1 through 14)</i>			169	21,713	10,017	8,139	5,992
Independent Hydro Projects							
16. Anderson Ranch	1950	USBR	2	40	19.7	19.6	13.0
17. Big Cliff	1954	USACE	1	21	13.5	12.2	9.9
18. Black Canyon	1925	USBR	2	8.5	8.3	7.5	6.2
19. Boise Diversion	1908	USBR	3	3	1.2	1.3	1.1
20. Chandler	1956	USBR	2	12	6.1	6.3	5.6
21. Cougar	1964	USACE	2	29	18.1	19.9	19.0
22. Cowitz Falls	1994	LCPD#1	2	70	40.3	27.7	26.2
23. Detroit	1953	USACE	2	115	62.1	49.0	41.3
24. Dexter	1955	USACE	1	17	11.4	11.2	9.2
25. Foster	1968	USACE	2	23	14.7	11.9	12.3
26. Green Peter	1967	USACE	2	92	39.3	29.3	27.4
27. Green Springs	1960	USBR	1	18	7.3	7.3	7.3
28. Hills Creek	1962	USACE	2	34	21.7	22.5	17.8
29. Lookout Point	1954	USACE	3	138	45.8	41.1	35.7
30. Lost Creek	1975	USACE	2	56	43.5	45.4	30.1
31. Minidoka	1909	USBR	4	28	22.5	16.6	11.2
32. Palisades	1957	USBR	4	177	96.2	84.1	69.2
33. Roza	1958	USBR	1	14	8.7	7.6	6.9
34. Total Independent Hydro Projects <i>(sum lines 16 through 33)</i>			38	896	480	420	349
Small Non-Federally Owned Hydro Projects							
35. Dworshak/Clearwater Small Hydro	2000	ID DWR	1	5.4	2.6	2.6	2.6
36. Rocky Brook	1985	MCPD#1	1	1.6	0.3	0.3	0.3
37. Total Non-Federally Owned Hydro Projects <i>(line 35 + line 36)</i>			2	7	2.9	2.9	2.9
38. Total Hydro Generation <i>(line 15 + line 34 + line 37)</i>			209	22,616	10,500	8,562	6,344

a/ Firm energy is the 12-month annual average for OY 2022 assuming 1937-critical water conditions
b/ Bonneville Dam generation totals include Bonneville Fishway
c/ High Stream Flow = 1974WY, Average StreamFlow = 1958WY, Firm Energy = 1937WY

Table 2-5

**Federal System
Non-Hydro Project Generation and Contract Purchases
OY 2022**

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	0.0
4. Foote Creek 4	2000	Wind	Foote Creek 4, LLC	0	0.0
5. Stateline Wind Project	2001	Wind	PPM, FLP	0	21.2
6. Stateline Phase I	2001	Wind	NW Wind Power	0	3.7
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. Total Federal System Non-Hydro Resources <i>(sum lines 1 through 10)</i>				1,169	1,164
Contract Purchases					
10. Canadian Entitlement for Canada (non-Federal)				237	135
11. Canadian Imports				1	1
12. Pacific Southwest Imports				0	0
13. Intra-Regional Transfers In (Pacific Northwest Purchases)				0	0
14. Slice Transmission Loss Return				48	29
15. Total Federal System Contract Purchases <i>(sum lines 12 through 16)</i>				286	165
16. Total Federal System Non-Hydro Resources and Contract Purchases <i>(line 11 + line 17)</i>				1,455	1,329

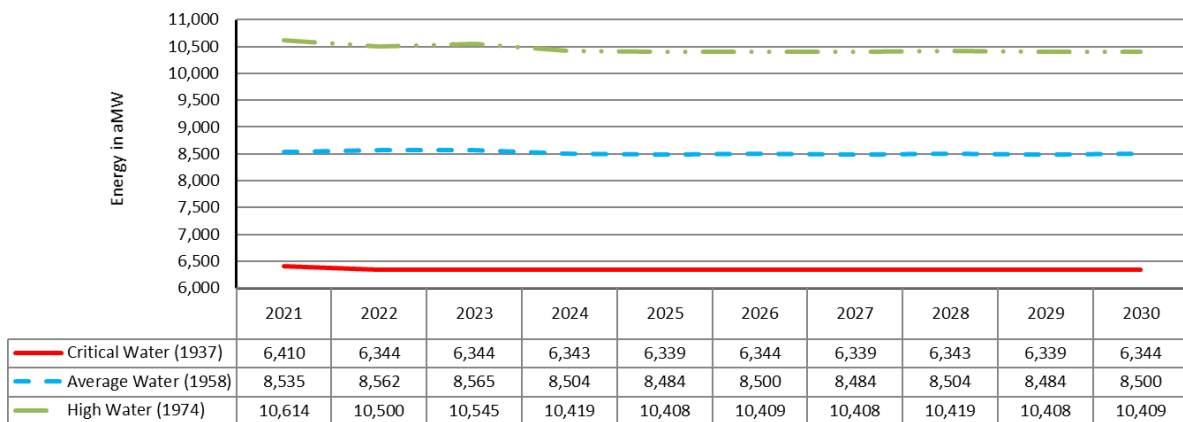
^{a/} This is the maximum generation for January 2022

^{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

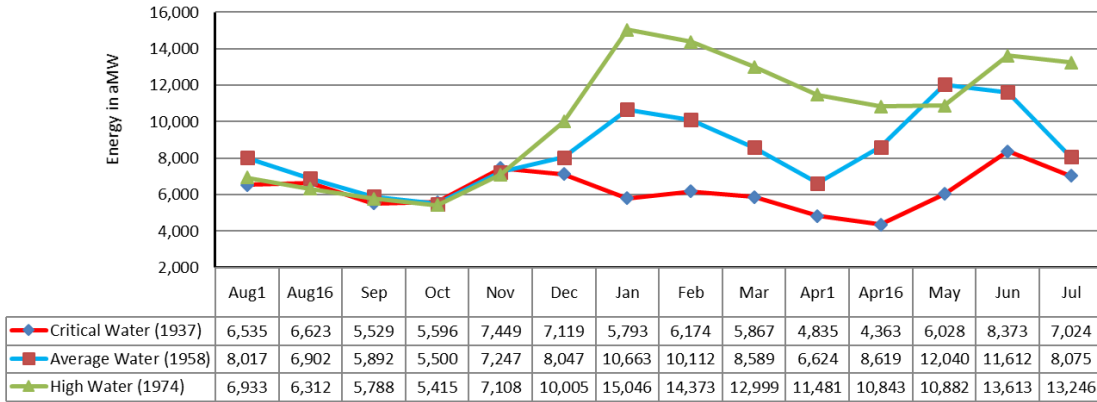
**Federal System
Variability of Annual Hydro Generation
OY 2021 through 2030
Under Different Water Conditions**



In OY 2022, annual Federal system hydro energy generation is forecasted to be 6,410 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 10,614 aMW. Table 2-6, above, shows the annual variability of Federal system hydro generation, and Table 2-7, on page 19, shows the monthly variability of the Federal system hydro generation for OY 2022, 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

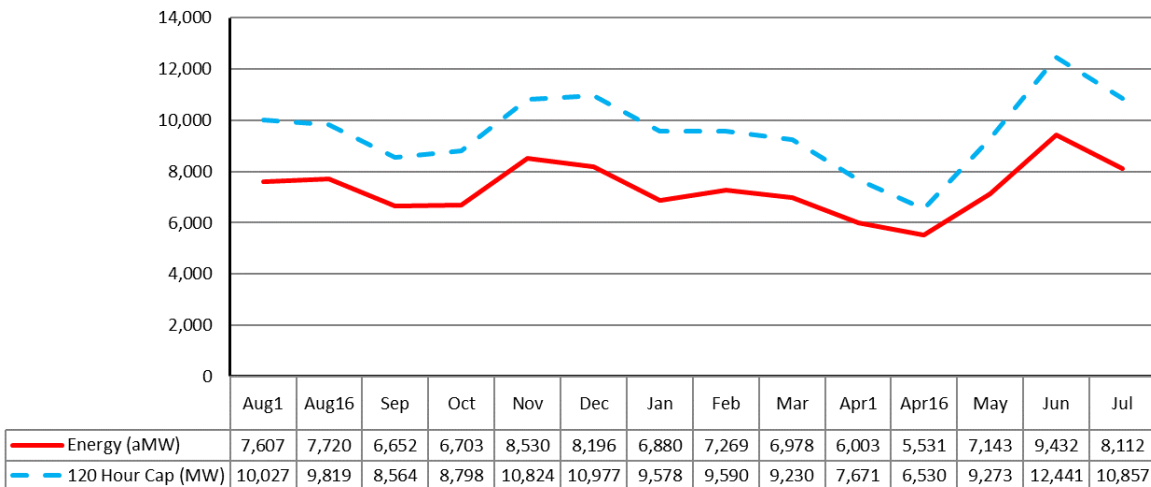
**Federal System
Variability of Monthly Hydro Generation
OY 2022
Under Different Water Conditions**



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 2022, 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 Generation
OY2022 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 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 37, for OY 2021 through 2030. The Federal system monthly energy loads and resources are shown in Exhibit 4-2, page 40, for OY 2021 through 2030. The details of each component are presented in the 2019 Loads and Resources Study Technical Appendix, Volume 1: Energy Analysis.

Table 2-9

**Federal System
Annual Energy Surplus/Deficit
OY 2021 through 2030
1937-Critical Water Conditions**

Energy (aMW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Surplus/Deficit	-194	-270	-354	-236	-367	-148	-207	-118	-247	-148

Table 2-10, below, compares the 2019 White Book Federal system annual firm energy surplus/deficit results to those from the 2018 White Book. The 2019 White Book shows a deficit throughout the studying period, with larger deficit during the middle 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 2021 through 2030
1937-Critical Water Conditions**

Energy (aMW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
2019 White Book	-194	-270	-354	-236	-367	-148	-207	-118	-247	-148
2018 White Book	-123	-256	-414	-300	-438	-224	-275	-190	-308	n/a
Difference <i>(2019 WBK – 2018 WBK)</i>	-71	-15	60	64	71	76	68	72	62	n/a

120-Hour Capacity: Table 2-11, next, 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 2021 through 2030 are shown in Exhibit 4-3, page 43. The Federal system monthly 120-Hour capacity loads and resources are shown in Exhibit 4-4, page 46, for OY 2022. The details of each component are presented in the 2019 Loads and Resources Study Technical Appendix, Volume 2: Capacity Analysis.

Table 2-11

**Federal System
January 120-Hour Capacity Surplus/Deficit
OY 2021 through 2030
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Surplus/Deficit	-1061	-1171	-1226	-1207	-1170	-950	-1083	-1085	-1056	-1047

Table 2-12, below, compares the 2019 White Book January firm 120-Hour capacity surplus/deficit results to those from the 2018 White Book. This study shows a decrease in January 120-Hour capacity deficits starting from 2022, due to a combination of decreased load obligations and increased January Federal system capabilities.

Table 2-12

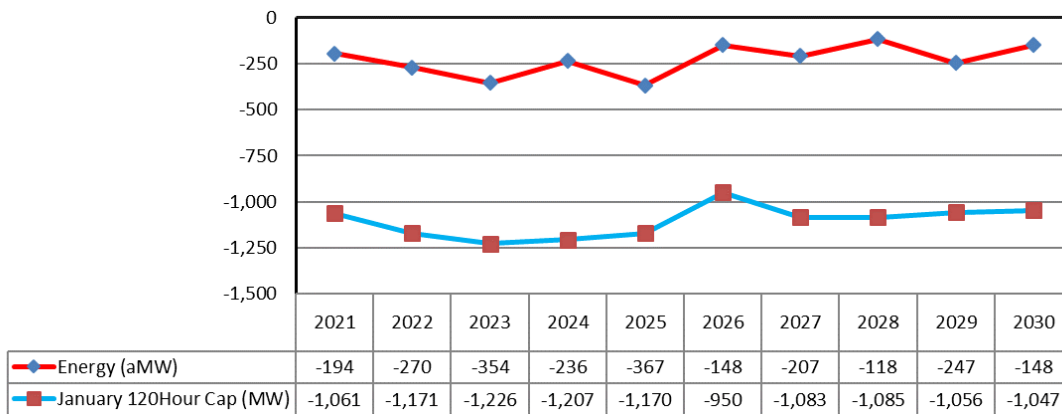
**Federal System
January 120-Hour Capacity Surplus/Deficit Comparison
OY 2021 through 2030
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
2019 White Book	-1061	-1171	-1226	-1207	-1170	-950	-1083	-1085	-1056	-1047
2018 White Book	-994	-1312	-1406	-1367	-1371	-1209	-1289	-1340	-1258	n/a
Difference <i>(2019 WBK - 2018WBK)</i>	-67	141	180	160	202	259	206	255	202	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 deficits as high as -367 aMW over the study period. The January firm 120-Hour capacity forecasts show the Federal system is deficit throughout the study period, ranging from -950 MW in OY 2026, to as high as -1,226 in OY 2023, and ending the study period -1,047 MW in OY 2030. Variations in the annual energy deficits between the odd and even OYs are due to the biennial Columbia Generation Station (CGS) maintenance schedule.⁴

Table 2-13

**Federal System
Annual Energy and January 120-Hour Capacity Surplus/Deficit
OY 2021 through 2030
1937-Critical Water Conditions**

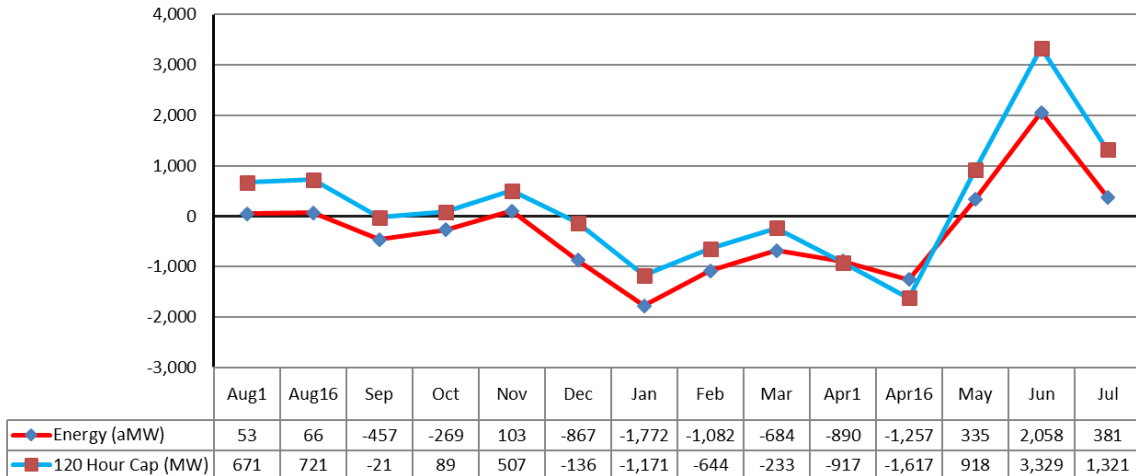


Federal System Monthly Surplus/Deficit: Table 2-14, page 23, graphically presents the Federal system monthly firm energy and 120-Hour capacity surpluses and deficits for OY 2022. Forecasts for energy and 120-Hour capacity maintain similar monthly shapes over the study period. This shows that for each 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.

⁴ During even calendar years, CGS does not have scheduled maintenance and is forecasted to produce 1,116 aMW annually. In odd calendar years, CGS has scheduled maintenance in May and June, and is forecasted to produce 994 aMW annually.

Table 2-14

**Federal System
Monthly Energy and 120-Hour Capacity Surplus/Deficit
OY 2022
1937-Critical Water Conditions**



Conclusion

Under 1937 critical water conditions the Federal system shows annual firm energy deficits over the study period. These annual energy deficits range from -194 aMW in OY 2021 to as high as -367 aMW in OY 2025, followed by an adjustment which starts in OY2026 as contract obligations expire. Under critical water conditions the Federal system generally shows monthly energy deficits across the winter and early spring, with 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 more than 3,100 aMW under better water conditions, while the monthly surplus/deficit position can vary by almost 7,000 aMW (January). Similarly, Federal system 120-Hour capacity surplus/deficits for OY 2021 can vary by almost 5,000 MW in January, and by almost 6,000 MW during the second half of April, 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 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 49.

THIS PAGE INTENTIONALLY LEFT BLANK

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 2021 through 2030. 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, include historic conservation savings, do not include explicit adjustments for future climate change impacts and are developed by Bonneville using the ALF system. 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 25, shows the forecasted composition of PNW regional load for OY 2022. For the PNW region, about 52 percent of the regional loads are represented by IOU customers. Public, cooperative, Tribal and Federal agency preference customers, along with 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 2022**

Customer Class	Energy (aMW)	Percent of Energy	January 120-Hour Capacity (MW)	Percent of Capacity
Investor-Owned Utility	12,790	52%	18,905	51%
Public Utility District	4,720	19%	7,734	21%
Municipality	2,622	11%	4,353	12%
Cooperative	2,384	10%	3,711	10%
Federal Agency	153	1%	252	1%
USBR	178	1%	284	1%
Direct-Service Industry¹	401	2%	413	1%
Marketer	3	0%	3	0%
Total Retail Load	23,252	95%	35,655	97%
Exports	1,142	5%	1,143	3%
Regional Load	24,394	100%	36,797	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.

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.

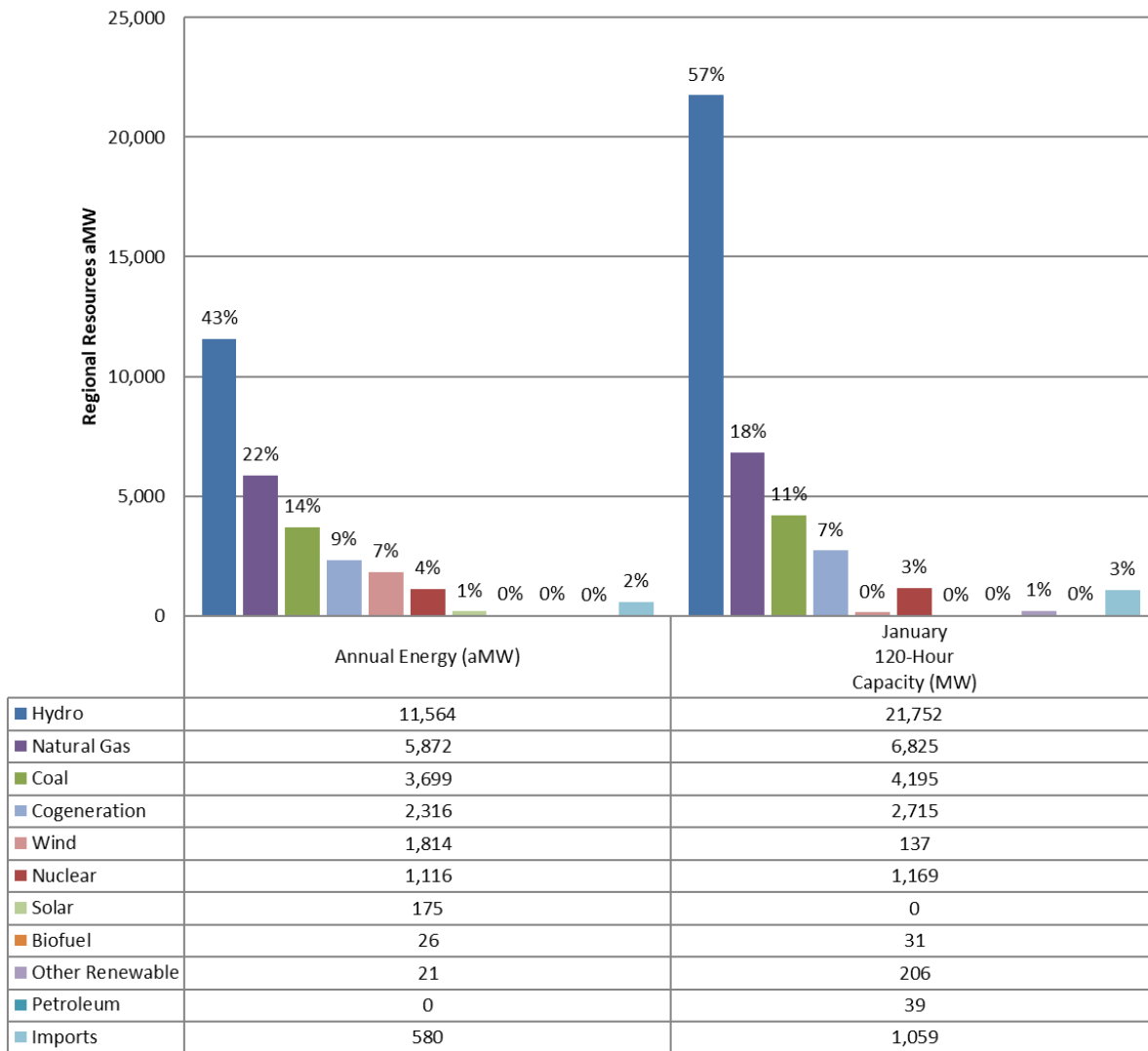
Table 3-2, next, summarizes the resource generation available to meet PNW regional loads. The generation forecasts for these resources are provided by Bonneville models or the project owners. New regional generating projects are included when those resources begin operating or are under construction 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 1³ (June 30, 2022), Colstrip 2⁵ (June 30, 2022), Valmy 1 (January 1, 2022), and Valmy 2 (January 1, 2026). Contract purchases are provided by individual utility, follow specific contract

⁵ Since completion of study retirement dates for Colstrip 1 and 2 accelerated to EOY 2019,

provisions and can have various delivery arrangements. For OY 2022, regional firm energy resources are comprised of approximately 43 percent hydro, 22 percent natural gas, 14 percent coal, 9 percent cogeneration, 7 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 2022
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, next, 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 2022, annual firm energy generation from regional hydro projects is forecasted to be 11,564 aMW. This represents about 41 percent of region’s resources. However, the generating potential from regional hydro projects can annually vary by nearly 7,000 aMW depending on water conditions.

Table 3-3

**PNW Region
Variability of Annual Hydro Generation
OY 2021 through 2030
Under Different Water Conditions**

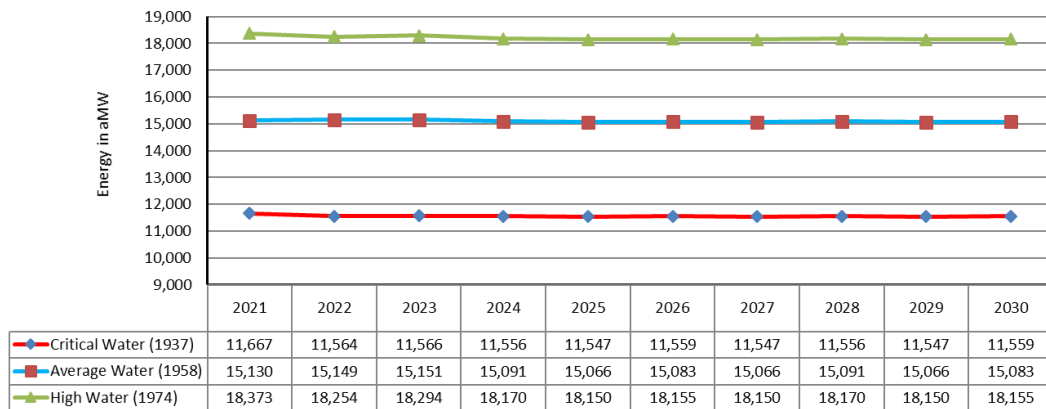
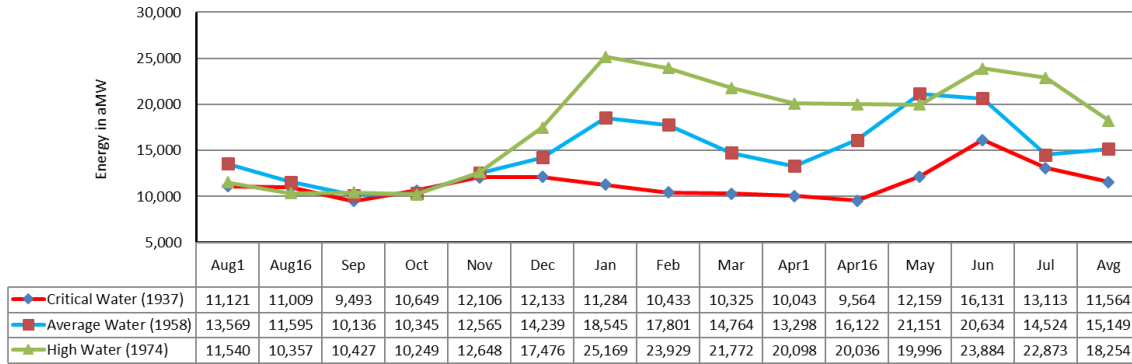


Table 3-4, page 28, shows the monthly variability of the region’s hydro generation under the same three water conditions. High generation levels in the December through mid-April period is largely due to drafting reservoirs for power production and flood control, which can vary widely due to rainfall 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 in a month, depending on the availability of water.

Table 3-4

**PNW Region
Variability of Monthly Hydro Generation
OY 2022
Under Different Water Conditions**



Variability Due to IPP Generation Delivered to the PNW Region: The PNW regional study includes uncommitted PNW IPP generation as regional resources. These resources, or the share of these resources, that are not committed to serving specific loads represent approximately 2,742 aMW of energy with an associated 3,351 MW of January 120-Hour capacity in OY 2022. 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 2021 through 2030 study period. Table 3-6, page 29, 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 2021 through 2030**

Regional Uncommitted IPP	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Annual Energy (aMW)	2942	2742	2712	2709	2710	2540	2466	2499	2506	2506
January 120-Hour Capacity (MW)	3391	3351	3162	3162	3162	2872	2872	2872	2872	2872

Table 3-6

**PNW Region
Uncommitted Independent Power Producer Projects
OY 2022**

Project	Annual Energy (aMW)	Peak	Fuel Type
Airport Solar	10	0	Solar
Centralia 1 ^{a/} ,2 ^{b/}	256	290	Coal
Cosmopolis Specialty Fibres	14	14	Wood Waste
Hermiston Power Project	567	630	Natural Gas
International Paper Energy Center	16	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
Klondike Wind 1	2	0	Wind
Leaning Juniper Wind	47	0	Wind
Longview Fibre Paper & Packaging	35	35	Wood Waste
Nippon Paper Cogen (Port Angeles)	11	12	Wood Waste
Pelton	13	41	Hydro
Priest Rapids	83	138	Hydro
Rock Island	121	213	Hydro
Rocky Reach	225	470	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
Tacoma Biomass (WestRock)	44	55	Waste
Tieton Dam (Yakima)	0	0	Hydro
Vansycle Wind	23	0	Wind
Wanapum	24	54	Hydro
Weyerhaeuser Longview	35	44	Wood Waste
Total Uncommitted IPP Generation	2,742	3,351	

^{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. Puget purchased an increasing amount of this project beginning Dec 1, 2014 and ending Nov 30, 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 (2,742 aMW in OY 2022) is available to serve the region's loads. The individual components of the PNW regional annual energy loads and resources for OY 2021 through 2030 are shown in Exhibit 5-1, page 55. The PNW regional monthly energy loads and resources for OY 2022 are shown in Exhibit 5-2, page 58. The details of each component for OY 2021 through 2030 are presented in the 2019 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 2021 through 2030
1937-Critical Water Conditions**

Energy (aMW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Surplus/Deficit	2,974	2,132	1,800	1,892	1,571	1,150	798	780	590	698

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 28 and 29.

Table 3-8

**PNW Region
Variability of Annual Energy Surplus/Deficit
Assuming Different Levels of Uncommitted IPP Generation
OY 2021 through 2030
1937-Critical Water Conditions**

Energy (aMW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
100% IPP	2,974	2,132	1,800	1,892	1,571	1,150	798	780	590	698
50% IPP	1,503	762	443	537	216	-120	-436	-470	-663	-555
0% IPP	32	-609	-913	-817	-1139	-1390	-1669	-1720	-1916	-1808

Table 3-9, below, compares the 2019 White Book PNW regional annual firm energy surplus/deficit forecasts to the 2018 White Book results. The PNW region continues to have annual energy surpluses throughout the study period. When compared to the 2018 White Book, the 2019 study shows lower annual energy surpluses at the start of the study period and increased surpluses in the rest of the study years, this is driver by flatter total retail loads then in the previous study.

Table 3-9

**PNW Region
Annual Energy Surplus/Deficit Comparison
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2021 through 2030
1937-Critical Water Conditions**

Energy (aMW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
2019 White Book	2,974	2,132	1,800	1,892	1,571	1,150	798	780	590	698
2018 White Book	3,141	2,303	1,637	1,750	1,416	965	614	579	403	n/a
Difference <i>(2019 WBK – 2018 WBK)</i>	-167	-170	163	142	155	185	184	201	187	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 2021 through 2030 are shown in Exhibit 5-3, page 61. The monthly PNW regional 120-Hour capacity loads and resources for OY 2021 are shown in Exhibit 5-4, page 64. The component details for OY 2021 through 2030 are presented in the 2019 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 2021 through 2030
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Surplus/Deficit	-969	-1,398	-1,699	-1,954	-1,990	-2,911	-3,081	-3,229	-3,325	-3,460

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 28 and 29.

Table 3-11

**PNW Region
Variability of January 120-Hour Capacity Surplus/Deficit
Assuming Different Levels of Uncommitted IPP Generation
OY 2021 through 2030
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
100% IPP	-969	-1,398	-1,699	-1,954	-1,990	-2,911	-3,081	-3,229	-3,325	-3,460
50% IPP	-2,665	-3,073	-3,280	-3,534	-3,571	-4,347	-4,517	-4,665	-4,761	-4,896
0% IPP	-4,360	-4,749	-4,860	-5,115	-5,152	-5,783	-5,953	-6,100	-6,197	-6,332

Table 3-12, below, compares the 2019 White Book January firm 120-Hour capacity forecast to the 2018 White Book results. Regional January 120-Hour capacity surplus/deficits show less deficits over the study period. The decreased January 120-Hour capacity deficits, compared to the 2018 White Book, are mainly driven by reduced non coincidental peaks in the updated TRL forecasts from ALF.

Table 3-12

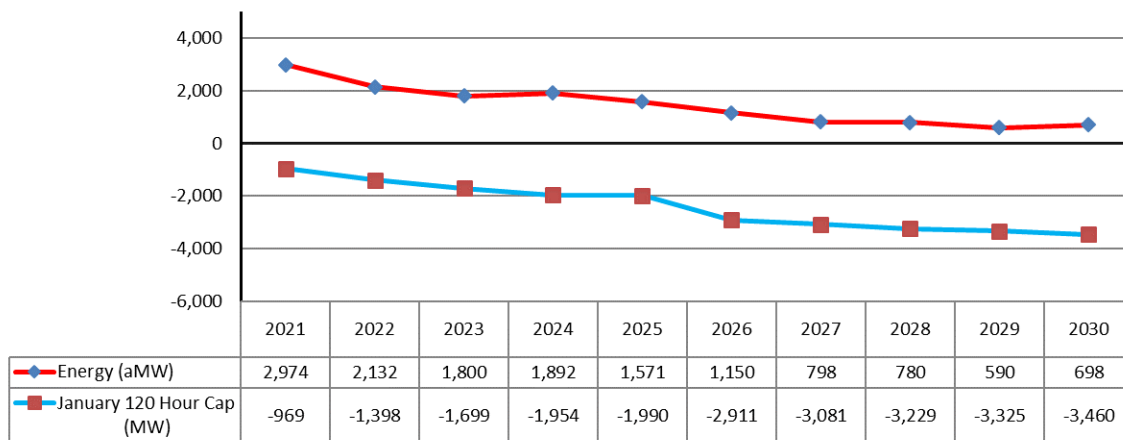
**PNW Region
January 120-Hour Capacity Surplus/Deficit Comparison
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2021 through 2030
1937-Critical Water Conditions**

January 120-Hour Capacity (MW)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
2019 White Book	-969	-1,398	-1,699	-1,954	-1,990	-2,911	-3,081	-3,229	-3,325	-3,460
2018 White Book	-1,588	-2,456	-3,056	-3,337	-3,436	-4,482	-4,589	-4,866	-4,891	n/a
Difference <i>(2019 WBK – 2018 WBK)</i>	679	1,059	1,357	1,384	1,446	1,571	1,508	1,637	1,566	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 698 aMW, while January 120-Hour capacity is deficit over the entire study period ending with a deficit of -3,460 MW. Continuing declines in the surplus/deficit position over the study period, for both annual energy and January 120-Hour capacity are driven by a combination of annual load growth, and the retirement of resources across the region.

Table 3-13

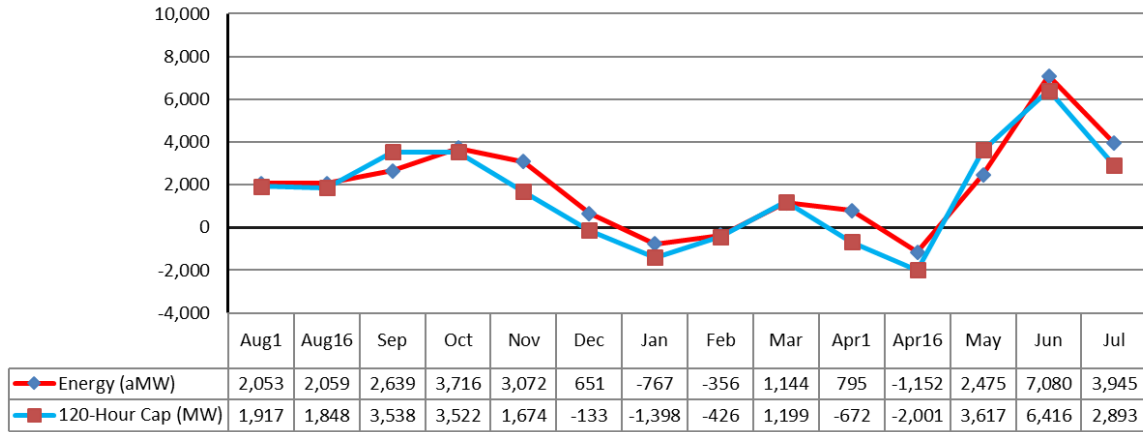
**PNW Region
Annual Energy and January 120-Hour Capacity Surplus/Deficit
OY 2021 through 2030
1937-Critical Water Conditions**



Regional Monthly Surplus/Deficit: Table 3-14, page 34, graphically presents the monthly energy and 120-Hour capacity surplus/deficit forecasts for OY 2022. 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 2022
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, or if committed resources retire early or unexpectedly. The surplus and deficit forecasts for all 80-historical water conditions are presented in Exhibit 5-5, page 67. Additional monthly and annual details for OY 2021 through 2030 are presented in the 2019 Loads and Resources Study Technical Appendix, Volume 1: Energy Analysis and the 2019 Loads and Resources Study Technical Appendix, Volume 2: Capacity Analysis.

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. Bonneville provides this PNW regional planning analysis for informational purposes only.

THIS PAGE INTENTIONALLY LEFT BLANK

Section 4: Federal System Analysis Exhibits

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit 4-1: Annual Energy

**Federal System Analysis Surplus Deficit
Operating Year 2021 to 2030
Using 1937-Water Conditions**

THIS PAGE INTENTIONALLY LEFT BLANK

Loads and Resources - Federal System
Operating Year: 2021 to 2030 Water Year: 1937
2019 White Book Report Date: 4/6/2020

S184-WB-20191230-103442

Energy-aMW	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Firm Obligations										
1 Load Following	3458	3472	3486	3496	3512	3529	3547	3560	3577	3593
2 Preference Customers	3146	3151	3164	3175	3190	3207	3224	3238	3253	3269
3 Federal Agencies	134	143	143	143	144	144	145	145	145	145
4 USBR	178	178	178	178	178	178	178	178	178	178
5 Federal Diversity	0	0	0	0	0	0	0	0	0	0
6 Tier 1 Block	572	571	564	552	550	549	549	548	548	548
7 Tier 1 Block	572	571	564	552	550	549	549	548	548	548
8 Slice	2818	2920	2928	2929	2922	2926	2915	2919	2907	2916
9 Slice Block	1314	1404	1442	1417	1437	1414	1434	1412	1427	1409
10 Slice Output from T1 System	1504	1516	1486	1513	1485	1512	1482	1508	1480	1508
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	818	740	676	675	676	560	476	476	476	476
14 Exports	629	529	465	464	465	465	465	465	465	465
15 Intra-Regional Transfers (Out)	188	211	211	211	211	94.6	10.7	10.7	10.7	10.7
16 Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0
17 Total Firm Obligations	7679	7714	7666	7664	7672	7577	7499	7515	7520	7545
Net Resources										
18 Hydro	6410	6344	6344	6343	6339	6344	6339	6343	6339	6344
19 Regulated Hydro - Net	6058	5992	5992	5992	5987	5992	5987	5992	5987	5992
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
22 Non-Hydro Renewable	51.0	48.5	34.8	33.0	33.0	33.0	19.8	1.90	0	0
23 Wind - Net	51.0	48.5	34.8	33.0	33.0	33.0	19.8	1.90	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	994	1116	994	1116	994	1116	994	1116	994	1116
27 Nuclear - Net	994	1116	994	1116	994	1116	994	1116	994	1116
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

Loads and Resources - Federal System
Operating Year: 2021 to 2030 Water Year: 1937

2019 White Book Report Date: 4/6/2020 *Continued*

S184-WB-20191230-103442

Energy-aMW	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
33 Contract Purchases	261	165	165	165	164	165	164	165	164	165
34 Imports	84.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
35 Intra-Regional Transfers (In)	12.4	0	0	0	0	0	0	0	0	0
36 Non-Federal CER	135	135	135	135	135	135	135	135	135	135
37 Slice Transmission Loss Return	28.6	28.8	28.3	28.8	28.2	28.8	28.2	28.7	28.1	28.7
38 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-231	-230	-226	-229	-225	-229	-225	-228	-224	-228
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	-231	-230	-226	-229	-225	-229	-225	-228	-224	-228
43 Total Net Resources	7484	7444	7312	7428	7305	7429	7292	7398	7273	7397
44 Total Surplus/Deficit	-194	-270	-354	-236	-367	-148	-207	-118	-247	-148

Exhibit 4-2: Monthly Energy

**Federal System Analysis Surplus Deficit
Operating Year 2022
Using 1937-Water Conditions**

THIS PAGE INTENTIONALLY LEFT BLANK

Loads and Resources - Federal System
Operating Year: 2022 Water Year: 1937
2019 White Book Report Date: 2/3/2020
S184-WB-20191230-103442

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
Firm Obligations															
45 Load Following	3545	3572	3174	2961	3436	3935	3894	3700	3253	3271	3271	3261	3476	3749	3472
46 Preference Customers	3102	3139	2792	2728	3269	3742	3705	3512	3040	2895	2895	2810	2999	3209	3151
47 Federal Agencies	128	129	119	125	152	179	178	172	148	132	132	123	124	137	143
48 USBR	315	304	263	108	15.3	14.5	10.4	16.3	64.9	244	244	327	353	403	178
49 Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50 Tier 1 Block	380	383	629	525	864	863	948	892	846	416	416	148	20.6	337	571
51 Tier 1 Block	380	383	629	525	864	863	948	892	846	416	416	148	20.6	337	571
52 Slice	2724	2738	2477	2659	3295	3432	3131	3079	2887	2530	2425	2724	3202	2948	2920
53 Slice Block	1214	1214	1158	1290	1499	1710	1701	1564	1447	1350	1350	1307	1279	1336	1404
54 Slice Output from T1 System	1510	1524	1319	1369	1797	1723	1431	1515	1440	1180	1075	1417	1923	1612	1516
55 Direct Service Industries	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
56 Direct Service Industry	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
57 Contract Deliveries	893	949	817	817	821	821	668	668	664	664	664	664	664	685	740
58 Exports	684	740	607	607	607	607	454	454	454	454	454	454	454	476	529
59 Intra-Regional Transfers (Out)	209	209	209	209	213	213	213	213	209	209	209	209	209	209	211
60 Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61 Total Firm Obligations	7554	7654	7109	6973	8428	9063	8653	8352	7662	6893	6788	6808	7374	7730	7714
Net Resources															
62 Hydro	6535	6623	5529	5596	7449	7119	5793	6174	5867	4835	4363	6028	8373	7024	6344
63 Regulated Hydro - Net	6171	6262	5187	5287	7190	6944	5677	6043	5634	4397	3917	5306	7662	6614	5992
64 Independent Hydro - Net	362	358	340	307	257	172	113	128	230	435	442	719	708	407	349
65 Small Hydro - Net	2.63	2.63	2.63	2.67	2.84	3.19	3.21	3.05	3.10	3.09	3.09	2.83	2.72	2.63	2.88
66 Non-Hydro Renewable	34.4	51.7	48.0	38.6	55.3	42.1	22.5	37.3	42.9	76.7	64.5	61.3	60.6	59.2	48.5
67 Wind - Net	34.4	51.7	48.0	38.6	55.3	42.1	22.5	37.3	42.9	76.7	64.5	61.3	60.6	59.2	48.5
68 Solar - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69 Other - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70 Thermal	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116
71 Nuclear - Net	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116
72 Coal - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73 Natural Gas - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74 Petroleum - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75 Biofuel - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76 Cogeneration - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77 Contract Purchases	156	168	163	160	172	171	160	165	166	160	158	160	175	164	165
78 Imports	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

Loads and Resources - Federal System
Operating Year: 2022 Water Year: 1937
2019 White Book Report Date: 2/3/2020

S184-WB-20191230-103442

79 Intra-Regional Transfers (In)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80 Non-Federal CER	126	138	137	133	137	137	132	135	138	137	137	132	137	132	135
81 Slice Transmission Loss Return	28.7	29.0	25.1	26.0	34.2	32.8	27.2	28.8	27.4	22.4	20.4	27.0	36.6	30.7	28.8
82 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83 Reserves & Losses	-235	-238	-205	-207	-262	-252	-212	-223	-215	-185	-171	-222	-292	-251	-230
84 Operating Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85 Balancing Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86 Transmission Losses	-235	-238	-205	-207	-262	-252	-212	-223	-215	-185	-171	-222	-292	-251	-230
87 Total Net Resources	7607	7720	6652	6703	8530	8196	6880	7269	6978	6003	5531	7143	9432	8112	7444
88 Total Surplus/Deficit	53	66	-457	-269	103	-867	-1,772	-1,082	-684	-890	-1,257	335	2,058	381	-270

Exhibit 4-3: Annual 120-Hour Capacity

**Federal System Analysis Surplus Deficit
Operating Year 2021 to 2030
Using 1937-Water Conditions**

THIS PAGE INTENTIONALLY LEFT BLANK

Loads and Resources - Federal System
Operating Year: 2021 to 2030 Water Year: 1937
2019 White Book Report Date: 10/5/2020

S184-WB-20191230-103442

January 120Hr-MW	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Firm Obligations										
1 Load Following	4640	4659	4694	4677	4696	4720	4783	4814	4803	4823
2 Preference Customers	5500	5514	5547	5575	5605	5634	5666	5696	5726	5754
3 Federal Agencies	231	244	241	241	243	244	245	245	245	246
4 USBR	284	284	284	284	284	284	284	284	284	284
5 Federal Diversity	-1375	-1383	-1379	-1424	-1437	-1442	-1413	-1411	-1453	-1460
6 Tier 1 Block	1047	1045	1029	968	963	961	997	998	959	959
7 Tier 1 Block	1047	1045	1029	968	963	961	997	998	959	959
8 Slice	3565	3674	3704	3642	3696	3655	3689	3658	3680	3650
9 Slice Block	1591	1701	1731	1696	1725	1688	1722	1691	1712	1682
10 Slice Output from T1 System	1974	1974	1973	1946	1971	1967	1967	1967	1968	1968
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	1511	1358	1358	1358	1358	1158	1158	1158	1158	1158
14 Exports	1295	1142	1142	1142	1142	1142	1142	1142	1142	1142
15 Intra-Regional Transfers (Out)	216	216	216	216	216	16.4	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	10775	10748	10796	10656	10725	10506	10639	10641	10612	10603
Net Resources										
18 Hydro	10114	10110	10107	9983	10097	10078	10080	10081	10082	10083
19 Regulated Hydro - Net	9911	9907	9905	9780	9894	9876	9877	9878	9880	9881
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
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	411	286	285	285	285	285	285	285	285	285
34 Imports	126	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
35 Intra-Regional Transfers (In)	0	0	0	0	0	0	0	0	0	0
36 Non-Federal CER	237	237	237	237	237	237	237	237	237	237
37 Slice Transmission Loss Return	47.5	47.5	47.5	46.8	47.4	47.3	47.3	47.4	47.4	47.4
38 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-1979	-1987	-1992	-1987	-1996	-1977	-1978	-1980	-1981	-1982
40 Operating Reserves	-735	-747	-753	-752	-757	-739	-740	-741	-742	-743
41 Balancing Reserves	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903

Loads and Resources - Federal System
Operating Year: 2021 to 2030 Water Year: 1937
2019 White Book Report Date: **10/5/2020** *Continued*

S184-WB-20191230-103442

January 120Hr-MW	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
⁴² Transmission Losses	-341	-336	-336	-332	-336	-335	-335	-336	-336	-336
⁴³ Total Net Resources	9714	9578	9570	9450	9556	9556	9556	9556	9556	9556
⁴⁴ Total Surplus/Deficit	-1,061	-1,171	-1,226	-1,207	-1,170	-950	-1,083	-1,085	-1,056	-1,047

Exhibit 4-4: Monthly 120-Hour Capacity

**Federal System Analysis Surplus Deficit
Operating Year 2022
Using 1937-Water Conditions**

THIS PAGE INTENTIONALLY LEFT BLANK

Loads and Resources - Federal System
Operating Year: 2022 Water Year: 1937
2019 White Book Report Date: 3/4/2020

S184-WB-20191230-103442

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Firm Obligations														
45 Load Following	4182	3906	3573	3588	4099	4666	4659	4393	3915	3958	3782	3692	3899	4271
46 Preference Customers	4331	4331	3974	4209	4902	5553	5514	5225	4713	4444	4444	4095	4182	4440
47 Federal Agencies	162	162	152	162	198	234	244	227	202	172	172	161	157	170
48 USBR	602	602	527	383	206	277	284	266	365	438	438	527	578	618
49 Federal Diversity	-914	-1189	-1080	-1166	-1208	-1398	-1383	-1325	-1364	-1095	-1272	-1089	-1018	-957
50 Tier 1 Block	406	406	674	559	928	919	1045	932	870	430	430	162	20.6	370
51 Tier 1 Block	406	406	674	559	928	919	1045	932	870	430	430	162	20.6	370
52 Slice	3190	3123	2822	3046	3768	4006	3674	3540	3315	2836	2572	3138	3829	3510
53 Slice Block	1214	1214	1158	1289	1498	1710	1701	1564	1447	1350	1350	1307	1279	1335
54 Slice Output from T1 System	1976	1910	1664	1756	2269	2296	1974	1976	1868	1486	1222	1831	2550	2175
55 Direct Service Industries	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
56 Direct Service Industry	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
57 Contract Deliveries	1565	1650	1504	1504	1511	1511	1358	1358	1351	1351	1351	1351	1351	1372
58 Exports	1356	1441	1295	1295	1295	1295	1142	1142	1142	1142	1142	1142	1142	1163
59 Intra-Regional Transfers (Out)	209	209	209	209	216	216	216	216	209	209	209	209	209	209
60 Firm Surplus Sale	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61 Total Firm Obligations	9355	9099	8585	8709	10317	11114	10748	10235	9463	8587	8147	8355	9111	9535
Net Resources														
62 Hydro	10509	10290	8921	9193	11380	11576	10110	10103	9699	8026	6813	9718	13076	11397
63 Regulated Hydro - Net	9936	9726	8397	8717	10958	11261	9907	9873	9309	7409	6179	8899	12232	10789
64 Independent Hydro - Net	569	560	522	472	417	311	198	225	385	613	629	815	840	605
65 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
66 Non-Hydro Renewable	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67 Wind - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68 Solar - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69 Other - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70 Thermal	1163	1163	1179	1181	1179	1180	1169	1169	1169	1160	1160	1151	1154	1168
71 Nuclear - Net	1163	1163	1179	1181	1179	1180	1169	1169	1169	1160	1160	1151	1154	1168
72 Coal - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73 Natural Gas - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74 Petroleum - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75 Biofuel - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76 Cogeneration - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77 Contract Purchases	286	284	278	280	293	293	286	286	283	274	267	282	299	290
78 Imports	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
79 Intra-Regional Transfers (In)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80 Non-Federal CER	237	237	237	237	237	237	237	237	237	237	237	237	237	237
81 Slice Transmission Loss Return	47.6	46.0	40.0	42.3	54.6	55.3	47.5	47.6	45.0	35.8	29.4	44.1	61.4	52.3
82 Augmentation Purchases	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83 Reserves & Losses	-1931	-1917	-1815	-1856	-2028	-2072	-1987	-1967	-1921	-1789	-1710	-1878	-2088	-1999
84 Operating Reserves	-675	-668	-611	-643	-745	-784	-747	-728	-694	-616	-577	-647	-747	-714
85 Balancing Reserves	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903

Loads and Resources - Federal System
Operating Year: 2023 Water Year: 1937
2019 White Book Report Date: 3/4/2020 *Continued*

S184-WB-20191230-103442

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
⁸⁶ Transmission Losses	-353	-346	-301	-310	-380	-385	-336	-336	-324	-270	-230	-328	-439	-382
⁸⁷ Total Net Resources	10027	9819	8564	8798	10824	10977	9578	9590	9230	7671	6530	9273	12441	10857
⁸⁸ Total Surplus/Deficit	671	721	-21	89	507	-136	-1,171	-644	-233	-917	-1,617	918	3,329	1,321

Exhibit 4-5: 80-Water Conditions Monthly Energy

**Federal System Analysis Surplus Deficit
Operating Year 2022**

THIS PAGE INTENTIONALLY LEFT BLANK

Federal Report Surplus Deficit By Water Year

Operating Year 2022

2019 White Book Report Date: 3/18/2020

S184-WB-20191230-103442

Energy-aMW - Surplus Deficit	Aug1	Aug1 6	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
1 1929 Federal Report Surplus Deficit	661	1113	-72.5	-350	-122	-1038	-881	-543	-367	-980	-1304	-13.2	2690	-293	-104
2 1930 Federal Report Surplus Deficit	148	126	-109	-290	16.0	-1025	-1660	-524	-413	-424	-895	301	916	670	-220
3 1931 Federal Report Surplus Deficit	324	227	-215	-286	-8.05	-846	-1578	-616	-354	-565	-1394	483	851	608	-220
4 1932 Federal Report Surplus Deficit	573	160	-171	-529	-373	-936	-962	-2055	1385	1656	3241	4481	3981	1979	817
5 1933 Federal Report Surplus Deficit	878	1090	274	-337	-234	595	1903	2117	1549	862	272	2612	5786	4220	1667
6 1934 Federal Report Surplus Deficit	2727	2535	390	255	2326	3900	4511	4434	3549	4153	3122	2887	3275	147	2650
7 1935 Federal Report Surplus Deficit	-5.17	260	-466	-398	-713	-443	1697	1941	1581	-215	713	2263	1738	2046	799
8 1936 Federal Report Surplus Deficit	2113	434	-235	-416	-167	-1046	-1519	-965	-149	-527	2141	4609	3635	1246	595
9 1937 Federal Report Surplus Deficit	52.8	66.0	-457	-269	103	-867	-1772	-1082	-684	-890	-1257	335	2058	381	-270
10 1938 Federal Report Surplus Deficit	314	81.4	-51.6	-362	-151	-78.5	1127	1577	2153	2120	3788	3523	2877	2310	1336
11 1939 Federal Report Surplus Deficit	106	28.2	82.7	-330	-293	-1112	255	464	398	138	1294	2224	1456	811	393
12 1940 Federal Report Surplus Deficit	-88.0	-14.3	-383	-219	155	106	539	17.4	1841	1123	416	2483	1504	-331	540
13 1941 Federal Report Surplus Deficit	-207	-182	-243	-455	147	-272	-504	-220	275	-653	-1379	335	1293	514	-27.6
14 1942 Federal Report Surplus Deficit	457	263	69.6	-519	316	1219	1186	1177	-312	-705	26.2	1133	3968	2860	923
15 1943 Federal Report Surplus Deficit	1196	1258	523	-287	-373	-440	2244	1951	2267	5345	4401	2989	5170	4169	2021
16 1944 Federal Report Surplus Deficit	1359	1005	-31.9	-385	-95.9	-1025	-365	-500	-670	-1249	-1623	-125	787	-68.9	-226
17 1945 Federal Report Surplus Deficit	305	-84.4	-288	-467	-148	-864	-1261	-924	-489	-1002	-1399	2082	3755	106	36.1
18 1946 Federal Report Surplus Deficit	250	149	-225	-420	28.9	31.1	932	1352	1553	3196	3896	3698	3094	2865	1385
19 1947 Federal Report Surplus Deficit	1773	1471	257	-439	498	2352	3130	2938	2562	1936	1244	3880	3549	2560	2040
20 1948 Federal Report Surplus Deficit	892	694	152	1929	1606	1039	3037	2579	1470	1244	2683	5223	5862	3011	2387
21 1949 Federal Report Surplus Deficit	2781	2648	643	-62.0	194	-108	916	1076	2646	1963	3071	4541	2904	241	1521
22 1950 Federal Report Surplus Deficit	-292	-378	-375	-431	-199	147	2811	3038	3072	3216	2137	3009	5259	4937	1960
23 1951 Federal Report Surplus Deficit	2699	2457	512	611	1900	2482	4271	5022	3853	3703	2751	3655	3234	3655	2906
24 1952 Federal Report Surplus Deficit	1946	816	238	1429	993	1141	2839	2664	1464	3430	4677	4785	3664	2377	2248
25 1953 Federal Report Surplus Deficit	1082	468	-431	-340	-145	-988	-178	3681	789	-1006	-380	2891	5735	3956	1235
26 1954 Federal Report Surplus Deficit	1312	1280	282	-127	496	582	2336	3163	2206	1285	1124	3557	4307	4716	1996
27 1955 Federal Report Surplus Deficit	3622	4040	1983	4.58	1048	554	-23.9	389	-844	-653	-731	2120	5473	4833	1562
28 1956 Federal Report Surplus Deficit	2540	1765	144	152	1509	2376	4138	4164	3883	3062	4726	5052	5193	3326	2991
29 1957 Federal Report Surplus Deficit	2165	2207	346	109	137	732	1181	405	2095	2950	1489	5545	5370	1468	1825
30 1958 Federal Report Surplus Deficit	1174	278	-206	-343	-50.8	-166	1910	1895	1374	463	1961	4883	4508	1177	1405
31 1959 Federal Report Surplus Deficit	952	356	-101	-126	1034	1873	3945	3757	1939	2419	1463	2879	4622	4014	2192
32 1960 Federal Report Surplus Deficit	2439	2658	2567	2683	2425	1718	2369	1825	1610	3862	2537	2465	3899	1994	2441
33 1961 Federal Report Surplus Deficit	1649	346	-37.5	-183	438	47.7	1741	2318	2737	2177	827	3162	4773	1417	1567
34 1962 Federal Report Surplus Deficit	997	585	-221	-442	29.5	55.7	1709	2005	179	805	3661	3110	3107	1300	1146
35 1963 Federal Report Surplus Deficit	1365	976	-86.2	345	1135	1568	2376	2008	298	-151	-565	2371	4024	1934	1396
36 1964 Federal Report Surplus Deficit	1036	578	412	-424	95.9	-1.58	641	870	-225	617	59.9	3204	6131	4407	1354
37 1965 Federal Report Surplus Deficit	2464	2452	1019	524	838	2624	4626	5378	3849	603	4317	3907	4294	2468	2857
38 1966 Federal Report Surplus Deficit	2390	2270	-9.90	35.4	234	290	1440	1546	271	1221	782	2014	3133	1868	1177
39 1967 Federal Report Surplus Deficit	1168	331	-93.0	-438	-187	714	3105	3186	2347	1055	-446	2658	5149	3507	1742
40 1968 Federal Report Surplus Deficit	1725	1699	361	-66.3	552	325	1898	2511	2564	-703	-795	1872	3976	2214	1426
41 1969 Federal Report Surplus Deficit	1903	2233	1453	644	1616	1149	3903	3936	2584	3185	3652	4539	4011	2486	2641
42 1970 Federal Report Surplus Deficit	829	197	-7.40	-8.69	226	-417	1787	2236	765	-515	-664	2742	4972	1293	1116
43 1971 Federal Report Surplus Deficit	449	292	-347	-330	35.3	147	4255	4666	3748	3017	2682	5111	5793	3995	2511
44 1972 Federal Report Surplus Deficit	2715	3024	558	132	379	622	3662	4207	5409	4395	2159	4498	5700	4116	2947
45 1973 Federal Report Surplus Deficit	2841	3310	713	71.0	381	243	1388	1578	119	-1462	-1667	209	1380	275	653
46 1974 Federal Report Surplus Deficit	339	-184	-302	-406	-157	1315	5225	5119	4709	4136	3644	4007	6021	5087	2868
47 1975 Federal Report Surplus Deficit	2981	3307	635	-510	-148	-295	1615	1804	2287	-48.6	48.2	3118	5504	4609	1817
48 1976 Federal Report Surplus Deficit	1782	1934	803	771	1825	3348	3818	3962	3001	3693	2516	4699	3954	4079	2932
49 1977 Federal Report Surplus Deficit	4030	4980	2494	136	-82.4	-868	-103	-330	-844	-1363	-1579	289	547	-137	351
50 1978 Federal Report Surplus Deficit	310	-28.2	-707	-761	-95.7	276	1239	1284	1228	3182	1099	3018	2447	2451	1054
51 1979 Federal Report Surplus Deficit	1261	1046	1328	160	267	-748	559	-13.6	1283	-329	390	3336	1611	-6.70	752
52 1980 Federal Report Surplus Deficit	-69.2	-214	-114	-325	-111	-1157	639	-465	-172	906	1899	4301	4179	1392	790
53 1981 Federal Report Surplus Deficit	103	0.91	92.9	-361	349	1579	3239	3049	499	-1099	-506	3298	5093	3453	1621
54 1982 Federal Report Surplus Deficit	2624	2613	347	-223	635	302	2463	4700	4957	3018	1406	4145	5280	4989	2692

Federal Report Surplus Deficit By Water Year

Operating Year 2022

2019 White Book Report Date: 3/18/2020 *Continued*

S184-WB-20191230-103442

Energy-aMW - Surplus Deficit	Aug1	Aug1 6	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
55 1983 Federal Report Surplus Deficit	2519	3029	1443	677	683	777	2859	3374	3880	2043	931	3417	3876	4006	2437
56 1984 Federal Report Surplus Deficit	2445	2728	743	-45.0	2104	1081	2589	2614	3143	1595	3166	3436	5275	3711	2466
57 1985 Federal Report Surplus Deficit	1977	1144	713	13.7	674	217	917	934	408	1406	1921	2742	1503	254	964
58 1986 Federal Report Surplus Deficit	-399	-528	-107	237	1106	411	1902	3350	4392	3198	2791	2599	3714	985	1745
59 1987 Federal Report Surplus Deficit	605	114	-259	-494	505	300	316	-264	888	-222	90.5	3051	1760	-156	501
60 1988 Federal Report Surplus Deficit	-119	-308	-333	-428	-204	-1251	-1446	-723	-374	-870	-306	510	1582	980	-207
61 1989 Federal Report Surplus Deficit	326	115	-171	-417	45.9	-221	-662	-1431	1118	948	3519	2749	1651	551	482
62 1990 Federal Report Surplus Deficit	10.0	33.9	-150	-287	333	779	1485	2638	1790	1097	2895	2654	3842	1985	1413
63 1991 Federal Report Surplus Deficit	1570	1596	-149	-457	2001	1280	3105	2721	1925	1601	1118	2884	3740	3802	1979
64 1992 Federal Report Surplus Deficit	2535	1973	-58.7	-466	48.7	-1189	-141	-61.4	179	-916	-650	2344	1237	-227	265
65 1993 Federal Report Surplus Deficit	10.1	-99.7	-459	-436	-25.9	-752	-1032	-1617	434	-205	-1023	3717	2797	1221	279
66 1994 Federal Report Surplus Deficit	329	482	-87.5	-291	183	-646	-1010	-234	-404	-808	259	1588	1505	762	126
67 1995 Federal Report Surplus Deficit	190	-71.9	-242	-382	-375	-696	459	1339	2045	190	-903	2806	3999	2093	893
68 1996 Federal Report Surplus Deficit	864	534	379	626	2701	4644	4867	5144	5098	3364	4164	3856	4382	3881	3327
69 1997 Federal Report Surplus Deficit	2303	2198	365	-165	564	1217	5109	5250	5177	3884	4361	5425	5600	4215	3251
70 1998 Federal Report Surplus Deficit	2344	3114	1359	2135	1477	215	1007	2448	1112	-325	-468	4700	4868	2358	2000
71 1999 Federal Report Surplus Deficit	1857	1681	-127	-312	-214	1020	3546	3758	4293	1593	2276	3378	4828	4521	2362
72 2000 Federal Report Surplus Deficit	3525	3547	458	-183	2271	1616	1706	1867	1890	2698	3456	3031	1214	1900	1867
73 2001 Federal Report Surplus Deficit	1338	-5.42	-233	-283	-154	-944	-405	-536	-370	-1267	-1567	224	383	101	-245
74 2002 Federal Report Surplus Deficit	397	-117	-678	-842	-210	-272	-820	-250	136	676	2435	2352	4520	3212	738
75 2003 Federal Report Surplus Deficit	567	612	-84.1	-238	97.6	-893	-602	300	1813	375	372	1241	4017	685	605
76 2004 Federal Report Surplus Deficit	-419	-235	-606	-383	461	228	-177	-642	289	212	116	1668	2536	686	330
77 2005 Federal Report Surplus Deficit	-166	383	663	131	288	529	1155	1774	303	-1067	-803	1752	2283	1074	755
78 2006 Federal Report Surplus Deficit	347	106	-369	-343	457	238	2322	3017	1700	3765	3454	4683	4480	1554	1785
79 2007 Federal Report Surplus Deficit	246	-115	-670	-437	492	308	1753	1127	2913	1661	516	3258	3154	1733	1235
80 2008 Federal Report Surplus Deficit	-10.2	-382	-880	-251	330	-468	-60.0	169	442	-112	-684	3586	5753	2964	918

Ranked Averages

81 Bottom 10 pct	444	255	-212	-343	-39.8	-908	-1076	-593	-369	-862	-1216	256	1320	362	-190
82 Middle 80 pct	1204	1036	178	-85.9	414	264	1397	1599	1485	1096	1223	3076	3735	2169	1374
83 Top 10 pct	1963	1773	435	281	1195	2328	4465	4781	4372	3355	3580	4387	4797	3854	3010

Section 5: Pacific Northwest Regional Analysis Exhibits

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit 5-1: Annual Energy

**Regional Analysis Surplus Deficit
Operating Year 2021 to 2030
Using 1937-Water Conditions**

THIS PAGE INTENTIONALLY LEFT BLANK

Loads and Resources - Pacific Northwest Region

Operating Year: 2021 to 2030 Water Year: 1937

2019 White Book Report Date: 4/6/2020

S184-WB-20191230-103442

Energy-aMW	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Regional Loads										
1 Retail Loads	22895	23252	23528	23616	23731	23825	23909	23960	24050	24130
2 Federal Agency	144	153	153	153	154	154	155	155	155	155
3 USBR	178	178	178	178	178	178	178	178	178	178
4 Cooperative	2311	2384	2470	2537	2570	2586	2601	2613	2630	2645
5 Municipality	2620	2622	2624	2626	2627	2628	2629	2631	2632	2634
6 Public Utility District	4501	4720	4855	4835	4852	4879	4899	4901	4912	4927
7 Investor-Owned Utility	12737	12790	12843	12884	12946	12995	13043	13079	13138	13187
8 Marketer	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
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	1288	1142	1049	1018	1018	1018	1018	1018	1016	1014
12 Canada	465	465	465	464	465	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	21.6	0	0	0	0	0	0	0	0	0
15 Pacific Southwest	771	655	583	553	552	552	552	552	550	548
16 Other	29.0	21.0	0	0	0	0	0	0	0	0
17 Total Regional Loads	24183	24394	24577	24634	24749	24843	24928	24978	25066	25144
Regional Resources										
18 Hydro	11667	11564	11566	11556	11547	11559	11547	11556	11547	11559
19 Regulated Hydro - Net	10391	10298	10300	10292	10281	10293	10281	10292	10281	10293
20 Independent Hydro - Net	1035	1024	1024	1023	1024	1024	1024	1023	1024	1024
21 Small Hydro - Net	242	242	242	241	242	242	242	241	242	242
22 Non-Hydro Renewable	2163	2166	2166	2166	2167	2166	2166	2164	2160	2159
23 Wind - Net	1811	1814	1814	1813	1814	1814	1814	1811	1807	1807
24 Solar - Net	175	175	175	175	175	175	175	175	175	175
25 Other - Net	177	176	176	178	177	176	176	178	177	176
26 Thermal	13499	13029	12868	13028	12821	12469	12201	12223	12128	12305
27 Nuclear - Net	994	1116	994	1116	994	1116	994	1116	994	1116
28 Coal - Net	4290	3699	3677	3741	3666	3191	3039	2945	2971	3024
29 Natural Gas - Net	5874	5872	5865	5827	5826	5824	5824	5827	5826	5821
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	2315	2316	2306	2319	2309	2311	2318	2310	2312	2318

Loads and Resources - Pacific Northwest Region

Operating Year: 2021 to 2030 Water Year: 1937

2019 White Book Report Date: 4/6/2020 *Continued*

S184-WB-20191230-103442

Energy-aMW	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
33 Imports	660	580	584	588	591	595	599	603	607	610
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	491	494	498	502	506	509	513	517	521	525
³⁷ Pacific Southwest	131	47.1	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	-831	-812	-807	-812	-806	-796	-787	-788	-785	-791
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	-831	-812	-807	-812	-806	-796	-787	-788	-785	-791
43 Total Regional Resources	27158	26527	26376	26526	26320	25993	25725	25758	25656	25842
44 Total Surplus/Deficit	2974	2132	1800	1892	1571	1150	798	780	590	698

Exhibit 5-2: Monthly Energy

**Regional Analysis Surplus Deficit
Operating Year 2022
Using 1937-Water Conditions**

THIS PAGE INTENTIONALLY LEFT BLANK

Loads and Resources - Pacific Northwest Region
Operating Year: 2022 Water Year: 1937
2019 White Book Report Date: 4/7/2020

S184-WB-20191230-103442

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
Regional Loads															
⁴⁵ Retail Loads	22852	23070	21021	21030	23860	26182	26163	25236	22911	22044	22044	21575	22207	23897	23252
⁴⁶ Federal Agency	139	140	130	136	159	186	186	180	156	143	143	135	136	149	153
⁴⁷ USBR	315	304	263	108	15.3	14.5	10.4	16.3	64.9	244	244	327	353	403	178
⁴⁸ Cooperative	2423	2447	2161	2060	2362	2668	2621	2533	2254	2212	2212	2259	2446	2602	2384
⁴⁹ Municipality	2357	2387	2280	2461	2867	3083	3135	3046	2700	2526	2526	2343	2314	2366	2622
⁵⁰ Public Utility District	4275	4310	4012	4208	4844	5438	5675	5404	4889	4554	4554	4320	4408	4631	4720
⁵¹ Investor-Owned Utility	12940	13077	11771	11651	13208	14388	14131	13654	12442	11959	11959	11787	12147	13343	12790
⁵² Marketer	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
⁵³ Direct-Service Industry	401	402	401	402	402	402	402	401	401	402	402	401	401	401	401
⁵⁴ Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
⁵⁵ Exports	1266	1513	1324	1044	1222	1076	705	869	931	1306	1179	1229	1273	1385	1142
⁵⁶ Canada	531	587	454	454	454	454	454	454	454	454	454	454	454	476	465
⁵⁷ 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
⁵⁸ Inland Southwest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
⁵⁹ Pacific Southwest	684	876	819	539	716	571	250	414	476	851	724	774	818	908	655
⁶⁰ Other	50.0	50.0	50.0	50.0	50.0	50.0	0	0	0	0	0	0	0	0	21.0
⁶¹ Total Regional Loads	24118	24583	22345	22074	25082	27258	26869	26105	23842	23350	23223	22804	23480	25282	24394
Regional Resources															
⁶² Hydro	11121	11009	9493	10649	12106	12133	11284	10433	10325	10043	9564	12159	16131	13113	11564
⁶³ Regulated Hydro - Net	9831	9726	8299	9609	11198	11182	10491	9576	9277	8521	8025	10176	14101	11565	10298
⁶⁴ Independent Hydro - Net	1000	995	967	874	778	822	667	723	883	1238	1254	1577	1605	1141	1024
⁶⁵ Small Hydro - Net	290	288	228	165	131	129	127	135	165	284	285	406	425	408	242
⁶⁶ Hon-Hydro Renewable	1691	2281	2116	1740	2298	1817	1127	1667	1863	3042	2643	2845	2837	2836	2166
⁶⁷ Wind - Net	1295	1885	1736	1393	1981	1519	849	1362	1528	2680	2280	2463	2460	2399	1814
⁶⁸ Solar - Net	218	218	203	168	139	119	111	126	156	185	185	213	223	237	175
⁶⁹ Other - Net	178	178	178	179	179	179	168	178	179	177	177	168	154	200	176

Loads and Resources - Pacific Northwest Region

Operating Year: 2022 Water Year: 1937

2019 White Book Report Date: **4/7/2020** *Continued*

S184-WB-20191230-103442

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
70 Thermal	13592	13599	13635	13715	13947	14049	13889	13838	13060	11349	10090	10553	11885	13478	13029
71 Nuclear - Net	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116
72 Coal - Net	3936	3936	3940	3941	3938	3942	3828	3827	3745	2413	2217	3359	3780	3824	3699
73 Natural Gas - Net	6092	6099	6163	6227	6360	6431	6424	6381	6318	5975	4931	3934	4609	6094	5872
74 Petroleum - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75 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
76 Cogeneration - Net	2424	2424	2391	2404	2507	2535	2496	2490	1855	1819	1801	2116	2355	2417	2316
77 Imports	569	569	504	476	664	764	601	600	502	449	449	497	643	694	580
78 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
79 East of Continental Divide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80 Inland Southwest	548	548	488	454	445	480	451	466	440	419	419	468	605	667	494
81 Pacific Southwest	0	0	0	0	181	235	87.4	63.3	0	0	0	0	0	0	47.1
82 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83 Reserves & Losses	-801	-815	-765	-789	-862	-854	-799	-788	-765	-739	-676	-774	-935	-895	-812
84 Operating Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85 Balancing Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86 Transmission Losses	-801	-815	-765	-789	-862	-854	-799	-788	-765	-739	-676	-774	-935	-895	-812
87 Total Regional Resources	26170	26642	24984	25790	28154	27909	26101	25750	24985	24145	22071	25280	30560	29226	26527
88 Total Surplus/Deficit	2053	2059	2639	3716	3072	651	-767	-356	1144	795	-1152	2475	7080	3945	2132

Exhibit 5-3: Annual 120-Hour Capacity

**Regional Analysis Surplus Deficit
Operating Year 2021 to 2030
Using 1937-Water Conditions**

THIS PAGE INTENTIONALLY LEFT BLANK

Loads and Resources - Pacific Northwest Region

Operating Year: 2021 to 2030 Water Year: 1937

2019 White Book Report Date: 10/5/2020

S184-WB-20191230-103442

January 120Hr-MW	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Regional Loads										
1 Retail Loads	33742	34272	34535	34671	34828	34980	35151	35299	35395	35531
2 Federal Agency	239	252	249	250	252	252	253	253	253	254
3 USBR	284	284	284	284	284	284	284	284	284	284
4 Cooperative	3631	3711	3835	3916	3956	3983	4008	4033	4057	4081
5 Municipality	4348	4353	4356	4358	4361	4364	4366	4369	4371	4374
6 Public Utility District	7393	7734	7772	7775	7811	7855	7881	7908	7929	7947
7 Investor-Owned Utility	18808	18905	19002	19096	19185	19270	19356	19447	19538	19636
8 Marketer	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
9 Direct-Service Industry	413	413	413	413	413	413	413	413	413	413
10 Federal Diversity	-1375	-1383	-1379	-1424	-1437	-1442	-1413	-1411	-1453	-1460
11 Exports	1352	1143	1143	1143	1143	1143	1143	1143	1143	1143
12 Canada	1142	1142	1142	1142	1142	1142	1142	1142	1142	1142
13 East Continental Divide	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14 Inland Southwest	0	0	0	0	0	0	0	0	0	0
15 Pacific Southwest	160	0	0	0	0	0	0	0	0	0
16 Other	50.0	0	0	0	0	0	0	0	0	0
17 Total Regional Loads	35094	35414	35677	35814	35970	36122	36293	36441	36537	36673
Regional Resources										
18 Hydro	21596	21752	21749	21625	21739	21720	21722	21723	21724	21725
19 Regulated Hydro - Net	20198	20354	20351	20227	20341	20322	20324	20325	20326	20327
20 Independent Hydro - Net	1243	1243	1243	1243	1243	1243	1243	1243	1243	1243
21 Small Hydro - Net	156	156	156	156	156	156	156	156	156	156
22 Non-Hydro Renewable	343	343	343	343	343	343	343	343	343	343
23 Wind - Net	137	137	137	137	137	137	137	137	137	137
24 Solar - Net	0	0	0	0	0	0	0	0	0	0
25 Other - Net	206	206	206	206	206	206	206	206	206	206
26 Thermal	15100	14973	14941	14941	14941	14138	14138	14138	14138	14138
27 Nuclear - Net	1169	1169	1169	1169	1169	1169	1169	1169	1169	1169
28 Coal - Net	4322	4195	4195	4195	4195	3392	3392	3392	3392	3392
29 Natural Gas - Net	6825	6825	6793	6793	6793	6793	6793	6793	6793	6793
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	1180	1059	1062	1065	1068	1071	1075	1078	1081	1085
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	600	604	607	610	613	616	620	623	626	630
37 Pacific Southwest	425	300	300	300	300	300	300	300	300	300
38 Other	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-4093	-4110	-4116	-4114	-4110	-4060	-4065	-4069	-4073	-4077
40 Operating Reserves	-1997	-2017	-2024	-2026	-2019	-1996	-2000	-2004	-2008	-2013
41 Balancing Reserves	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903

Loads and Resources - Pacific Northwest Region
Operating Year: 2021 to 2030 Water Year: 1937
2019 White Book Report Date: 10/5/2020 *Continued*

S184-WB-20191230-103442

January 120Hr-MW	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
⁴² Transmission Losses	-1194	-1190	-1189	-1185	-1189	-1162	-1162	-1162	-1162	-1162
⁴³ Total Regional Resources	34125	34016	33979	33860	33980	33211	33212	33212	33212	33213
⁴⁴ Total Surplus/Deficit	-969	-1398	-1699	-1954	-1990	-2911	-3081	-3229	-3325	-3460

Exhibit 5-4: Monthly 120-Hour Capacity

**Regional Analysis Surplus Deficit
Operating Year 2022
Using 1937-Water Conditions**

THIS PAGE INTENTIONALLY LEFT BLANK

Loads and Resources - Pacific Northwest Region
Operating Year: 2022 Water Year: 1937
2019 White Book Report Date: 2/5/2020

S184-WB-20191230-103442

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Regional Loads														
45 Retail Loads	30354	30078	27115	27743	31634	34275	34272	32884	30084	28520	28344	27272	28641	30882
46 Federal Agency	174	174	164	174	207	242	252	235	210	184	184	173	170	182
47 USBR	602	602	527	383	206	277	284	266	365	438	438	527	578	618
48 Cooperative	3222	3222	2945	2986	3363	3777	3711	3563	3262	3197	3197	3125	3233	3418
49 Municipality	3233	3233	3032	3456	3945	4348	4353	4162	3825	3479	3479	3004	3064	3253
50 Public Utility District	5672	5672	5270	5803	6741	7444	7734	7286	6755	6248	6248	5689	5640	5947
51 Investor-Owned Utility	17951	17951	15843	15692	17966	19169	18905	18282	16617	15655	15655	15429	16560	18007
52 Marketer	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
53 Direct-Service Industry	412	412	412	413	412	412	413	412	412	413	413	412	412	412
54 Federal Diversity	-914	-1189	-1080	-1166	-1208	-1398	-1383	-1325	-1364	-1095	-1272	-1089	-1018	-957
55 Exports	1724	1809	1663	1354	1346	1346	1143	1143	1143	1143	1151	1151	1460	1481
56 Canada	1203	1288	1142	1142	1142	1142	1142	1142	1142	1142	1142	1142	1142	1163
57 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
58 Inland Southwest	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59 Pacific Southwest	420	420	420	111	103	103	0	0	0	0	8.04	8.04	317	317
60 Other	100.0	100.0	100.0	100.0	100.0	100.0	0	0	0	0	0	0	0	0
61 Total Regional Loads	32077	31887	28778	29097	32980	35620	35414	34027	31227	29663	29494	28422	30101	32363
Regional Resources														
62 Hydro	22016	21738	20176	20441	22313	23095	21752	21272	20931	19043	18256	21055	25223	23403
63 Regulated Hydro - Net	19988	19720	18287	18725	20713	21542	20354	19896	19239	16954	16142	18613	22702	21212
64 Independent Hydro - Net	1664	1656	1605	1515	1432	1392	1243	1207	1485	1765	1789	1997	2059	1749
65 Small Hydro - Net	365	363	284	201	168	161	156	169	207	324	325	446	463	443
66 Non-Hydro Renewable	354	354	354	355	354	354	343	355	354	354	354	355	353	353
67 Wind - Net	137	137	137	137	137	137	137	137	137	137	137	137	137	137
68 Solar - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69 Other - Net	217	217	217	218	217	217	206	218	217	217	217	218	216	216
70 Thermal	14630	14630	14723	14866	15017	15103	14973	14920	14231	12550	11732	13672	14060	14506
71 Nuclear - Net	1163	1163	1179	1181	1179	1180	1169	1169	1169	1160	1160	1151	1154	1168
72 Coal - Net	4321	4321	4320	4321	4321	4322	4195	4195	4194	3119	3119	4196	4193	4193
73 Natural Gas - Net	6463	6463	6523	6618	6749	6819	6825	6778	6730	6307	5252	6144	6025	6465
74 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
75 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
76 Cogeneration - Net	2614	2614	2632	2677	2699	2713	2715	2709	2069	1896	2133	2112	2618	2611
77 Imports	925	925	790	731	980	1085	1059	1091	793	697	697	740	998	1078
78 Canada	146	146	146	147	102	124	155	188	213	147	147	147	146	146
79 East of Continental Divide	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80 Inland Southwest	779	779	644	584	578	661	604	603	580	550	550	593	852	932
81 Pacific Southwest	0	0	0	0	300	300	300	300	0	0	0	0	0	0
82 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83 Reserves & Losses	-3980	-3963	-3778	-3825	-4061	-4200	-4110	-4037	-3883	-3653	-3547	-3782	-4118	-4085
84 Operating Reserves	-1890	-1881	-1746	-1782	-1947	-2057	-2017	-1959	-1846	-1736	-1682	-1758	-1938	-1948
85 Balancing Reserves	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903	-903
86 Transmission Losses	-1187	-1178	-1129	-1139	-1211	-1240	-1190	-1175	-1134	-1014	-962	-1121	-1277	-1233
87 Total Regional Resources	33945	33685	32266	32568	34603	35437	34016	33601	32426	28991	27493	32039	36516	35256
88 Total Surplus/Deficit	1867	1798	3488	3472	1624	-183	-1398	-426	1199	-672	-2001	3617	6416	2893

THIS PAGE INTENTIONALLY LEFT BLANK

Exhibit 5-5: 80-Water Conditions Monthly Energy

**Regional Analysis Surplus Deficit
Operating Year 2022**

THIS PAGE INTENTIONALLY LEFT BLANK

Regional Report Surplus Deficit By Water Year

Operating Year 2022

2019 White Book Report Date: 3/18/2020

S184-WB-20191230-103442

Energy-aMW - Surplus Deficit	Aug1	Aug1 6	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
1 1929 Regional Report Surplus Deficit	4031	3990	3602	3655	3887	903	249	1095	1701	218	-740	2526	8565	2428	2696
2 1930 Regional Report Surplus Deficit	2133	1995	3301	3618	3022	404	-398	1468	1659	1252	-542	2797	4377	3971	2220
3 1931 Regional Report Surplus Deficit	2249	2076	3154	3487	3202	616	-153	800	1877	692	-1224	2835	3760	3302	2071
4 1932 Regional Report Surplus Deficit	2417	1731	3135	3160	2790	664	1074	-965	5223	5866	7478	9934	10534	6860	4288
5 1933 Regional Report Surplus Deficit	4229	3777	3889	3344	4137	4308	6013	6032	5726	4136	1657	7219	13589	11716	6072
6 1934 Regional Report Surplus Deficit	7609	6882	4637	5429	9077	10709	11196	10767	9712	10005	7173	7763	8338	3077	8026
7 1935 Regional Report Surplus Deficit	1940	2298	2670	3272	3585	2518	5674	6151	5524	1710	2342	6848	7109	7155	4549
8 1936 Regional Report Surplus Deficit	5944	2907	3199	3082	3225	638	195	229	2114	1423	5323	10357	10108	5390	3875
9 1937 Regional Report Surplus Deficit	2053	2059	2639	3716	3072	651	-767	-356	1144	795	-1152	2475	7080	3945	2132
10 1938 Regional Report Surplus Deficit	2654	1890	3446	3266	4096	3098	4750	5314	6563	6550	8460	9526	8573	7435	5483
11 1939 Regional Report Surplus Deficit	2672	2281	3524	3265	3340	977	3146	3352	3416	2850	4147	6496	5989	4357	3650
12 1940 Regional Report Surplus Deficit	1776	1922	2905	3482	3624	3072	3217	2708	6171	4308	1714	6768	5547	1875	3693
13 1941 Regional Report Surplus Deficit	1192	1412	2874	3442	3343	1947	1033	1922	2767	641	-1668	2508	4985	3076	2392
14 1942 Regional Report Surplus Deficit	2170	1892	3338	3375	3711	5171	4143	4547	1747	812	1474	4217	10274	8384	4335
15 1943 Regional Report Surplus Deficit	4084	4181	4408	3287	3677	2423	6528	6346	7113	12154	9882	8315	12692	11827	6805
16 1944 Regional Report Surplus Deficit	5085	4011	3913	3906	3203	1053	1382	1453	1279	606	-1758	1475	4118	2383	2347
17 1945 Regional Report Surplus Deficit	2154	1635	2770	3149	2613	583	872	990	1632	302	-1049	5783	10069	3396	2785
18 1946 Regional Report Surplus Deficit	2441	2134	3272	3888	3700	3265	4681	5178	5762	8640	8983	9812	9295	9034	5747
19 1947 Regional Report Surplus Deficit	5502	4822	4146	3412	5332	8076	7877	8549	8047	6585	4730	9063	9758	7915	6909
20 1948 Regional Report Surplus Deficit	3809	3429	4007	8608	7660	5169	7884	7149	5285	5074	6576	11733	13946	9189	7505
21 1949 Regional Report Surplus Deficit	7800	7359	5006	4157	4730	2661	3715	4594	7760	6726	7549	10600	9221	4065	5939
22 1950 Regional Report Surplus Deficit	2060	1701	3098	3565	3940	3513	7924	8575	9132	9333	6427	8262	13145	13206	6996
23 1951 Regional Report Surplus Deficit	7960	7307	4836	6081	8723	8979	10542	12623	10494	10180	7496	9555	9507	10492	9006
24 1952 Regional Report Surplus Deficit	6156	3946	4497	7688	6496	5554	7438	7663	5619	8652	10175	11478	10183	7602	7382
25 1953 Regional Report Surplus Deficit	4183	3534	2914	3916	2914	592	3109	9549	4367	829	577	8077	13522	10870	5334
26 1954 Regional Report Surplus Deficit	4908	4652	4249	3992	5340	4719	7324	8736	7196	5909	3827	9025	11364	12856	7029
27 1955 Regional Report Surplus Deficit	9184	9693	7744	4333	6607	4231	2576	3505	1073	1755	-773	5719	13246	12631	5976
28 1956 Regional Report Surplus Deficit	7361	5475	4201	5215	7791	8393	10489	10144	10383	8804	10756	11593	13345	10170	8984
29 1957 Regional Report Surplus Deficit	6597	6448	4522	4796	4658	5014	4784	3877	6924	8455	4144	12398	13040	5936	6580
30 1958 Regional Report Surplus Deficit	4429	2628	3262	3421	3518	2695	6278	6794	5452	3954	5211	11200	11450	5314	5611
31 1959 Regional Report Surplus Deficit	3945	2560	3460	3835	6475	7219	9783	9453	6652	7778	4875	8031	11521	11002	7234
32 1960 Regional Report Surplus Deficit	6847	7046	9107	10122	9394	6598	6482	6380	5839	10280	6551	7156	10192	7112	7808
33 1961 Regional Report Surplus Deficit	5396	2997	3671	3690	5409	3180	5953	7487	7852	6823	2453	8141	11705	5629	5942
34 1962 Regional Report Surplus Deficit	4307	2860	3261	3451	3736	3029	5574	6026	2830	4922	8684	8179	9043	5474	5066
35 1963 Regional Report Surplus Deficit	4898	3955	3716	4697	6760	6411	6480	7305	3362	2294	-197	6685	10753	6597	5674
36 1964 Regional Report Surplus Deficit	3867	3149	4421	3393	4528	3104	4056	4339	2319	4242	1526	8295	14441	11922	5600
37 1965 Regional Report Surplus Deficit	7201	6830	5855	5315	5790	8659	10890	12487	10317	4483	9753	9882	10752	7941	8480
38 1966 Regional Report Surplus Deficit	6906	6567	3979	4334	4701	3549	5159	5160	3560	5722	2971	6296	9042	6715	5297
39 1967 Regional Report Surplus Deficit	4133	2700	3689	3321	3734	4806	8347	8614	7445	4826	473	7732	13142	10177	6409
40 1968 Regional Report Surplus Deficit	5551	5206	4334	4534	5430	3846	6480	7902	8220	1043	-951	5925	11016	7659	5888
41 1969 Regional Report Surplus Deficit	5771	6568	6871	5948	7778	5619	9531	9522	7599	9259	9076	11086	10852	7913	8156
42 1970 Regional Report Surplus Deficit	4168	2664	3736	4010	4475	2336	6211	7014	4260	1452	-642	7753	12000	5774	5098
43 1971 Regional Report Surplus Deficit	3181	2678	3206	3965	3577	3318	10521	11699	10405	9009	7100	11630	14292	11764	7922
44 1972 Regional Report Surplus Deficit	7901	7900	4872	4707	5242	4418	9590	10920	14134	11998	6368	10842	14339	11687	8976
45 1973 Regional Report Surplus Deficit	8143	8532	5397	4532	4976	4148	5178	5347	2843	528	-1956	2783	5408	3375	4299
46 1974 Regional Report Surplus Deficit	2460	1426	3544	3328	3598	5836	12706	12739	12251	10552	9009	10080	14603	13415	8624
47 1975 Regional Report Surplus Deficit	8384	8521	5046	3360	3989	3026	5966	6275	7071	2924	1746	8763	13233	12578	6683
48 1976 Regional Report Surplus Deficit	5822	6140	5413	6201	8297	10329	9995	10055	8523	9703	6605	11036	10823	11352	8844
49 1977 Regional Report Surplus Deficit	9953	11123	8654	4269	3744	1184	1830	1639	1210	194	-2227	2186	3053	1875	3275
50 1978 Regional Report Surplus Deficit	2045	1507	2554	2244	3173	3820	4649	4657	5046	8778	3865	8479	7795	8031	4879
51 1979 Regional Report Surplus Deficit	4645	4306	6722	4342	4479	1614	2986	2763	5467	1458	1589	8143	6266	3135	4334
52 1980 Regional Report Surplus Deficit	1824	1748	3359	3293	3297	1155	3545	2277	2578	4394	5389	10449	11043	5924	4471
53 1981 Regional Report Surplus Deficit	2275	2170	3796	3246	4753	7015	8333	8660	3727	211	176	8073	12037	9437	5944
54 1982 Regional Report Surplus Deficit	6927	6676	4290	3799	5332	3929	6937	11697	12261	8629	4426	10128	12645	12934	8086

Regional Report Surplus Deficit By Water Year

Operating Year 2022

2019 White Book Report Date: **3/18/2020** *Continued*

S184-WB-20191230-103442

Energy-aMW - Surplus Deficit	Aug1	Aug1 6	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
55 1983 Regional Report Surplus Deficit	7138	7708	6469	5604	5592	5073	8484	9317	10537	6790	3304	8967	10437	11203	7845
56 1984 Regional Report Surplus Deficit	7186	7324	5100	4231	8833	5431	8218	7655	8726	5470	6738	8312	12675	10283	7731
57 1985 Regional Report Surplus Deficit	6183	4391	5171	4338	5948	3417	3963	4170	3617	5539	5035	7906	6293	3519	4905
58 1986 Regional Report Surplus Deficit	1420	1230	3630	4789	6804	3686	6454	9009	11751	9047	6737	7528	9981	4827	6445
59 1987 Regional Report Surplus Deficit	3258	2301	3390	3766	4721	3461	2932	2331	4938	2018	1843	7702	5823	2454	3862
60 1988 Regional Report Surplus Deficit	1602	1330	3682	3034	2567	88.1	111	725	1814	719	871	2893	5867	4598	2306
61 1989 Regional Report Surplus Deficit	2263	1818	3052	3688	3728	2336	1224	-381	4656	4605	8404	7654	6554	4337	3803
62 1990 Regional Report Surplus Deficit	2262	2123	3445	3401	5039	4989	5944	7386	6299	5060	6795	7325	10386	7241	5780
63 1991 Regional Report Surplus Deficit	5114	4999	3499	3699	8696	5505	7956	8006	6667	6114	3687	7660	10139	10740	6869
64 1992 Regional Report Surplus Deficit	7108	5852	3544	2958	4006	789	2121	2528	2991	493	-576	5827	4293	1881	3120
65 1993 Regional Report Surplus Deficit	1556	1391	3175	3057	3076	802	349	-524	3331	2158	-878	8950	8140	5317	3172
66 1994 Regional Report Surplus Deficit	3209	2749	3407	3587	3371	1310	704	1684	2078	868	2410	5114	5384	3955	2938
67 1995 Regional Report Surplus Deficit	2042	1595	3060	3586	2631	1805	3348	5517	7066	3082	-779	7616	10805	7008	4612
68 1996 Regional Report Surplus Deficit	4172	2818	4186	5353	10148	12251	12074	13179	13053	9694	10048	9903	11323	10563	9593
69 1997 Regional Report Surplus Deficit	6651	6244	4423	3893	5421	5685	12198	12643	13135	10342	10245	12268	13859	11828	9322
70 1998 Regional Report Surplus Deficit	7124	8112	6840	9223	7464	3939	5042	7295	5360	2410	524	10825	12247	7517	7070
71 1999 Regional Report Surplus Deficit	5506	5594	3574	4071	3372	5503	9433	9725	11093	6335	6189	8866	12677	12352	7703
72 2000 Regional Report Surplus Deficit	9262	8936	4613	3921	9051	6648	5858	6029	6148	8115	8421	8075	6095	6520	6696
73 2001 Regional Report Surplus Deficit	4558	2442	3263	3413	3160	680	906	1034	1496	475	-2059	2413	3099	2432	2055
74 2002 Regional Report Surplus Deficit	2089	1393	2456	1950	2679	2330	1575	2035	2808	3787	5921	6864	11362	9577	4190
75 2003 Regional Report Surplus Deficit	3718	2991	3391	3203	3631	854	1486	3080	6019	2967	2012	4412	9880	3911	3803
76 2004 Regional Report Surplus Deficit	962	1271	2980	3290	4179	3002	2135	1236	3023	2497	1528	5114	7636	4365	3349
77 2005 Regional Report Surplus Deficit	1666	2676	5030	4188	4598	4039	4470	5249	2985	140	-800	5188	7167	4865	4128
78 2006 Regional Report Surplus Deficit	2407	1961	3446	3244	3968	3113	7458	7952	5886	9332	7805	10542	11553	5689	6110
79 2007 Regional Report Surplus Deficit	2755	1833	2973	3014	5158	3606	5749	4742	8877	6038	2197	8035	8548	6043	5266
80 2008 Regional Report Surplus Deficit	2219	1305	2513	3217	3696	1963	2149	2421	3381	2059	-344	8575	13564	9212	4450
Ranked Averages															
81 Bottom 10 pct	2863	2414	3304	3534	3182	793	295	1018	1717	675	-1034	2490	5231	3267	2277
82 Middle 80 pct	4443	3982	4104	4067	4824	3627	5179	5630	5630	4777	3705	8024	10033	7312	5570
83 Top 10 pct	6191	5518	4666	5012	6876	8069	11060	11849	11536	9469	8785	10645	12319	10931	8979

