

2022 Pacific Northwest Loads and Resources Study

July 2022





Department of Energy

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

June 27, 2022

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 2022 White Book presents Federal system and the region’s load obligations, contracts, and resources as of December 2021 for operating years (OY) 2023 through 2032. The 2022 White Book includes the following 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 firm (critical) water conditions; the Federal system is projected to have annual energy deficits across the study period, ranging from as low as 25 aMW to as large as 292 aMW. These annual energy deficits projections are slightly less than those projected in the 2019 White Book. Under average water conditions, the Federal system is projected to have annual energy surpluses through the study period.
 - January 120-Hour Capacity Surplus/Deficits: Under critical water conditions; the Federal system is projected to have January 120-Hour capacity deficits over the study period, ranging from 911 MW to as high as 1267 MW. While these 120-Hour capacity deficits are similar to those projected in the 2019 White Book, OY2023 is forecasted to have smaller deficit and the rest of the study period is forecasted to have slightly larger 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 2,277 aMW in OY 2024, slowly decreasing to deficit of 543 aMW by OY 2031. These annual energy projections are larger surpluses in the first half of study period and slightly more deficits in the second

half to those presented in the 2019 White Book. Under average water conditions; the PNW region would see even larger energy surpluses over the study horizon.

- **January 120-Hour Capacity Surplus/Deficits:** Under critical water conditions; the PNW region is projected to have January 120-Hour capacity deficits over the study period, ranging from 767 MW to 4,506 MW, except for the first year (OY 2023) which is slightly surplus. These deficit projections are smaller than those shown in the 2019 White Book. Under average water conditions; the PNW region has January 120-Hour capacity surpluses through the final year of this study.
- **Federal System Climate Change Analysis** - presents the updated federal system generation forecasts based on Bonneville's 2020 Modified Flows, select RMJOC-II scenarios, and the most recent Climate Resiliency effort. Although this issue of the White Book still presents the traditional 80-year water year streamflow record with firm (critical) water year of 1937 as its base, future White Books will migrate to the new hydro planning methodologies.

The results of the 2022 White Book are overall similar to the 2019 White Book and BPA is currently developing its 2022 Resource Program which will identify solutions to its needs. Many factors contribute to the uncertainty of the longer term resources outlook for the region; such as resource retirements and development, resource adequacy and the efforts surrounding it, carbon free resource requirements, and the most recent Climate Resiliency efforts. As with resources, there is also much uncertainty with loads including the potential for electrification. The 2022 White Book is available on BPA's website: <https://www.bpa.gov/energy-and-services/power/resource-planning> 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 upon request. Available report list can be found in Appendix A.

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

Sincerely,

WILLIAM LEADY Digitally signed by WILLIAM
LEADY
Date: 2022.06.27 16:19:35 -07'00'

William J. Leady Jr.
Acting Vice President, Generation Asset Management

Enclosure

2022 PACIFIC NORTHWEST LOADS AND RESOURCES STUDY
The White Book

BONNEVILLE POWER ADMINISTRATION
July 2022

Cover Picture:

Source: BPA Photo Archive <https://river.bpa.gov>

Bonneville Dam is located in the Columbia River Gorge National Scenic Area 64 kilometer/ 40 miles east of Portland, Oregon, and Vencouver, Washington. Bonneville Lock and Dam, built and operated by the U.S. Army Corps of Engineers, was the first federal lock and dam on the Columbia and Snake rivers. Construction began in 1933 and the lock and dam was dedicated by President Franklin D. Roosevelt on September 28, 1937.

Bonneville Lock and Dam is named for Army Captain Benjamin Bonneville, an early day visionary who led an exploration to the Oregon Country and charted extensive sections of what became the Oregon Trail.

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.....	5
Planning Context.....	5
Load Obligations.....	6
Resource Types.....	6
Hydro resources.....	6
Non-hydro renewable resources.....	7
Thermal resources.....	7
Contract purchases.....	7
Adjustments to Resources.....	7
Hydro Resources Modeling.....	8
Firm (Critical) Water Planning.....	9
Variability of Hydro Generation.....	10
Hydro Capacity Modeling.....	10
Notable Updates.....	10
Sources of 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
Table 2-3.....	16
Electrification in Load Obligations.....	16
Table 2-4.....	17
Resources.....	17
Federal System Resource Types.....	17
Table 2-5.....	18
Table 2-6.....	19
Table 2-7.....	20
Federal System Hydro Generation Variability.....	20
Table 2-8.....	21
Table 2-9.....	22
Table 2-10.....	22
Key Results.....	23
Annual Energy.....	23
Table 2-11.....	23
Table 2-12.....	23
120-Hour Capacity.....	23
Table 2-13.....	24
Table 2-14.....	24
Federal System Annual Surplus/Deficits.....	24
Table 2-15.....	25
Federal System Monthly Surplus/Deficit.....	25
Table 2-16.....	25
Conclusion.....	26

SECTION 3: PACIFIC NORTHWEST REGIONAL ANALYSIS..... 27

Regional Loads.....27
Table 3-1..... 28
Electrification in Regional Loads.....28
Table 3-2..... 29
Regional Resources.....29
Table 3-3..... 30
Regional Hydro Generation Variability..... 30
Table 3-4..... 31
Table 3-5..... 32
Variability Due to IPP Generation Delivered to the PNW Region..... 32
Table 3-6..... 32
Table 3-7..... 33
Key Results..... 34
Annual Energy..... 34
Table 3-8..... 34
Table 3-9..... 34
Table 3-10..... 35
January 120-Hour Capacity..... 35
Table 3-11..... 35
Table 3-12..... 36
Table 3-13..... 36
Regional Annual Surplus/Deficit..... 36
Table 3-14..... 37
Regional Monthly Surplus/Deficit..... 37
Table 3-15..... 37
Conclusion.....38

SECTION 4: FEDERAL SYSTEM CLIMATE CHANGE ANALYSIS..... 39

Introduction.....39
Methods.....39
2020 Modified flow update39
Figure 4-1..... 40
Figure 4-2..... 40
Climate Change Datasets..... 41
Figure 4-3..... 41
Observed climate change scenario..... 42
Figure 4-4..... 42
Figure 4-5..... 44
Firm energy analysis..... 44
Table 4-6..... 45
Figure 4-7..... 45
Table 4-8..... 46
Figure 4-9..... 47
Conclusion.....47

SECTION 5: FEDERAL SYSTEM ANALYSIS EXHIBITS..... 49

Exhibit 5-1: Annual Energy..... 51
Exhibit 5-2: Monthly Energy..... 55
Exhibit 5-3: Annual 120-Hour Capacity..... 59
Exhibit 5-4: Monthly 120-Hour Capacity..... 63
Exhibit 5-5: 80-Water Conditions Monthly Energy..... 67

SECTION 6: PACIFIC NORTHWEST REGIONAL ANALYSIS EXHIBITS.....	71
Exhibit 6-1: Annual Energy.....	73
Exhibit 6-2: Monthly Energy.....	77
Exhibit 6-3: Annual 120-Hour Capacity.....	81
Exhibit 6-4: Monthly 120-Hour Capacity.....	85
Exhibit 6-5: 80-Water Conditions Monthly Energy.....	89

SECTION 7: CLIMATE CHANGE DATASET EXHIBITS.....	93
Exhibit 7-1: RMJOC-II Scenarios	95
Exhibit 7-2: Most Recent 30 Water Year	101
Exhibit 7-3: Historical 90 Water Year.....	105

APPENDIX A - REPORTS AVAILABLE UPON REQUEST	
- OPERATING YEAR 2023 - 2032.....	109
1. Annual Energy.....	109
2. Monthly Energy.....	109

THIS PAGE IS INTENTIONALLY LEFT BLANK

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 (operating year 2023 through 2032). 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) 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 available upon request). The Federal System Analysis is presented in [Section 2](#), and the Pacific Northwest Regional Analysis is presented in [Section 3](#).

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 additional studies and data into its planning that look at different analytical methods and analyze different scenarios. The Federal System Needs Assessment is commonly completed as part of the Resource Program, which is underway. Updated results from those studies are not part of this White Book but will be published as part of the next Resource Program. The 2020 Needs Assessment results can be seen in the 2020 Resource Program, at [Resource Planning - Bonneville Power Administration \(bpa.gov\)](#). The Federal System Needs Assessment presents analysis looking at hydro based on several different water records as Bonneville continues to evaluate what represents the most accurate method of evaluating forecasted generation ([Section 4](#)).

The 2022 White Book is published as a single summary document. Historically, the summary document has been accompanied by two Technical Appendices, one for Energy Analysis and a second for Capacity Analysis. Beginning with this White Book (2022) the Technical Appendices will no longer be published. As an alternate, Bonneville will be creating a repository of commonly requested reports that will be available in electronic format along with the Summary document, at [White Book: Loads and Resources Study](#). This repository of commonly requested reports will be populated as requests for that information are made, please contact [Steve Bellcoff](#), srbellcoff@bpa.gov, (503) 230-3319 with requests. [Appendix A](#) contains a list of reports previously included in the Technical Appendices, and reports are available upon request.

¹ Operating Year (OY) is the time frame August 1 through July 31. For example, OY 2023 is August 1, 2022 through July 31, 2023.

The total retail load, contract, and generation forecasts used in this study were updated as of December 31, 2021. The 2022 White Book supersedes the 2019 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, 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 one of 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) 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, however they do use temperature normals based on recent history in order to be consistent with recent climate trends. 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 (including the Federal system) are predominantly 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 from the project owners, and those are described below.

Hydro resources

- Regulated Hydro: Regulated hydro projects mainly consist of PNW Columbia River Basin hydro 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 hydro 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](#) section.

- **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 single 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. The Federal system and PNW regional capacity analyses assume zero capacity contribution from solar 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 reported 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 2022 White Book are modeled consistent with those used in Bonneville's BP-22 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 and vary by water conditions, based on the sum of all generation and contract purchase forecasts. The transmission loss factor has several components that combine to give the estimate of losses typically associated with Federal system generation: (1) step-up transformers from generation to the high-voltage transmission network, (2) high-voltage network transmission, (3) transfers to Federal loads over non-Federal transmission systems, and (4) step-down transformers from high-voltage transmission to low-voltage delivery. The Federal system transmission loss factors used in this Study are:
 - Energy is 3.02 percent, September through May and 3.38 percent, June through August.
 - Capacity is 3.07 percent, September through May and 3.43 percent, June through August.

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 mid-Columbia Federal system, 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 considered 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 both power and non-power operating requirements, including those described in the Biological Assessment of Effects of the Operations and Maintenance of the Federal Columbia River System on ESA-Listed Species (2020 BA) and any modifications that arose during the development of the associated biological opinions issued by the National Oceanic and Atmospheric Administration (NOAA) Fisheries and the U.S. Fish and Wildlife Service (USFWS). The HYDSIM studies also include operations described in the Northwest Power and Conservation Council's (NWPCC) Fish and Wildlife Program published October 2014 and amended in 2020. The studies incorporate spring spill up to applicable water quality standards for Total Dissolved Gas (TDG) and summer spill informed by the results of biological performances standard testing conducted over the last decade to measure dam passage survival for out-migrating juvenile fish (performance standard

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 evaluate the new 90 year modified flows historical record as well as current climate trend in order to establish future hydro planning methodologies. See analysis in [Section 4](#) for additional information.

spill). The HYDSIM studies include the operational measures contained in the Columbia River System Operations (CRSO) Environmental Impact Statement (EIS) Record of Decision (ROD) released in September 2020. Measures that are physical structural modifications (e.g., upgrading spill weirs), are implemented appropriately in studies based on estimated project implementation and completion timelines. Each hydro study specifies particular hydroelectric project operations for fish, such as seasonal flow objectives, minimum flow levels for fish, spill for juvenile fish passage, reservoir target elevations and drawdown limitations, and turbine operation 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 Western 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 2022 White Book are based on the official 2022 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 British Columbia 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.

Firm (Critical) Water Planning: To ensure sufficient generation to meet load, Bonneville bases its resource planning on critical water conditions or firm expected generation. Critical (firm) 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-firm (critical) water conditions). Bonneville periodically reviews the critical period, and could change or adjust that period or its definition in the future if appropriate. The hydro generation forecasts under 1937-firm (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 White Book study uses three streamflow scenarios to demonstrate the magnitude of hydro generation variability:

- Low water flows: 1937-firm (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: Bonneville uses the RiverWare model to forecast usable hydro capacity for long-term planning purposes. RiverWare is used to simulate the relationship of hydro energy to hydro peaking capability for Federal system regulated hydro resources. RiverWare incorporates the monthly 80 historical water year reservoir storage and flows from HYDSIM. For each month, RiverWare forecasts hourly Federal system hydro generation by maximizing 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 RiverWare 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 capacity forecasts, as well as and 1-Hour capacity forecasts, for hydro resources are created by evaluating hourly generation from the RiverWare, 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 ($6 \times 5 \times 4 = 120$ 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 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 2022 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, 2021, including:

- Updated power and non-power operating requirements, including those described in the Biological Assessment of Effects of the Operations and Maintenance of the Federal Columbia River System on ESA-Listed Species (2020 BA) and any modifications that arose during the development of the associated biological opinions issued by the National Oceanic and Atmospheric Administration (NOAA) Fisheries and the U.S. Fish and Wildlife Service (USFWS)
- Updated retirement dates associated with announced Thermal (coal) generation retirements.
- Addition of electrification forecast and its impact on load for Bonneville, in [Section 2](#), and [Section 3](#).
- Addition of Federal System Climate Change Analysis, [Section 4](#), presents updated generation forecasts based on Bonneville's 2020 Modified Flows, and more recent current climate change trends.

Sources of Uncertainty

The forecasts presented in this document represent the best information currently available under the defined metrics for loads and resources. However, 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 court actions and/or operational agreements;
- 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;
- 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.

THIS PAGE IS 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 2023 through 2032. 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 upon request.

Load Obligations

Bonneville's ALF system is used to forecast Federal system load obligations, as described previously in [Section 1: Summary - Load Obligations](#). 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 Direct Service Industry (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 must meet statutory directives to provide reserve power to irrigation district facilities associated with USBR projects. Individual USBR project authorizations provide 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 Regional Dialogue PSCs, customers must make periodic elections of how to serve their Above Rate Period High Water Mark (A-RHWM) load by 1) adding new non-Federal resources; 2) 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 Regional Dialogue PSC obligation forecasts include elected and forecasted A-RHWM load for the study period. [Table 2-1](#) presents the A-RHWM load included in Bonneville's obligations by FY, which are consistent with the BP-22 Final Rate Proposal.

Table 2-1

**Federal System
Annual Above-Rate High Water Mark (A-RHWM) Obligations
FY 2023 through 2032**

Energy (aMW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
A-RHWM Obligations	169	225	262	288	310	333	355	374	391	411

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 runs through September 30, 2022, and the contract has been extended through September 30, 2028. 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 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 Regional Dialogue 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 0.47 percent average annual load reduction over the study period Bonneville’s forecast of requirements load increases about 7 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, and Federal system capacity sales. Overall, the total Federal system load obligations remain relatively flat on an annual basis over the study period.

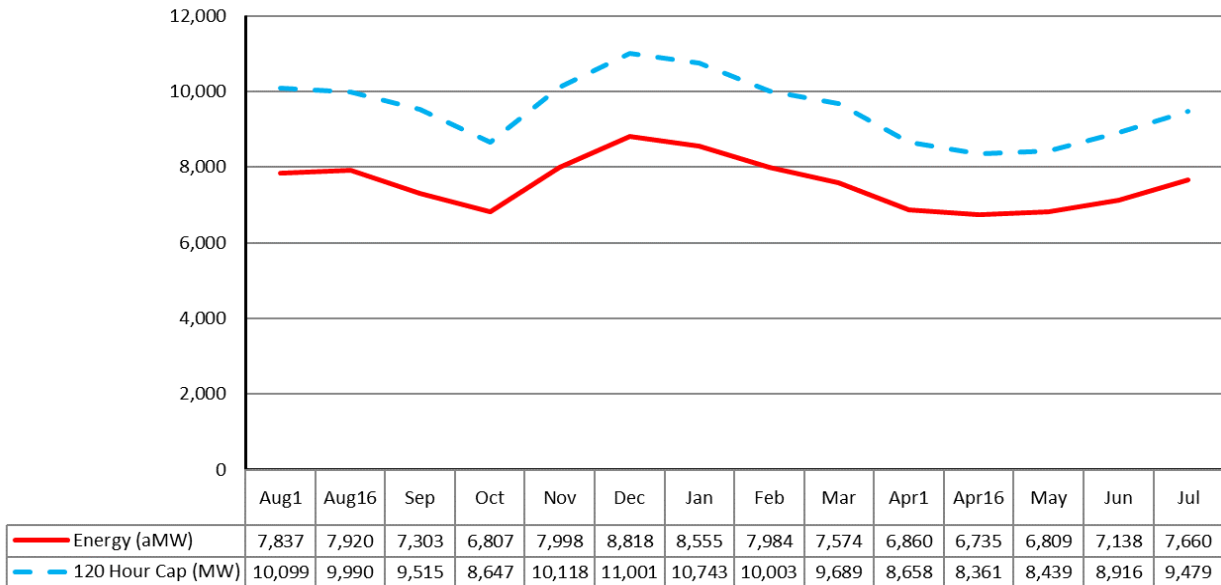
Conservation: The PSC obligation forecasts developed by ALF are expected load forecasts, which include conservation identified by individual Bonneville customers.

Bonneville loads 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](#), next, illustrates the monthly shape of the forecasted Federal

system firm load obligations for OY 2023. Monthly energy and 120-Hour capacity are projected to maintain a similar shape over the study period.

Table 2-2

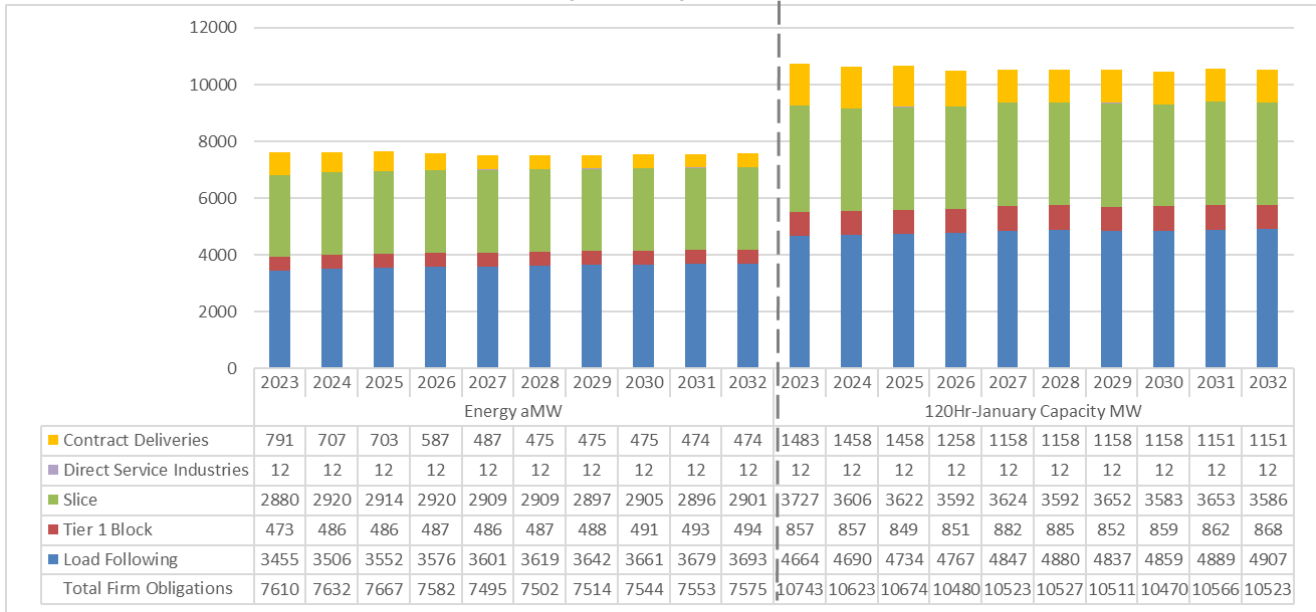
**Federal System
Monthly Energy and 120-Hour Capacity Load Obligations
OY 2023**



On an annual basis Bonneville loads vary across the study period. [Table 2-3](#), next, illustrates the annual Federal system firm load obligations for OY2023 through 2032.

Table 2-3

**Federal System
Annual Energy and 120-Hour Capacity Load Obligations
OY 2023 through 2032
By Category
1937 – Firm (Critical) Water Condition**

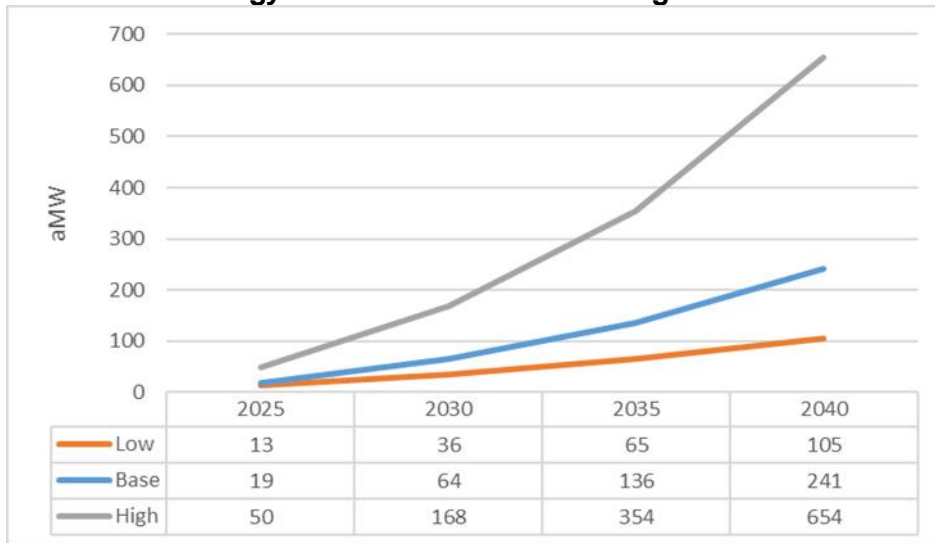


Electrification in Load Obligations

While Bonneville’s contractual load forecast includes a small increase in load resulting from electrification, the growing interest in electrification suggests a potential for significant load growth in the future and an area Bonneville will continue to monitor. The following table, [Table 2-4](#), presents Bonneville’s view of the possible range of load growth resulting from electrification in customers’ load. While this study includes the ‘Base’ forecasted load increases from the table, the range of possible load increase is presented. It is important to note that due to the structure of Bonneville’s contracts, only a share of increased load may become a Bonneville obligation. These possible electrification increases are expected to result from electrical vehicle use and the increasing conversion to electric applications to reduce greenhouse gases.

Table 2-4

**Federal System
Annual Energy – Electrification Load Obligation Increases**



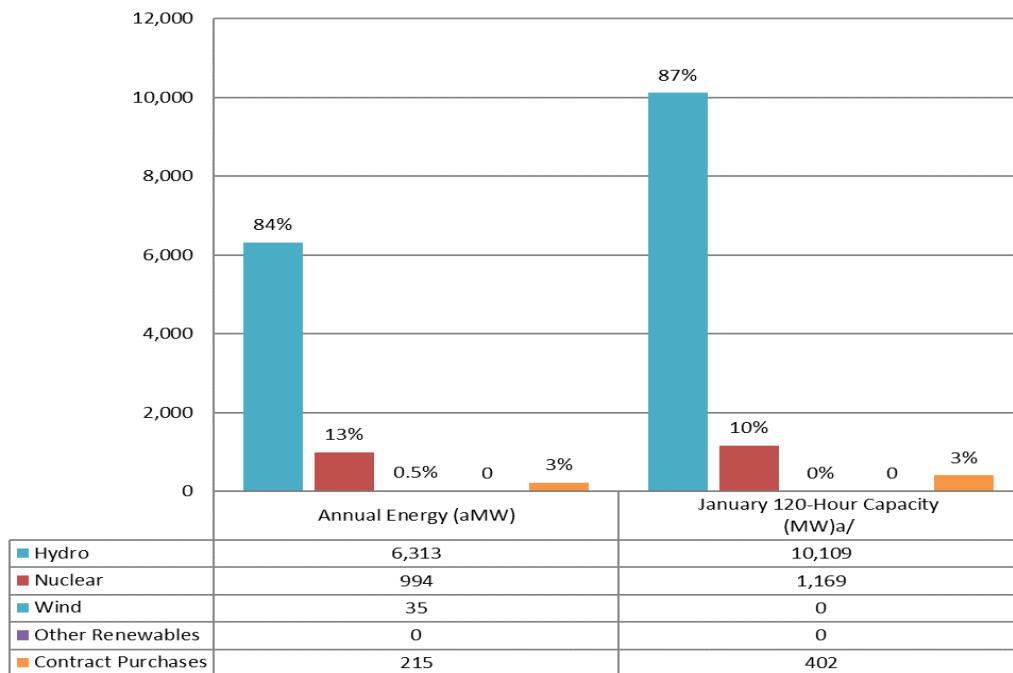
Resources

In the PNW, Bonneville is directed to market power from Federal hydroelectric projects and other resources acquired by Bonneville to meet Bonneville’s firm power contractual obligations. 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 2-5](#), summarizes Bonneville’s resources and contract purchases available to meet the Federal system load obligations. For OY 2023, Federal system resources are forecast to produce 7,557 annual aMW of generation under 1937-firm (critical) water conditions. Federal system energy resources are comprised of approximately 84 percent hydro, 13 percent nuclear (Columbia Generating Station), 3 percent contract purchases, and less than 1 percent wind.

Table 2-5

**Federal System
Generation Forecast by Resource Type
OY 2023
1937-Firm (Critical) Water Conditions**



^{a/} Federal resource estimates are before adjustments for reserves and transmission losses

The composition of the Federal system resources are detailed below.

- **Federal System Hydro Resources:** [Table 2-6](#) shows the Federal system hydro resources from which Bonneville markets firm and non-firm power. Additionally it shows the variability of individual Federal system hydro project generation for the three water conditions that represent firm (critical), average and high water conditions.
- **Federal System Non-Hydro Resources:** Federal system non-hydro resources are generating resources whose output have been purchased by Bonneville. [Table 2-7](#) shows these generating resources, which include: 1) Columbia Generating Station; and 2) wind 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 2-7](#) 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 2-6

**Federal System
Hydro Project Generation by Various Streamflow Conditions
OY 2023**

Project	Initial Service Date	Operator	Number of Units	Maximum Capacity ^{d/} (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	18.9	23.7	23.2
2. Bonneville ^{b/}	1938	USACE	18	1,242	592	522	371
3. Chief Joseph	1955	USACE	27	2,607	1,628	1,381	1,113
4. Dworshak	1974	USACE	3	465	274	221	141
5. Grand Coulee / GCL Pumping	1941	USBR	27	6,735	2,998	2,424	1,934
	1973		6	314			
6. Hungry Horse	1952	USBR	4	428	123	87	72
7. Ice Harbor	1961	USACE	6	693	295	204	110
8. John Day	1968	USACE	16	2,180	1,293	975	689
9. Libby	1975	USACE	5	605	258	223	169
10. Little Goose	1970	USACE	6	930	361	219	112
11. Lower Granite	1975	USACE	6	930	353	233	106
12. Lower Monumental	1969	USACE	6	930	370	232	110
13. McNary	1953	USACE	14	1,120	709	549	417
14. The Dalles	1957	USACE	22	2,182	1,054	817	595
15. Total Regulated Hydro Projects <i>(sum lines 1 through 15)</i>			169	21,409	10,326	8,110	5,961
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. Cowlitz 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 17 through 34)</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 36 + line 37)</i>			2	7	2.9	2.9	2.9
38. Total Hydro Generation <i>(line 16 + line 35 + line 38)</i>			209	22,312	10,809	8,533	6,313

a/ Firm energy is the 12-month annual average for OY 2023 assuming 1937-critical water conditions

b/ Bonneville Dam generation totals include Bonneville Fishway

c/ High Streamflow = 1974WY, Average Streamflow = 1958WY, Firm Energy = 1937WY

d/ Maximum Capacity represent full capacity of resource including overload.

Table 2-7

**Federal System
Non-Hydro Project Generation and Contract Purchases
OY 2023**

Project	Initial Service Date	Resource Type	Operator	Maximum Capacity ^{a/} (Peak MW)	Firm Energy (aMW)
Non-Hydro Resources					
1. Columbia Generating Station	1984	Nuclear	ENW	1,169	994
2. Condon Wind Project ^{b/}	2002	Wind	Condon Wind Project, LLC	0	1.8
3. Stateline Wind Project ^{c/}	2001	Wind	PPM, FLP	0	21.2
4. Klondike Phase III ^{d/}	2007	Wind	NW Wind Power	0	11.8
5. Fourmile Hill Geothermal ^{e/}	Not in Service	Geo.	Calpine	0	0
6. Total Federal System Non-Hydro Resources <i>(sum lines 1 through 5)</i>				1,169	1,028
Contract Purchases					
7. Canadian Entitlement for Canada (non-Federal)				235	134
8. Canadian Imports				1	1
9. Pacific Southwest Imports				0	0
10. Intra-Regional Transfers In (Pacific Northwest Purchases)				125	48
11. Slice Transmission Loss Return				41	31
12. Total Federal System Contract Purchases <i>(sum lines 7 through 11)</i>				402	215
13. Total Federal System Non-Hydro Resources and Contract Purchases <i>(line 6 + line 12)</i>				1,571	1,243

a/ This is the maximum generation for January 2023

b/ Condon Wind Project contract expiring 2024

c/ Stateline Wind Project contract expiring in 2028

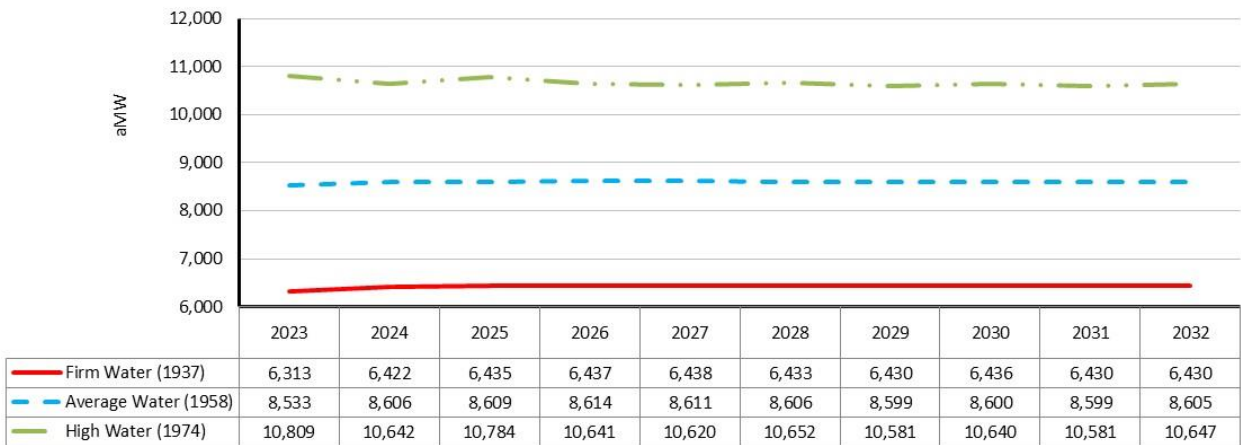
d/ Klondike Phase III Project expiring in 2029

e/ 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 2-8](#), next, shows the annual variability of hydro generation under three streamflow conditions: 1) 1937-firm (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 2-8

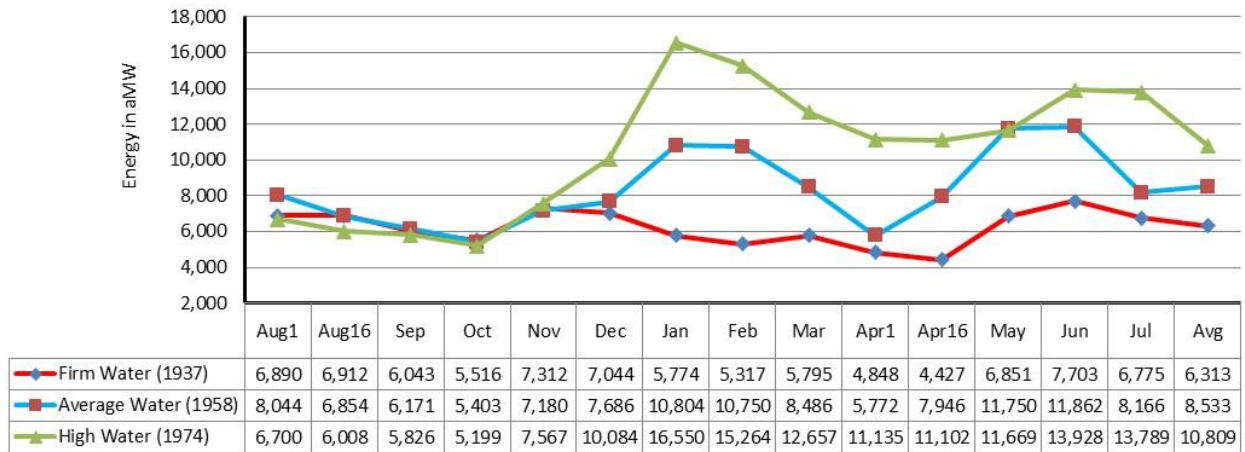
**Federal System
Variability of Annual Hydro Generation
OY 2023 through 2032
Under Different Water Conditions**



In OY 2023, annual Federal system hydro energy generation is forecasted to be 6,313 aMW under 1937-firm (critical) water conditions. However, under the high streamflow condition (represented by 1974-water conditions), these same Federal system hydro resources would generate 10,809 aMW. [Table 2-8](#), above, shows the annual variability of Federal system hydro generation, and [Table 2-9](#) shows the monthly variability of the Federal system hydro generation for OY 2023, under the same three streamflow scenarios. High generation levels in the December through mid-April period are 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 10,000 aMW in a single month depending on project operations and the availability of water.

Table 2-9

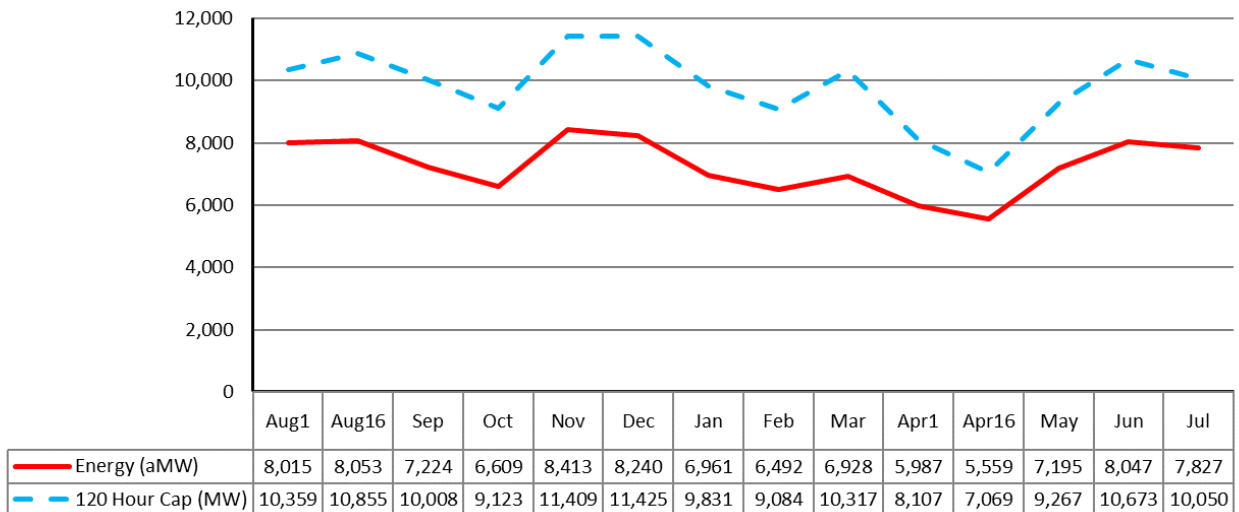
**Federal System
Variability of Monthly Hydro Generation
OY 2023
Under Different Water Conditions**



Total Federal System Resources: [Table 2-10](#), below, illustrates the monthly shape of the forecasted total Federal system generation for energy and 120-Hour capacity for OY 2023, under 1937-firm (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 2-10

**Federal System
Monthly Generation
OY2023 Energy and 120-Hour Capacity
Under 1937-Firm (Critical) Water Conditions**



Key Results

Annual Energy: [Table 2-11](#), 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 5-1](#) for OY 2023 through 2032. The Federal system monthly energy loads and resources are shown in [Exhibit 5-2](#) for OY 2023.

Table 2-11

**Federal System
Annual Energy Surplus/Deficit
OY 2023 through 2032
1937-Firm (Critical) Water Conditions**

Energy (aMW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Surplus/Deficit	-292	-103	-245	-39	-118	-25	-164	-68	-204	-105

[Table 2-12](#), below, compares the 2022 White Book Federal system annual firm energy surplus/deficit results to those from the 2019 White Book. The 2022 White Book shows a deficit throughout the studying period, with larger deficits in the beginning of the study period. These results reflect changes in both load obligations and Federal system generation.

Table 2-12

**Federal System
Annual Energy Surplus/Deficit Comparison
OY 2023 through 2032
1937-Firm (Critical) Water Conditions**

Energy (aMW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
2022 White Book	-292	-103	-245	-39	-118	-25	-164	-68	-204	-105
2019 White Book	-354	-236	-367	-148	-207	-118	-247	-148	n/a	n/a
Difference <i>(2022 WBK – 2019 WBK)</i>	62	132	122	109	90	92	83	80	n/a	n/a

120-Hour Capacity: [Table 2-13](#), next, shows that the Federal system January 120-Hour capacity is deficit under 1937-firm (critical) water conditions throughout the study period. The detailed components of the Federal system January 120-Hour capacity loads and resources for OY 2023 through 2032 are shown in [Exhibit 5-3](#). The Federal system monthly 120-Hour capacity loads and resources are shown in [Exhibit 5-4](#) for OY 2023.

Table 2-13

**Federal System
January 120-Hour Capacity Surplus/Deficit
OY 2023 through 2032
1937- Firm Critical Water Conditions**

January 120-Hour Capacity (MW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Surplus/Deficit	-911	-1,215	-1,312	-1,086	-1,263	-1,254	-1,099	-1,208	-1,163	-1,267

[Table 2-14](#), below, compares the 2022 White Book January firm 120-Hour capacity surplus/deficit results to those from the 2019 White Book. This study shows an increase in January 120-Hour capacity deficits starting from 2024, due to a combination of increase in load obligations and reduction in January Federal resources.

Table 2-14

**Federal System
January 120-Hour Capacity Surplus/Deficit Comparison
OY 2023 through 2032
1937-Firm (Critical) Water Conditions**

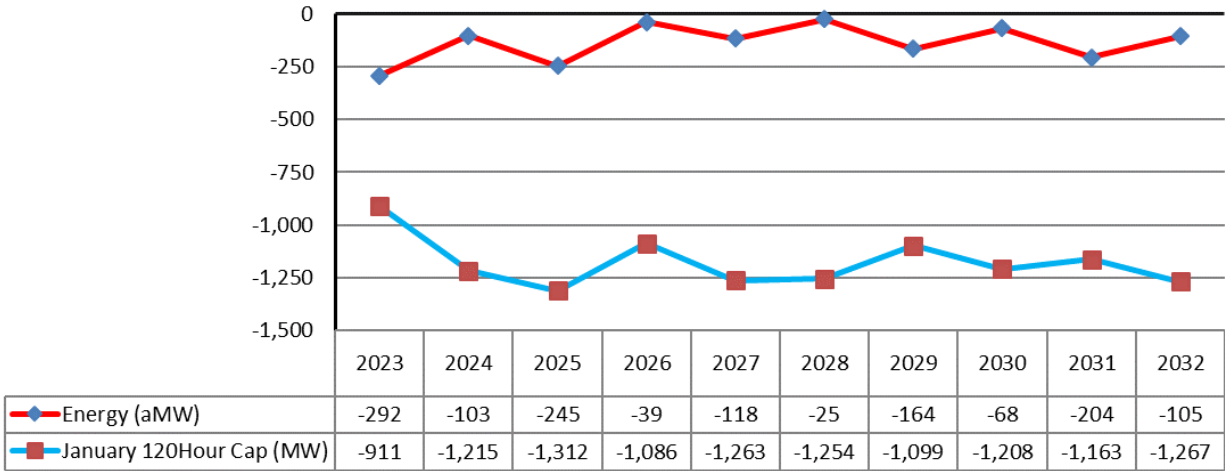
January 120-Hour Capacity (MW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
2022 White Book	-911	-1,215	-1,312	-1,086	-1,263	-1,254	-1,099	-1,208	-1,163	-1,267
2019 White Book	-1,226	-1,207	-1,170	-950	-1,083	-1,085	-1,056	-1,047	n/a	n/a
Difference <i>(2022 WBK – 2019 WBK)</i>	315	-9	-143	-136	-179	-169	-43	-161	n/a	n/a

Federal System Annual Surplus/Deficits: [Table 2-15](#), 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 292 aMW over the study period. The January firm 120-Hour capacity forecasts show the Federal system is deficit throughout the study period, ranging from 911 MW in OY 2023, to as high as 1,312 in OY 2025, and ending the study period 1,267 MW in OY 2032. Variations in the annual energy deficits between the odd and even OYs are due to the biennial Columbia Generation Station (CGS) maintenance schedule.³

³ During even calendar years, CGS does not have scheduled maintenance and is forecast 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 2-15

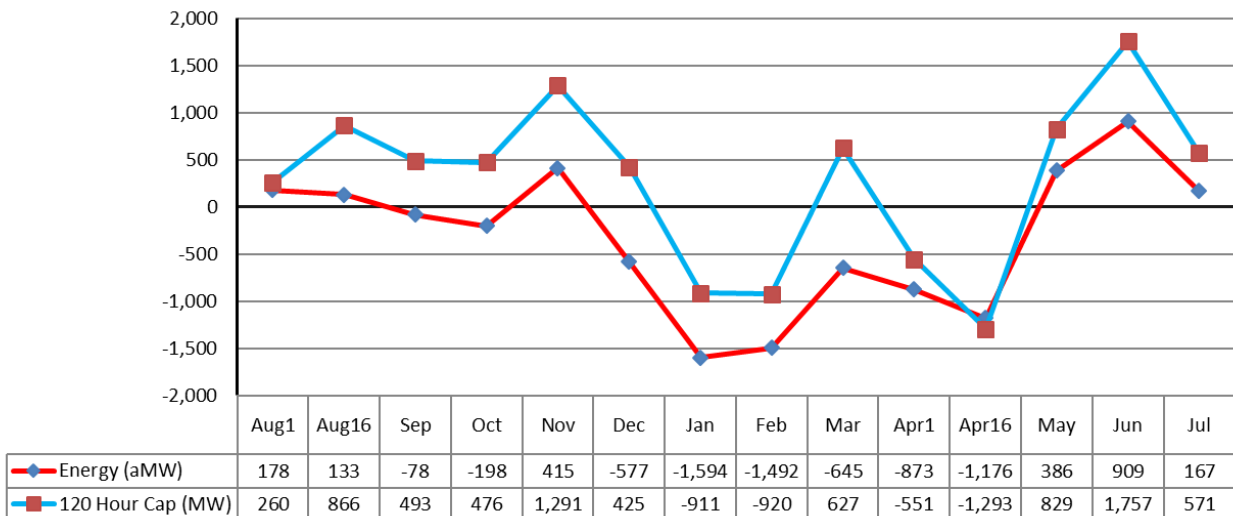
**Federal System
Annual Energy and January 120-Hour Capacity Surplus/Deficit
OY 2023 through 2032
1937-Firm (Critical) Water Conditions**



Federal System Monthly Surplus/Deficit: [Table 2-16](#) graphically presents the Federal system monthly firm energy and 120-Hour capacity surpluses and deficits for OY 2023. 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 or deficit position changes during the year, with January, February, and the second half of April showing the largest monthly deficits and the spring (May through June) showing the largest surpluses.

Table 2-16

**Federal System
Monthly Energy and 120-Hour Capacity Surplus/Deficit
OY 2023
1937-Firm (Critical) Water Conditions**



Conclusion

Under 1937 firm (critical) water conditions the Federal system shows annual firm energy deficits over the 2023-2032 study period. These annual energy deficits range from 25 aMW in OY 2028 to as high as 292 aMW in OY 2023. As contract obligations expire in OY 2025 energy deficits become smaller and then grow again over time. Under firm (critical) water conditions, the Federal system generally shows monthly energy deficits across the winter and early spring until spring runoff start, with surpluses through 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 120-Hour capacity deficits during the winter and surpluses through the rest of the year. Like the Federal system energy analysis, the 120-Hour capacity analysis has large deficits during the winter and large surpluses during the spring runoff (May and June), under 1937-firm (critical) 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 2,400 aMW under better water conditions, while the monthly surplus or deficit position can vary by more than 8,000 aMW (January). Similarly, Federal system 120-Hour capacity surpluses and deficits for OY 2023 can vary by more than 5,000 MW in January as well as in 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-firm (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 5-5](#). Additional monthly and annual details for OY 2023 through 2032 are available upon request, and a detailed list of available data is included in [Appendix A](#).

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 2023 through 2032. 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, and do not include specific adjustments for future climate change impacts. With the exception of power commitments under the Treaty, all Export contract deliveries follow individual contract terms and are not assumed to be renewed after their expiration. Treaty power deliveries are assumed to be in place through the study period. The sum of the forecasted TRL and Export contracts represent the regional loads for the PNW. Regional loads are comprised of about 95 percent retail loads and 5 percent exports.

[Table 3-1](#) shows the forecasted composition of PNW regional load for OY 2023. For the PNW region, about 54 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 comprise less than one percent of regional loads.

Table 3-1

**PNW Region
Firm Regional Loads by Customer Class
OY 2023**

Customer Class	Energy (aMW)	Percent of Energy	January 120-Hour Capacity (MW)	Percent of Capacity
Investor-Owned Utility	13,083	54%	18,559	52%
Public Utility District	4,545	19%	7,390	21%
Municipality	2,504	10%	4,002	11%
Cooperative	2,513	10%	3,797	11%
Federal Agency	125	1%	221	1%
USBR	188	1%	201	1%
Direct-Service Industry ¹	45	0%	62	0%
Marketer	3	0%	3	0%
Total Retail Load	23,006	95%	34,235	97%
Exports	1,085	5%	1,143	3%
Regional Load	24,093	100%	35,377	100%

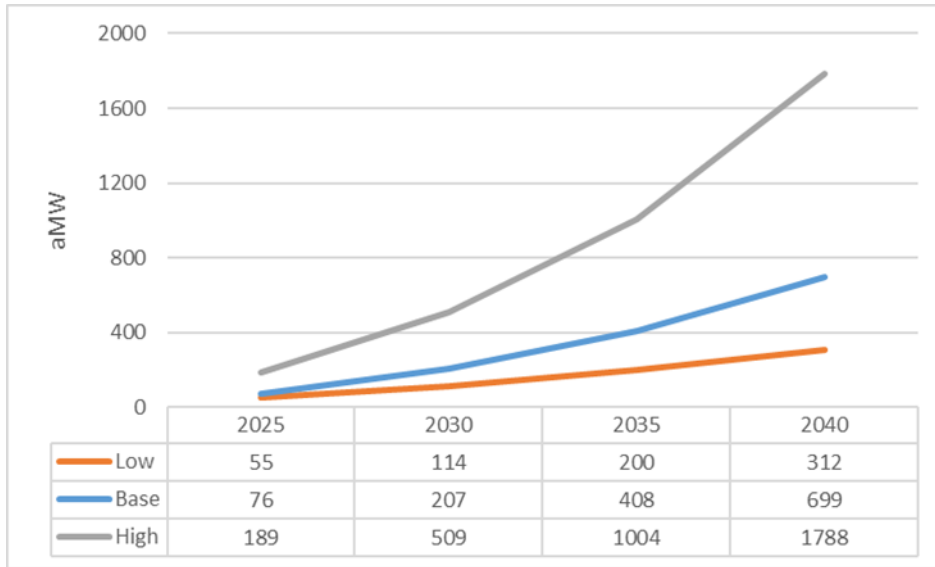
¹ Direct-Service Industry (DSI) loads include regional loads currently served by Bonneville through DSI service contracts and former DSIs served by other energy suppliers.

Electrification in Regional Loads

The regional load forecast includes some electrification, however the growing interest in electrification signals a potential for significant load growth in the future. [Table 3-2](#), next, presents Bonneville's view of the possible range of electrification load increases to regional loads. While this study includes the 'Base' forecasted load increases from the table related to electrification, the table shows the range of possible load increase from electrification, with possible electrification load increases on a scale of 2.5 times the base forecast in 2030. Load increases due to electrification are expected to result from electrical vehicle use and the increasing conversion to electric applications to reduce greenhouse gases.

Table 3-2

PNW Region
Annual Energy – Electrification Load Obligation Increases



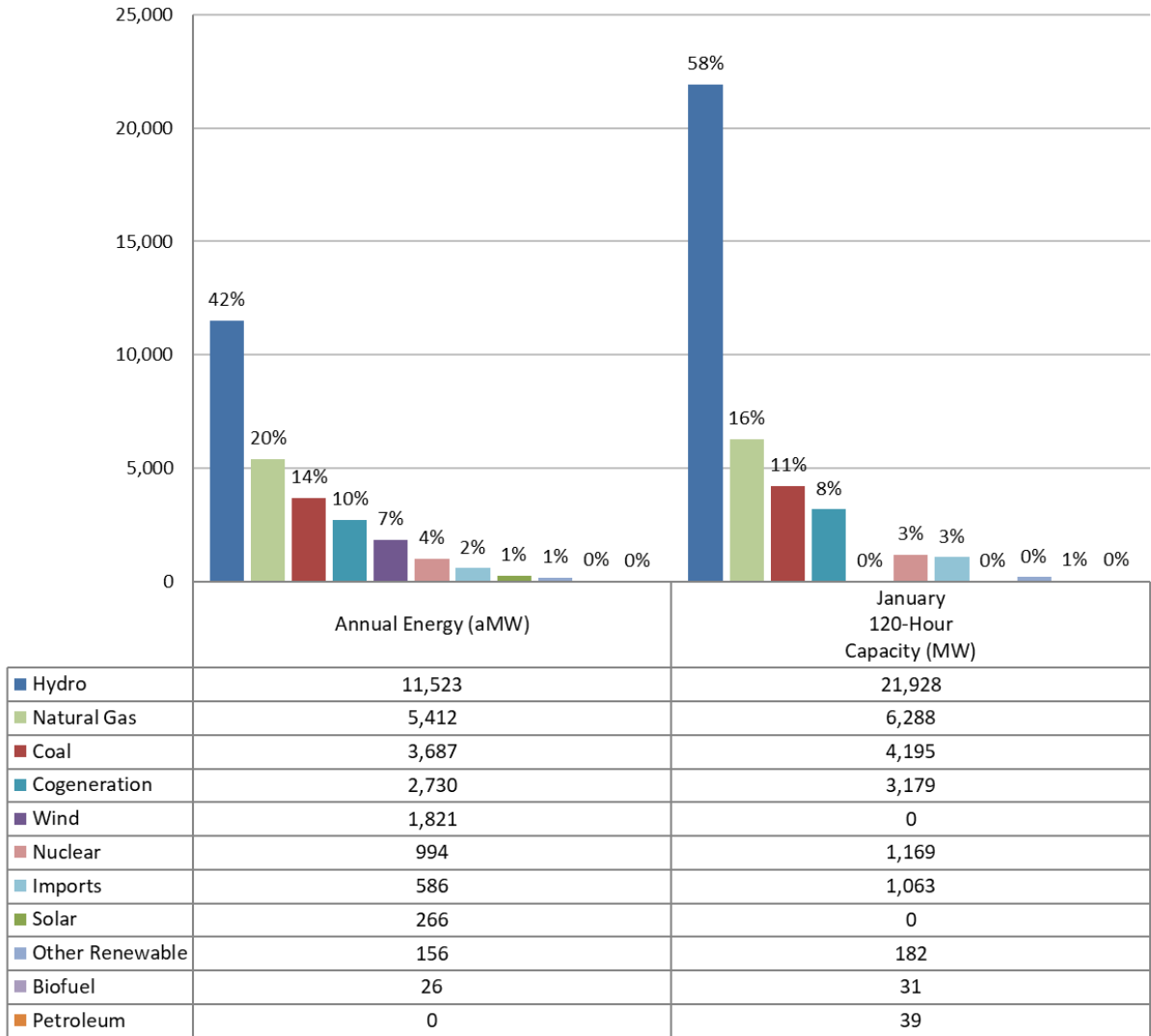
Regional Resources

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 3-3](#), 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: Centralia 2 (December 1, 2025), Valmy 1 (January 1, 2022), and Valmy 2 (January 1, 2026). Contract purchases are provided by individual utility, follow specific contract provisions and can have various delivery arrangements. For OY 2023, regional firm energy resources are comprised of approximately 43 percent hydro, 20 percent natural gas, 14 percent coal, 10 percent cogeneration, 7 percent wind, 4 percent nuclear, and imports, solar and other renewables make up one percent or less each.

Table 3-3

**PNW Region
Generation by Resource Type
OY 2023
1937-Firm (Critical) Water Conditions**



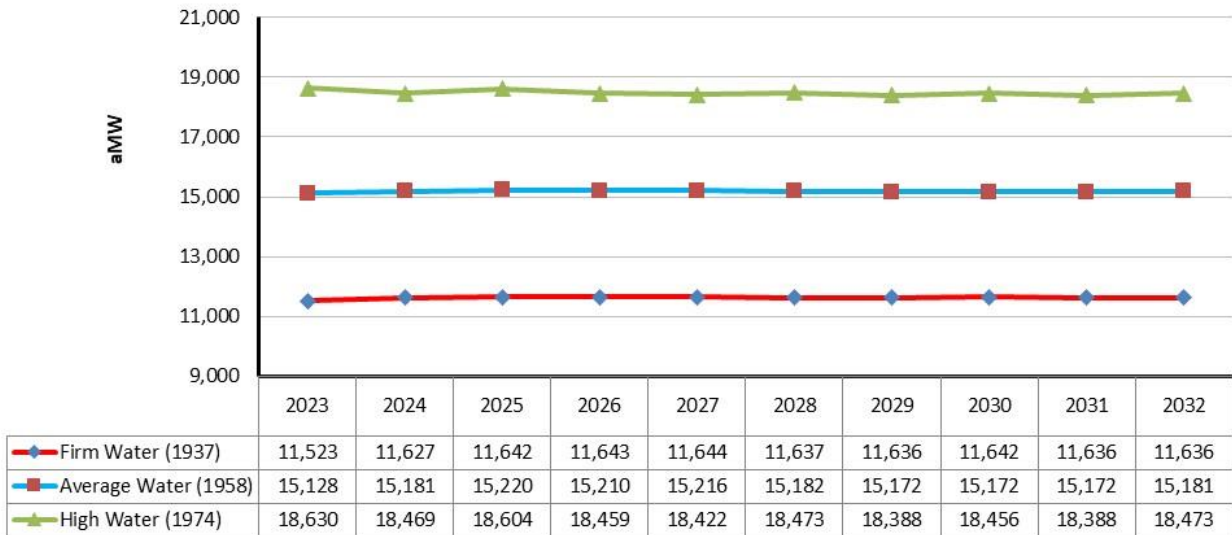
Regional Hydro Generation Variability: The generating capability of the region’s hydroelectric projects depends upon the amount of water flowing through the facilities, the physical capacity of the facilities, flow requirements pursuant to non-power requirements, and other operating limitations. Bonneville 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 3-4, next, shows the annual variability of the region’s hydro generation under the three streamflow scenarios: 1) 1937-firm (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 2023, annual firm energy generation from regional hydro projects is forecasted to be 11,523 aMW. This represents about 42 percent of region’s resources.

However, the generating potential from regional hydro projects can vary annually by 7,000+ aMW depending on water conditions.

Table 3-4

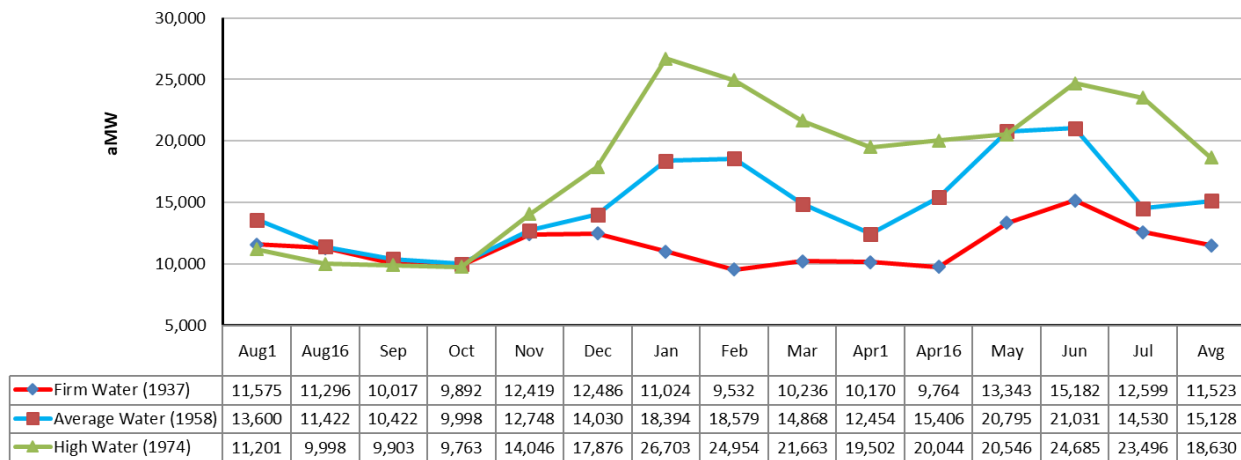
**PNW Region
Variability of Annual Hydro Generation
OY 2023 through 2032
Under Different Water Conditions**



[Table 3-5](#) shows the monthly variability of the region’s hydro generation under the same three water conditions for OY2023. 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 as much as 15,000 aMW in a month, depending on the availability of water.

Table 3-5

**PNW Region
Variability of Monthly Hydro Generation
OY 2023
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 2,699 aMW of energy with an associated 3,172 MW of January 120-Hour capacity in OY 2023. 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 3-6](#), below, details the region’s total uncommitted IPP annual energy and January 120-Hour capacity generation forecasts over the OY 2023 through 2032 study period. [Table 3-7](#) 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 3-6

**PNW Region
Uncommitted Independent Power Producer Generation
Annual Energy and January 120-Hour Capacity
OY 2023 through 2032**

Regional Uncommitted IPP	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Annual Energy (aMW)	2,699	2,695	2,696	2,526	2,452	2,485	2,492	2,492	2,492	2,490
January 120-Hour Capacity (MW)	3,172	3,172	3,172	2,881	2,881	2,881	2,881	2,881	2,881	2,881

Table 3-7

**PNW Region
Uncommitted Independent Power Producer Projects
OY 2023**

Project	Energy	Peak	Fuel Type
Airport Solar	13	0	Solar
Centralia Complex ^{a/b/}	256	290	Coal
Condon Wind	10	0	Wind
Cosmopolis Specialty Fibres	14	14	Wood Waste
Hermiston Power Project	567	630	Wood Waste
International Paper Energy Center	17	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	6	0	Wind
Klondike Wind 3	16	0	Wind
Klondike Wind 3a	12	0	Wind
Leaning Juniper Wind	47	0	Wind
Longview Fibre Paper & Packaging	35	35	Wood Waste
Nippon Paper Cogen (Port Angeles)	0	0	Wood Waste
Pelton	14	41	Hydro
Priest Rapids	83	154	Hydro
Rock Island	96	154	Hydro
Rocky Reach	179	339	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	Wood Waste
Tieton Dam (Yakima)	0	0	Hydro
Vansycle Wind	23	0	Wind
Wanapum	24	60	Hydro
Weyerhaeuser Longview	35	44	Wood Waste
Total Uncommitted IPP Generation	2,706	3,172	

^{a/} Centralia #1 (670 MW) retired Dec 1, 2020

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

Key Results

Annual Energy: [Table 3-8](#), below, shows significant annual energy surpluses for the PNW region throughout most of the study period, under 1937-firm (critical) water conditions. This study assumes that 100 percent of the PNW region’s uncommitted IPP generation (2,261 aMW in OY 2023) is available to serve the region’s loads. The individual components of the PNW regional annual energy loads and resources for OY 2023 through 2032 are shown in [Exhibit 6-1](#). The PNW regional monthly energy loads and resources for OY 2023 are shown in [Exhibit 6-2](#). The details of each component for OY 2023 through 2032 are available upon request.

Table 3-8

**PNW Region
Annual Energy Surplus/Deficit
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2023 through 2032
1937-Firm (Critical) Water Conditions**

Energy (aMW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Surplus/Deficit	2,261	2,277	1,810	1,180	646	394	43	47	-543	-440

[Table 3-9](#), below, shows the significant variability in PNW regional annual firm energy surplus/deficit forecasts depending on the level of uncommitted IPP generation available to the region. IPP generation is detailed in [Tables 3-6](#) and [3-7](#).

Table 3-9

**PNW Region
Variability of Annual Energy Surplus/Deficit
Assuming Different Levels of Uncommitted IPP Generation
OY 2023 through 2032
1937-Firm (Critical) Water Conditions**

Energy (aMW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
100% IPP	2,261	2,277	1,810	1,180	646	394	43	47	-543	-440
50% IPP	911	930	462	-83	-581	-848	-1,203	-1,199	-1,789	-1,685
0% IPP	-438	-418	-886	-1,346	-1,807	-2,090	-2,449	-2,444	-3,035	-2,930

[Table 3-10](#), below, compares the 2022 White Book PNW regional annual firm energy surplus or deficit forecasts to the 2019 White Book results. The PNW region continues to have annual energy surpluses throughout most of the study period. When compared to the 2019 White Book, the 2022 study shows higher annual energy surpluses at the start of the study period and decreases and becomes deficit starting in 2027, which is driven by significant increase in regional load over the out years than the previous study.

Table 3-10

**PNW Region
Annual Energy Surplus/Deficit Comparison
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2023 through 2032
1937-Firm (Critical) Water Conditions**

Energy (aMW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
2022 White Book	2261	2277	1810	1180	646	394	43	47	-543	-440
2019 White Book	1800	1892	1571	1150	798	780	590	698	n/a	n/a
Difference <i>(2022 WBK – 2019 WBK)</i>	461	385	239	30	-152	-385	-547	-651	n/a	n/a

January 120-Hour Capacity: [Table 3-11](#), below, shows the January firm 120-Hour capacity surpluses and deficits for the PNW region. The region is forecasted to have January 120-Hour capacity deficits over most of the study period. This assumes that 100 percent of PNW uncommitted IPP generation is available to serve regional loads. The individual components of the PNW regional January 120-Hour capacity loads and resources for OY 2023 through 2032 are shown in [Exhibit 6-3](#). The monthly PNW regional 120-Hour capacity loads and resources for OY 2023 are shown in [Exhibit 6-4](#).

Table 3-11

**PNW Region
January 120-Hour Capacity Surplus/Deficit
Assuming 100% of Uncommitted IPP Generation is Available to the Region
OY 2023 through 2032
1937-Firm (Critical) Water Conditions**

January 120-Hour Capacity (MW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Surplus/Deficit	6	-767	-1,069	-2,173	-2,524	-2,846	-2,936	-3,298	-4,300	-4,506

[Table 3-12](#), next, 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 3-6](#) and [3-7](#).

Table 3-12

**PNW Region
 Variability of January 120-Hour Capacity Surplus/Deficit
 Assuming Different Levels of Uncommitted IPP Generation
 OY 2023 through 2032
 1937-Firm (Critical) Water Conditions**

January 120-Hour Capacity (MW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
100% IPP	6	-767	-1,069	-2,173	-2,524	-2,846	-2,936	-3,298	-4,300	-4,506
50% IPP	-1,580	-2,353	-2,655	-3,613	-3,964	-4,287	-4,377	-4,739	-5,740	-5,947
0% IPP	-3,165	-3,939	-4,241	-5,054	-5,405	-5,727	-5,818	-6,179	-7,181	-7,388

[Table 3-13](#), below, compares the 2019 White Book January firm 120-Hour capacity forecast to the 2019 White Book results. Regional January 120-Hour capacity surplus/deficits show smaller deficits over the study period. The decreased January 120-Hour capacity deficits, compared to the 2019 White Book, are mainly driven by reduced noncoincidental peaks in the updated TRL forecasts from ALF.

Table 3-13

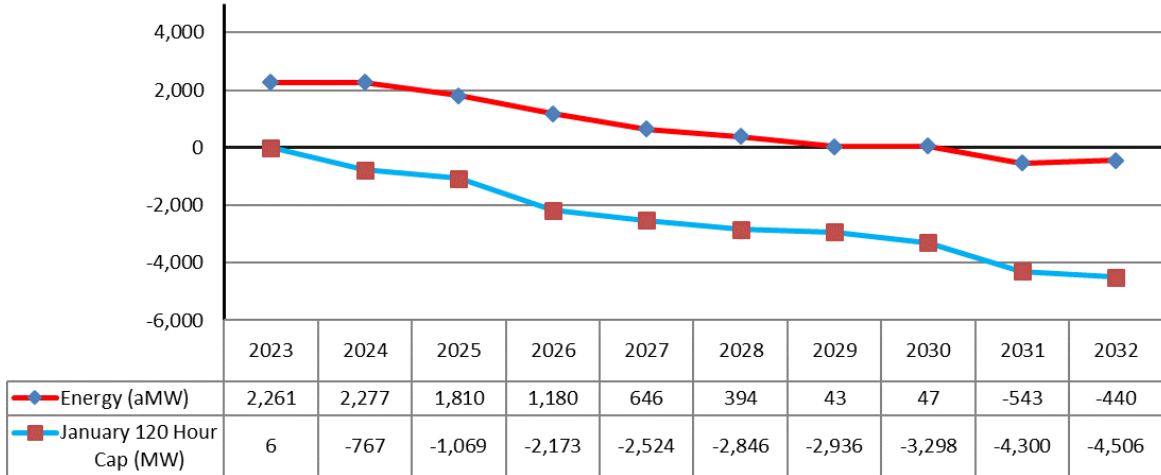
**PNW Region
 January 120-Hour Capacity Surplus/Deficit Comparison
 Assuming 100% of Uncommitted IPP Generation is Available to the Region
 OY 2023 through 2032
 1937-Firm (Critical) Water Conditions**

January 120-Hour Capacity (MW)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
2022 White Book	6	-767	-1,069	-2,173	-2,524	-2,846	-2,936	-3,298	-4,300	-4,506
2019 White Book	-1,699	-1,954	-1,990	-2,911	-3,081	-3,229	-3,325	-3,460	n/a	n/a
Difference <i>(2019 WBK – 2018 WBK)</i>	1,705	1,186	921	739	558	383	389	162	n/a	n/a

Regional Annual Surplus/Deficit: [Table 3-14](#), graphically presents the annual firm energy and January 120-Hour capacity surplus and 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 and deficit declines over the 10-year study period. By the end of the period, the study shows an annual energy deficit of 440 aMW, while January 120-Hour capacity is deficit over most of the study period ending with a deficit of 4,506 MW. Continuing declines in the surplus and 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 reduction of resources across the region.

Table 3-14

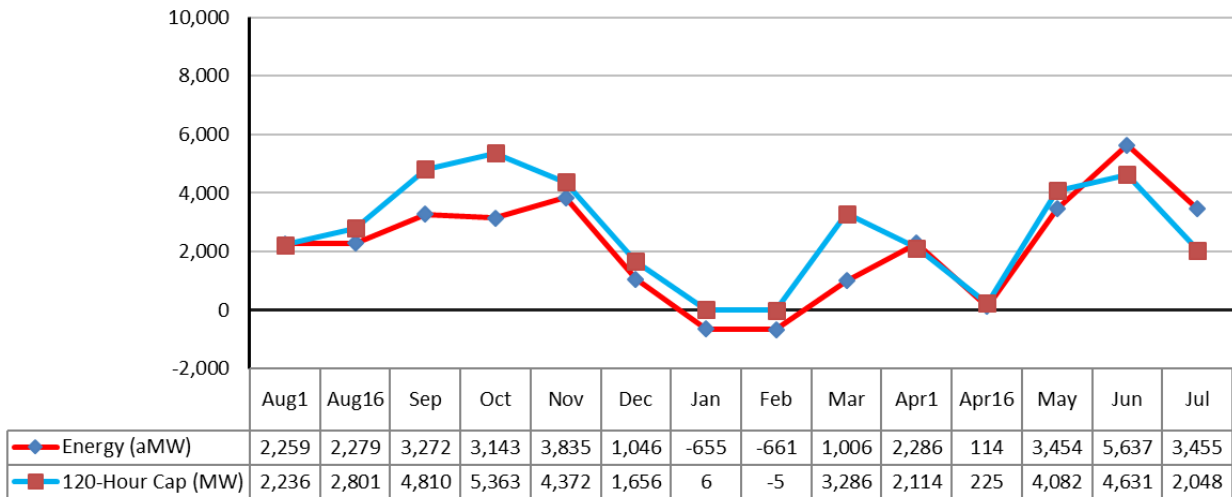
**PNW Region
Annual Energy and January 120-Hour Capacity Surplus/Deficit
OY 2023 through 2032
1937-Firm (Critical) Water Conditions**



Regional Monthly Surplus/Deficit: [Table 3-15](#) graphically presents the monthly energy and 120-Hour capacity surplus or deficit forecasts for OY 2023. 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 during the year, with January and February 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 3-15

**PNW Region
Monthly Energy and 120-Hour Capacity Surplus/Deficit
OY 2023
1937-Firm (Critical) Water Conditions**



Conclusion

The PNW region is projected to have annual firm energy surpluses until the last two years of the 2023-2032 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 across the study period. 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 6-5](#). Additional monthly and annual details for OY 2023 through 2032 are available upon request, and a detailed list can be found in [Appendix A](#).

The regional energy and capacity deficits identified in this analysis may be mitigated through resource options discussed in the Northwest Power and Conservation Council's 2021 Northwest Power Plan. Bonneville provides this PNW regional planning analysis for informational purposes only.

Section 4: Federal System Climate Change Analysis

Introduction

The analysis presented herein is intended to provide an understanding of the generation changes from 14-Federal dams on the Columbia River and its tributaries from emerging climate change trends, and the changing climate projected into the future under the same operational assumptions. This analysis also served as the data behind Bonneville's recent Climate Change Resiliency effort, and Bonneville's change to future hydro generation forecast data sets.

The climate change analysis presented here is the culmination of two major efforts: The routine decadal updates to Modified Streamflows used in long term planning, and the second report of the River Management Joint Operating Committee climate change studies (commonly referred to as RMJOC-II) commissioned in 2013 and published in 2020 [River Management Joint Operating Committee (RMJOC): Bonneville Power Administration, United States Army Corps of Engineers, United States Bureau of Reclamation, "Climate and Hydrology Datasets for RMJOC Long-Term Planning Studies: Second Edition (RMJOC-II) Part II: Columbia River Reservoir Regulation and Operations—Modeling and Analyses", August 2020. Available Online: <https://www.bpa.gov/energy-and-services/power/climate-change-fcrps> (Accessed 4/7/2022)].

Methods

Hydro generation forecasts were produced at monthly granularity using the HYDSIM model, with April and August being split months, for a 14-period year. Details on [Hydro Resources Modeling](#) can be found in Section 1. A year is defined as a fiscal year, from October-September, whereas other sections of the White Book are in operating year. Operations modeled in this report are reflective of the 2020 Environmental Impact Statement Preferred Alternative. These same assumptions were used in the BP-22 Final Proposal, which have been documented in detail elsewhere and are available upon request. Since this study, the only modeling change with a significant impact to generation has been an update to the way flexible spill operations are modeled. The change is a result of calibrating the model to be more reflective of the observed operation. Auxiliary data that correspond to the 2020 Modified Flows are provided to Bonneville by Federal partners, and through the Western Power Pool as a part of the Pacific Northwest Coordination Agreement (e.g. water supply forecast, flood control, and hydro independent generation, and rule curves). These data are expected to be available February of 2023. In place of such data, Bonneville subject matter experts provided proxy data as appropriate.

2020 Modified flow update

Generation forecasts issued by Bonneville for the timeframe 2024 and beyond will be based upon the 2020 Modified Flows beginning with the publication of Contract Rates High Water Mark. The flows were published October 2020, and documented in the technical report [Bonneville Power Administration, Department of Energy, Portland, OR. 2020 Level Modified Streamflow. Available: <https://www.bpa.gov/energy-and-services/power/historical-streamflow-data>, accessed: 2022/03/10]. [Figure 4-1](#) shows the overall average flow changes at The Dalles reprinted here from [Table 4-6](#) in the report, where 2010 Modified Flows, aka 80-historic Water Year (WY), and 2020 Modified Flows, 90-historic Water Year records, is shown in comparison. Though changes in sub-basin flows varied in the study, overall flows increased modestly at this location commonly used for planning purposes. The resulting generation comparison is provided in [Figure 4-2](#). The "+" is the 5th percentile, and the whiskers represent the 10th and 90th percentiles, the lower and upper hinges of the box are the 25th and 75th percentiles. The bold black horizontal line is the median, and the white dot is the mean. The projects included in the Fed-14 include: Libby, Hungry Horse, Albeni Falls, Grand Coulee, Chief

Joseph, Dworshak, Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville.

Figure 4-1

**Monthly Average Flows at The Dalles Comparison
2010 Modified Flows (TDA5M) vs. 2020 Modified Flows (TDA6M)**

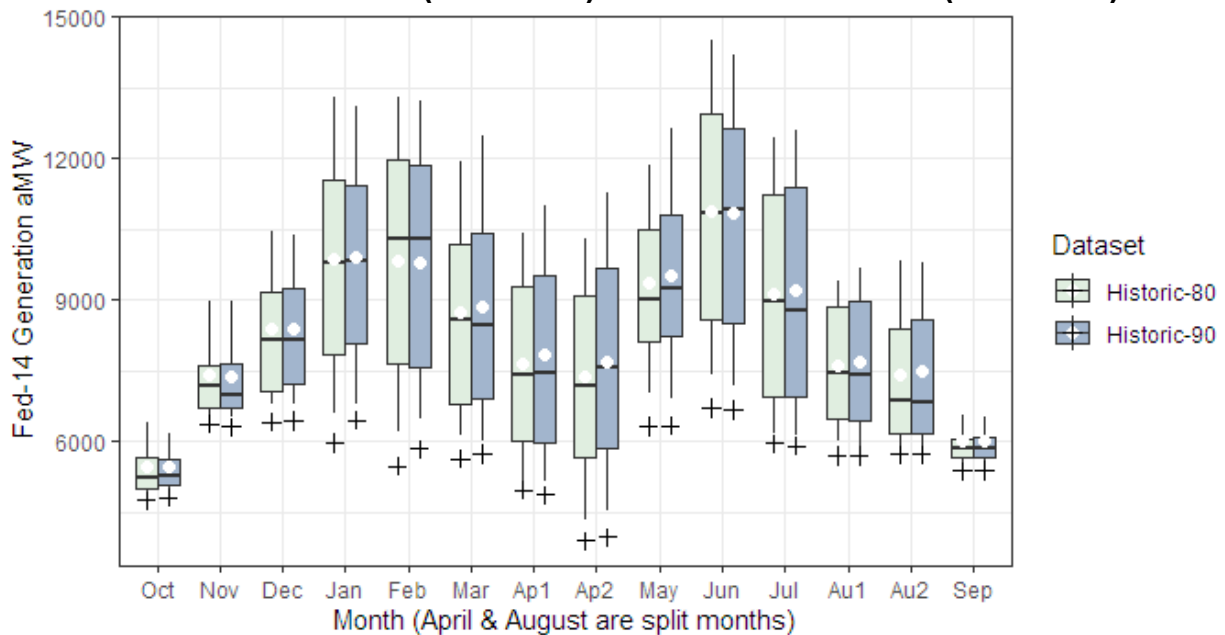
Reprint of Table 4-6 from <https://www.bpa.gov/energy-and-services/power/historical-streamflow-data>

Table 4-6. Lower Columbia Basin at The Dalles Dam Average Monthly 5M vs. 6M

Month	TDA5M (cfs)	TDA6M (cfs)	Diff. (cfs)	% Change
Jan	93995	94311	316	0.3
Feb	105614	105539	-74	-0.1
Mar	128973	132790	3817	3.0
Apr	215168	219399	4231	2.0
May	414075	418360	4285	1.0
Jun	464102	463901	-201	0.0
Jul	245739	249710	3971	1.6
Aug	127019	128723	1704	1.3
Sep	84943	87160	2217	2.6
Oct	80915	81021	107	0.1
Nov	89738	91398	1660	1.8
Dec	91953	92269	316	0.3

Figure 4-2

**Federal 14 Projects Monthly Average Generation comparison
2010 Modified Flows (Historic-80) vs. 2020 Modified Flows (Historic-90)**



Overall the changes in streamflow set provided similar generation on average for the primary 14 hydroelectric projects. More notable changes are higher generation in March and April consistent with higher natural flows in those months (see [Figure 4-1](#)).

While it isn't unexpected that the generation distributions would remain similar with the modest addition of 10 years to the 80 year streamflow set, an analysis of the 30-year hydrographs (section 4.4.1 of the report) revealed a small but noticeable shift in peak flows, and an earlier date of peak flow beginning with the 1969-1998 hydrograph and amplifying to the most recent set of 1989-2018. The data also show a statistically significant increase in winter runoff volume, and earlier (but not quite statistically significant) flow recessions in the summer.

Climate Change Datasets

The generation impacts using a subset of 19 representative climate change streamflow projections under 2016 operations are published in the RMJOC Part II report (hereafter referred to as RMJOC-II), and are shown in Figure 4-3. The generation trends show a pattern of increasing expectations of higher generation from November through April, consistent with warmer temperatures in all seasons, increased average precipitation, more precipitation falling as rain instead of snow in some basins, and earlier spring runoff. Generation without operational adaptations to climate change would result in significantly less generation from July through October. This primarily reflects lower flows from the Northern portion of the basin, where earlier runoff results in an extended period of lower natural flows. Flow in the Snake River Basin is expected to produce more generation from December through April as well, with no significant impacts the remainder of the year. In Figure 4-3, blue and red data are from the 19 climate change projections, where the "2030s" refer to the years 2020-2049, and the "2070s" refer to the years "2060-2089". The operations have not been adapted for the climate change flows. The historical Baseline (gray boxes) refers to a set of four historical baselines consisting of simulated historical streamflows from the period 1976-2005 (see section 9.2.2 of the report). The Historic Baseline differs from the modified flows, as it is meant to level any biases in the modeling approach. All selected scenarios are from the RCP 8.5 set, which is the model assumption that assumes the highest amount of radiative forcing is achieved (8.5 W/m² reflection of heat back to the surface by the atmosphere) under current emission trajectories.

Figure 4-3

Federal 14 Projects Monthly Generation Comparison
 Reprint from RMJOC-II report Section 9.4

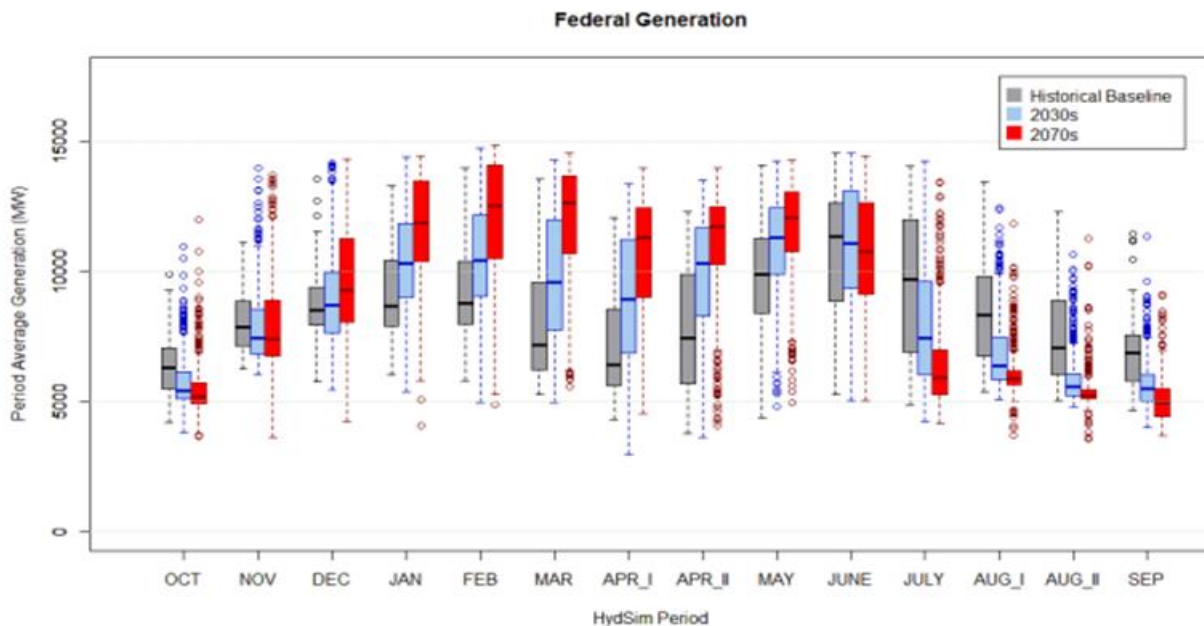


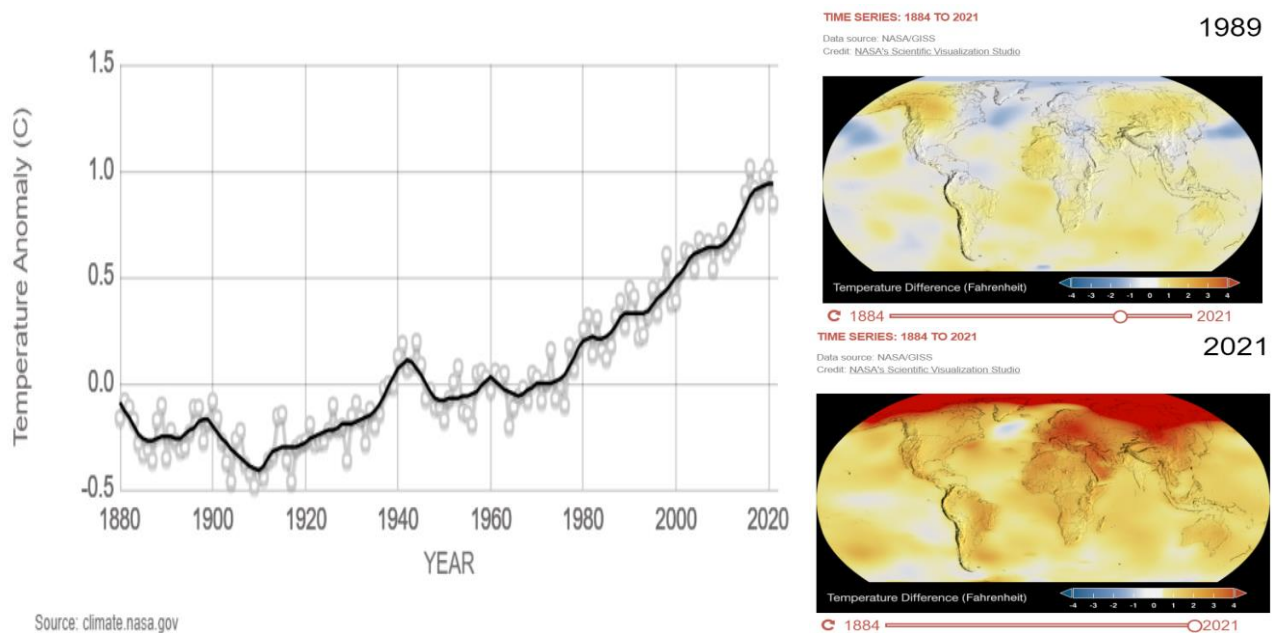
Figure 83. Combined generation of the 14 federal hydrogeneration projects in the Columbia River Basin. Distribution in the 2030s and 2070s is based on the 19 RMJOC-II streamflow scenarios used for power modeling.

Observed climate change scenario

Due to the apparent evolution in observed runoff patterns, staff recommended that Bonneville explore shortening the period of streamflow records used for long term planning to better account for the emerging climate change signals. Using a shorter 30-year period of record is a common meteorological and hydrologic practice that is also employed in other areas of river management, such as establishing dry year thresholds, and the average expectation of the seasonal runoff. [Figure 4-4](#) illustrates that the observed temperatures in the past 30 years are significantly higher both globally and in the Pacific Northwest. Earth's surface continues to significantly warm, with recent global temperatures being the highest in the past 2,000-plus years. Since 1980, the global temperature has been above the 1884 baseline. [Figure 4-4](#) also includes two snapshots of global temperature changes since the 1884 baseline. 1989 was about 0.5 Celsius warmer in the Pacific Northwest. Temperatures have only continued to increase. Temperatures in the past 30 years represent a significant departure from history. (Graphics from <https://climate.nasa.gov/vital-signs/ocean-heat/> available: 04/11/2022). In the remainder of this report, the use of the most recent 30 years of the 2020 Modified Flows is explored for use in generation forecasts.

Figure 4-4

Earth Surface Temperature by Year



Three generation sets are compared in this section going forward, all use the same operational assumptions as the CRSO Preferred Alternative from the 2020 EIS, and all follow the modeling methodology that is used to model generation for the Rate Case:

- 1) "Historic-90": Based on the 2020 Modified Flows, 1929 to 2018, this study represents a typical update.
- 2) "Recent-30": Based the 2020 Modified Flows, this study was conducted to use contemporary data as inputs. A separate critical period was developed from September 2000 through February 2002 ("2001") rather than the 1937 firm (critical) period (September 1936 to April 30th 1937). Note: The selection of critical period had an insignificant impact on generation.

3) “RMJOC-II”: Four climate scenarios were selected from the 19 shown in [Figure 4-3](#), and only the “2030s” (2020-2049 period) were analyzed. All selected scenarios are from the RCP 8.5 set, which is the model assumption that assumes the highest amount of radiative forcing is achieved (8.5 W/m² reflection of heat back to the surface by the atmosphere) under current emission trajectories. The four scenarios were carefully selected to represent a reasonable range of potential future climate change scenarios impacting net generation, which have the following characteristics relative to the larger ensemble of 19:

- a. **CanESM2-MACA-PRMS-P1**: Is the warmest and wettest scenario.
- b. **MIROC5-BCSD-VIC-P3**: Near the median temperature projection; just above median precipitation above Grand Coulee, but below median Precipitation in the Snake River basin.
- c. **HadGEM2-CC-MACA-VIC-P1**: Warmer scenario; median precipitation above Grand Coulee, but above the median precipitation in the Snake River basin.
- d. **GFDL-BCSD-VIC-P2**: One of the coolest/driest scenarios.

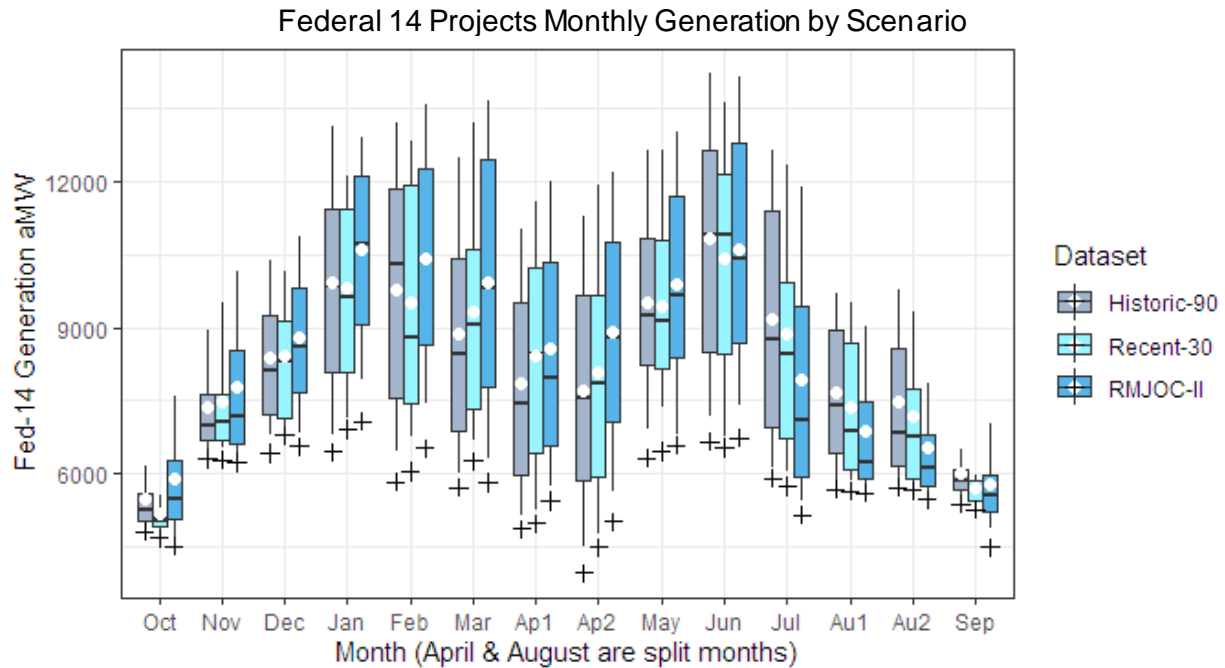
Note: The naming convention used above is: “Global Climate Model” – “Downscaling model” – “Hydrological model”

The tables of Federal-14 generation data corresponding to the figures that follow can be found in [Section 7](#).

[Figure 4-5](#) shows the Federal-14 generation distributions of monthly generation for each of the three datasets. The data show that the “Recent-30” have similar ranges (5th percentile to 90th percentile shown) and similar interquartile ranges (the distance from the top to bottom of the box). The “Recent-30” show the largest differences from the “Historic-90”, which is the 2020 Modified Flows, in July-October, where the “Recent-30” exhibits less generation in all quantiles consistent with the lower natural flows in those periods, and in Mar through Ap1 where the generation is greater in all quantiles than the “Historic-90”, consistent with earlier run-off in those periods. Box plot details follows previously described structure as in [Figure 4-2](#).

[Figure 4-5](#) also shows the generation which results from the selected four RMJOC-II streamflows in the “2030s”. The RMJOC-II data follow the same conclusions as mentioned in [Figure 4-3](#). Relative to the historic flow sets, there is some upward bias in the flows July through November (see Section 9.2.2, figure 78 in the report), and consequently the RMJOC-II generation forecast may also be biased upward at times in those months. We note that the generation trends of the “Recent-30” appear to be a midpoint between the “Historic-90” and the RMJOC-II. The “Recent-30” do not show the increased generation in fall and winter that is expected from the RMJOC-II, at least so far. Finally we note that the range of outcomes in the RMJOC-II dataset are broader than the historic dataset for most of the seasons. Although there is an expectation of greater average generation from increased precipitation, planners should take note that periods of drought are still very likely in the future, and future precipitation projections are more uncertain than temperatures. We also note that the RMJOC-II data warns of the potential for low generation in the summer. It is possible that active reservoir management practices could increase flows (to support fish and wildlife) in these seasons, which could have a positive influence on generation.

Figure 4-5



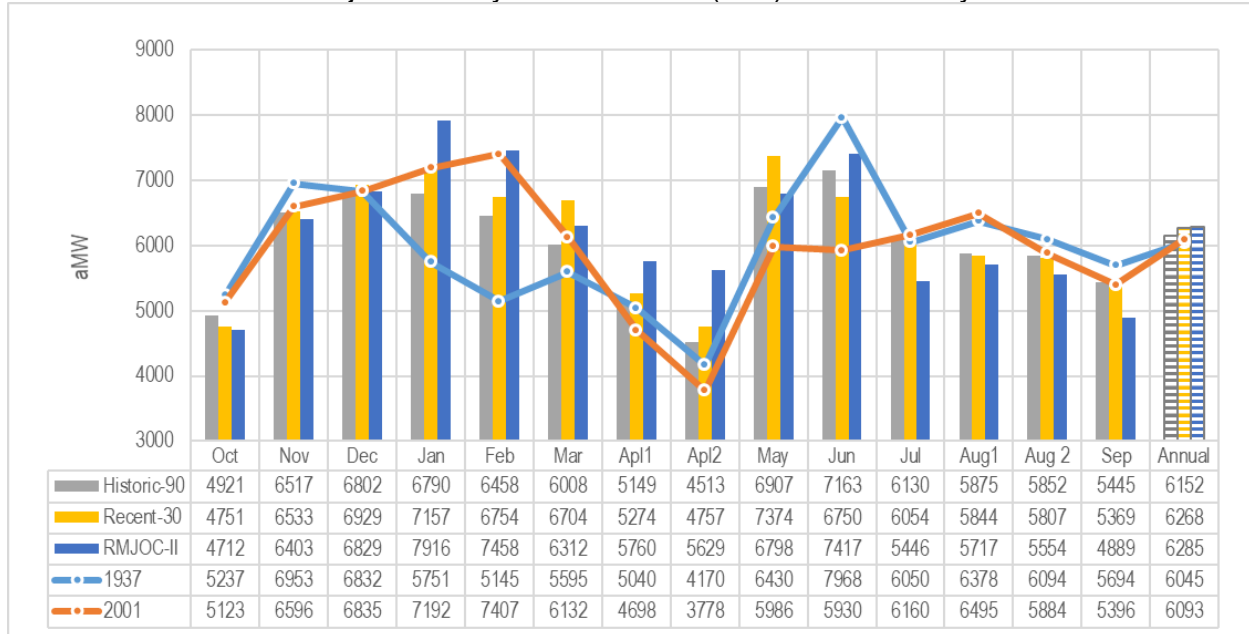
Firm energy analysis

With Bonneville looking at the Recent 30 years and the RMJOC-II analysis it was also important to think about what firm energy would look like in a situation that didn't include the historical 1937 firm (critical) water year. As a result, firm energy was analyzed by comparing the generation at the 10th percentiles (P10) by period, with single fiscal years of 1937 (as historically used to represent firm generation) and 2001 (the analogue fiscal year that serves the least load in the "Recent-30").

Generation from individual water years can be above or below the P10 lines as shown in [Table 4-6](#). In the 90 year record the ten lowest generation years are characterized by having several periods with generation below the P10 (14-period years). Fiscal year 1944, the lowest generation year of record as an example, has eight periods below the P10. It is fairly common to encounter a year with a single period below the P10 level. In the 90 year record, 43 years have at least one of the 14 periods at or below P10 generation (see [Figure 4-7](#)). As shown in [Figure 4-7](#), it's rarer for a year to encounter multiple low generation periods, this is due to the interaction of streamflow with reservoir operations.

Table 4-6

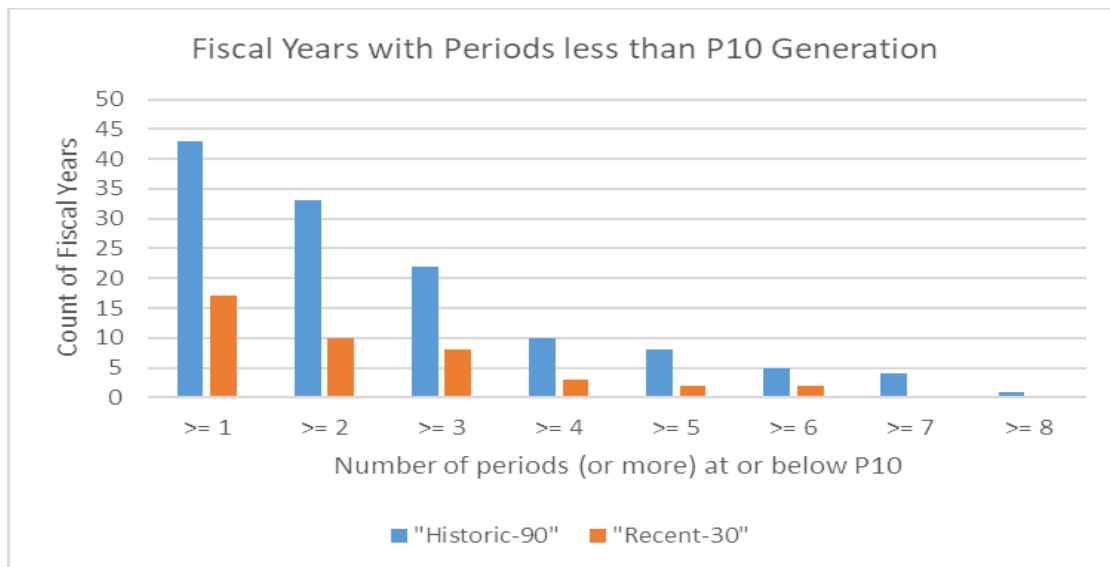
Federal 14 Project Monthly 10th Percentile (P10) Generation by Scenarios



Even though there are no Fiscal Years with generation below the P10 for all 14 periods in the study, the annualized (“Annual”) P10 of the Historic-90 and Recent-30 datasets have slightly larger annual generation values than the years 1937 and 2001 (Table 4-6). Figure 4-5 shows the additional risk of observing P5 generation (+ markers), which can be close to the P10 values at times. The lower tails of the distributions are much longer in January through June than the rest of the year, and those months drive the individual years to be lower in annual generation. The RMJOC-II data suggest that the P10 generation will remain about the same when annualized. Under current operations, the RMJOC-II streamflows are regulated to have higher generation in the winter and lower generation in the summer and fall.

Figure 4-7

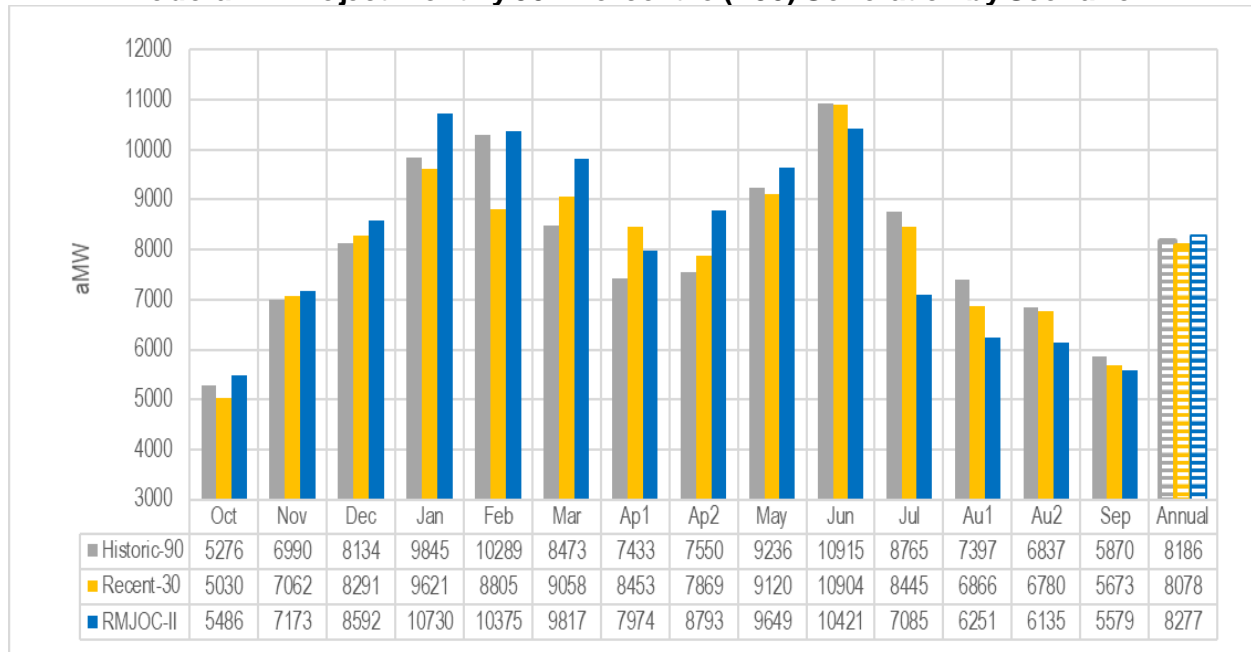
Frequency of Monthly (Periods) with Less than P10 Generation



While the low water years in the “Recent-30” result in higher firm generation by either method (single low generation fiscal year, or P10 by month) compared to the “Historic-90”, the “Recent-30” have slightly less generation at the median as shown in [Table 4-8](#). The RMJOC-II data show that the P50 generation will increase in the winter months, and decrease in the summer months. The slight increase in P50 generation for RMJOC-II in October and November could be modeling bias in the underlying streamflows.

Table 4-8

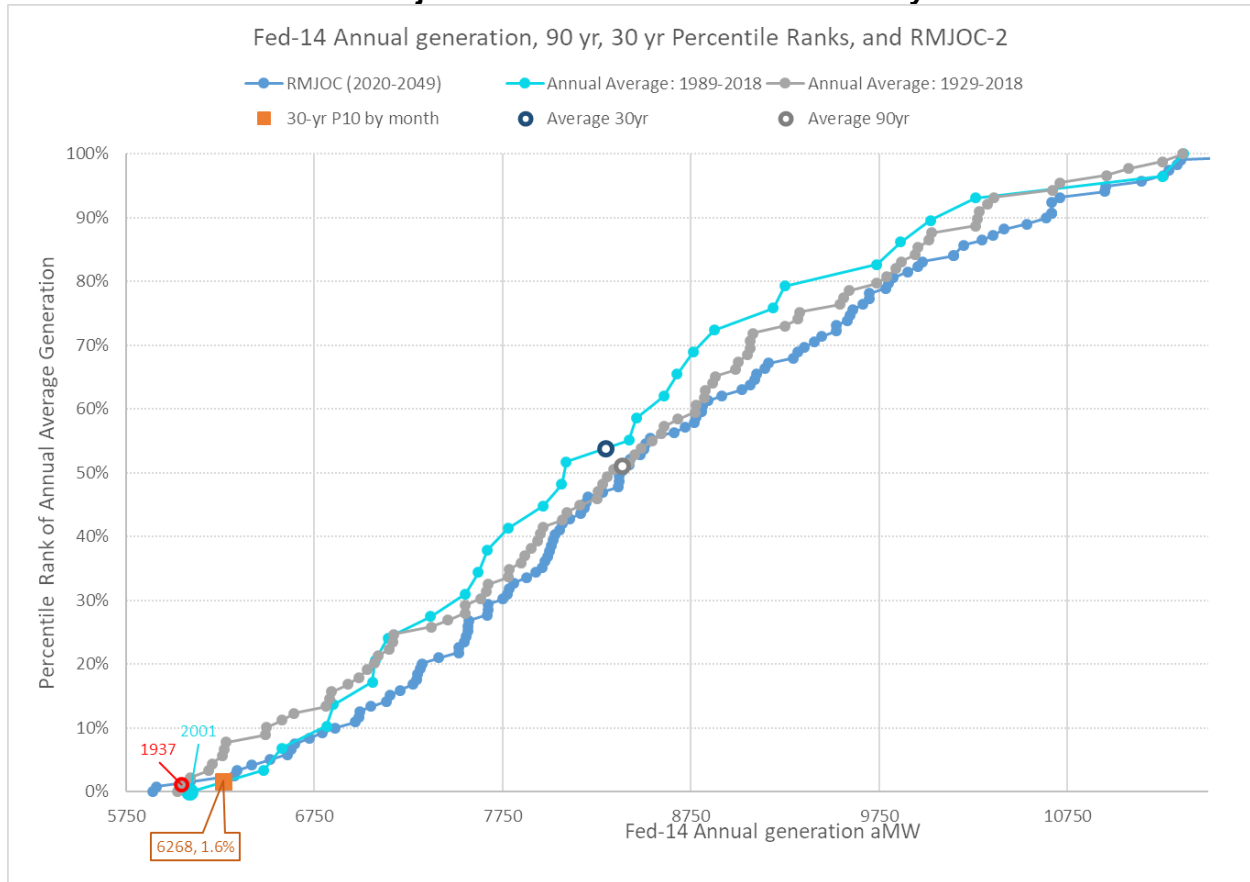
Federal 14 Project Monthly 50th Percentile (P50) Generation by Scenario



The annual generation from the three streamflowsets are shown in [Figure 4-9](#). The “Recent-30” exhibit higher generation in the lowest 10 percent of observations of annual generation. This primarily is the result of the warmer winters of recent history, which support higher winter flows. Six out of the ten lowest generation years from the 90 year record occurred between 1929 and 1945. The winter of 1937 was particularly cold, resulting in frozen tributary streams and very low winter flows. In contrast, 2001 had lower volume runoff compared to 1937, and exhibits a runoff pattern consistent with contemporary flows. The RMJOC-II data are trending to higher generation in the bottom 10 percent than the “Historic 90”, and are fairly close to the “Recent-30”. The figure shows that two of the 120 of the simulated flows included in this analysis are lower in annual generation compared to the historical data. The RMJOC-II distribution trends towards higher generation than the historic datasets for the rest of the distribution. Whereas the “Recent 30” shows an expectation of less generation from the 20th-80th percentiles on an annual basis.

Figure 4-9

Federal 14 Projects Percentile Rank Distribution by Scenario



Conclusion

The 2020 Modified Flows result in a very slight change in the generation forecast when comparing the 80-year to 90-year sets, with overall increased flows on average (Figure 4-1 and 4-2). Climate change in the next 30 years is expected to increase generation in the winter and spring, and decrease in the summer owing to warmer annual temperatures including in the winter. More precipitation falling as rain instead of snow in some low elevation sub-basins, earlier spring runoff, and earlier streamflow recessions (Figure 4-3).

The last 30 years of average temperature and runoff in the basin have changed significantly from historic baselines (Figure 4-4, and section 4.4.1 of the 2020 Modified Flows report). The generation from the FCRPS has been flatter across the winter and spring due to earlier spring run-off and higher early spring flows (Figure 4-5, Tables 4-6, and 4-8). The generation has also decreased in summer relative to the full record. This has resulted in less generation in the 20th through 80th percentiles on an annual basis (Figure 4-9). Meanwhile generation values such as those observed during the dry cold years 1929 through 1945 have not been occurring in the basin since that time (Figure 4-9) as reflected by a shift in the lowest 10th percentile to higher generation values in the “Recent-30” and RMJOC-II.

There is an expectation that the low generation conditions will be less severe in the winter and more severe in the summer. Overall there is an expectation that annual generation might increase in the next 30 years (Figure 4-9).

Bonneville has recently completed its Climate Change Resiliency effort, with a decision to adopt the following approach to future long-term hydro planning:

- 1) For routine planning, the base streamflow assumptions for the long-term hydro generation forecast will include only the recent 30 years from the 2020 Level Modified Streamflow (1989 to 2018).
- 2) For longer-term planning (15 or more years into the future, on a rolling basis), Bonneville will assess at its discretion whether the base streamflow assumptions for a given study should be based on future climate change studies (such as RMJOC-II).
- 3) Bonneville will calculate annual firm energy from the monthly 10th percentiles (P10) of generation from the period of record (currently 1989-2018).

Additional information about [Climate Change and the FCRPS \(including the Climate Change Resiliency effort\)](#) is available on Bonneville's website. Future White Books will reflect this change.

Section 5: Federal System Analysis Exhibits

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 5-1: Annual Energy

**Federal System Analysis Surplus Deficit
Operating Year 2023 to 2032**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Loads and Resources - Federal System
Operating Year: 2023 to 2032 Water Year: 1937
2022 White Book (80 WY) Report Date: 5/4/2022

S228-WB-20220504-112334

Energy-aMW	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Firm Obligations										
1 Load Following	3455	3506	3552	3576	3601	3619	3642	3661	3679	3693
2 Preference Customers	3151	3189	3224	3243	3265	3281	3303	3319	3332	3346
3 Federal Agencies	115	130	139	145	148	150	151	154	158	159
4 USBR	188	188	188	188	188	188	188	188	188	188
5 Federal Diversity	0	0	0	0	0	0	0	0	0	0
6 Tier 1 Block	473	486	486	487	486	487	488	491	493	494
7 Tier 1 Block	473	486	486	487	486	487	488	491	493	494
8 Slice	2880	2920	2914	2920	2909	2909	2897	2905	2896	2901
9 Slice Block	1336	1325	1344	1322	1341	1316	1332	1312	1331	1309
10 Slice Output from T1 System	1543	1595	1570	1598	1568	1593	1565	1593	1565	1593
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	791	707	703	587	487	475	475	475	474	474
14 Exports	502	464	464	464	464	464	464	464	464	464
15 Intra-Regional Transfers (Out)	289	243	239	123	22.4	10.7	10.7	10.7	9.44	9.44
16 Total Firm Obligations	7610	7632	7667	7582	7495	7502	7514	7544	7553	7575
Net Resources										
17 Hydro	6313	6422	6435	6437	6438	6433	6430	6436	6430	6430
18 Regulated Hydro - Net	5961	6071	6083	6084	6086	6082	6078	6084	6078	6081
19 Independent Hydro - Net	349	349	349	349	349	349	349	349	349	346
20 Small Hydro - Net	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.87
21 Non-Hydro Renewable	34.8	33.0	33.0	33.0	19.8	1.90	0	0	0	0
22 Wind - Net	34.8	33.0	33.0	33.0	19.8	1.90	0	0	0	0
23 Solar - Net	0	0	0	0	0	0	0	0	0	0
24 Other - Net	0	0	0	0	0	0	0	0	0	0
25 Thermal	994	1116	994	1116	994	1116	994	1116	994	1116
26 Nuclear - Net	994	1116	994	1116	994	1116	994	1116	994	1116
27 Coal - Net	0	0	0	0	0	0	0	0	0	0
28 Natural Gas - Net	0	0	0	0	0	0	0	0	0	0
29 Petroleum - Net	0	0	0	0	0	0	0	0	0	0
30 Biofuel - Net	0	0	0	0	0	0	0	0	0	0
31 Cogeneration - Net	0	0	0	0	0	0	0	0	0	0
32 Contract Purchases	215	202	201	202	168	168	168	169	168	169
33 Imports	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
34 Intra-Regional Transfers (In)	48.0	33.8	33.7	33.7	0	0	0	0	0	0
35 Non-Federal CER	134	134	134	135	135	135	135	135	135	135
36 Slice Transmission Loss Return	31.4	32.5	32.0	32.6	32.0	32.5	31.9	32.5	31.9	32.5
37 Reserves & Losses	-237	-244	-241	-245	-242	-243	-242	-244	-243	-245
38 Operating Reserves	0	0	0	0	0	0	0	0	0	0
39 Balancing Reserves	0	0	0	0	0	0	0	0	0	0
40 Transmission Losses	-237	-244	-241	-245	-242	-243	-242	-244	-243	-245
41 Total Net Resources	7318	7528	7422	7543	7378	7476	7350	7476	7348	7470
42 Total Surplus/Deficit	-292	-103	-245	-39	-118	-25	-164	-68	-204	-105

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 5-2: Monthly Energy

**Federal System Analysis Surplus Deficit
Operating Year 2023**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Loads and Resources - Federal System
Operating Year: 2023 Water Year: 1937
2022 White Book (80 WY) Report Date: 5/4/2022
S228-WB-20220504-112334

Energy-aMW	Aug1	Aug1	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
		6													
Firm Obligations															
1 Load Following	3537	3539	3098	2984	3275	3947	3944	3656	3298	3262	3241	3222	3495	3745	3455
2 Preference Customers	3101	3105	2719	2759	3148	3788	3784	3505	3115	2921	2898	2781	3004	3210	3151
3 Federal Agencies	105	105	93.3	103	117	148	152	133	123	108	108	96.3	96.1	107	115
4 USBR	330	329	286	123	9.66	10.8	8.39	18.0	60.9	233	235	345	395	427	188
5 Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 Tier 1 Block	320	321	523	444	708	713	775	728	693	358	355	129	20.2	284	473
7 Tier 1 Block	320	321	523	444	708	713	775	728	693	358	355	129	20.2	284	473
8 Slice	2849	2838	2629	2624	3257	3399	3104	2868	2853	2510	2412	2729	2893	2886	2880
9 Slice Block	1190	1190	1136	1217	1419	1623	1616	1482	1368	1274	1274	1238	1210	1265	1336
10 Slice Output from T1 System	1659	1649	1493	1407	1837	1776	1488	1385	1485	1236	1138	1490	1683	1621	1543
11 Direct Service Industries	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	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	12.0	12.0	12.0	12.0	12.0
13 Contract Deliveries	1119	1210	1041	742	746	746	719	721	718	718	715	717	718	733	791
14 Exports	708	790	628	480	480	480	454	454	454	454	454	454	454	472	502
15 Intra-Regional Transfers (Out)	412	420	412	262	266	266	265	267	264	263	261	262	263	261	289
16 Total Firm Obligations	7837	7920	7303	6807	7998	8818	8555	7984	7574	6860	6735	6809	7138	7660	7610
Net Resources															
17 Hydro	6890	6912	6043	5516	7312	7044	5774	5317	5795	4848	4427	6851	7703	6775	6313
18 Regulated Hydro - Net	6525	6551	5700	5206	7053	6869	5657	5186	5562	4410	3982	6129	6992	6366	5961
19 Independent Hydro - Net	362	358	340	307	257	172	113	128	230	435	442	719	708	407	349
20 Small Hydro - Net	2.63	2.63	2.63	2.67	2.84	3.19	3.21	3.05	3.10	3.09	3.09	2.83	2.72	2.63	2.88
21 Non-Hydro Renewable	30.6	45.9	42.6	25.3	36.2	27.6	14.8	24.4	28.1	50.2	42.3	45.2	44.7	43.7	34.8
22 Wind - Net	30.6	45.9	42.6	25.3	36.2	27.6	14.8	24.4	28.1	50.2	42.3	45.2	44.7	43.7	34.8
23 Solar - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Other - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Thermal	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	360	409	1116	994
26 Nuclear - Net	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	360	409	1116	994
27 Coal - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Natural Gas - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Petroleum - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Biofuel - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Cogeneration - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32 Contract Purchases	262	263	249	160	211	310	274	237	206	161	148	166	175	169	215
33 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
34 Intra-Regional Transfers (In)	86.7	87.5	83.3	0	38.9	139	113	75.0	39.5	0	0	0	0	0	48.0
35 Non-Federal CER	136	137	136	131	136	136	131	134	137	136	125	136	136	131	134
36 Slice Transmission Loss Return	38.1	37.9	29.0	27.3	35.7	34.5	28.9	26.9	28.8	24.0	22.1	28.9	38.7	37.2	31.4
37 Reserves & Losses	-283	-284	-226	-208	-263	-258	-218	-203	-217	-188	-174	-227	-285	-276	-237
38 Operating Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39 Balancing Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40 Transmission Losses	-283	-284	-226	-208	-263	-258	-218	-203	-217	-188	-174	-227	-285	-276	-237
41 Total Net Resources	8015	8053	7224	6609	8413	8240	6961	6492	6928	5987	5559	7195	8047	7827	7318
42 Total Surplus/Deficit	178	133	-78	-198	415	-577	-1,594	-1,492	-645	-873	-1,176	386	909	167	-292

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 5-3: Annual 120-Hour Capacity

**Federal System Analysis Surplus Deficit
Operating Year 2023 to 2032**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Loads and Resources - Federal System
Operating Year: 2023 to 2032 Water Year: 1937
2022 White Book (80 WY) Report Date: 5/4/2022

S228-WB-20220504-112334

120Hr-MW	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Firm Obligations										
1 Load Following	4102	4144	4165	4282	4298	4331	4273	4258	4282	4375
2 Preference Customers	4380	4413	4469	4505	4528	4558	4579	4605	4632	4656
3 Federal Agencies	146	149	168	175	182	183	186	191	195	198
4 USBR	620	620	620	620	620	620	620	620	620	620
5 Federal Diversity	-1044	-1039	-1093	-1018	-1033	-1031	-1113	-1159	-1166	-1099
6 Tier 1 Block	330	329	341	350	351	350	340	339	342	355
7 Tier 1 Block	330	329	341	350	351	350	340	339	342	355
8 Slice	3310	3371	3306	3327	3253	3288	3309	3323	3303	3322
9 Slice Block	1190	1238	1220	1239	1213	1239	1211	1230	1205	1230
10 Slice Output from T1 System	2121	2133	2086	2087	2040	2049	2098	2092	2098	2092
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	2344	1536	1511	1511	1311	1211	1211	1211	1211	1211
14 Exports	1510	1201	1201	1201	1201	1201	1201	1201	1201	1201
15 Intra-Regional Transfers (Out)	834	334	309	309	109	9.44	9.44	9.44	9.44	9.44
16 Total Firm Obligations	10099	9392	9335	9482	9224	9192	9145	9142	9149	9275
Net Resources										
17 Hydro	10623	10677	10468	10476	10262	10303	10520	10495	10520	10495
18 Regulated Hydro - Net	10050	10104	9895	9903	9689	9730	9947	9922	9947	9922
19 Independent Hydro - Net	569	569	569	569	569	569	569	569	569	569
20 Small Hydro - Net	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49
21 Non-Hydro Renewable	0	0	0	0	0	0	0	0	0	0
22 Wind - Net	0	0	0	0	0	0	0	0	0	0
23 Solar - Net	0	0	0	0	0	0	0	0	0	0
24 Other - Net	0	0	0	0	0	0	0	0	0	0
25 Thermal	1163	1163	1163	1163	1163	1163	1163	1163	1163	1163
26 Nuclear - Net	1163	1163	1163	1163	1163	1163	1163	1163	1163	1163
27 Coal - Net	0	0	0	0	0	0	0	0	0	0
28 Natural Gas - Net	0	0	0	0	0	0	0	0	0	0
29 Petroleum - Net	0	0	0	0	0	0	0	0	0	0
30 Biofuel - Net	0	0	0	0	0	0	0	0	0	0
31 Cogeneration - Net	0	0	0	0	0	0	0	0	0	0
32 Contract Purchases	435	285	284	284	285	285	286	286	286	286
33 Imports	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
34 Intra-Regional Transfers (In)	150	0	0	0	0	0	0	0	0	0
35 Non-Federal CER	235	235	235	235	237	237	237	237	237	237
36 Slice Transmission Loss Return	48.7	49.0	47.9	48.0	46.9	47.1	48.2	48.1	48.2	48.1
37 Reserves & Losses	-1862	-1868	-1862	-1870	-1844	-1857	-1875	-1883	-1884	-1889
38 Operating Reserves	-667	-676	-677	-686	-666	-676	-689	-694	-697	-698
39 Balancing Reserves	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825
40 Transmission Losses	-370	-367	-360	-359	-353	-357	-361	-365	-362	-366
41 Total Net Resources	10359	10257	10053	10052	9866	9894	10094	10061	10085	10055
42 Total Surplus/Deficit	260	865	719	571	641	702	950	919	936	780

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 5-4: Monthly 120-Hour Capacity

**Federal System Analysis Surplus Deficit
Operating Year 2023**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Loads and Resources - Federal System
Operating Year: 2023 Water Year: 1937
2022 White Book (80 WY) Report Date: 5/4/2022
S228-WB-20220504-112334

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Firm Obligations														
1 Load Following	4102	3811	3501	3531	3899	4598	4664	4319	3916	3847	3798	3648	3943	4303
2 Preference Customers	4380	4380	3941	4069	4639	5445	5413	5114	4728	4433	4433	4077	4253	4433
3 Federal Agencies	146	146	135	153	168	204	213	193	175	162	162	140	137	149
4 USBR	620	620	577	407	104	144	201	177	343	425	425	520	600	619
5 Federal Diversity	-1044	-1335	-1152	-1098	-1012	-1195	-1164	-1164	-1331	-1173	-1222	-1088	-1047	-898
6 Tier 1 Block	330	330	562	474	762	761	857	761	713	382	382	137	20.2	312
7 Tier 1 Block	330	330	562	474	762	761	857	761	713	382	382	137	20.2	312
8 Slice	3310	3411	3182	3129	3936	4120	3727	3428	3572	2942	2693	3165	3465	3358
9 Slice Block	1190	1190	1136	1217	1419	1623	1616	1482	1368	1274	1274	1238	1210	1265
10 Slice Output from T1 System	2121	2221	2046	1912	2517	2497	2111	1946	2205	1668	1420	1927	2255	2093
11 Direct Service Industries	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	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	12.0	12.0	12.0	12.0
13 Contract Deliveries	2344	2425	2258	1502	1509	1509	1483	1483	1476	1476	1476	1476	1476	1494
14 Exports	1510	1591	1424	1167	1167	1167	1142	1142	1142	1142	1142	1142	1142	1159
15 Intra-Regional Transfers (Out)	834	834	834	334	341	341	341	341	334	334	334	334	334	334
16 Total Firm Obligations	10099	9990	9515	8647	10118	11001	10743	10003	9689	8658	8361	8439	8916	9479
Net Resources														
17 Hydro	10623	11151	10178	9410	11807	11761	10109	9351	10661	8363	7259	10775	12303	10451
18 Regulated Hydro - Net	10050	10587	9653	8934	11386	11446	9906	9121	10271	7745	6625	9956	11459	9842
19 Independent Hydro - Net	569	560	522	472	417	311	198	225	385	613	629	815	840	605
20 Small Hydro - Net	3.49	3.49	3.00	4.11	4.49	4.60	4.59	4.62	4.58	4.58	4.58	4.58	4.09	3.19
21 Non-Hydro Renewable	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 Wind - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 Solar - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Other - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Thermal	1163	1163	1179	1181	1179	1180	1169	1169	1169	1160	1160	0	0	1168
26 Nuclear - Net	1163	1163	1179	1181	1179	1180	1169	1169	1169	1160	1160	0	0	1168
27 Coal - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 Natural Gas - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 Petroleum - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 Biofuel - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Cogeneration - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32 Contract Purchases	435	437	426	273	335	434	402	349	329	268	264	273	288	284
33 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
34 Intra-Regional Transfers (In)	150	150	150	0	50.0	150	125	75.0	50.0	0	0	0	0	0
35 Non-Federal CER	235	235	235	235	235	235	235	235	235	235	235	235	235	235
36 Slice Transmission Loss Return	48.7	51.0	39.7	37.1	48.9	48.5	41.0	37.8	42.8	32.4	27.6	37.4	51.8	48.1
37 Reserves & Losses	-1862	-1895	-1775	-1741	-1912	-1951	-1848	-1785	-1842	-1684	-1614	-1781	-1917	-1852
38 Operating Reserves	-667	-683	-632	-625	-725	-762	-711	-671	-689	-601	-563	-659	-710	-668
39 Balancing Reserves	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825
40 Transmission Losses	-370	-388	-318	-291	-363	-363	-313	-289	-328	-258	-225	-297	-382	-360
41 Total Net Resources	10359	10855	10008	9123	11409	11425	9831	9084	10317	8107	7069	9267	10673	10050
42 Total Surplus/Deficit	260	866	493	476	1,291	425	-911	-920	627	-551	-1,293	829	1,757	571

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 5-5: 80-Water Conditions Monthly Energy

**Federal System Analysis Surplus Deficit
Operating Year 2023**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Federal Report Surplus Deficit By Water Year
Operating Year 2023
2022 White Book (80 WY) Report Date: 5/4/2022
S228-WB-20220504-112334

Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
1 1929 Federal Report Surplus Deficit	387	888	75.3	29.1	271	-554	-652	-379	-244	-785	-1250	-618	1536	-325	-104
2 1930 Federal Report Surplus Deficit	-26.5	-47.5	184	-337	258	-795	-932	-545	-602	-940	-1067	120	163	568	-246
3 1931 Federal Report Surplus Deficit	161	72.1	114	-325	358	-511	-1267	-545	-183	-588	-1331	-5.21	89.3	580	-210
4 1932 Federal Report Surplus Deficit	435	-0.58	-33.5	-388	-6.93	-600	-671	-1455	1671	2202	2290	3092	3650	1591	786
5 1933 Federal Report Surplus Deficit	526	774	109	-65.4	158	955	2376	3062	1610	740	-123	2025	5138	4153	1699
6 1934 Federal Report Surplus Deficit	2267	2374	246	526	2878	4394	5668	5158	3226	4295	3081	3249	2356	32.8	2798
7 1935 Federal Report Surplus Deficit	-83.5	78.9	-190	-348	-336	-25.9	1854	2862	1014	-297	-164	1596	1471	2094	803
8 1936 Federal Report Surplus Deficit	1951	222	-176	-156	209	-584	-1098	-1340	240	-870	1813	3818	2867	1430	574
9 1937 Federal Report Surplus Deficit	178	133	-78.4	-198	415	-577	-1594	-1492	-645	-873	-1176	386	909	167	-292
10 1938 Federal Report Surplus Deficit	21.1	-233	-57.9	-160	502	288	2322	813	2479	1627	3021	2701	2745	2205	1341
11 1939 Federal Report Surplus Deficit	-143	-243	82.8	-70.0	102	-786	266	802	383	-4.64	443	1973	688	875	359
12 1940 Federal Report Surplus Deficit	205	14.9	28.6	-214	358	-525	1018	305	1794	991	327	1311	602	65.5	461
13 1941 Federal Report Surplus Deficit	-368	-316	-217	-217	624	181	-510	-548	-68.4	-304	-622	582	565	359	-1.43
14 1942 Federal Report Surplus Deficit	198	70.1	-107	-176	704	1799	2000	1476	-154	-816	277	466	2981	2501	943
15 1943 Federal Report Surplus Deficit	770	784	149	-162	169	246	2697	3142	2069	4875	3964	2568	4366	3851	2012
16 1944 Federal Report Surplus Deficit	1115	766	-72.1	-313	299	-726	-769	187	-623	-1261	-1572	-396	-75.8	-92.3	-258
17 1945 Federal Report Surplus Deficit	165	-286	-197	-290	241	-562	-1062	-882	-320	-1088	-1351	1313	3265	45.7	24.1
18 1946 Federal Report Surplus Deficit	252	-31.0	47.7	-362	219	305	1593	1206	2210	2700	3154	3291	2973	2741	1439
19 1947 Federal Report Surplus Deficit	1508	1581	132	-220	992	2870	3403	3944	2771	958	527	2951	2796	2519	2031
20 1948 Federal Report Surplus Deficit	1044	409	214	2007	2074	1437	3430	3577	998	407	2633	5211	5837	2466	2449
21 1949 Federal Report Surplus Deficit	2329	2598	410	224	772	-176	1974	585	2690	1196	3170	4169	2001	184	1465
22 1950 Federal Report Surplus Deficit	-604	-562	-287	-376	175	292	3675	2758	3313	3214	1617	2193	4583	5390	1958
23 1951 Federal Report Surplus Deficit	2498	2229	227	970	2376	3015	4757	5506	3576	3221	2273	3091	2610	3861	2913
24 1952 Federal Report Surplus Deficit	1742	743	165	1803	1402	1536	2958	3389	1803	2683	3805	4668	2759	2578	2290
25 1953 Federal Report Surplus Deficit	1216	167	-102	-336	431	-613	490	3982	549	-1077	-787	1754	5399	3556	1216
26 1954 Federal Report Surplus Deficit	1252	1159	312	3.02	818	1009	3127	3591	2177	911	794	3278	4197	5003	2125
27 1955 Federal Report Surplus Deficit	3355	3844	1742	503	1536	936	18.0	585	-605	-90.8	-905	1373	4802	5023	1590
28 1956 Federal Report Surplus Deficit	2551	1723	185	271	1940	2902	4996	4451	3291	2839	5169	4758	5468	3602	3158
29 1957 Federal Report Surplus Deficit	1965	1966	123	290	735	1066	1299	1489	1592	2987	640	4962	5148	1608	1843
30 1958 Federal Report Surplus Deficit	1039	90.2	17.4	-283	315	-97.5	2175	2578	1370	-181	1460	4057	4014	1206	1370
31 1959 Federal Report Surplus Deficit	819	185	80.9	-137	1398	2353	4357	4711	2281	1444	1200	1985	4346	4032	2254
32 1960 Federal Report Surplus Deficit	2013	2361	2307	3356	3004	2187	2321	2360	1344	3338	2053	2024	3122	2292	2431
33 1961 Federal Report Surplus Deficit	1499	156	27.6	-22.6	820	401	2731	2299	2751	1618	353	2812	5119	1284	1662
34 1962 Federal Report Surplus Deficit	757	409	-9.24	-506	449	405	1465	2966	-77.1	1061	2414	2255	3080	1233	1114
35 1963 Federal Report Surplus Deficit	1206	787	129	241	1528	2016	1814	3057	386	-181	-450	1582	2873	2154	1361
36 1964 Federal Report Surplus Deficit	1383	494	475	-80.9	306	349	304	1814	-177	680	-101	2051	5645	4533	1362
37 1965 Federal Report Surplus Deficit	2290	1979	880	788	1216	3150	4983	5978	3621	1209	1998	3728	3664	3096	2889
38 1966 Federal Report Surplus Deficit	2389	2369	161	199	357	561	1108	2505	528	1101	634	1126	2272	1955	1160
39 1967 Federal Report Surplus Deficit	1127	97.6	2.16	-311	230	985	3100	4455	2214	813	15.4	1752	4824	3606	1805
40 1968 Federal Report Surplus Deficit	1506	1252	247	98.9	1121	671	2641	2487	2715	-709	-1059	1287	3037	2364	1427
41 1969 Federal Report Surplus Deficit	1738	1307	1276	953	2061	1548	4223	4628	2376	3887	3361	3981	3192	2572	2648
42 1970 Federal Report Surplus Deficit	1023	749	102	-85.4	769	-60.7	1555	3195	811	-592	-917	2031	4677	637	1129
43 1971 Federal Report Surplus Deficit	433	248	85.1	-302	312	168	4423	5729	3405	2548	2177	4698	5669	3967	2550
44 1972 Federal Report Surplus Deficit	2436	2753	429	291	957	972	4650	4009	5181	4435	1747	4347	5771	4040	3025
45 1973 Federal Report Surplus Deficit	2645	3054	585	544	735	594	1048	1178	34.9	-554	-1509	572	578	40.3	645
46 1974 Federal Report Surplus Deficit	36.3	-542	-241	-435	605	1700	6481	5961	4495	3837	3825	3996	5556	5402	3074
47 1975 Federal Report Surplus Deficit	2747	3120	555	-133	303	25.2	1810	2592	2247	-55.6	203	1894	5098	4379	1812
48 1976 Federal Report Surplus Deficit	1522	1543	636	1003	2299	3842	4181	4560	3205	3067	2319	4256	3316	3911	2947
49 1977 Federal Report Surplus Deficit	3819	4873	2158	557	254	-460	-383	370	-868	-1271	-1578	-68.7	-275	-154	341
50 1978 Federal Report Surplus Deficit	180	-180	-445	-560	53.4	673	1382	795	2071	1700	931	2516	2635	2927	1118

Federal Report Surplus Deficit By Water Year
Operating Year 2023
2022 White Book (80 WY) Report Date: 5/4/2022
S228-WB-20220504-112334

Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
51 1979 Federal Report Surplus Deficit	558	263	1108	490	609	-374	874	112	1170	159	-191	2668	1051	1.66	679
52 1980 Federal Report Surplus Deficit	-164	-354	55.6	-136	216	-960	762	-320	32.8	-175	1630	4103	3689	1262	769
53 1981 Federal Report Surplus Deficit	-26.4	-134	33.6	-189	643	2157	3061	3937	539	-1003	-429	1876	5066	3303	1621
54 1982 Federal Report Surplus Deficit	2444	2436	387	-81.6	950	803	3099	4942	4833	2415	1000	3119	4674	4801	2628
55 1983 Federal Report Surplus Deficit	2334	2843	1211	988	1063	1287	3335	3085	4508	1691	791	2113	2888	4117	2372
56 1984 Federal Report Surplus Deficit	2241	1828	546	215	2539	1471	3093	3095	3038	1790	2069	2313	4984	3701	2406
57 1985 Federal Report Surplus Deficit	1824	961	586	320	1018	567	1400	1408	500	877	812	2063	960	238	938
58 1986 Federal Report Surplus Deficit	-485	-646	-38.7	373	1497	764	2236	3685	4335	3172	1739	1883	3132	1093	1721
59 1987 Federal Report Surplus Deficit	464	-13.9	-89.3	-389	768	650	470	45.2	789	-49.7	801	2393	893	-360	484
60 1988 Federal Report Surplus Deficit	-437	-660	-371	-489	319	-782	-1230	-744	-236	-896	-90.0	304	717	839	-225
61 1989 Federal Report Surplus Deficit	107	-144	-5.45	-565	567	167	-68.9	-1209	1265	1161	2618	2018	788	717	472
62 1990 Federal Report Surplus Deficit	-265	-276	-177	-245	643	1205	2024	3358	1917	772	1866	1389	3351	3059	1451
63 1991 Federal Report Surplus Deficit	1784	961	-49.9	-411	2466	1725	2897	4210	2194	1588	514	1990	2626	3804	1975
64 1992 Federal Report Surplus Deficit	2369	1769	-181	-113	464	-845	117	176	625	-581	-247	1324	255	-231	273
65 1993 Federal Report Surplus Deficit	-137	-192	-196	-649	207	-373	-856	-1592	257	428	-958	3045	2087	1132	231
66 1994 Federal Report Surplus Deficit	550	562	230	-322	409	-330	-897	-294	-159	-740	454	1122	442	369	83.3
67 1995 Federal Report Surplus Deficit	-120	-383	-15.7	-414	120	-191	477	1071	2393	272	-695	1839	3966	1591	861
68 1996 Federal Report Surplus Deficit	686	419	337	790	3242	5298	5823	5873	4872	2253	3767	3080	4352	4046	3427
69 1997 Federal Report Surplus Deficit	2132	839	177	3.78	929	1609	5541	6225	4562	3716	4576	5210	5862	4258	3314
70 1998 Federal Report Surplus Deficit	2180	3007	1155	2464	1763	564	1548	2596	1187	-257	-209	3453	3992	2598	1973
71 1999 Federal Report Surplus Deficit	2013	1133	186	-149	64.9	1076	4184	3805	4636	1713	1869	2076	4168	4437	2315
72 2000 Federal Report Surplus Deficit	3304	3362	180	-170	2379	2060	2428	2208	2170	2230	2716	2063	596	2042	1815
73 2001 Federal Report Surplus Deficit	1143	-228	-232	-249	186	-518	-408	182	-387	-1294	-1521	-305	-333	-24.3	-256
74 2002 Federal Report Surplus Deficit	179	-373	-339	-693	-101	27.8	-348	-234	260	624	2052	1763	3902	3234	728
75 2003 Federal Report Surplus Deficit	530	496	-76.9	-278	500	-542	-245	322	1933	517	771	780	3027	270	567
76 2004 Federal Report Surplus Deficit	-476	-337	-300	-483	819	628	527	461	229	167	71.6	609	1528	434	344
77 2005 Federal Report Surplus Deficit	-531	141	30.2	408	921	1278	1253	2427	479	-938	-870	752	1281	1177	734
78 2006 Federal Report Surplus Deficit	209	-190	-39.3	-614	967	598	2766	4224	1538	3470	2328	3809	3558	1537	1749
79 2007 Federal Report Surplus Deficit	50.9	-281	-266	-488	652	650	2268	1485	3049	2023	882	1916	1905	1779	1190
80 2008 Federal Report Surplus Deficit	-102	-425	-478	-472	671	-337	1107	596	883	-138	-930	2655	5003	2688	960
Ranked Averages															
81 Middle 80 pct	300	84.2	-371	-473	58.8	-223	745	1078	736	248	217	1434	2139	1314	1348
82 Top 10 pct	1824	1480	319	468	1827	2987	5231	5302	4003	3208	3195	3968	4328	3583	3061

Section 6: Pacific Northwest Regional Analysis Exhibits

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 6-1: Annual Energy

**Regional Analysis Surplus Deficit
Operating Year 2023 to 2032**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Loads and Resources - Pacific Northwest Region
Operating Year: 2023 to 2032 Water Year: 1937
2022 White Book (80 WY) Report Date: 5/5/2022

S228-WB-20220504-112334

Energy-aMW	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Regional Loads										
1 Retail Loads	23006	23310	23596	23888	24169	24438	24703	24881	24990	25067
2 Federal Agency	125	140	149	155	157	158	159	162	167	167
3 USBR	188	188	188	188	188	188	188	188	188	188
4 Cooperative	2513	2671	2823	3009	3181	3349	3484	3571	3616	3635
5 Municipality	2504	2511	2508	2505	2504	2501	2502	2504	2509	2512
6 Public Utility District	4545	4602	4673	4737	4805	4867	4937	4985	5005	5026
7 Investor-Owned Utility	13083	13151	13207	13246	13287	13329	13385	13424	13458	13493
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	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
10 Federal Diversity	0	0	0	0	0	0	0	0	0	0
11 Exports	1085	1018	1017	1017	1017	1017	1015	1013	765	670
12 Canada	464	464	464	464	464	464	464	464	464	464
13 East Continental Divide	3.37	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14 Inland Southwest	10.8	0	0	0	0	0	0	0	0	0
15 Pacific Southwest	607	553	552	552	552	552	550	548	300	205
16 Other	0	0	0	0	0	0	0	0	0	0
17 Total Regional Loads	24091	24328	24614	24906	25186	25455	25718	25894	25756	25737
Regional Resources										
18 Hydro	11523	11627	11642	11643	11644	11637	11636	11642	11636	11636
19 Regulated Hydro - Net	10256	10361	10375	10376	10377	10371	10368	10375	10368	10370
20 Independent Hydro - Net	1024	1023	1024	1024	1024	1023	1024	1024	1024	1023
21 Small Hydro - Net	244	243	244	244	244	243	244	244	244	243
22 Non-Hydro Renewable	2243	2243	2244	2243	2243	2243	2244	2243	2227	2238
23 Wind - Net	1821	1819	1821	1821	1821	1819	1821	1821	1805	1817
24 Solar - Net	266	266	266	266	266	266	266	266	266	266
25 Other - Net	156	157	157	156	156	157	157	156	156	156
26 Thermal	12848	13003	12795	12443	12175	12197	12102	12279	12028	12197
27 Nuclear - Net	994	1116	994	1116	994	1116	994	1116	994	1116
28 Coal - Net	3687	3751	3676	3201	3049	2955	2981	3034	2948	2962
29 Natural Gas - Net	5412	5373	5372	5371	5371	5373	5372	5368	5371	5372
30 Petroleum - Net	0	0	0	0	0	0	0	0	0	0
31 Biofuel - Net	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5
32 Cogeneration - Net	2730	2737	2727	2729	2736	2728	2730	2736	2690	2721
33 Imports	586	589	593	597	601	605	609	613	133	38.8
34 Canada	38.8	38.8	38.8	38.8	38.8	38.8	38.8	38.8	36.7	36.5
35 East of Continental Divide	0	0	0	0	0	0	0	0	0	0
36 Inland Southwest	498	502	506	509	513	517	521	525	93.6	0
37 Pacific Southwest	48.7	48.8	48.9	48.9	49.0	49.1	49.2	49.2	2.19	2.28
38 Other	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-848	-856	-850	-839	-831	-832	-829	-835	-811	-814
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	-848	-856	-850	-839	-831	-832	-829	-835	-811	-814
43 Total Regional Resources	26352	26605	26424	26086	25832	25850	25761	25941	25212	25297
44 Total Surplus/Deficit	2261	2277	1810	1180	646	394	43.1	47.1	-543	-440

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 6-2: Monthly Energy

**Regional Analysis Surplus Deficit
Operating Year 2023**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Loads and Resources - Pacific Northwest Region
Operating Year: 2023 Water Year: 1937
2022 White Book (80 WY) Report Date: 5/5/2022

S228-WB-20220504-112334

Energy-aMW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
Regional Loads															
1 Retail Loads	22942	22958	20811	20861	23315	26086	25755	24662	22683	21824	21675	21198	22157	23870	23006
2 Federal Agency	116	116	105	114	125	155	160	140	130	119	119	108	107	119	125
3 USBR	330	329	286	123	9.66	10.8	8.39	18.0	60.9	233	235	345	395	427	188
4 Cooperative	2530	2532	2243	2203	2417	2804	2799	2655	2418	2349	2334	2385	2601	2762	2513
5 Municipality	2274	2276	2184	2337	2641	3002	3003	2871	2633	2424	2400	2204	2211	2286	2504
6 Public Utility District	4310	4313	3956	4151	4698	5376	5324	5028	4619	4352	4323	4107	4214	4436	4545
7 Investor-Owned Utility	13336	13345	11990	11884	13377	14689	14411	13903	12773	12298	12215	12002	12583	13793	13083
8 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
9 Direct-Service Industry	44.1	44.1	43.8	45.8	45.8	45.8	46.2	44.9	45.4	45.7	45.4	44.3	44.4	44.0	45.0
10 Federal Diversity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11 Exports	1290	1564	1345	917	1095	913	686	838	895	1241	1125	1171	1216	1325	1085
12 Canada	514	596	454	454	454	454	454	454	454	454	454	454	454	472	464
13 East Continental Divide	15.4	15.6	14.9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.37
14 Inland Southwest	25.8	25.8	25.8	25.8	25.8	25.8	0	0	0	0	0	0	0	0	10.8
15 Pacific Southwest	735	927	850	436	613	432	231	382	440	786	670	716	760	852	607
16 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Total Regional Loads	24232	24522	22156	21779	24410	26999	26441	25500	23578	23065	22800	22369	23373	25195	24091
Regional Resources															
18 Hydro	11575	11296	10017	9892	12419	12486	11024	9532	10236	10170	9764	13343	15182	12599	11523
19 Regulated Hydro - Net	10250	9978	8807	8855	11513	11539	10234	8678	9191	8651	8229	11364	13155	11053	10256
20 Independent Hydro - Net	1000	995	967	874	778	822	666	723	882	1238	1253	1576	1604	1140	1024
21 Small Hydro - Net	325	323	244	163	128	126	124	132	162	280	282	403	422	405	244
22 Non-Hydro Renewable	1826	2419	2201	1798	2308	1796	1136	1704	1936	3151	2749	2971	3004	2970	2243
23 Wind - Net	1300	1892	1742	1398	1988	1525	852	1367	1533	2690	2289	2472	2469	2408	1821
24 Solar - Net	370	370	302	241	162	113	137	179	244	304	304	352	402	382	266
25 Other - Net	157	157	157	159	158	158	147	158	158	157	157	147	133	179	156
26 Thermal	13441	13448	13493	13528	13729	13867	13824	13772	12671	12367	10660	9812	11187	13380	12848
27 Nuclear - Net	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	360	409	1116	994
28 Coal - Net	3821	3822	3825	3826	3824	3828	3828	3827	3541	2926	2729	3431	3842	3824	3687
29 Natural Gas - Net	5613	5620	5655	5719	5851	5921	5914	5872	5808	5661	4674	3587	4262	5587	5412
30 Petroleum - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31 Biofuel - Net	23.6	23.6	25.4	26.7	27.0	24.6	24.3	24.4	27.0	25.4	25.4	27.2	25.0	25.8	25.5
32 Cogeneration - Net	2867	2867	2871	2840	2911	2978	2941	2932	2179	2638	2116	2406	2649	2827	2730
33 Imports	576	576	509	480	668	768	605	604	507	454	454	502	651	703	586
34 Canada	20.8	20.8	15.8	22.0	38.9	49.3	62.3	70.8	62.7	30.2	30.2	28.9	38.6	27.0	38.8
35 East of Continental Divide	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36 Inland Southwest	554	554	491	457	447	483	453	468	443	422	422	471	611	674	498
37 Pacific Southwest	1.57	1.57	1.57	1.63	182	237	89.0	64.9	1.63	1.63	1.63	1.63	1.63	1.63	48.7
38 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-927	-938	-792	-776	-880	-873	-803	-773	-766	-789	-714	-804	-1015	-1002	-848
40 Operating Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41 Balancing Reserves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42 Transmission Losses	-927	-938	-792	-776	-880	-873	-803	-773	-766	-789	-714	-804	-1015	-1002	-848
43 Total Regional Resources	26491	26801	25428	24922	28245	28045	25786	24838	24584	25352	22913	25823	29010	28649	26352
44 Total Surplus/Deficit	2259	2279	3272	3143	3835	1046	-655	-661	1006	2286	114	3454	5637	3455	2261

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 6-3: Annual 120-Hour Capacity

**Regional Analysis Surplus Deficit
Operating Year 2023 to 2032**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Loads and Resources - Pacific Northwest Region
Operating Year: 2023 to 2032 Water Year: 1937
2022 White Book (80 WY) Report Date: 5/5/2022

S228-WB-20220504-112334

120Hr-MW	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Regional Loads										
1 Retail Loads	30253	30669	30944	31384	31675	32025	32262	32477	32630	32799
2 Federal Agency	158	161	180	187	194	194	197	201	205	208
3 USBR	620	620	620	620	620	620	620	620	620	620
4 Cooperative	3336	3511	3667	3873	4044	4247	4410	4528	4596	4632
5 Municipality	3125	3138	3137	3148	3147	3150	3149	3158	3159	3147
6 Public Utility District	5886	5973	6051	6134	6207	6285	6363	6441	6477	6503
7 Investor-Owned Utility	18110	18244	18320	18378	18434	18499	18574	18627	18676	18726
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	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7	59.7
10 Federal Diversity	-1044	-1039	-1093	-1018	-1033	-1031	-1113	-1159	-1166	-1099
11 Exports	1828	1519	1519	1519	1519	1520	1519	1511	1511	1202
12 Canada	1201	1201	1201	1201	1201	1201	1201	1201	1201	1201
13 East Continental Divide	26.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14 Inland Southwest	25.8	0	0	0	0	0	0	0	0	0
15 Pacific Southwest	575	317	317	317	317	317	317	309	309	0
16 Other	0	0	0	0	0	0	0	0	0	0
17 Total Regional Loads	32081	32189	32464	32904	33194	33545	33781	33989	34142	34001
Regional Resources										
18 Hydro	22650	22704	22495	22502	22288	22330	22547	22522	22547	22522
19 Regulated Hydro - Net	20623	20677	20468	20475	20261	20303	20520	20495	20520	20495
20 Independent Hydro - Net	1664	1664	1664	1664	1664	1664	1664	1664	1664	1664
21 Small Hydro - Net	363	363	363	363	363	363	363	363	363	363
22 Non-Hydro Renewable	193	193	193	193	193	193	193	193	193	193
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	193	193	193	193	193	193	193	193	193	193
26 Thermal	14463	14433	14433	14433	13630	13630	13630	13630	13630	13570
27 Nuclear - Net	1163	1163	1163	1163	1163	1163	1163	1163	1163	1163
28 Coal - Net	4194	4194	4194	4194	3391	3391	3391	3391	3391	3391
29 Natural Gas - Net	5959	5929	5929	5929	5929	5929	5929	5929	5929	5929
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	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
32 Cogeneration - Net	3078	3078	3078	3078	3078	3078	3078	3078	3078	3018
33 Imports	936	944	952	960	969	977	986	995	1004	146
34 Canada	146	146	146	146	146	146	146	146	146	144
35 East of Continental Divide	0	0	0	0	0	0	0	0	0	0
36 Inland Southwest	788	796	804	812	821	829	838	847	856	0
37 Pacific Southwest	1.57	1.63	1.71	1.77	1.85	1.92	2.01	2.08	2.14	2.20
38 Other	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-3924	-3939	-3935	-3932	-3874	-3887	-3911	-3917	-3923	-3893
40 Operating Reserves	-1880	-1894	-1898	-1894	-1870	-1882	-1898	-1905	-1910	-1913
41 Balancing Reserves	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825
42 Transmission Losses	-1219	-1220	-1213	-1213	-1179	-1181	-1188	-1187	-1188	-1156
43 Total Regional Resources	34317	34335	34138	34156	33206	33243	33445	33423	33450	32537
44 Total Surplus/Deficit	2236	2146	1674	1252	11.5	-302	-336	-566	-691	-1464

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 6-4: Monthly 120-Hour Capacity

**Regional Analysis Surplus Deficit
Operating Year 2023**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Loads and Resources - Pacific Northwest Region

Operating Year: 2023 Water Year: 1937

2022 White Book (80 WY) Report Date: 5/5/2022

S228-WB-20220504-112334

120Hr-MW	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Regional Loads														
1 Retail Loads	30253	29963	27060	26621	30409	33176	33071	32067	29256	27649	27600	26808	28701	30904
2 Federal Agency	158	158	147	164	176	212	221	200	183	173	173	151	149	161
3 USBR	620	620	577	407	104	144	201	177	343	425	425	520	600	619
4 Cooperative	3336	3336	3011	3032	3334	3826	3797	3657	3412	3300	3300	3226	3379	3544
5 Municipality	3125	3125	2890	3138	3605	4107	4002	3842	3620	3304	3304	2961	3011	3150
6 Public Utility District	5886	5886	5460	5795	6660	7366	7390	6971	6485	6061	6061	5649	5688	5938
7 Investor-Owned Utility	18110	18110	16064	15119	17478	18651	18559	18320	16479	15495	15495	15325	16856	18328
8 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
9 Direct-Service Industry	59.7	59.7	60.6	61.6	62.0	62.0	62.4	61.7	62.0	62.4	62.4	61.1	61.5	59.8
10 Federal Diversity	-1044	-1335	-1152	-1098	-1012	-1195	-1164	-1164	-1331	-1173	-1222	-1088	-1047	-898
11 Exports	1828	1909	1742	1176	1168	1168	1143	1143	1143	1143	1151	1151	1460	1477
12 Canada	1201	1283	1142	1142	1142	1142	1142	1142	1142	1142	1142	1142	1142	1159
13 East Continental Divide	26.0	26.0	26.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14 Inland Southwest	25.8	25.8	25.8	25.8	25.8	25.8	0	0	0	0	0	0	0	0
15 Pacific Southwest	575	575	549	8.04	0	0	0	0	0	0	8.04	8.04	317	317
16 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 Total Regional Loads	32081	31872	28802	27797	31577	34344	34214	33210	30399	28792	28751	27959	30160	32381
Regional Resources														
18 Hydro	22650	23029	21750	21174	23830	23783	21928	20828	22250	19984	18932	22235	24707	22654
19 Regulated Hydro - Net	20623	21012	19865	19462	22234	22235	20534	19455	20561	17900	16822	19797	22189	20466
20 Independent Hydro - Net	1664	1656	1605	1515	1433	1392	1243	1208	1486	1766	1790	1998	2059	1750
21 Small Hydro - Net	363	361	280	197	164	156	151	164	203	319	320	441	459	439
22 Non-Hydro Renewable	193	193	193	194	193	193	182	194	193	193	193	194	192	192
23 Wind - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 Solar - Net	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 Other - Net	193	193	193	194	193	193	182	194	193	193	193	194	192	192
26 Thermal	14463	14463	14526	14671	14821	14904	14901	14849	14160	13553	12537	12455	12841	14437
27 Nuclear - Net	1163	1163	1179	1181	1179	1180	1169	1169	1169	1160	1160	0	0	1168
28 Coal - Net	4194	4194	4193	4194	4194	4195	4195	4195	4194	3341	3859	4196	4193	4193
29 Natural Gas - Net	5959	5959	5989	6086	6215	6282	6288	6243	6195	6152	5097	5615	5496	5932
30 Petroleum - Net	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5
31 Biofuel - Net	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
32 Cogeneration - Net	3078	3078	3096	3141	3163	3177	3179	3173	2533	2832	2352	2576	3082	3075
33 Imports	936	936	796	737	985	1090	1063	1095	798	703	703	745	1009	1090
34 Canada	146	146	146	147	102	124	155	188	213	147	147	147	146	146
35 East of Continental Divide	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36 Inland Southwest	788	788	648	588	581	665	607	606	583	554	554	597	861	942
37 Pacific Southwest	1.57	1.57	1.57	1.63	302	302	302	302	1.63	1.63	1.63	1.63	1.63	1.63
38 Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39 Reserves & Losses	-3924	-3948	-3653	-3615	-3880	-3970	-3855	-3761	-3715	-3528	-3389	-3588	-3957	-3943
40 Operating Reserves	-1880	-1892	-1764	-1739	-1916	-2005	-1946	-1884	-1824	-1724	-1646	-1749	-1896	-1895
41 Balancing Reserves	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825	-825
42 Transmission Losses	-1219	-1232	-1065	-1050	-1139	-1140	-1084	-1052	-1067	-979	-918	-1015	-1236	-1223
43 Total Regional Resources	34317	34673	33612	33160	35949	36000	34220	33205	33684	30906	28976	32040	34792	34430
44 Total Surplus/Deficit	2236	2801	4810	5363	4372	1656	6.14	-5.10	3286	2114	225	4082	4631	2048

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 6-5: 80-Water Conditions Monthly Energy

**Regional Analysis Surplus Deficit
Operating Year 2023**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Regional Report Surplus Deficit By Water Year
Operating Year 2023
2022 White Book (80 WY) Report Date: 5/4/2022
S228-WB-20220504-112334

Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
1 1929 Regional Report Surplus Deficit	3521	3835	3926	4205	4320	1220	487	1479	1899	3252	78.4	2275	6679	2514	2860
2 1930 Regional Report Surplus Deficit	1917	1900	3852	2870	3536	532	266	1715	1420	2050	309	3483	3794	3672	2350
3 1931 Regional Report Surplus Deficit	1972	1954	3784	2985	4021	878	234	1054	2155	2241	-96.6	2842	2980	3301	2275
4 1932 Regional Report Surplus Deficit	2217	1690	3287	2910	3624	947	905	-115	6032	8496	7455	9018	11218	6245	4515
5 1933 Regional Report Surplus Deficit	3326	3605	3895	3661	4770	4433	6570	7982	5931	5651	2431	6888	13595	11827	6407
6 1934 Regional Report Surplus Deficit	6837	6888	4586	5830	9690	10893	12662	12040	9254	11591	8232	9060	7685	2806	8416
7 1935 Regional Report Surplus Deficit	1760	2023	3210	3147	4178	2787	5737	7977	4606	3196	1751	6555	7304	7297	4743
8 1936 Regional Report Surplus Deficit	5655	2696	3424	3339	3753	865	-3.86	538	2626	3118	5602	10107	9701	5692	4059
9 1937 Regional Report Surplus Deficit	2259	2279	3272	3143	3835	1046	-655	-661	1006	2286	114	3454	5637	3455	2261
10 1938 Regional Report Surplus Deficit	2064	1536	3482	3481	5082	3333	6432	4112	7460	7552	9180	9029	9460	7306	5782
11 1939 Regional Report Surplus Deficit	2192	1892	3731	3547	3811	1489	2696	3976	3318	4161	3505	6876	5276	4439	3746
12 1940 Regional Report Surplus Deficit	2326	1932	3643	3233	4080	1612	4030	3266	6193	5797	2672	5707	4557	2544	3768
13 1941 Regional Report Surplus Deficit	851	1348	2934	3357	4389	2514	858	1420	2070	2765	258	3539	4302	2874	2575
14 1942 Regional Report Surplus Deficit	1841	1812	3260	3594	4839	5950	5221	5196	1985	2776	3252	4006	9561	7817	4680
15 1943 Regional Report Surplus Deficit	3321	3470	3865	3301	4235	3188	7156	8820	7075	12853	10035	8416	11743	11337	6974
16 1944 Regional Report Surplus Deficit	4753	3873	3900	3339	4098	1860	222	2742	1747	1595	-1101	1752	3160	2346	2470
17 1945 Regional Report Surplus Deficit	1912	1410	3022	2841	3438	1340	562	832	1911	2594	-361	5484	9859	3030	2926
18 1946 Regional Report Surplus Deficit	2633	1878	3793	3189	4455	3479	5490	5036	7124	9652	9469	9777	10201	8894	6102
19 1947 Regional Report Surplus Deficit	5094	5318	4076	3556	5953	8469	8406	10561	8288	6350	4766	8539	9529	7915	7153
20 1948 Regional Report Surplus Deficit	4161	3224	4294	8464	8210	5329	8495	8934	4621	5148	7846	12160	14409	8383	7774
21 1949 Regional Report Surplus Deficit	6974	7496	4815	4532	5453	2101	5159	4004	8042	6950	9146	10867	8703	3897	6081
22 1950 Regional Report Surplus Deficit	1457	1480	3301	3220	4749	3280	9224	8452	9822	10815	6943	7401	13331	13923	7240
23 1951 Regional Report Surplus Deficit	7578	7231	4565	6543	9297	9415	11332	13704	10149	10845	8090	9343	9672	10891	9290
24 1952 Regional Report Surplus Deficit	5833	4000	4535	8035	6943	5772	7531	9104	6342	9160	10112	11576	9719	8008	7662
25 1953 Regional Report Surplus Deficit	4518	2668	3714	3101	4058	1066	4071	10263	3995	2793	683	7037	13796	10304	5517
26 1954 Regional Report Surplus Deficit	4891	4703	4443	4134	5649	4958	8438	9865	7243	6912	4920	9318	12013	13348	7496
27 1955 Regional Report Surplus Deficit	8679	9587	7485	5068	7232	4358	2521	3942	1396	4202	453	5496	12684	13011	6228
28 1956 Regional Report Surplus Deficit	7263	5675	4245	5448	8332	8738	11933	10891	9484	9717	12576	11615	14711	10691	9460
29 1957 Regional Report Surplus Deficit	6277	6317	4344	5007	5409	5076	4811	5967	5868	10350	4141	12103	13282	6154	6795
30 1958 Regional Report Surplus Deficit	4216	2401	3665	3246	4154	2544	6492	8112	5499	4501	5585	10681	11288	5321	5755
31 1959 Regional Report Surplus Deficit	3677	2473	3881	3762	6991	7528	10582	11199	7245	7506	5668	7248	12003	11335	7591
32 1960 Regional Report Surplus Deficit	6128	6836	8821	10918	10093	6874	6411	7486	5556	11191	6755	7163	9892	7664	8018
33 1961 Regional Report Surplus Deficit	5190	2763	4014	3858	5832	3269	7331	7816	8079	7635	2934	8312	12651	5453	6300
34 1962 Regional Report Surplus Deficit	3504	2945	3681	2998	4527	3245	4845	7913	2387	6983	8351	7583	9870	5423	5246
35 1963 Regional Report Surplus Deficit	4687	3877	4155	4528	7209	6661	5528	9238	3497	3930	1193	6327	9766	7067	5873
36 1964 Regional Report Surplus Deficit	4551	3243	4715	3834	4682	3195	3327	6066	2249	6026	2127	7436	14464	12347	5842
37 1965 Regional Report Surplus Deficit	6890	6270	5803	5644	6197	9006	11583	13805	9970	7184	7438	10206	10746	9194	8809
38 1966 Regional Report Surplus Deficit	7031	7048	4544	4484	4665	3497	4501	6979	3947	7128	3932	5661	8489	6932	5507
39 1967 Regional Report Surplus Deficit	4167	2542	3854	3341	4315	4770	8379	10963	7148	5954	2572	6925	13553	10429	6741
40 1968 Regional Report Surplus Deficit	5228	4799	4345	4717	6163	3916	7507	8254	8569	2780	-556	5923	10413	7956	6146
41 1969 Regional Report Surplus Deficit	5490	5246	6767	6299	8276	5797	10125	10908	7246	11484	9837	10760	10435	8123	8369
42 1970 Regional Report Surplus Deficit	4148	3705	4286	3891	5220	2445	5555	8816	4350	2858	-288	7345	12266	4280	5271
43 1971 Regional Report Surplus Deficit	2976	2765	4029	3294	4669	3105	10716	13856	9979	9577	7862	11511	14799	11827	8237
44 1972 Regional Report Surplus Deficit	7443	7705	4896	4854	5971	4564	10969	11206	14069	13317	7125	11085	14893	11862	9335
45 1973 Regional Report Surplus Deficit	7774	8322	5360	5213	5283	4256	4499	4747	2625	3801	-1489	4154	4874	2855	4424
46 1974 Regional Report Surplus Deficit	1898	1025	3160	3018	5413	6273	14551	14294	12088	11337	10083	10440	14818	13984	9148
47 1975 Regional Report Surplus Deficit	7998	8444	5169	3795	4509	3115	5933	7773	7235	4570	2960	7571	13157	12239	6869
48 1976 Regional Report Surplus Deficit	5441	5734	5311	6485	8887	10718	10671	11152	9030	10324	7860	10888	10917	11325	9163
49 1977 Regional Report Surplus Deficit	9546	11136	8242	4893	4041	2031	984	2819	1183	1378	-1437	2021	2280	1909	3397
50 1978 Regional Report Surplus Deficit	1857	1476	2416	2971	3371	4102	4818	3931	6631	7895	5102	8325	8973	8980	5232

Regional Report Surplus Deficit By Water Year
Operating Year 2023
2022 White Book (80 WY) Report Date: 5/4/2022
S228-WB-20220504-112334

Energy-aMW - Surplus Deficit	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul	Avg
51 1979 Regional Report Surplus Deficit	3449	3170	6558	4795	4805	1735	3388	3086	5102	3961	1592	8163	6069	2949	4398
52 1980 Regional Report Surplus Deficit	1570	1646	3811	3512	3742	975	3667	2664	2893	4061	6457	10808	11080	5659	4642
53 1981 Regional Report Surplus Deficit	2043	2118	3879	3345	5169	7564	8203	10262	3800	2135	1561	6738	12599	9260	6200
54 1982 Regional Report Surplus Deficit	6513	6654	4522	3937	5616	4290	7888	12343	12544	9228	5273	9526	12542	12817	8297
55 1983 Regional Report Surplus Deficit	6854	7647	6299	6029	5977	5438	9230	9028	11893	7942	4649	7880	9667	11471	8041
56 1984 Regional Report Surplus Deficit	6883	5988	4963	4477	9334	5612	8844	8752	8655	7554	6336	7627	12700	10350	7877
57 1985 Regional Report Surplus Deficit	6010	4329	5123	4725	6316	3555	4327	5147	3735	6448	4813	7595	6035	3437	5056
58 1986 Regional Report Surplus Deficit	1201	1159	3829	4980	7295	3821	7029	9535	11696	10603	6739	7196	10121	4916	6657
59 1987 Regional Report Surplus Deficit	2893	2340	3629	3297	5623	3786	3132	2996	4743	3977	4175	7635	4955	2038	4046
60 1988 Regional Report Surplus Deficit	1020	878	2826	2528	3510	1219	151	686	2015	2228	2313	3649	4912	4342	2425
61 1989 Regional Report Surplus Deficit	1929	1609	3359	2662	5043	2621	1911	164	4994	6787	8509	7292	5670	4623	3995
62 1990 Regional Report Surplus Deficit	1788	1850	3469	3205	5638	5301	6906	8840	6456	6181	6622	6155	10260	9112	6105
63 1991 Regional Report Surplus Deficit	5541	4149	3594	3296	9428	5811	7565	10714	7224	7680	3692	7190	9163	10975	7095
64 1992 Regional Report Surplus Deficit	6761	5798	3378	3374	4560	892	2456	3024	3722	3414	1208	5146	3125	1787	3339
65 1993 Regional Report Surplus Deficit	1211	1354	2761	2159	3791	1225	-49.0	-220	3072	4915	399	9043	7672	5249	3238
66 1994 Regional Report Surplus Deficit	3374	3265	4231	2992	4071	1602	327	1769	2605	3592	3702	5354	4005	3081	3085
67 1995 Regional Report Surplus Deficit	1349	1141	3334	2801	3835	2312	3290	5267	7708	4836	594	7260	11327	6129	4758
68 1996 Regional Report Surplus Deficit	3535	2968	4361	5624	10797	12614	13439	14613	12928	9352	10580	9457	11673	10976	9944
69 1997 Regional Report Surplus Deficit	6320	4079	4321	4068	5797	5854	12957	14415	12333	11401	11533	12741	14650	12112	9623
70 1998 Regional Report Surplus Deficit	6881	8125	6671	9608	7710	4022	5863	7824	5501	4098	2116	9896	11524	8051	7271
71 1999 Regional Report Surplus Deficit	5840	4386	4260	3584	4320	5126	10400	10144	11990	8264	7226	7764	12125	12505	7911
72 2000 Regional Report Surplus Deficit	8831	8834	4322	3750	9145	6888	6857	6844	6807	9082	8713	7413	5477	6849	6839
73 2001 Regional Report Surplus Deficit	4266	2219	3335	3229	3698	1705	428	2223	1366	1670	-1222	2193	2379	2221	2182
74 2002 Regional Report Surplus Deficit	1776	1125	2577	2612	2679	2540	1820	2243	3143	5447	6753	6700	11282	9664	4404
75 2003 Regional Report Surplus Deficit	3247	3121	3650	2933	4173	1059	1951	3193	6250	4842	3807	4685	9065	3153	3960
76 2004 Regional Report Surplus Deficit	848	1257	2946	3226	5066	3424	3059	3286	2922	4075	2538	4409	6453	3773	3571
77 2005 Regional Report Surplus Deficit	915	2451	4073	4557	5517	4955	4633	6607	3316	1914	298	4567	5844	4799	4290
78 2006 Regional Report Surplus Deficit	2396	1491	3418	2578	5411	3446	8126	10222	5797	10684	7521	10356	10930	5954	6399
79 2007 Regional Report Surplus Deficit	2040	1573	3133	2767	5760	3837	6543	5501	9235	8198	4253	6902	7289	6268	5436
80 2008 Regional Report Surplus Deficit	2049	1365	3411	2587	4066	1719	3772	3232	4228	3738	4.10	8092	13150	8815	4722
Ranked Averages															
81 Middle 80 pct	3766	3422	4002	3811	5017	3245	4622	5678	5112	5526	3694	6894	8945	6683	5373
82 Top 10 pct	5912	5286	4583	5279	7820	8675	12233	12902	11034	10563	9280	10537	12196	10427	9243

Section 7: Climate Change Dataset Exhibits

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 7-1: RMJOC-II Scenarios

Federal 14 Projects Hydro Generation Forecast Annual Energy Fiscal Year 2022

1. **CanESM2-MACA-PRMS-P1**: Is the warmest and wettest scenario.
2. **MIROC5-BCSD-VIC-P3**: Near the median temperature projection; just above median precipitation above Grand Coulee, but below median Precipitation in the Snake River basin.
3. **HadGEM2-CC-MACA-VIC-P1**: Warmer scenario; median precipitation above Grand Coulee, but above the median precipitation in the Snake River basin.
4. **GFDL-BCSD-VIC-P2**: One of the coolest/driest scenarios.

THIS PAGE IS INTENTIONALLY LEFT BLANK

Federal 14 Projects Generation by Water Year
 RMJOC-II (2030s and 2060s) Scenarios
 Fiscal Year 2022

SCENARIOS - aMW	WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	15-Apr	30-Apr	MAY	JUNE	JULY	15-Aug	31-Aug	SEP	AVG.
	2020	7597	9010	8593	10319	8802	7095	6795	7216	8042	9116	5484	5826	5596	6754	7786
	2021	7763	8976	9938	11483	10866	5690	6909	9997	9549	10685	8465	6880	6179	5713	8659
	2022	5238	6979	9504	11516	10719	10000	8885	10375	10124	10033	5970	5568	5695	5241	8368
	2023	5727	7654	8477	10081	8458	11113	9384	10681	9427	9711	5211	5959	5648	5179	8069
	2024	4936	8445	10703	11479	10606	10048	10312	9566	9554	8662	5230	6029	5455	4130	8281
	2025	4648	6545	7179	6780	6541	5383	4249	4646	11103	10217	6228	6153	5888	5596	6725
	2026	5478	7165	8528	12477	13925	13998	13411	12563	12005	11251	10507	7982	7312	6038	10144
	2027	6551	7235	11173	12904	11964	13064	11553	12266	13648	14544	13739	10146	9988	6830	11140
	2028	7425	8568	9054	11640	9545	12410	10487	10610	9664	13753	8072	6260	6097	6062	9406
	2029	6860	10620	11206	12397	14538	13853	11446	10720	9757	11273	12115	10404	10129	7646	10947
	2030	7720	9886	9632	11623	9308	7952	6305	5253	5444	4899	4736	5474	5437	5248	7300
	2031	4164	6005	5870	6112	6198	8890	11856	11656	12180	9717	8288	7500	6565	5796	7671
	2032	5896	7966	11129	11735	11092	9836	5925	6668	8714	14765	9402	6684	6183	6010	9099
	2033	5703	6821	8138	10741	13803	13475	8955	8871	9316	8270	9427	8872	9382	11520	9579
	2034	10764	13047	12151	14231	13652	13249	11566	13123	11670	12305	9453	6950	6505	6808	11350
	2035	8928	8992	8625	11436	8566	7286	6004	6364	8202	7907	5825	5790	5586	6924	7878
	2036	6393	7896	10028	12171	12368	9471	11087	11789	12725	11716	7488	8072	8003	5725	9611
	2037	6269	9984	10276	11478	13428	11669	5935	7918	9391	7991	4685	5901	5503	4286	8479
	2038	4422	6609	6260	7991	7214	10853	10056	8010	7981	7442	6168	6540	6016	5561	7150
	2039	5046	6321	7532	10330	7429	12097	6403	8275	9138	8611	5915	6058	5749	5099	7572
	2040	4791	6151	10598	11612	10822	13677	10207	10062	11354	9022	6051	6101	5724	5532	8805
	2041	5309	6592	10261	12312	12819	12730	7997	11050	11294	9641	5766	5794	6376	6944	9087
	2042	10462	10515	10383	10298	9282	9707	10041	11948	12779	10331	6069	5672	5933	5191	9319
	2043	5065	7340	11227	12577	11939	10894	9127	9770	9634	9929	5600	6095	5620	5937	8768
	2044	8962	13859	12049	12902	13552	12528	7770	11116	13429	12595	11760	8585	6866	7270	11331
	2045	8306	10164	9633	8351	8079	8800	10448	9807	14533	15121	9560	7459	6299	6768	9696
	2046	11258	12380	14015	14077	14382	13288	13239	12169	10696	7846	5890	5544	6068	5491	10634
	2047	9251	13446	14083	14104	13387	13283	13302	13253	13790	13764	11525	8825	7574	6989	12082
	2048	6202	8521	10898	11549	10502	11030	11967	11632	9748	10591	5592	6112	5587	4822	8916
	2049	5844	10825	13752	13769	12923	13672	12617	12025	10791	10156	6117	5869	6098	5789	10144
	2060	7667	11460	11740	14276	14615	13849	14185	13553	11246	10350	5821	5928	6001	6099	10559
	2061	6038	13439	14000	13874	14209	13311	12578	11665	11944	10342	5237	5632	6405	6109	10525
	2062	7728	12215	13438	13368	14553	13799	13230	11933	9690	8546	4904	5877	5910	5282	10136
	2063	6148	9669	10264	13103	13580	11806	9418	13565	14691	13260	6173	5309	5615	5594	10076
	2064	5235	8218	8910	14187	14669	13930	14140	13889	12241	11033	6345	5382	5661	5742	9981
	2065	6688	12075	12890	12263	14306	13719	13752	14214	11605	8578	5904	5727	6048	5507	10254
	2066	7385	10591	10690	11909	13061	12417	9352	9204	9256	8154	5262	6083	5564	5445	9081
	2067	5313	6918	6590	9834	12002	11339	9435	12333	10343	9520	5527	6026	5620	4124	8156
	2068	4541	9666	10966	12701	13120	13315	10667	11958	14862	12309	8926	6651	6397	5984	10343
	2069	5215	8272	12036	14045	14380	13509	12546	13116	13599	9588	5331	5797	6327	5813	10032
	2070	5984	9298	13590	12762	13436	12567	10097	7755	8135	6718	5852	5909	5735	5553	9033
	2071	5372	8602	14014	14183	14529	13555	13652	13537	10308	14353	6927	6102	8301	6916	10768
	2072	12572	12671	13906	13775	14604	13344	6966	9494	9812	10551	7434	6151	5996	5704	10717
	2073	5542	11147	12585	13924	14034	12757	13614	13887	12089	10729	6079	5672	5701	5695	10305
	2074	7049	8691	10547	12686	14159	13870	12023	13197	13249	11748	12195	9228	8792	9058	11223
	2075	7394	8719	9373	11597	14244	14245	12170	11032	10436	7473	5739	5754	5612	5184	9278
	2076	9771	11120	11885	11154	14031	14226	13220	11013	10899	10543	6589	6049	5656	5607	10301
	2077	5908	12448	13592	13781	13576	13709	12280	10930	9859	8526	5023	5997	5605	4609	9845
	2078	4712	7187	13351	13899	14267	13726	13975	10735	9450	9358	5342	5504	5580	4952	9484
	2079	6086	10863	13837	14002	14277	13744	13874	14035	11448	9832	5424	6031	5686	4317	10276
	2080	4780	11439	14025	14087	14457	13830	12279	10031	8716	9145	5946	5572	6264	5659	9912
	2081	7588	13467	11546	11776	11167	11053	7804	6435	4919	4930	5422	6172	6380	5243	8360
	2082	5529	9800	9375	12158	14559	14025	11297	9500	7495	7670	5306	5985	5536	5074	8890
	2083	4640	6437	8667	12105	13303	13847	10865	8319	9518	8105	4882	5651	7124	4264	8456
	2084	4501	7468	11599	14364	13882	13310	14080	13200	13357	13353	7079	5887	6159	6780	10429
	2085	6857	8129	11004	13600	14710	13935	14004	12728	9932	8308	5258	5773	5899	4800	9614
	2086	4662	7456	8952	14051	14360	14074	12564	8167	8490	6909	5449	5784	5690	4437	8715
	2087	5590	7524	9595	12912	14450	13882	14316	12869	9714	8971	5241	5836	5738	4605	9287
	2088	4812	13412	13434	13049	14089	13493	8275	7073	8163	9174	5590	6035	5773	5088	9472
	2089	6388	11893	12900	13900	14087	13543	13265	9236	7340	8262	5422	5673	6516	5382	9676

CanESM2_RCP85_MACA_PRMS_P1

Federal 14 Projects Generation by Water Year
 RMJOC-II (2030s and 2060s) Scenarios
 Fiscal Year 2022

SCENARIOS - aMW	WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	15-Apr	30-Apr	MAY	JUNE	JULY	15-Aug	31-Aug	SEP	AVG.
2020	5527	6538	6692	6341	6294	6054	5361	3969	4463	6903	5960	6300	5751	5497	5911	
2021	5433	7542	7991	10411	8649	12094	10348	9855	11028	9481	11044	11233	10187	7582	9350	
2022	6269	8962	9389	12281	12251	12488	10741	12526	12385	14442	12488	8485	7140	6136	10532	
2023	6324	7768	7956	10319	9246	9799	6585	6316	8976	13241	6709	6197	6055	5431	8186	
2024	5364	6242	6431	7305	8333	6316	5841	4076	5570	5906	5479	6075	5679	5383	6090	
2025	4814	6413	7986	9850	6490	6103	5241	4776	7728	7978	6195	5898	5457	5190	6625	
2026	5095	6795	7853	12462	12460	12184	10005	11968	12584	14300	14335	12277	10855	7458	10665	
2027	7976	11140	9938	12479	12738	9455	7484	11143	11605	14614	11972	9391	7548	8537	10665	
2028	6918	10151	10686	11821	12767	11223	7576	8796	11089	13199	7804	5809	6761	5983	9664	
2029	6999	8432	10546	9725	9184	9160	7468	6824	8090	8916	6148	5696	6129	5292	7959	
2030	4793	7850	9044	10493	9747	9152	9196	9898	8328	8711	6694	5531	5728	5277	7925	
2031	6262	9609	10878	12562	13937	13527	13316	12983	13158	13629	13113	10406	8523	6400	11290	
2032	7378	10359	9844	11720	13062	14022	13295	11251	9893	12318	9450	6618	6265	5786	10197	
2033	5648	6480	8117	10378	11632	12595	9867	9589	10825	11668	6968	5945	6079	5903	8811	
2034	5419	8641	8696	8843	9321	7050	6794	7429	6586	6851	5165	5848	6082	4438	6991	
2035	4679	7240	8370	9777	8654	9234	5845	8963	9465	9469	7544	8901	7598	5624	7974	
2036	5826	8794	9067	12269	13349	13577	12394	12695	12685	12268	7945	5557	5675	5712	9954	
2037	5664	9267	8492	11179	10910	13633	9321	13324	12732	14390	12355	9215	7857	6552	10414	
2038	6013	8295	9864	10877	12031	12307	7437	7106	6631	8012	4258	5862	5555	5024	8000	
2039	4752	6765	8185	8701	7842	6342	5673	5375	6658	6010	4846	5662	5557	4716	6323	
2040	4677	7244	8851	11415	12029	13705	11442	10613	12256	11662	8839	7217	6787	5624	9520	
2041	5847	7078	9231	9734	9662	10134	5941	8400	10269	10299	5588	5946	5727	5338	8008	
2042	6093	7126	10030	11922	12701	13493	11575	11187	11135	13270	9346	6693	7770	6181	9977	
2043	6565	10225	9293	11060	8945	8531	6873	6920	6806	6744	5006	5742	5334	5147	7554	
2044	4872	6538	7690	7938	7817	7867	6574	8225	9040	8186	5360	5619	5744	5272	6969	
2045	4967	7153	8682	12087	12917	13734	12765	12905	13664	14403	10981	8224	6592	5650	10354	
2046	6120	9696	11821	13810	14116	13758	13512	13089	13399	14419	11036	8075	7690	5976	11259	
2047	5721	7419	8873	10870	11425	11631	9687	10326	9061	8356	6997	6645	6254	5501	8509	
2048	5384	7671	8694	8148	8700	6972	6000	5973	8015	7917	5513	5944	5565	5169	6987	
2049	4982	6537	8118	9512	9614	7992	7876	9009	8338	9826	6148	6192	5914	5430	7566	
2060	6770	10966	12661	14009	14520	13948	11582	11453	10484	10000	5463	5694	6237	5614	10144	
2061	5989	8129	9972	11309	10233	11408	12554	12275	14275	13275	5748	5658	5918	5380	9484	
2062	5141	7654	9505	13863	14231	13483	13319	12460	11233	11328	6029	4656	6040	5426	9646	
2063	5653	6222	10798	13956	13884	13547	13378	12945	12236	10565	9344	7379	6609	5542	10141	
2064	5494	6110	8372	11080	9546	13926	11290	10011	13039	9684	5369	5524	6028	5104	8684	
2065	5383	7258	8845	8876	9076	7971	5717	4296	6046	5348	4510	5429	5429	5176	6566	
2066	4112	5942	6531	8296	6407	9340	9484	7882	7641	8610	5201	6053	6490	5624	6889	
2067	6415	8244	8863	11957	9346	12459	12932	13571	13750	13787	8737	6092	6573	5667	9902	
2068	5371	6393	7359	12204	13823	13680	13439	12929	13419	14588	8693	6813	7657	5825	10131	
2069	7227	9431	11345	13391	13680	13428	11880	10556	10556	11231	7399	5853	5823	5625	10008	
2070	6339	11200	11629	13439	13987	13409	13343	12418	11692	12580	7753	5175	5912	6009	10510	
2071	6233	7794	9426	11276	8823	13751	9360	10015	12252	11111	5621	5528	5979	6802	9049	
2072	6875	8581	9602	13836	13778	13433	14344	14017	11139	8709	5084	5815	5798	5184	9667	
2073	5275	6371	8007	8765	8639	8584	7195	11403	12085	11700	6855	5716	6092	5609	8085	
2074	5708	9263	11100	12221	14067	13769	13444	13082	13948	12258	5287	4804	5696	5046	10069	
2075	5021	6236	8566	13960	14387	13775	10406	10280	9759	8718	8581	7394	7378	5524	9331	
2076	7226	11566	11846	14204	13108	13869	12505	12593	11819	10039	4804	5754	5808	4695	10114	
2077	4580	6121	7094	8979	9947	8740	8618	10022	10322	8572	4703	6068	6168	4573	7405	
2078	4893	6920	9427	12289	10766	13138	11291	11580	10693	8968	5690	6175	5636	4847	8738	
2079	4917	8090	8650	13656	14085	13576	13079	12783	13336	12425	5156	4563	4599	4420	9617	
2080	4770	6367	12837	13326	13399	13618	11666	13210	13607	14260	7185	5153	7015	5629	10286	
2081	5546	7609	9712	10592	9556	8141	5630	6134	7660	6242	4638	5678	5524	4940	7168	
2082	5173	6475	8357	10440	10164	10081	7089	8250	7677	6662	4956	5879	5874	4963	7362	
2083	4379	7288	10088	11092	9388	11595	9442	6687	8054	8623	5375	6073	5915	5376	7938	
2084	5540	6441	9850	14097	14163	13490	13329	12786	13138	14097	7823	5293	5205	5090	10153	
2085	5092	7990	10564	12038	11931	10981	10944	9096	10230	9813	5143	6180	6090	4294	8666	
2086	4805	6718	7261	10636	10239	10930	6958	9349	9092	7898	5462	5754	5441	4394	7586	
2087	4345	6807	6204	5922	6485	7002	4885	5587	5437	6018	4322	5054	5005	5416	5677	
2088	4283	5784	5730	6505	6457	10392	13204	11926	10374	7567	5122	5978	5679	4791	7114	
2089	4904	7444	7681	11542	14458	13188	10860	11889	10651	7315	6165	5251	5610	5315	8753	

MIROC5_RCP85_BCSD_VIC_P3

Federal 14 Projects Generation by Water Year
RMJOC-II (2030s and 2060s) Scenarios
Fiscal Year 2022

SCENARIOS - aMW	WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	15-Apr	30-Apr	MAY	JUNE	JULY	15-Aug	31-Aug	SEP	AVG.
	2020	6273	7669	9281	12303	12279	10631	6697	5462	9705	12759	9554	7005	6343	5622	9062
	2021	5360	7354	8292	11774	11026	10315	10221	10903	12980	12943	9848	7661	6815	5758	9443
	2022	5182	6284	6307	9723	9656	8661	7940	6516	8390	6420	5981	6118	5714	5008	7050
	2023	5061	6587	7489	8543	7620	7236	5767	5645	6673	7107	5941	6030	6028	5324	6606
	2024	4957	6224	8257	10509	10662	9244	8409	9881	10645	10047	5398	5630	5790	5219	7991
	2025	5302	7112	8035	10617	10697	8548	6580	6393	7133	6904	6003	6055	5529	5380	7315
	2026	5218	6229	8309	12519	12925	11613	7110	6682	9572	9618	7418	6624	6141	5541	8499
	2027	5563	6599	7176	9003	8511	7685	11108	8791	9613	13163	7562	6394	6160	7501	8202
	2028	6310	8148	8698	14285	14506	13939	10071	8148	11825	13193	11884	9394	7631	7708	10666
	2029	8744	9261	9607	11967	12255	11537	8153	10348	13541	13876	15046	10329	8748	6811	10953
	2030	6392	9200	11278	13383	13402	11386	10005	11896	11828	10636	7488	6116	5866	5730	9783
	2031	5763	6834	8590	11030	10900	9748	10184	8898	6734	10870	9914	7128	7206	5496	8534
	2032	7106	6832	9908	12512	12772	12633	10183	11136	8973	12573	9896	7070	6714	5722	9698
	2033	5585	7811	9258	10193	9141	8972	6579	7274	12309	11716	6637	6242	6397	5497	8362
	2034	5324	6963	7508	11037	10556	10028	6932	7801	11935	12956	5842	5890	6082	5096	8369
	2035	4981	6128	7453	10480	10503	8905	9813	10552	9511	11487	6301	6139	5811	5643	8107
	2036	7206	7095	7717	9913	9256	8365	9210	8493	11053	8801	5309	5895	5474	4086	7776
	2037	4388	6359	7342	8331	7352	7318	12138	9441	7493	9959	6735	6325	6125	5674	7321
	2038	5318	6592	7414	10755	9876	10224	8038	8846	10413	13230	6698	6689	6201	5846	8424
	2039	5555	7370	9844	13222	13790	12760	7895	9133	9131	8717	7382	7206	6332	5454	9019
	2040	5560	7957	9464	12249	11907	8762	7319	7783	10323	12051	7767	6440	6001	5644	8776
	2041	5494	7922	8679	10720	10680	11124	6908	9109	12078	11242	6892	6104	6079	5840	8720
	2042	5132	7188	8501	10648	9548	8785	6780	7888	8446	7191	5109	5836	5287	3943	7272
	2043	4533	6454	7368	6176	5616	5245	5431	4824	6320	6718	6371	6366	6040	4501	5890
	2044	4034	5967	6739	10408	9303	10640	10023	9134	9177	8966	6292	5830	5694	5204	7666
	2045	5057	6683	7063	8910	10099	8616	9595	10200	10472	8154	5543	5873	5501	4267	7519
	2046	4929	6632	7562	11765	10799	13595	8989	7132	13314	13597	10776	8758	9037	7973	9826
	2047	7531	10034	10693	13285	14349	13840	10941	12828	13096	14120	8165	6310	6216	5562	10709
	2048	5174	6506	8095	12229	11341	10324	6931	7740	7124	7613	5468	5801	5513	5323	7673
	2049	5146	6408	8042	13156	13938	13557	13385	13580	13761	11747	5451	5393	5551	5366	9596
	2060	5303	6515	7248	10011	9133	8688	6183	6288	8733	9424	5389	6083	5683	4812	7276
	2061	5057	7201	8279	11447	12269	11556	6591	7982	8931	8218	5480	6285	6072	4868	8042
	2062	4981	6678	7270	8665	7908	7478	4425	4515	6415	7650	4905	5734	5610	4823	6403
	2063	4398	6569	8050	10664	10524	11994	12182	10005	14676	13809	6389	5436	5822	5277	9077
	2064	5199	6350	7834	10165	9520	9444	9236	7172	7868	6637	5089	5799	5468	4304	7183
	2065	4900	7289	8341	11393	10989	13857	13473	13067	14013	8842	4686	5802	5843	4754	9002
	2066	5086	6382	9254	12453	11601	13885	13566	11497	10924	9818	5173	6067	5814	4669	8961
	2067	4834	7004	8513	11734	12806	11144	8666	11930	11113	9949	5188	6243	5920	4299	8553
	2068	4525	6759	7742	12273	10567	13692	13398	11201	13929	13328	5960	5685	5790	5400	9343
	2069	5322	10520	11412	13685	14476	13244	11955	12996	13802	12150	6525	6171	6007	5702	10420
	2070	6453	7807	13715	14234	12991	13212	13237	12807	13282	12395	8651	6060	5875	5590	10600
	2071	5277	6715	8112	13133	13338	12672	11251	11881	11314	9444	4810	5928	5400	4321	8836
	2072	4691	6414	7470	9281	10200	11006	8269	8010	6161	5868	4899	5919	5727	4089	6995
	2073	3109	5626	5026	5634	7370	8030	8454	8132	6695	6253	4867	5784	6033	4917	5963
	2074	4899	8194	9045	11781	9794	13683	13035	12954	14171	11614	6540	5360	5642	5591	9481
	2075	5700	7652	8929	11707	10746	10931	8541	5685	6911	5209	5081	5908	5614	3843	7454
	2076	5418	7265	9350	10778	14392	13339	12987	13130	14393	11674	5529	5497	5789	5259	9654
	2077	5060	6877	8814	12610	13583	13406	12230	13621	10932	9241	4862	5760	5476	4422	8999
	2078	4860	6485	7669	11908	14687	12992	11680	10673	9178	10401	5091	5640	5793	5089	8728
	2079	5106	8637	10917	11802	13338	12445	8148	9547	9216	8273	5703	5832	5273	4230	8646
	2080	4327	6740	6527	7376	6694	5994	5454	5565	7179	6128	4942	5940	5479	4186	5941
	2081	4405	6202	5874	10553	9204	12404	11904	14299	11949	7990	4841	5912	5702	4578	8067
	2082	4098	6351	7369	10574	9858	10121	3939	6269	5899	5712	5167	5615	5347	4282	6656
	2083	4117	6766	10028	13966	14130	13397	13536	11079	9062	6767	5293	6050	5838	4560	8832
	2084	5005	7274	10932	14098	14172	13246	11805	12358	9786	8296	5520	5842	5553	4311	9187
	2085	4972	7034	8661	14283	14318	13551	12611	11335	9855	9184	4917	5753	5823	5092	9102
	2086	4728	7058	10279	12641	13760	13580	12681	12373	13905	12289	7045	5835	5779	5741	9921
	2087	5768	8800	11576	13939	13725	13419	12990	12374	13692	11710	6453	5729	5738	5342	10215
	2088	5031	6629	11201	12018	12211	11599	5208	7391	7302	6982	4581	5551	5412	3420	7726
	2089	4019	6310	7902	10713	8359	12386	14065	13077	9421	8862	4488	5504	6000	4973	8057

HadGEM2-CC_RCP85_MACA_VIC_P1

Federal 14 Projects Generation by Water Year
RMJOC-II (2030s and 2060s) Scenarios
Fiscal Year 2022

SCENARIOS - aMW	WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	15-Apr	30-Apr	MAY	JUNE	JULY	15-Aug	31-Aug	SEP	AVG.
	2020	5731	6692	6570	7508	10898	5034	4549	4708	6329	12505	8946	7303	6642	5949	7292
	2021	5755	6905	7085	7091	7757	5847	5698	6886	10067	8945	5766	5719	5875	5099	6861
	2022	5066	6866	8242	9604	8569	8610	6818	8532	9077	11290	7582	5927	6177	5138	7809
	2023	4970	6908	6799	8182	12282	11482	11102	11001	10306	13060	12779	7932	7572	6265	9295
	2024	6441	8574	8166	14034	14555	14170	11806	10864	11729	11383	10228	7556	6728	5967	10297
	2025	5995	8284	9498	12122	11620	10961	8440	8678	12066	14671	10094	8215	7914	6999	9900
	2026	6083	6646	7557	9048	8788	6402	7733	8354	10080	15098	7875	6521	7078	5674	8163
	2027	5079	6612	9685	11105	10729	8700	7238	8422	9449	11613	9422	9286	7467	7654	8841
	2028	5851	7760	9171	10884	8633	6440	5831	6863	9253	9459	5857	5748	6108	4955	7544
	2029	5082	6578	7223	7261	6560	5532	7486	7637	9634	9231	8768	5973	6783	5735	7133
	2030	5465	7288	8772	11782	9939	9949	8383	9155	8391	9529	8708	7658	6621	5444	8425
	2031	5088	6929	10596	12180	11760	12942	11326	8615	9126	11248	13092	9473	8432	5716	9797
	2032	5338	6925	6928	7917	8566	5683	5688	6762	6702	5918	5630	6037	5457	4567	6337
	2033	4700	7180	8170	9366	9369	8009	5555	6106	6567	13329	11719	6955	6661	5686	8050
	2034	5236	6342	6538	6291	6070	5832	6529	6053	7232	8668	7670	5701	6161	4897	6419
	2035	4413	6643	6820	9809	8226	8020	6337	8623	10495	11773	9682	7989	6700	5629	8026
	2036	5349	6627	7127	8737	8429	6895	5594	5035	7132	13400	13521	9001	7694	7445	8191
	2037	7504	10980	9800	10098	8597	6636	5985	7442	7408	8490	6110	5808	6072	4816	7751
	2038	4713	6510	6072	7979	6527	7430	7089	7658	6953	9130	6241	6188	5939	4781	6645
	2039	4529	6268	7715	8703	7461	6696	6248	7217	10268	11246	9031	5991	6372	5336	7516
	2040	5042	6785	8216	10516	10248	9185	7411	6595	9720	14193	14395	10164	11881	7912	9524
	2041	9244	8548	8868	7907	9368	6551	6127	5734	8887	12152	7172	6554	6335	5263	8017
	2042	5079	6683	6830	9031	9768	7811	7439	7614	7895	10363	6640	6287	5892	5452	7410
	2043	5020	6947	8115	7897	7925	6278	6190	6478	7711	8045	6377	6240	5566	5032	6791
	2044	5172	6935	6748	6573	6260	5939	5455	5481	8685	8734	6498	6204	5876	5104	6513
	2045	5026	7915	7969	12000	11889	10135	10923	10474	13716	11547	7761	6273	6173	5304	9163
	2046	4960	6657	9405	9512	9788	8582	7952	8394	8479	7824	6383	6052	5635	5325	7565
	2047	5876	8272	8672	10532	10059	7198	8864	7766	10667	10478	9064	6653	6326	5176	8389
	2048	5776	6536	8113	8978	10150	6969	5123	5068	8460	9383	6278	5990	5805	4918	7204
	2049	4446	6798	7248	8986	9670	13760	12265	11790	12248	12776	8697	7248	7108	5942	9141
	2060	5439	7210	10490	13637	14319	13571	13169	12879	13296	14556	11429	8780	7340	5892	10898
	2061	8471	8970	9595	12141	12118	12976	12506	13623	13999	14527	13029	11770	11845	7684	11532
	2062	7749	9751	10518	12865	12993	10843	10812	9570	14202	14912	10365	8438	8329	6108	10727
	2063	5739	7871	8154	12136	12118	13317	13183	11767	10369	10283	6587	6529	6144	5620	9229
	2064	5908	8476	9074	11911	11989	11098	11446	11516	12125	12055	6282	5874	6028	5620	9316
	2065	5884	8828	12844	13482	13997	10412	6330	6909	11743	11540	7377	6076	5857	5489	9493
	2066	5153	6048	7379	8451	7435	6240	5210	6832	11048	12756	9159	6159	6073	5268	7591
	2067	4960	6721	6994	8403	7194	7924	10164	10106	13154	10606	6589	5657	6133	5067	7806
	2068	4755	6206	7358	11963	13224	12572	11635	12011	12669	14577	8696	6155	6298	5786	9636
	2069	5174	6207	6342	9607	7646	8238	10737	11480	12249	13183	5903	5626	6016	4941	8030
	2070	5000	6670	7491	8003	8175	7657	9922	11299	12461	13258	7179	6089	6032	5309	8147
	2071	5179	6133	8802	12230	11825	12305	12779	11053	13153	10076	6853	5834	5867	5136	9108
	2072	4886	6099	7196	14150	14717	13906	13200	13210	13548	13473	9526	6904	6696	5803	10258
	2073	5105	6760	7056	11055	13297	13755	11333	9527	11908	14541	8699	6304	6453	5740	9532
	2074	4985	10355	8978	11053	13461	13558	13595	11803	14088	14654	8777	6613	6370	5854	10382
	2075	6395	7056	8479	11223	12585	12331	11098	10744	11480	10299	5814	5864	5729	4678	8899
	2076	4943	6820	7167	8338	7338	7504	7230	8415	10306	9028	5580	6110	5864	4916	7144
	2077	4976	6256	6878	11534	14299	14072	13272	12765	13687	12556	11310	9642	9821	7034	10423
	2078	6559	9625	10933	13423	13965	13901	12187	11175	13819	10513	5622	5547	6074	5033	10052
	2079	4903	6783	8294	9983	9537	9061	10330	11774	11590	8600	5937	6142	5901	4263	7993
	2080	4588	6363	6967	8935	7201	8934	5708	10038	11729	14773	9856	7841	7908	6465	8466
	2081	5802	6880	8059	9427	8938	8734	7095	8338	9295	8637	5790	5774	5863	5111	7510
	2082	5600	8490	10291	12183	12115	12060	11001	11754	10391	8974	5054	6056	5734	5020	8933
	2083	4942	6142	6382	9253	7146	11649	11682	10243	11899	10910	6912	6121	5928	5083	8115
	2084	4999	6575	8239	11118	12338	10435	11067	10463	10921	9999	5587	6153	5972	4458	8442
	2085	5008	6507	7755	12527	13187	12399	13613	12055	12422	11127	9010	6155	6772	5615	9548
	2086	5266	7965	8611	11811	11887	12853	9471	10105	8081	8136	4499	5992	5645	4466	8242
	2087	4719	6739	11052	12112	10961	14190	12421	11725	10770	10394	6534	5756	5947	5079	9199
	2088	4867	7144	8937	11698	11264	9599	8262	8644	13928	15003	6598	5918	6202	5579	9083
	2089	5317	6917	9218	12554	14039	12803	11467	10892	13211	14962	10809	6907	6736	5836	10281

GFDL_ESM2M_RCP85_BCSD_VIC_P2

Exhibit 7-2: Most Recent 30 Water Year

**Federal 14 Projects Hydro Generation Forecast
Annual Energy
Fiscal Year 2024**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Federal 14 Projects Generation by Water Year
Recent 30 Water Year
Fiscal Year 2024

aMW	WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	15-Apr	30-Apr	MAY	JUNE	JULY	15-Aug	31-Aug	SEP	AVG.
1	1989	4693	6877	7773	7424	5590	8004	7768	10420	9007	7585	7069	5909	6162	5422	7058
2	1990	5141	7123	9426	10227	11662	9008	8209	8557	7968	10924	9819	8802	9124	5667	8676
3	1991	4917	9684	9574	11624	12495	9465	8678	7164	8860	10088	12179	9366	8453	5482	9249
4	1992	5050	6919	6267	8082	7317	7365	5706	5744	8132	6488	5802	6070	6049	5709	6576
5	1993	4758	6699	6957	6689	4859	6722	7047	4729	10551	8536	7508	6744	6894	6024	6851
6	1994	5064	6926	6942	6759	6618	6539	5278	6864	7991	6767	6375	6134	5864	5720	6481
7	1995	4967	6704	7370	8098	8579	9864	6511	5403	8417	11323	8956	7053	6829	6230	7779
8	1996	6338	10560	14251	14742	14459	14413	9559	11821	10876	12163	11509	8957	9268	5952	11254
9	1997	5339	7345	9537	14551	14605	13154	11523	13340	14834	15334	12257	9478	10388	7252	11364
10	1998	8183	8705	8352	9574	10396	8360	6373	6048	11299	11519	9527	9156	7772	5972	8874
11	1999	5042	6277	8571	13206	11995	13741	8702	9275	8551	12366	12870	10856	10982	5857	9864
12	2000	5096	9488	10127	10913	10583	9378	8701	10464	9123	8210	8512	7871	6003	5412	8605
13	2001	5100	6655	6809	7164	7417	5923	4788	3891	6143	5934	6082	6500	5914	5371	6089
14	2002	4639	6292	7504	7100	6769	7143	7240	9451	9224	11350	10523	6937	6856	5603	7620
15	2003	5112	7140	6763	7443	7108	9108	7141	7501	8217	9868	6618	5471	5807	5386	7141
16	2004	4939	7548	8284	8426	7923	6968	6332	5894	7661	8447	6601	5577	6731	5821	7072
17	2005	5859	7660	9236	9727	10426	7334	5231	4828	7431	8252	7879	6439	6146	5678	7553
18	2006	4675	7559	8324	11489	12486	8672	10831	9455	10857	12029	7909	6033	5890	5395	8761
19	2007	4832	6971	8540	10711	9383	10647	8868	7306	8592	9435	8492	6103	5814	5144	8062
20	2008	4921	7303	7047	8921	8084	7538	6104	4760	9712	13700	9843	6795	7697	5849	7966
21	2009	5133	7001	7988	9573	8045	7325	8751	7941	9116	9025	5694	5745	5510	5620	7367
22	2010	5093	6559	7058	7718	7739	6038	4586	4296	5936	11877	8381	5897	5552	5345	6815
23	2011	4786	6639	8852	11583	12978	10512	12011	7797	11597	15148	15423	10617	9185	5982	10261
24	2012	5522	7281	8110	9668	9030	9603	11927	13025	12631	13584	13329	9868	9835	5719	9737
25	2013	5012	8468	10406	9973	8354	6933	10393	8173	9159	11798	8879	7218	6545	5981	8422
26	2014	5249	6852	7073	9499	7537	11513	10569	8868	9388	10885	9942	8393	7608	5748	8459
27	2015	4990	8392	10176	11648	12118	12439	8227	6050	6863	6600	5693	6115	5908	5213	8088
28	2016	5019	6643	7869	8223	6997	10065	11467	11234	9837	8443	6097	5855	5806	5646	7668
29	2017	4882	9686	8582	11180	10590	14757	14649	12836	12642	12485	8367	8297	7626	5485	10021
30	2018	4937	5867	8298	11979	12813	10695	9773	9729	12877	12299	8398	6996	6860	5666	9188

THIS PAGE IS INTENTIONALLY LEFT BLANK

Exhibit 7-3: Historical 90 Water Year

**Federal 14 Projects Hydro Generation Forecast
Energy Annual
Fiscal Year 2024**

THIS PAGE IS INTENTIONALLY LEFT BLANK

Federal 14 Projects Generation by Water Year

**90 Water Year
Fiscal Year 2024**

aMW	WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	15-Apr	30-Apr	MAY	JUNE	JULY	15-Aug	31-Aug	SEP	AVG.
1	1929	5436	6668	6810	6805	6630	6135	5302	4027	5759	8210	5694	6242	6363	6071	6261
2	1930	5125	6827	6391	6487	6154	5581	4978	4561	6806	6748	6901	6419	6561	5959	6188
3	1931	5183	6968	6862	6572	6469	6363	5593	4040	6520	6151	6910	6957	6438	5870	6283
4	1932	5180	6464	7306	6650	5043	8405	8913	9799	10142	11728	8457	6837	7638	5913	7665
5	1933	5395	6522	8835	10735	10994	8585	7404	6125	8874	14187	12266	9251	9759	6184	9063
6	1934	6068	10235	13380	14592	13698	11134	11871	10314	10297	10575	6458	6282	6543	5611	9939
7	1935	5284	5891	7805	10184	11146	7873	5685	6129	8035	9294	8831	9022	6681	5524	7784
8	1936	5306	6656	6727	6427	6472	6704	5268	7860	10419	11087	7670	6308	6412	5656	7171
9	1937	5237	6953	6832	5751	5145	5595	5040	4170	6430	7968	6050	6378	6094	5694	6045
10	1938	5274	6909	8059	10580	8005	9191	8080	10066	9690	10677	9273	6555	6152	5878	8250
11	1939	5381	6408	6364	7745	8201	6564	6169	6560	8921	6965	7461	7075	6912	5852	6930
12	1940	5224	6926	6484	8896	7912	8540	7614	6332	7989	7164	6339	5685	5921	5587	6985
13	1941	5383	6966	7749	7174	6831	6841	5819	5118	7070	7364	6597	6423	6541	5772	6643
14	1942	5428	7289	9798	10240	9694	5976	5474	6273	7220	10394	9581	7440	7470	5980	7902
15	1943	5306	6338	8011	10014	11347	8603	11357	11971	11119	10560	11812	7783	7580	5737	9001
16	1944	5048	6681	6535	6602	7189	5580	4948	3755	5648	6685	6060	6543	6114	5611	6022
17	1945	5206	6720	6873	6067	5811	5848	4511	3920	8074	10578	6283	6452	6383	5821	6495
18	1946	5034	6466	7759	9059	8425	9316	9074	10581	10340	11023	10058	8400	8414	6074	8484
19	1947	5147	7460	11024	11716	12310	9787	7145	7696	10021	11013	9204	6957	6656	6142	8988
20	1948	8031	8944	9422	11768	11778	7590	6868	9710	13739	15030	9507	9684	9696	6463	10015
21	1949	5833	7311	7267	10192	7659	9992	7705	10006	11301	9269	6574	5477	5733	5449	7948
22	1950	5123	6540	8033	12166	10407	10721	10080	8484	9036	13295	14194	9522	9666	6072	9540
23	1951	6559	9100	11180	13604	14137	11767	10020	9883	11298	9699	11836	8871	7564	6078	10269
24	1952	7497	7814	9328	11115	11099	8386	8941	11512	13105	10415	9845	8178	6729	5579	9319
25	1953	4984	6936	6614	8122	12172	6896	4802	5129	8963	14325	11230	8489	8202	6185	8282
26	1954	5558	7286	8693	11365	11744	9105	7284	7403	10362	13039	13627	10780	11546	8269	9790
27	1955	6075	8375	8861	7563	7784	5634	6321	4835	8037	13297	13529	9702	8765	6076	8340
28	1956	5749	8724	11208	13451	12365	10672	9575	13321	13832	14121	11444	8908	9302	5920	10668
29	1957	5810	7268	8754	8986	8018	8263	10562	7249	14005	13664	8628	7906	6491	5784	8777
30	1958	5069	6690	7315	10043	10284	8108	6033	7920	12061	12426	7802	7579	6706	5888	8303
31	1959	5384	7904	10397	13110	13206	9471	8372	8038	9255	12439	12450	9061	8731	8982	9954
32	1960	9822	10314	10528	10709	10293	7982	10347	9182	8925	11287	8880	8369	6721	5962	9327
33	1961	5453	7327	8042	11305	10031	10265	8437	6837	10814	14100	7956	7353	7039	5811	8819
34	1962	4830	6876	7821	9304	11125	5920	7266	9675	9334	10834	7334	8022	7492	5950	7935
35	1963	5782	8225	10139	9905	11182	6738	6064	5415	8274	10685	8700	7726	7179	6462	8255
36	1964	5382	6643	8015	7878	9570	6012	7252	5836	9458	14603	12584	9239	9844	6947	8593
37	1965	6524	7852	11560	13573	14167	11620	8525	11617	11053	10856	10619	9519	9738	6035	10283
38	1966	5720	6837	8187	9017	10541	7127	7920	6865	7460	10612	8577	7656	6589	5826	7847
39	1967	5131	6608	8784	11402	13010	9138	7118	5975	8917	13788	11166	8396	8313	6184	9062
40	1968	5631	7864	8318	10995	10312	10073	5578	4515	7703	10941	9453	8653	8542	7619	8544
41	1969	6680	8901	9505	13007	13124	9953	11002	11253	11648	11544	9427	7444	7700	5826	9839
42	1970	5412	7415	7191	9343	11292	7181	5600	4749	8934	12717	7087	7325	6864	5890	7867
43	1971	5095	6576	7322	13014	14487	11144	10019	9603	13546	15523	12052	9840	9774	6205	10357
44	1972	5349	7142	8623	13552	11887	14625	12260	8810	12818	15292	12034	9958	10352	6447	10708
45	1973	5753	6977	7951	9188	8781	6660	5718	3793	7190	7156	6157	6291	5714	5520	6832
46	1974	4998	7010	9285	15152	13920	12912	11017	11923	11873	15282	14289	10215	10447	6513	11074
47	1975	5312	6744	7204	9855	10358	9646	6506	6703	8882	13987	12894	8309	8573	6571	8867
48	1976	6156	9125	12567	13071	13241	11241	10319	9774	11199	11795	12100	11534	12993	8654	10956
49	1977	5966	6767	7314	7511	7551	5342	4605	3690	6245	5989	5972	6521	6117	5409	6206
50	1978	4837	6280	8117	9307	8387	9010	8431	7394	9283	9591	10765	7082	6730	7506	8160

Federal 14 Projects Generation by Water Year

90 Water Year

Fiscal Year 2024

aMW	WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	15-Apr	30-Apr	MAY	JUNE	JULY	15-Aug	31-Aug	SEP	AVG.
51	1979	5976	6999	6824	8884	7248	8018	6533	5966	9345	8342	6153	6029	6084	5866	7166
52	1980	5238	6716	6145	8479	6812	6480	5949	8595	11245	11062	8386	6700	6825	5980	7550
53	1981	5295	7139	10246	11855	12443	7269	5159	5585	9218	14265	10100	9490	9670	6374	9078
54	1982	5315	7498	8471	11245	13237	13844	9382	8518	10517	14070	13615	9528	10439	7288	10323
55	1983	6293	7574	9187	11889	10789	13323	8902	8002	9076	10274	12254	9162	9201	6383	9561
56	1984	5383	9083	9345	11573	10949	10663	8727	9583	10047	12694	11554	8850	7777	6374	9588
57	1985	5407	7460	8509	9835	9247	7329	7143	7316	8649	8522	6075	5772	5557	5730	7459
58	1986	5683	8040	8150	9633	11606	13685	10437	7945	9437	9945	8276	7221	6352	5693	8827
59	1987	4958	7536	8573	8339	7278	7901	6268	6887	9561	7536	5791	5699	5576	5381	7091
60	1988	4943	6907	6302	6070	5874	6081	5059	5872	6586	7526	7335	6508	6234	5806	6272
61	1989	4718	6924	7663	7372	5650	7926	7598	10363	9002	7406	7150	5877	6063	5501	7031
62	1990	5164	7123	9385	10207	11662	9059	7461	8513	8353	10972	9815	8773	9118	5687	8681
63	1991	4946	9658	9526	11628	12537	9439	8679	7123	8888	10094	12185	9354	8436	5499	9249
64	1992	5076	6866	6312	8049	7301	7359	5684	5555	8224	6509	5857	6092	6072	5678	6578
65	1993	4783	6665	6894	7160	4833	7311	6735	5002	9494	8503	7542	6807	6798	6037	6841
66	1994	5089	6868	6988	6007	5957	6023	5888	7755	8714	7228	6463	6108	5854	5688	6488
67	1995	4991	6710	7289	8066	8581	9929	6464	5229	8421	11408	9015	7117	6739	6240	7781
68	1996	6367	10542	14235	14750	14455	14393	9557	11780	10854	12202	11517	8969	9217	5972	11252
69	1997	5369	7347	9473	14583	14604	13142	11506	13332	14834	15334	12265	9462	10366	7273	11363
70	1998	8211	8695	8298	9430	10665	8331	6372	5901	11351	11519	9553	9119	7806	5976	8878
71	1999	5067	6220	8569	13174	11969	13733	8790	9323	8571	12375	12877	10840	10981	5879	9866
72	2000	5126	9461	10078	10871	10505	9475	8716	10391	9101	8243	8554	7845	6038	5478	8607
73	2001	5123	6596	6835	7192	7407	6132	4698	3778	5986	5930	6160	6495	5884	5396	6093
74	2002	4635	6288	7456	7121	6840	7114	7225	9320	9167	11605	10531	6908	6849	5638	7632
75	2003	5131	7088	6817	7212	7379	9079	7137	7327	8239	9921	6706	5384	5793	5401	7145
76	2004	4952	7537	8228	8357	7923	6886	6351	5936	7736	8473	6687	5496	6683	5832	7068
77	2005	5888	7657	9189	9568	10415	7278	5330	4903	7487	8274	7918	6497	6078	5683	7549
78	2006	4694	7570	8254	11390	12523	8759	10893	9398	10801	12190	7929	6073	5832	5413	8771
79	2007	4858	6939	8489	10653	9296	10782	8877	7175	8638	9463	8481	6282	5786	5164	8065
80	2008	4921	7305	6967	9013	7961	7589	6105	4698	9801	13700	9851	6859	7590	5870	7967
81	2009	5161	6981	7932	9603	7938	7295	8864	7893	9112	9118	5778	5654	5494	5636	7369
82	2010	5112	6556	6980	7875	7571	5969	4577	4500	5872	11909	8404	5962	5484	5351	6812
83	2011	4807	6640	8793	11634	12999	10485	12011	7716	11625	15156	15423	10601	9168	5999	10261
84	2012	5552	7290	8024	9631	8992	9656	11985	13025	12627	13589	13325	9846	9820	5768	9736
85	2013	5024	8444	10361	9991	8326	6872	10442	8033	9261	11822	8917	7188	6549	5996	8422
86	2014	5279	6861	6966	9612	6889	11959	10586	8795	9418	10889	9951	8365	7604	5766	8452
87	2015	5020	8369	10127	11437	12364	12429	8220	5909	6918	6658	5687	6115	5908	5239	8089
88	2016	5042	6619	7818	8354	6365	10602	11463	11126	9728	8476	6137	5856	5874	5716	7671
89	2017	4920	9710	8535	10927	10868	14734	14650	12841	12685	12490	8359	8397	7560	5493	10026
90	2018	4962	5854	8240	11995	12838	10742	9768	9688	12872	12313	7659	5730	7073	5270	9052

Appendix A - Reports Available Upon Request – Operating Year 2023 - 2032

1. Annual Energy

- 1.1. Federal Report Surplus/ Deficit – Annual
- 1.2. Regional Report Surplus/ Deficit – Annual
- 1.3. Regional Total Retail Load – Annual
- 1.4. Regional Exports – Annual
- 1.5. Regional Imports – Annual
- 1.6. Regional Intra-Regional Transfer – Annual
- 1.7. BPA Sales to Preference and Legacy Customers – Annual
- 1.8. Regional Regulated Hydro – Annual
- 1.9. Regional Independent Hydro – Annual
- 1.10. Regional Small Hydro – Annual
- 1.11. Regional Non-Hydro Renewable – Wind – Annual
- 1.12. Regional Non-Hydro Renewable – Solar – Annual
- 1.13. Regional Non-Hydro Renewable – Other – Annual
- 1.14. Regional Thermal – Nuclear – Annual
- 1.15. Regional Thermal – Coal – Annual
- 1.16. Regional Thermal – Natural Gas – Annual
- 1.17. Regional Thermal – Petroleum – Annual
- 1.18. Regional Thermal – Biofuel – Annual
- 1.19. Regional Thermal – Cogeneration – Annual
- 1.20. Non-Federal CER Deliveries to BPA – Annual
- 1.21. Federal Report Surplus/ Deficit by 80 Water Year – Annual
- 1.22. Regional Report Surplus/ Deficit by 80 Water Year – Annual

2. Monthly Energy

- 1.1. Federal Report Surplus/ Deficit – Monthly
- 1.2. Regional Report Surplus/ Deficit – Monthly
- 1.3. Regional Total Retail Load – Monthly
- 1.4. Regional Exports – Monthly
- 1.5. Regional Imports – Monthly
- 1.6. Regional Intra-Regional Transfer – Monthly
- 1.7. BPA Sales to Preference and Legacy Customers – Monthly
- 1.8. Regional Regulated Hydro – Monthly
- 1.9. Regional Independent Hydro – Monthly
- 1.10. Regional Small Hydro – Monthly
- 1.11. Regional Non-Hydro Renewable – Wind – Monthly
- 1.12. Regional Non-Hydro Renewable – Solar – Monthly
- 1.13. Regional Non-Hydro Renewable – Other – Monthly
- 1.14. Regional Thermal – Nuclear – Monthly
- 1.15. Regional Thermal – Coal – Monthly
- 1.16. Regional Thermal – Natural Gas – Monthly
- 1.17. Regional Thermal – Petroleum – Monthly
- 1.18. Regional Thermal – Biofuel – Monthly
- 1.19. Regional Thermal – Cogeneration – Monthly
- 1.20. Non-Federal CER Deliveries to BPA – Monthly
- 1.21. Federal Report Surplus/ Deficit by 80 Water Year – Monthly
- 1.22. Regional Report Surplus/ Deficit by 80 Water Year – Monthly

