BP-22 Rate Proceeding

Final Proposal

Power Loads and Resources Study

BP-22-FS-BPA-03

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POWER LOADS AND RESOURCES STUDY

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COMMONLY USED ACRONYMS AND SHORT FORMS

AAC	Anticipated Accumulation of Cash
ACNR	Accumulated Calibrated Net Revenue
ACS	Ancillary and Control Area Services
AF	Advance Funding
AFUDC	Allowance for Funds Used During Construction
AGC	automatic generation control
aMW	average megawatt(s)
ANR	Accumulated Net Revenues
ASC	Average System Cost
BAA	Balancing Authority Area
BiOp	Biological Opinion
BPA	Bonneville Power Administration
BPAP	Bonneville Power Administration Power
BPAT	Bonneville Power Administration Transmission
Bps	basis points
Btu	British thermal unit
CAISO	California Independent System Operator
CIP	Capital Improvement Plan
CIR	Capital Investment Review
CDQ	Contract Demand Quantity
CGS	Columbia Generating Station
CHWM	Contract High Water Mark
CNR	Calibrated Net Revenue
COB	California-Oregon border
COE	U.S. Army Corps of Engineers
COI	California-Oregon Intertie
Commission	Federal Energy Regulatory Commission
Corps	U.S. Army Corps of Engineers
COSA	Cost of Service Analysis
COU	consumer-owned utility
Council	Northwest Power and Conservation Council (see also “NPCC”)
COVID-19	coronavirus disease 2019
CP	Coincidental Peak
CRAC	Cost Recovery Adjustment Clause
CRFM	Columbia River Fish Mitigation
CSP	Customer System Peak
CT	combustion turbine
CWIP	Construction Work in Progress
CY	calendar year (January through December)
DD	Dividend Distribution
DDC	Dividend Distribution Clause
dec	decrease, decrement, or decremental

DERBS	Dispatchable Energy Resource Balancing Service
DFS	Diurnal Flattening Service
DNR	Designated Network Resource
DOE	Department of Energy
DOI	Department of Interior
DSI	direct-service industrial customer or direct-service industry
DSO	Dispatcher Standing Order
EE	Energy Efficiency
EESC	EIM Entity Scheduling Coordinator
EIM	Energy imbalance market
EIS	environmental impact statement
EN	Energy Northwest, Inc.
ESA	Endangered Species Act
ESS	Energy Shaping Service
e-Tag	electronic interchange transaction information
FBS	Federal base system
FCRPS	Federal Columbia River Power System
FCRTS	Federal Columbia River Transmission System
FELCC	firm energy load carrying capability
FERC	Federal Energy Regulatory Commission
FMM-IIE	Fifteen Minute Market – Instructed Imbalance Energy
FOIA	Freedom of Information Act
FORS	Forced Outage Reserve Service
FPS	Firm Power and Surplus Products and Services
FPT	Formula Power Transmission
FRP	Financial Reserves Policy
F&W	Fish & Wildlife
FY	fiscal year (October through September)
G&A	general and administrative (costs)
GARD	Generation and Reserves Dispatch (computer model)
GDP	Gross Domestic Product
GI	generation imbalance
GMS	Grandfathered Generation Management Service
GSP	Generation System Peak
GSR	Generation Supplied Reactive
GRSPs	General Rate Schedule Provisions
GTA	General Transfer Agreement
GWh	gigawatthour
HLH	Heavy Load Hour(s)
HOSS	Hourly Operating and Scheduling Simulator (computer model)
HYDSIM	Hydrosystem Simulator (computer model)
IE	Eastern Intertie
IIE	Instructed Imbalance Energy
IM	Montana Intertie

inc	increase, increment, or incremental
IOU	investor-owned utility
IP	Industrial Firm Power
IPR	Integrated Program Review
IR	Integration of Resources
IRD	Irrigation Rate Discount
IRM	Irrigation Rate Mitigation
IRPL	Incremental Rate Pressure Limiter
IS	Southern Intertie
kcfs	thousand cubic feet per second
kW	kilowatt
kWh	kilowatthour
LAP	Load Aggregation Point
LDD	Low Density Discount
LGIA	Large Generator Interconnection Agreement
LLH	Light Load Hour(s)
LMP	Locational Marginal Price
LPP	Large Project Program
LT	long term
LTF	Long-term Firm
Maf	million acre-feet
Mid-C	Mid-Columbia
MMBtu	million British thermal units
MNR	Modified Net Revenue
MRNR	Minimum Required Net Revenue
MW	megawatt
MWh	megawatthour
NCP	Non-Coincidental Peak
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NFB	**N**ational Marine Fisheries Service (NMFS) **F**ederal Columbia River Power System (FCRPS) **B**iological Opinion (BiOp)
NLSL	New Large Single Load
NMFS	National Marine Fisheries Service
NOAA Fisheries	National Oceanographic and Atmospheric Administration Fisheries
NOB	Nevada-Oregon border
NORM	Non-Operating Risk Model (computer model)
NWPA	Northwest Power Act/Pacific Northwest Electric Power Planning and Conservation Act
NP-15	North of Path 15
NPCC	Northwest Power and Conservation Council
NPV	net present value
NR	New Resource Firm Power

NRFS	NR Resource Flattening Service
NRU	Northwest Requirements Utilities
NT	Network Integration
NTSA	Non-Treaty Storage Agreement
NUG	non-utility generation
NWPP	Northwest Power Pool
OATT	Open Access Transmission Tariff
O&M	operations and maintenance
OATI	Open Access Technology International, Inc.
ODE	Over Delivery Event
OS	oversupply
OY	operating year (August through July)
PDCI	Pacific DC Intertie
PF	Priority Firm Power
PFp	Priority Firm Public
PFx	Priority Firm Exchange
PNCA	Pacific Northwest Coordination Agreement
PNRR	Planned Net Revenues for Risk
PNW	Pacific Northwest
POD	Point of Delivery
POI	Point of Integration or Point of Interconnection
POR	point of receipt
PPC	Public Power Council
PRSC	Participating Resource Scheduling Coordinator
PS	Power Services
PSC	power sales contract
PSW	Pacific Southwest
PTP	Point-to-Point
PUD	public or people's utility district
RAM	Rate Analysis Model (computer model)
RAS	Remedial Action Scheme
RCD	Regional Cooperation Debt
RD	Regional Dialogue
RDC	Reserves Distribution Clause
REC	Renewable Energy Certificate
Reclamation	U.S. Bureau of Reclamation
REP	Residential Exchange Program
REPSIA	REP Settlement Implementation Agreement
RevSim	Revenue Simulation Model
RFA	Revenue Forecast Application (database)
RHWM	Rate Period High Water Mark
ROD	Record of Decision
RPSA	Residential Purchase and Sale Agreement
RR	Resource Replacement

RRS	Resource Remarketing Service
RSC	Resource Shaping Charge
RSS	Resource Support Services
RT1SC	RHWM Tier 1 System Capability
RTD-IIE	Real-Time Dispatch – Instructed Imbalance Energy
RTIEO	Real-Time Imbalance Energy Offset
SCD	Scheduling, System Control, and Dispatch Service
SCADA	Supervisory Control and Data Acquisition
SCS	Secondary Crediting Service
SDD	Short Distance Discount
SILS	Southeast Idaho Load Service
Slice	Slice of the System (product)
SMCR	Settlements, Metering, and Client Relations
SP-15	South of Path 15
T1SFCO	Tier 1 System Firm Critical Output
TC	Tariff Terms and Conditions
TCMS	Transmission Curtailment Management Service
TDG	Total Dissolved Gas
TGT	Townsend-Garrison Transmission
TOCA	Tier 1 Cost Allocator
TPP	Treasury Payment Probability
TRAM	Transmission Risk Analysis Model
Transmission System Act	Federal Columbia River Transmission System Act
Treaty	Columbia River Treaty
TRL	Total Retail Load
TRM	Tiered Rate Methodology
TS	Transmission Services
TSS	Transmission Scheduling Service
UAI	Unauthorized Increase
UDE	Under Delivery Event
UFE	unaccounted for energy
UFT	Use of Facilities Transmission
UIC	Unauthorized Increase Charge
UIE	Uninstructed Imbalance Energy
ULS	Unanticipated Load Service
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish & Wildlife Service
VER	Variable Energy Resource
VERBS	Variable Energy Resource Balancing Service
VOR	Value of Reserves
VR1-2014	First Vintage Rate of the BP-14 rate period (PF Tier 2 rate)
VR1-2016	First Vintage Rate of the BP-16 rate period (PF Tier 2 rate)
WECC	Western Electricity Coordinating Council
WSPP	Western Systems Power Pool

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1. INTRODUCTION AND OVERVIEW

1.1 Introduction

The Power Loads and Resources Study (Study) contains the load and resource data used to develop Bonneville Power Administration's (BPA's) wholesale power rates. This Study illustrates how each component of the loads and resources analysis is completed, how the components relate to each other, and how they fit into the rate development process. The Power Loads and Resources Study Documentation (Documentation), BP-22-FS-BPA-03A, contains details and results supporting this Study.

This Study focuses on fiscal years (FYs) 2022-2023 and has two primary purposes: (1) to determine BPA's monthly and annual energy load and resource balance (load-resource balance); and (2) to provide specific results that are used as inputs in other rate case study processes and calculations. To ensure that BPA has sufficient firm generation to meet its firm load obligations, BPA bases its resource planning on hydro generation estimates under historical critical water conditions (1937). *See* § 3.1.2.1.3 below.

This Study provides inputs for various other studies, processes, and calculations in the ratemaking process. The results of this Study provide data to (1) the Power Rates Study, (2) the Power Revenue Requirement Study, (3) the Power and Transmission Risk Study, (4) the Generation Inputs Study, and (5) the Power Market Price Study and Documentation.

1.2 Overview of Methodology

This Study includes three main components: (1) load data, including a forecast of the Federal system loads and contract obligations; (2) resource data, including Federal system generating resource and contract purchase estimates, total Pacific Northwest (PNW) regional hydro resource estimates, and the estimated power purchases that are eligible for

Section 4(h)(10)(C) credits under the Pacific Northwest Electric Power Planning and Conservation Act (Northwest Power Act), 16 U.S.C. § 839–839h; and (3) the Federal system load-resource balance, which compares Federal system loads, contract obligations, and sales to the Federal system generating resources and contract purchases.

The first component of the Power Loads and Resources Study is the Federal system load obligation forecast—the firm energy that BPA expects to serve during FY 2022-2023 under firm requirements contract obligations and other BPA contract obligations. The load estimates are discussed in Section 2 of this Study and are detailed in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A.

The second component of this study is resource data, which includes the forecast of (1) Federal system resources, (2) PNW regional hydro resources, and (3) power purchases eligible for 4(h)(10)(C) credits. The Federal system resource forecast includes hydro and non-hydro generation estimates plus power deliveries from BPA contract purchases. The Federal system resource estimates are discussed in Section 3.1 below and are detailed in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A. The PNW regional hydro resources include all hydro resources in the PNW, whether Federally or non-Federally owned. The regional hydro estimates are discussed in Section 3.2 below and are detailed in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A. The resource estimates used to calculate the 4(h)(10)(C) credits are discussed in Section 3.3 below, and the estimated power purchases eligible for 4(h)(10)(C) credits are detailed in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A.

The third component of this Study is BPA's load-resource balance, which is calculated on an annual average energy basis for each year of the rate period, FY 2022 and FY 2023. BPA's

firm energy load-resource balance is calculated by subtracting BPA's load and contract obligations from the Federal system resources. The load-resource balance is discussed in Section 4 below and is detailed in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A.

Throughout the Study and Documentation, the load and resource forecasts are shown using three different measurements. The first, energy in average megawatts (aMW), is the average amount of energy produced or consumed over a given time period, in most cases a month. The second measurement, heavy load hour energy in megawatthours (MWh), is the total MWh generated or consumed over the heavy load hours of a given time period. Heavy load hours (referred to as either Heavy or HLH) can vary by contract but generally are clock hours 06:00 to 22:00 Monday through Saturday, excluding North American Electric Reliability Corporation (NERC) holidays. The third measurement, light load hour energy in MWh, is the total MWh generated or consumed over the light load hours of a given timeframe. Light load hours (referred to as either Light or LLH) can also vary by contract but generally are clock hours 23:00 to 05:00 Monday through Saturday, all day Sunday, and all day on NERC holidays. Resource forecasts are shown using an additional measurement, one-hour capacity. One-hour capacity (in MW) is the single highest one hour of forecast generation per month and represents the peak forecast capacity that a resource can be expected to generate in that month. These measurements are used to ensure that BPA will have adequate resources to meet the variability of loads.

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2. FEDERAL SYSTEM LOAD OBLIGATION FORECAST

2.1 Overview

The Federal System Load Obligation forecasts include (1) BPA's projected firm requirements power sales contract (PSC) obligations to consumer-owned utilities (COUs) and Federal agencies (together, for purposes of this Study, called Public Agencies or Public Agency Customers); (2) PSC obligations to investor-owned utilities (IOUs); (3) PSC obligations to direct-service industries (DSIs); (4) reserve power delivery obligations to the U.S. Bureau of Reclamation (Reclamation); and (5) other BPA contract obligations, including contract obligations outside the PNW region (Exports) and contract obligations within the PNW region (Intra-Regional Transfers (Out)). This section summarizes BPA's forecasts of these obligations.

2.2 Public Agencies' Total Retail Load and Firm Requirements Power Sales Contract (PSC) Obligation Forecasts

In December 2008, BPA executed PSCs with Public Agencies under which BPA is obligated to provide power deliveries from October 1, 2011, through September 30, 2028. These contracts are referred to as Contract High Water Mark (CHWM) contracts. Three types of CHWM contracts were offered to customers: Load Following, Slice/Block, and Block (with or without Shaping Capacity). Of the 135 BPA Public Agency CHWM customers, 119 have Load Following contracts, 13 have Slice/Block contracts, and three have Block contracts.

BPA's obligation to serve Public Agency Customers under their CHWM contracts incorporates the following: Tier 1 System Capability; updated forecasts of each customer's total load obligation; individual customers' dedicated resource amounts; and individual customers' elections for Above-Rate Period High Water Mark (Above-RHWM) load service. The Tier 1 System Capability is determined for each rate period in the RHWM Process.

Above-RHWM load is determined for each rate period in the RHWM Process; any Above-RHWM load service placed on BPA is seen as Tier 2 Load Service. *See* Power Rates Study, BP-22-FS-BPA-01, § 1.4.2.

Under the CHWM contracts, BPA's load obligation to each customer can consist of RHWM load and Above-RHWM load. The RHWM Process sets the maximum amount of power that a customer may purchase each year of the rate period at the Tier 1 rate, subject to that customer's calculated Net Requirement net of its New Large Single Loads (NLSLs). *See* Tiered Rate Methodology (TRM), BP-12-A-03, § 4.2. Above-RHWM load for each year of the rate period is calculated by subtracting the customer's RHWM from the difference between its forecast Total Retail Load (TRL) (less NLSLs) and its existing resources.

Each customer elects how to serve Above-RHWM load by (1) adding new non-Federal dedicated resources; (2) buying power from sources other than BPA; and/or (3) requesting BPA to supply all or a part of this power. *See* TRM, BP-12-A-03, § 4.3. Under the terms of the CHWM contract and the TRM, the first two options are identified as self-supply and result in a change in the dedicated resource amounts for that customer. If a customer elects for BPA to serve all or part of its Above-RHWM load, BPA will first serve this load from federal surplus generation, then, if needed, purchase power or acquire the output from non-federal generating resources in order meet customer's elected Above-RHWM load at a Tier 2 rate. Non-federal power purchased or acquired to serve Tier 2 load is separate and distinct from BPA's Tier 1 System Capability (*see* Power Rates Study, BP-22-FS-BPA-01, § 1.4.2). Above-RHWM load served by BPA is identified as Tier 2 Load Service, and non-federal power purchases and acquisitions above firm Federal surplus generation to serve Tier 2 load are identified as Tier 2 Augmentation.

2.2.1 Load Following PSC Obligation Forecasts

The Load Following product provides firm power to meet the customer's total retail load, less the dedicated power from the customer's non-Federal resource generation and purchases from other suppliers. The total monthly firm obligation forecast for Public Agency Customers that purchase the Load Following product is based on the sum of the utility-specific firm requirements PSC load obligation forecasts, which are customarily produced by BPA analysts. The method used for preparing the load obligation forecasts is as follows.

First, using BPA's Agency Load Forecast (ALF) model, BPA analysts produce utility-specific forecasts of total retail load by applying least-squares regression on historical monthly energy loads, and for a growing number of customers, a statistically adjusted end-use (SAE) model. The least-squares regression-based models may include several independent variables, such as a time trend, heating degree days, cooling degree days, and monthly indicator variables. The SAE models replace typical independent variables used in load forecasting with calculated indexes for structural measures associated with heating equipment, cooling equipment, and other energy-consuming technologies. Heating and cooling degree days are measures of temperature effects to account for changes in electricity usage related to temperature changes. Heating degree days are calculated when the temperature is below a base temperature, such as 65 degrees F; similarly, cooling degree days are calculated when the temperature is above a base temperature. The results from these computations are utility-specific monthly forecasts of total retail energy load. The energy value for total retail load is split into HLH and LLH time periods using recent historical relationships.

Second, estimates of customer-owned and consumer-owned dedicated resource generation and contract purchases dedicated to serve retail loads (including those to serve Above RHWM load) are subtracted from the utility-specific total retail load forecasts to produce BPA's total firm load obligation forecast for each utility. These load obligation forecasts provide the basis for the Load Following product sales projections incorporated in BPA ratemaking.

A list of the 119 Public Agency Customers that have purchased the Load Following product appears in Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Table 1.1.1. BPA's total PSC load obligation forecast including Federal agencies is summarized in *id.*, Tables 1.2.1 for energy, 1.2.2 for HLH, and 1.2.3 for LLH, on Line 3 (Load Following). The components of this forecast are also included in the calculation of the load-resource balance, *id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 1 (Load Following).

2.2.2 Block PSC Obligation Forecasts

The Block product provides a planned amount of firm requirements power to serve the customer's retail load up to its planned net requirement. The Block product provides a planned amount of firm requirements power in a fixed monthly shape. The customer is responsible for using its own non-Federal resources or unspecified resources to meet any load in excess of its planned monthly BPA purchase.

The three Public Agency Customers that have selected the Block product are identified in *id.*, Table 1.1.2. BPA's forecast of the total Block Obligation is summarized in *id.*, Tables 1.2.1 for energy, 1.2.2 for HLH, and 1.2.3 for LLH, on Line 14 (Tier 1 Block). This

forecast is also included in the calculation of the load-resource balance, *id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 6 (Tier 1 Block).

2.2.3 Slice/Block PSC Obligation Forecasts

The Slice/Block product provides firm requirements power to serve the customer's retail load up to its planned net requirement. For each fiscal year, the planned annual Slice/Block amounts are adjusted based on BPA's calculation of the customer's planned net requirement under the contract. The Block portion of the Slice/Block product provides a planned amount of firm requirements power in a fixed monthly shape, while the Slice Output from the Tier 1 System portion provides planned amounts of firm requirements power in the shape of BPA's generation from the Tier 1 System.

The annual Slice/Block forecast and the monthly shape of the Slice/Block product for FY 2022-2023 are calculated by multiplying (1) the Tier 1 Block Monthly Shaping Factors in the customer's CHWM contract by (2) the customer's planned annual net requirement in aMW less its annual forecast Critical Slice Amounts, as defined in the CHWM contract. Critical Slice Amounts are forecast to equal the customer's Slice Percentage, adjusted as described in the TRM, BP-12-A-03, § 3.6, multiplied by the applicable annual RHWM Tier 1 System Capability.

BPA's Slice Output obligation for the Slice/Block customers is forecast by multiplying the monthly forecast of Tier 1 System output by the sum of the individual customers' Slice Percentages as listed in the Slice/Block CHWM contracts. The Tier 1 System output is comprised of specific Federal system resources and contracts identified in the TRM. *See* Section 3.4 below.

A list of the 13 Slice/Block customers appears in Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Table 1.1.3. BPA's forecast of the total Slice/Block PSC Obligation is summarized in *id.*, Tables 1.2.1 for energy, 1.2.2 for HLH, and 1.2.3 for LLH, on Line 8 (Slice Block) and Line 11 (Slice Output from Tier 1 System). This forecast is also included in the calculation of the load-resource balance, *id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 8 (Slice).

2.2.4 Tier 2 Load Service PSC Obligation Forecasts

The Tier 2 product provides the portion of Above-RHWM load for which customers have elected BPA to serve. Under the CHWM contracts, each customer's load is separated into load that is eligible to be purchased at Tier 1 rates, and Above-RHWM load, which can be purchased from BPA at Tier 2 rates or self-supplied by the customer. The RHWM Process sets the maximum amount of power that a customer may purchase each year of the rate period under Tier 1 rates, subject to that customer's calculated Net Requirement exclusive of its New Large Single Loads (NLSLs). *See* TRM, BP-12-A-03, § 4.2. Above-RHWM load for each year of the rate period is calculated by subtracting the customer's RHWM from the difference between its forecast Total Retail Load (TRL) (less NLSLs) and its existing resources, if positive. Each customer elects how to serve Above-RHWM load. If the customer elects to purchase all or part of its Above RHWM load from BPA, it is called Tier 2 load.

BPA's forecast of the total Tier 2 Load Service Obligation is summarized in Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 1.2.1 for energy, 1.2.2 for HLH, and 1.2.3 for LLH, on Line 17 (Tier 2 - Load Growth) and Line 22 (Tier 2 – Short Term). This forecast is also included in the calculation of the load-resource balance, *id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 16 (Tier 2 - Load Service).

2.2.5 Sum of Load Following, Slice/Block, Block and Tier 2 PSC Obligation Forecasts

The sum of the projected firm requirements PSC obligations, for customers with CHWM contracts, comprises the Public Agencies Preference Customers' portion of the Priority Firm Public (PFp) load obligation forecast. Each customer's load obligation forecast accounts for the reported amount of conservation the customer plans to achieve during the FY 2022-2023 rate period. These forecasts do not include additional BPA-funded conservation beyond what the customers have reported they plan to achieve. As individual customers achieve conservation measures in addition to what they already committed to, the customers will receive credits on their power bills reflecting lower loads due to the additional conservation measures. The annual average energy Priority Firm Power (PF) load obligations for FY 2022-2023 are presented, by product, in Table 1 of this Study.

2.3 Investor-Owned Utilities Sales Forecast and Other Load Served at NR Rate

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. Most of the IOUs have signed BPA power sales contracts for net requirement service for FY 2011 through 2028; however, no IOUs have chosen to take service under these contracts. If requested, and eligible by contract, BPA would serve any net requirements of an IOU at the New Resource Firm Power (NR) rate. No net requirements power sales to regional IOUs are forecast for FY 2022-2023 based on BPA's current contracts with the regional IOUs.

In addition, BPA makes power available at the NR rate to any public body, cooperative, or Federal agency to the extent such power is used to serve any NLSL as defined by the Northwest Power Act, 16 U.S.C. § 839–839h. BPA also offers products at the NR rate for

public agency customers electing to serve their NLSLs with their own dedicated resources. No sales at the NR rate are forecast in the FY 2022-2023 rate period.

2.4 Direct Service Industry Sales Forecast

BPA will make power sales deliveries to one direct service industry customer, Port Townsend Paper Corporation (Port Townsend), during the FY 2022-2023 rate period.

Port Townsend's current contract with BPA runs through September 30, 2022. BPA deliveries under this contract will provide Port Townsend with a maximum contract demand of 15.75 MW through September 30, 2022. Jefferson County PUD serves Port Townsend's wheel-turning load (load not integral to the industrial process) and Port Townsend's Old Corrugated Containers (OCC) recycling plant load, totaling 8.5 aMW. Jefferson County PUD's load forecast reflects this service arrangement. In this study, BPA assumes that it will continue to serve the remainder of Port Townsend's load during the entire FY 2022-2023 rate period, approximately 12 aMW.

BPA's DSI contract obligation is included in the Federal system load-resource balance in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 11 (DSI Obligation).

2.5 Reclamation Irrigation District Obligations

BPA provides power from the Federal system for Reclamation project loads and to serve several irrigation districts associated with Reclamation projects. These irrigation districts have been authorized by Congress to receive reserved power from specified Federal Columbia River Power System (FCRPS) projects as part of the Reclamation project authorization. Reclamation also may purchase power from the FCRPS if reserved power is

not sufficient to serve irrigation loads. BPA does not contract directly with these irrigation districts; instead, there are several agreements between BPA and Reclamation that provide details on the power deliveries.

A list of Reclamation obligations appears in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Table 1.1.4. BPA's forecast of the total Reclamation load is summarized in *id.*, Tables 1.2.1 for energy, 1.2.2 for HLH, and 1.2.3 for LLH, on Line 27 (Reclamation Obligation). This forecast is also included in the calculation of the load-resource balance, *id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 4 (Reclamation Obligation).

2.6 Other Federal System Contract Obligations

BPA provides Federal power to customers under a variety of contract arrangements not included in the Public Agencies, IOU, DSI, or Reclamation forecasts. 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 Columbia River Treaty. These arrangements, collectively called "Other Contract Obligations," are specified by individual contract provisions and can have various delivery arrangements and rate structures. BPA's Other Contract obligations are considered to be firm and are assumed to be served by the Federal system resources regardless of weather, water, or economic conditions. These contracts include obligations delivered to entities outside the PNW region (Exports) and obligations delivered to entities within the PNW region (Intra-Regional Transfers (Out)). These contract obligations are modeled individually and are specified for monthly energy in aMW, HLH, and LLH.

BPA's Export contract obligations are detailed in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 2.1.1 for energy, 2.1.2 for HLH, and 2.1.3 for LLH. BPA's Intra-Regional Transfers (Out) contract obligations are detailed in *id.*, Tables 2.3.1 for energy, 2.3.2 for HLH, and 2.3.3 for LLH. These forecasts are also included in the calculation of the load-resource balance, *id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 14 (Exports) and Line 15 (Intra-Regional Transfers (Out)).

BPA's load-resource balance in this Study is used to help set the Priority Firm Tier 1 rates. Trading floor sales are included in BPA's load-resource balance. Revenue impacts of trading floor contracts are reflected as presales of secondary energy and are included as secondary revenues credited to non-Slice customer rates.

3. RESOURCE FORECAST

3.1 Federal System Resource Forecast

3.1.1 Overview

BPA markets power and provides transmission services to serve the firm electric load needs of its customers. BPA does not own generating resources; rather, BPA markets power from Federal and specific non-Federal generating resources to meet BPA's Federal load obligations. In addition, BPA purchases power to serve firm requirements load through contracts that add to the Federal system resource capability. These resources and contract purchases are collectively called "Federal system resources." Federal system resources are classified as hydro resources (regulated, independent, and small hydro projects); other resources (large thermal and renewable resources); and contract purchases. Federal system resource forecasts are adjusted to take into account reserves and transmission loss estimates, which reduce the Federal system resource capability.

3.1.2 Hydro Generation

The Federal system hydro resources are comprised of the generation from regulated, independent, and small hydro projects. Regulated hydro projects and the process used for estimating the generation of regulated hydro projects are detailed in Section 3.1.2.1 below. Independent hydro projects and the methodology used for forecasting the generation of independent hydro projects are described in Section 3.1.2.2 below. BPA also purchases the output from two small hydro projects. The generation estimates for these small hydro projects were provided by the individual project owners and are assumed not to vary by water year; they are included in Section 3.1.2.3 below.

3.1.2.1 Regulated Hydro Generation Forecast

BPA markets the generation from the Federal system hydro projects. These projects are primarily owned and operated by either the U.S. Army Corps of Engineers (Corps) or Reclamation.

This Study uses BPA's hydrosystem simulator model (HYDSIM) to estimate the energy production that can be expected from specific hydroelectric power projects in the Columbia River Basin when operating in a coordinated fashion and meeting power and non-power requirements for 80 historical water years (October 1928 through September 2008). The hydro projects modeled in HYDSIM are called regulated hydro projects.

The hydro regulation study uses individual project operating characteristics and conditions to determine the energy production expected from each individual project. Physical characteristics of each project come from annual Pacific Northwest Coordination Agreement (PNCA) data submittals from regional utilities and government agencies involved in the coordination and operation of regional hydro projects. The HYDSIM model provides project-by-project monthly energy generation estimates for the regulated hydro projects for each water year modeled. HYDSIM incorporates and produces data for 14 periods per year: 10 calendar months and two periods each for April and August. April and August are modeled differently because the hydro system generation can differ significantly between the beginning and end of these months due to changes in streamflows and operating constraints. This 14-period data set is referred to as monthly data for simplicity.

There are three main steps of the hydro regulation studies that estimate regulated hydro generation. First, the Canadian operation is determined based on the best available

information from the Columbia River Treaty (Treaty) planning and coordination process. The Treaty calls for an Assured Operating Plan (AOP) to be completed six years prior to each operating year and a Detailed Operating Plan (DOP) to be completed, if necessary, the year prior to the operating year. The DOP reflects modifications to the AOP if agreed to by the U.S. and Canada and is usually completed a few months prior to the beginning of the operating year. These official DOP studies from the Treaty process are not available in time for use in BPA's ratemaking process. Therefore, "surrogate DOP" studies are used to represent the best available estimate for Canadian Treaty operations. The "surrogate DOP" studies include the official AOP study assumptions plus the most recent plant data and constraints available from project owners through the PNCA planning and coordination process.

Second, an Actual Energy Regulation study (AER step) is run in HYDSIM to determine the operation of the hydro system under each of the 80 years of historical water conditions while meeting the Firm Energy Load Carrying Capability (FELCC) produced in the PNCA final hydro regulation. In this step, the Canadian operation is first determined by the "surrogate DOP" study, and then the U.S. Federal, U.S. non-Federal, and Canadian reservoirs draft water to meet the Coordinated System FELCC while meeting individual reservoir non-power operating requirements.

Third, an 80-year operational study (OPER step) is run in HYDSIM with the estimated regional firm loads developed for each year of the study and with any deviations from the PNCA data submittals necessary to reflect expected operations during the rate period. In the OPER step the non-Federal projects are fixed to their operations from the AER step, and the Federal projects operate differently based on the deviations from PNCA data and the estimated regional firm load.

In summary, a "surrogate DOP" is used to determine the Canadian operations; an AER step is run based on PNCA data to determine the operation of the non-Federal projects; and an OPER step is run to determine the operation of the Federal projects based on PNCA data plus additional assumptions needed to reflect expected operations. The end result of these three steps is generally referred to as the hydro regulation study. *See* Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, § 8.

For the Power Loads and Resources Study, separate hydro regulation studies are performed for each year of the rate period. Completing hydro regulation studies for each year allows the hydro generation estimates to capture changes in the variables that characterize yearly variations in hydro operations due to firm loads, firm resources, markets for hydro energy products in better-than-critical water conditions, and project operating limitations and requirements. These variables affect the amount and timing of energy available from the hydro system and are updated annually to reflect current expectations. Sections 3.1.2.1.1-4 below contain additional details on the process of producing the regulated hydro generation estimates used in this Study.

Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 3.1.1 for energy, 3.1.2 for HLH, 3.1.3 for LLH, and 3.1.4 for one-hour capacity, Lines 1-14, list the Federal hydro projects included in BPA's Regulated Hydro Generation forecast. The regulated hydro HLH/LLH split and one-hour capacity is based on the Federal system regulated hydro generation estimates produced by BPA's Hourly Operating and Scheduling Simulator (HOSS) analyses, which utilize the HYDSIM hydro regulation studies as their base input. *See* Section 3.1.2.1.4 below.

The net regulated hydro energy generation provide inputs for the Power and Transmission Risk Study, BP-22-FS-BPA-05, and the Power Market Price Study and Documentation, BP-22-FS-BPA-04. The HLH and LLH Federal system regulated hydro generation estimates are later combined with the Federal system independent hydro HLH and LLH estimates, in the Power and Transmission Risk Study.

3.1.2.1.1 Assumptions in the HYDSIM Hydro Regulation Study

The HYDSIM studies encompass the power and non-power operating requirements expected to be in effect during the rate period, 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 (NPCC) Fish and Wildlife Program published October 2014 and amended in 2020. More specifically, the HYDSIM studies incorporate spring spill up to applicable water quality standards for Total Dissolved Gas (TDG) and summer spill informed by the results of biological performances standard testing conducted over the last decade to measure dam passage survival for out-migrating juvenile fish (performances standard spill). In total, 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. Certain measures that are physical structural modifications (*e.g.*, upgrading spill weirs), for example, were typically excluded from the rate period based on estimated project implementation and completion timelines. Each of these hydro regulation studies 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. Specific assumptions for the HYDSIM hydro regulation studies are detailed in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Section 8.

HYDSIM uses hydro plant operating characteristics in combination with power and non-power requirements to simulate the coordinated operation of the hydro system. These operating requirements include but are not limited to: storage content limits determined by rule curves; maximum project draft rates determined by each project owner as provided by the annual PNCA data submittals; and flow and spill objectives described in applicable NOAA Fisheries and USFWS biological opinions. Some limited deviations from the 2020 PNCA data submittals were necessary to accurately model anticipated operations for the rate period, such as fine-tuning the study to reflect typical in-season management decisions that are not reflected in the 2020 PNCA data submittals.

The following is an overview of the HYDSIM modeling changes have been made since the BP-20 Power Loads and Resources Final Study (see Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, § 8 for more detail).

- The AER is based on PNCA data submittal updates for Operating Year 2021. The notable AER updates are:
  - Canadian project operations have been updated based on the "surrogate 2022 DOP" using the Corps' water supply forecast. Because the 2022 and 2023 AOP studies include identical Canadian operations, the surrogate DOP studies are the same within the FY 2022 and FY 2023 HYDSIM studies.
  - CRSO EIS Preferred Alternative flood controls were updated from the Corps, including Storage Reservation Diagram changes at Libby and

Grand Coulee dams, decrease in the Grand Coulee draft rate used in planning to 0.8 feet/day, and a new Grand Coulee upstream storage adjustment methodology.

  - Water supply forecast updated to correspond with updated flood controls.
  - Juvenile Passage spill operations were updated to reflect the 2019-2021 Spill Operation Agreement.

- In the OPER study, the regional residual hydro loads (RRHL) used in HYDSIM were updated to include current forecasts of loads, contract sales and purchases, and non-hydro generation. The RRHL are calculated by subtracting the regional firm non-hydro resources from the total regional firm load. The RRHL in the BP-22 HYDSIM study are about 631 aMW higher than in the BP-20 HYDSIM study when averaged over the two-year rate period.
- Updates to the OPER study were also made to better reflect expected actual operations in the rate period from 2018 BA and the CRSO EIS preferred alternative:
  - Deeper draft of storage projects were allowed for hydropower generation at Dworshak in January-March periods and Grand Coulee in September-October periods.
  - Sliding scale summer drafts at Libby and Hungry Horse were adjusted to summer-ending elevations based on local forecasts for each project. This operation is intended to provide flexibility in balancing objectives for meeting both local resident fish and downstream flow augmentation.

- Dworshak operations to the variable draft limits (VDL) during January-March were updated to potentially increase generation and reduce spill while protecting the ability to refill.
- Grand Coulee operations for variable storage content in September (between 1277-1288 feet) and October (between 1283-1288 feet) were updated for power operations depending on available water and market conditions.

- The John Day reservoir was operated a foot higher in April-May to disrupt salmonid predator reproduction.
- Spill updates since the BP-20 Power Loads and Resources Final Study:
  - Juvenile bypass spill in this Study, for FY 2022 and FY 2023, was modeled to match the FY 2020 fish passage plan (125 percent TDG flex-spill operation) for the spring spill period in all water conditions for the eight lower Snake and lower Columbia projects. Spill during the summer period was set to the performance standard spill level.
  - This spill operation includes the late summer transition spill that was first implemented in 2020 under the Flexible Spill Agreement, where spill levels are reduced between August 15-31.
  - 10 thousand cubic feet per second (kcfs) of spill was modeled at McNary, Ice Harbor, Lower Monumental, and Lower Granite, and 5 kcfs at Little Goose to provide safe and effective downstream passage for adult steelhead that overshoot and then migrate back downstream during the months when these fish are actively migrating but when there has not been any scheduled spill for juvenile fish bypass. As described in the 2020 BA, this spill for overshoots will be provided at least three days each week, and four hours each day, from October 1 to November 15 and from March 1 to March 31.

    - TDG spill caps at eight Lower Snake and Lower Columbia projects were updated based on the Corp's February 1, 2021, PNCA data submittal, reflecting observations and information gleaned during the 2020 spill season.
- Spill priorities and TDG spill production estimates have been updated to incorporate the most recent data for overgeneration spill. Federal powerhouse availability factors have been updated using a combination of planned outages, forced outages (based on historical data and current forecasts of equipment condition), and updated balancing and operating reserve requirement assumptions. These components are incorporated into the availability factors in HYDSIM to reflect reductions in powerhouse generating capability.
- The lack of market spill has been updated based on estimates from the Aurora® model.

The separate effects of these HYDSIM modeling changes have not been analyzed, but resulted in overall changes to the Federal generation profile. These changes generally decrease firm annual average generation in 1937 critical water conditions (explained in Section 3.1.2.1.3 below) over the two-year rate period relative to results of the final BP-20 Power Loads and Resoures Study . The BP-22 rate period annual average Federal generation in 1937 critical water conditions decreases about 183 aMW compared to the BP-20 rate period. The BP-22 rate period 80-year annual average Federal generation decreases about 172 aMW compared to the BP-20 rate period. The Federal generation decrease is largely attributable to the loss of Federal generation that resulted from the updates to the spill assumptions, as well as the Libby and Hungry Horse sliding scale drafts.

The assumptions used in the hydro regulation studies were the same for both years of the rate period, FY 2022 and FY 2023, except for the following:

- The hydro availability factors used to model anticipated unit outages were different in the FY 2022 and FY 2023 studies.
- The RRHL forecasts were calculated specifically for each study year. The loads incorporated in the FY 2023 hydro regulation study are about 326 aMW higher than the loads projected for the FY 2022 hydro regulation study on an annual average basis.
- The amounts of spill due to lack of market were different in the two hydro regulation studies. These differences come from the Aurora® model which simulates the different anticipated market conditions in FY 2022 and FY 2023.

3.1.2.1.2 80-Year Modified Streamflows

The HYDSIM model uses streamflows from historical years as the basis for estimating power production of the hydroelectric system. The HYDSIM studies are developed using the 2010 modified streamflow data set. Historical streamflows are modified to reflect the changes over time due to the effects of irrigation and consumptive diversion demand, return flow, and changes in contents of upstream reservoirs and lakes. The modified streamflows are also adjusted in this Study to include updated estimates of Grand Coulee irrigation pumping using data provided by Reclamation in its PNCA data submittal for Operating Year 2022.

Eighty years of streamflow data are used because hydro is a resource with a high degree of variability in generation from year to year. The Study uses an 80-year hydro regulation study to forecast the expected operations of the regulated hydro projects for varying hydro

conditions. Approximately 80 percent of BPA's Federal system resource stack is comprised of hydro generation, which can vary annually by about 5,000 aMW depending on water conditions. HYDSIM estimates regulated hydro project generation for varying water conditions and takes into account specific flows, volumes of water, elevations at dams, biological opinions, and many other aspects of the hydro system.

3.1.2.1.3 Critical Water for Firm Planning

To ensure that the agency has sufficient generation to meet load, BPA bases its resource planning on critical water conditions. Critical water conditions are when the PNW hydro system would produce the least amount of power while taking into account the historical streamflow record, power and non-power operating constraints, the planned operation of non-hydro resources, and system load requirements. For operational purposes, BPA currently defines critical water conditions as those that occurred during the critical period of September 1, 1936, through April 30, 1937, as determined in the PNCA planning process. For planning purposes and to align with the fiscal years used in this study, however, the study uses the historical streamflows from October 1936 through September 1937 water conditions as the critical period. These streamflows are designated "1937 critical water conditions." The hydro generation estimates under 1937 critical water conditions determine the critical period firm energy for the regulated and independent hydro projects. This is called the firm energy load-carrying capability, or FELCC.

3.1.2.1.4 Regulated Hydro HLH/LLH Split and One-Hour Capacity Calculations using HOSS

The monthly energy produced by HYDSIM for each regulated hydro project is split between heavy and light load hours and provide inputs for RevSim in the Power and Transmission Risk Study, BP-22-FS-BPA-05, Section 4.1.1.1.2. To calculate the HLH/LLH regulated hydro

splits, BPA completes an hourly simulation of the regulated hydro projects' operation using the computer model Hourly Operating and Scheduling Simulator (HOSS). The hourly outputs of HOSS are not directly used for ratemaking purposes. Rather, the hourly HOSS outputs are used to derive monthly Federal system regulated hydro energy relationships. These monthly energy relationships provide the monthly HLH energy and LLH energy shapes used in ratemaking.

To simulate hourly Federal regulated hydro generation, the HOSS model uses HYDSIM monthly project flows, monthly reservoir content, and other power and non-power constraints discussed in Section 3.1.2.1 above. HOSS studies also incorporate current forecasts of monthly Regulating Reserve, Operating Reserve, Load Following Reserve, Dispatchable Energy Resource Balancing Service (DERBS) Reserve, and Variable Energy Resource Balancing Service (VERBS) Reserve.

The resulting HOSS studies shape the monthly energy from HYDSIM into HLH and LLH Federal hydro generation for each of the 80-water-year conditions of the study period. These projections are the basis for the Federal system hydro energy relationships that provide the monthly HLH and LLH energy splits that are shown in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 3.1.2 and 3.1.3 and are inputs to the Power and Transmission Risk Study, BP 22-FS-BPA-05, Section 4.1.1.1.5.1. These forecasts are also included in the calculation of the load-resource balance, which is included in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 25 (Regulated Hydro-Net).

The same HOSS studies provide the hourly peak Federal hydro generation values for each month of the 80-water-year conditions. The hourly outputs from HOSS are entered into a

Microsoft Excel spreadsheet, and the curve-fitting function in Excel is used to generate a peaking capacity curve and associated equation for each period that reflects the one-hour peaking capacity. The equations are then applied to the HYDSIM monthly generation estimates, which results in a one-hour peaking capacity (variable Y) for any input average energy generation (variable X). The monthly one-hour capacity values are shown in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Table 3.1.4.

3.1.2.2 Independent Hydro Generation Forecast

Federal independent hydro includes hydro projects whose generation output typically varies by water condition; however, the generation forecasts for these projects are not modeled or regulated in the HYDSIM study. BPA markets the power from independent hydro projects that are owned and operated by Reclamation, the Corps, and other project owners. Federal independent hydro generation and one-hour capacity estimates are provided by Reclamation and the Corps for 80 water years (October 1928 through September 2008). These estimates also include power purchased from the Cowlitz Falls hydro project owned by Lewis County Public Utility District. Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 3.2.1, 3.2.2, 3.2.3, and 3.2.4, Lines 1-18, list the hydro projects included in BPA's Independent Hydro Generation forecast.
The energy estimates for Federal independent hydro generation used in this Study are summarized in *id.*, Tables 3.2.1 for energy, 3.2.2 for HLH, 3.2.3 for LLH, and 3.2.4 for one-hour capacity, Line 20. This forecast is also included in the calculation of the load-resource balance, *id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 26 (Independent Hydro-Net).

The HLH/LLH splits and the one-hour capacity for the independent hydro generation estimates are developed based on historical generation data. This Study provides the

monthly HLH and LLH generation for the Federal system independent hydro resources used in the Power and Transmission Risk Study.

3.1.2.3 Small Hydro Generation Forecast

BPA's small hydro resource purchases are from the Dworshak/Clearwater Small Hydro project and Rocky Brook hydro project. Generation estimates for these small hydro projects are provided by each individual project owner and are assumed not to vary by water year. Small hydro resources are detailed in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 3.3.1 for energy, 3.3.2 for HLH, 3.3.3 for LLH, and 3.3.4 for one-hour capacity. This forecast is also included in the calculation of the load-resource balance, *id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 27 (Small Hydro Resources).

3.1.3 Non-Hydro Renewable Generation Forecasts

Non-hydro renewable generation includes the purchased output from non-Federally owned wind and solar resources (Federal purchases of shares of the Condon Wind Project, Klondike I Wind Project, Klondike III Wind Project, and Stateline Wind project). The generation and capacity forecasts for these resources take into account historical generation values. These projects are detailed in *id.*, Tables 4.2.1 for energy, 4.2.2 for HLH, 4.2.3 for LLH, and 4.2.4 for one-hour capacity. This forecast is also included in the calculation of the load-resource balance, *id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 28 (Non-Hydro Renewable Resources).

3.1.4 Thermal Generation Forecasts

Thermal generation forecasts include the purchased output from non-Federally owned projects and project generation that is directly assigned to BPA. The only thermal resource

is the Columbia Generation Station project. Forecasts for this project include a two-year refueling cycle. The generation and capacity forecast incorporates facility and equipment improvements made since the final BP-20 Power Loads and Resources Study.

The generation forecast for Columbia Generating Station is shown in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 4.1.1 for energy, 4.1.2 for HLH, 4.1.3 for LLH, and 4.1.4 for one-hour capacity. This forecast is also included in the calculation of the load-resource balance, *id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 32 (Thermal).

3.1.5 Contract Purchases

BPA purchases or receives power under a variety of contractual arrangements to help meet Federal load obligations. The contracts are categorized as (1) power purchases, (2) power or energy exchange purchases, (3) capacity-for-energy exchange contracts, (4) power purchased or assigned to BPA under the Columbia River Treaty, and (5) transmission loss returns under Slice/Block contracts. These arrangements are collectively called "Contract Purchases." The transmission loss returns category captures the return of Slice transmission losses to the Federal system by Slice customers under Slice/Block contracts. BPA's Contract Purchases are considered firm Federal system resources that are delivered to the Federal system regardless of weather, water, or economic conditions.

BPA's expected Contract Purchases are detailed in the documentation as follows. Power purchases from delivery points outside the PNW region are termed Imports, which are found in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 2.2.1 for energy, 2.2.2 for HLH, and 2.2.3 for LLH. Non-Federal Canadian Entitlement Return (CER) deliveries are found in *id.*, Tables 2.4.1 for energy, 2.4.2 for HLH, and 2.4.3 for LLH. Power purchases from delivery points within the PNW region are called

Intra-Regional Transfers (In) and are found in *id.*, Tables 2.3.1 for energy, 2.3.2 for HLH, and 2.3.3 for LLH. Slice Transmission Loss Returns to BPA do not have their own detailed table but are included in the Federal system load-resource balance in the forecasts of "Contract Purchases." *See id.*, Tables 9.1.1 for energy, 9.1.2 for HLH, and 9.1.3 for LLH, on Line 40 (Imports), Line 41 (Intra-Regional Transfers (In)), Line 42 (Non-Fed CER), and Line 43 (Slice Transmission Loss Returns).

3.1.6 Uncommitted Purchases

Uncommitted Purchases include estimates of any Tier 1 system augmentation purchases required to meet any annual deficits of the Federal system to meet Tier 1 load service, and Tier 2 augmentation to meet Tier 2 load service that is greater than the forecasted available Federal System, in order for the Federal System to be in load-resource balance. Calculation of augmentation purchases are discussed in Section 4.2 below. *See* Power and Transmission Risk Study, BP-22-FS-BPA-05, § 4.1.1.2.3.

3.1.7 Federal System Transmission Losses

Federal system transmission loss estimates are treated as generation reductions in this Study. These losses are calculated monthly and vary by water conditions. The loss factors used have 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, October thru May; 3.38 percent, June thru August; and 3.02 percent in September.

- Capacity is 3.07 percent, October thru May; 3.43 percent, June thru August; and 3.07 percent in September.

The estimated magnitude of each loss factor component for energy and capacity is as follows:

(1) Step-up transformers between the Federal generation and the transmission network: average losses of 0.31 percent for energy and 0.36 percent for capacity.

(2) High-voltage network: uses a monthly factor set by season.

October	November	December	January	February	March	April	May	June	July	August	September
1.95%	1.95%	1.95%	1.95%	1.95%	1.95%	1.95%	1.95%	2.31%	2.31%	2.31%	1.95%

(3) Transfer service to Federal system loads over non-Federal transmission systems: average losses of 0.49 percent for energy and 0.43 percent for capacity.

(4) Step-down transformers: average losses of 0.27 percent for energy and 0.33 percent for capacity.

These transmission loss factor components were developed in 1992 and reaffirmed by Transmission Services in 1994, 2000, and 2011. In 2014, BPA updated the transmission loss factor for the third component, transfer service to Federal loads over non-Federal transmission systems; this update was first included in studies for the BP-16 rate case. In addition, BPA has now updated the second component, High-voltage network losses, which are used in this Study. *See* BPA Open Access Transmission Tariff, TC-22-A-03-AP01, Schedule 11. The Power and Transmission Risk Study and the Power Rates Study also use these transmission loss factors.

3.2 Regional Hydro Resources

3.2.1 Overview

This Study produces total PNW regional hydro resource estimates for FY 2022 and FY 2023. Additionally, it provides the hydro resource inputs for the Aurora® model, which provides forecasts used in the Power Market Price Study and Documentation, BP-22-FS-BPA-04.

3.2.2 PNW Regional 80-Water-Year Hydro Generation

PNW regional hydro resource estimates are one of the inputs to the Aurora® model and are comprised of all PNW regulated, independent, and small hydro resources for FY 2022 and FY 2023. Regulated hydro generation estimates for this study are developed for each of the 80 water years (October 1928 through September 2008) using the HYDSIM study described in Section 3.1.2.1 above. Independent hydro generation estimates are provided by the project owners for the same 80 water years. *See* Section 3.1.2.2, above. Small hydro generation estimates are provided by the project owners and are assumed not to vary by water year. Small hydro projects are described in Section 3.1.2.3, above.

The total regional regulated, independent, and small hydro energy is summarized for each of the 80 water years for FY 2022-2023 in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Section 5.

3.3 4(h)(10)(C) Credits

3.3.1 Overview

The Northwest Power Act directs BPA to make expenditures to protect, mitigate, and enhance fish and wildlife affected by the development and operation of Federal hydroelectric projects in the Columbia River Basin and its tributaries. These expenditures

are to be made in a manner consistent with the Power Plan and Fish and Wildlife Program developed by the NPCC and consistent with other purposes of the Northwest Power Act. 16 U.S.C. § 839–839h.

Section 4(h)(10)(C) of the Northwest Power Act requires that the costs of mitigating these impacts be properly accounted for among the various purposes of the hydroelectric projects by making sure that when BPA funds mitigation on behalf of both power and non-power project purposes, ratepayers recoup the non-power share. The non-power purposes include flood control, irrigation, recreation, and navigation. The percentage of costs attributable to non-power purposes is 22.3 percent. This percentage is the systemwide average of cost allocations for non-power purposes of the FCRPS provided by the Reclamation and the Corps for their hydropower projects.

Following the Northwest Power Act's requirement for appropriate cost allocation, BPA annually recoups the non-power portion of costs associated with fish measures through "4(h)(10)(C) credits" against BPA's payments to the U.S. Treasury. This Study estimates the replacement power purchases resulting from changes in hydro system operations to benefit fish and wildlife. These power purchases are part of the calculation of 4(h)(10)(C) credits in the Power and Transmission Risk Study, BP-22-FS-BPA-05, § 4.1.1.1.5.6. The operations to benefit fish and wildlife are described in this Study in Section 3.1.2.1.1.

3.3.2 Forecast of Power Purchases Eligible for 4(h)(10)(C) Credits

The power purchases eligible for 4(h)(10)(C) credits are estimated by comparing power purchase estimates between two HYDSIM hydro regulation studies. The first hydro regulation study, termed the "with-fish" study, models hydro system operations using current requirements for fish mitigation and wildlife enhancement under 80 historical

water year conditions (October 1928 through September 2008). The HYDSIM study completed for this Study serves as the "with-fish" study for the power purchase estimates. The second hydro regulation study, called the "no-fish" study, models the hydro system operation assuming no operational changes were made to benefit fish and wildlife using the same 80 historical water year conditions.

BPA estimates the power purchases required to meet a specific firm load (described below) under the with-fish study and the power purchases required to meet the same firm load under the no-fish study. The 4(h)(10)(C) credits do not pertain to the entire generation difference between the with-fish study and the no-fish study; instead, the credits pertain to only a portion of the additional power purchases in the with-fish study. BPA receives 4(h)(10)(C) credits for the non-power portion (22.3 percent) of the additional power purchases it must make in the with-fish study relative to the no-fish study.

The specific firm load used in the calculation of 4(h)(10)(C) credits was a part of the original negotiated arrangement between the Department of Energy and the U.S. Treasury allowing BPA to claim the credits. A fundamental principle of this arrangement for claiming 4(h)(10)(C) credits is that the calculation must not be affected by BPA's marketing decisions. To separate the credit calculation from BPA marketing decisions, 4(h)(10)(C) credits are calculated using the load that could have been served with certainty while drafting the system from full to empty without fish operations under the worst energy-producing water conditions in the 80-year record (referred to as the critical period, which is 1929-1932 in the no-fish study). This FELCC is the amount of firm energy that BPA would have been entitled to sell without fish operations and is used as the firm load in the 4(h)(10)(C) power purchases analysis.

The differences between the Federal FELCC and the Federal generation in the with-fish study determine the power purchases under the with-fish study. Similarly, the differences between the Federal FELCC and the Federal generation in the no-fish study determine the power purchases under the no-fish study. The instances where power purchases are greater in the with-fish study compared to the no-fish study result in power purchases eligible for 4(h)(10)(C) credits. Alternatively, when power purchases are less in the with-fish study than in the no-fish study, the difference constitutes a negative 4(h)(10)(C) credit.

The differences in energy purchase amounts between the with-fish and no-fish hydro studies are calculated for each period and water condition of the 80 water year studies. The differences are shown for the rate period in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 6.1.1 and 6.1.2. These power purchases are used as inputs to the Power and Transmission Risk Study, where, combined with Aurora market price estimates, they are used to calculate the 4(h)(10)(C) credits for power purchases. The non-power portion (22.3 percent) of the average expense for these purchases is used as the forecast of 4(h)(10)(C) credits for Federal hydro system fish operations.

3.4 Use of Tier 1 System Firm Critical Output Calculation

The forecast Tier 1 System Firm Critical Output (T1SFCO) used in the ratemaking process was calculated for the FY 2022–2023 rate period in the BP-22 RHWM Process. Power Rates Study, BP-22-FS-BPA-01, § 1.4.2. The T1SFCO adds forecasts of hydro generation, thermal generation, and contract purchases together, and subtracts specified system obligations as shown in Tables 3.1 through 3.4 in the TRM, BP-12-A-03. RHWM Tier 1 System Capability is the sum of the T1SFCO and RHWM Augmentation. TRM, BP-12-A-03,

§ 3.1. The BP-22 RHWM Process rescaled the CHWMs to this RHWM Tier 1 System Capability to arrive at individual customers' RHWM values for the FY 2022–2023 rate period.

Supporting tables for the T1SFCO used in this Study for the calculation of the Tier 1 System output are provided in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Section 7. T1SFCO is 6,667 aMW when averaged over the two-year rate period, FY 2022–2023. *Id.*, Table 7.1.1. RHWM Augmentation is 69 aMW, and RHWM Tier 1 System Capability is 6,736 aMW over the two-year rate period, FY 2022-2023. The BP-22 RHWM Process calculated an adjusted Slice Output of 22.36267 percent of the RHWM Tier 1 System Capability.

4. FEDERAL SYSTEM LOAD-RESOURCE BALANCE

4.1 Overview

For BPA to plan operations and set power rates, the Federal system must be in load and resource balance; that is, BPA must produce an annual forecast showing that it has enough resources available to meet its forecast firm loads under critical water conditions. The load-resource balance is composed of the monthly energy amounts of BPA's resources, which include hydro, non-hydro, and contract purchases, less BPA's load obligations, which are comprised of BPA's power sales contract obligations and other contract obligations.

4.2 Firm Load-Resource Balance

To determine whether the Federal system is in load-resource balance, the forecast amount of BPA's annual firm energy resources under critical water conditions (1937) is estimated and compared to BPA's total annual firm energy loads. If BPA's expected firm energy resources are equal to BPA's total expected load obligations, then BPA is considered to be in load-resource balance. If the load-resource balance is not zero, BPA calculates adjustments to its loads or resources to maintain BPA in load-resource balance.

If BPA's annual firm energy resources are estimated to be greater than BPA's forecasted firm load obligations, BPA is considered to be annual firm energy surplus. If surplus, BPA would calculate the amount of surplus sales needed to increase load obligations to keep the Federal system in load-resource balance: first by serving Tier 2 loads and then by identifying firm surplus sales if still surplus after serving all of BPA's Tier 2 loads. Conversely, if BPA's annual firm energy resources are estimated to be lower than BPA's forecasted load obligations, BPA is considered to be in annual firm energy deficit. If deficit, BPA would calculate the amount of system augmentation purchases needed to keep the Federal system in load-resource balance. If deficit, BPA calculates the amount of system

augmentation needed to meet Tier 1 loads (Tier 1 Sytem Augmentation) and any additional augmentation needed to meet Tier 2 loads (Tier 2 System Augmentation) separately so that it can allocate augmentation costs to the appropriate rates.

Annual firm surplus sales and system augmentation purchases may not fully balance monthly Federal system HLH or LLH energy surpluses or deficits. Purchases made to meet individual monthly HLH or LLH energy deficits are called balancing purchases and are presented in the Power and Transmission Risk Study Documentation, BP-22-FS-BPA-05A.

4.3 Firm Federal System Energy Load-Resource Balance

Table 2 shows a summary of the Federal system annual energy load-resource balance for FY 2022-2023. Under 1937 critical water conditions, the Federal system is expected to be in firm energy load-resource balance for each year of the rate period. For FY 2022, 152 aMW of firm surplus sales are forecast to achieve load-resource balance; for FY 2023, 20 aMW of firm surplus sales are forecast to achieve load-resource balance. Table 2, Line 7. The individual components that make up the Federal system annual energy load-resource balance for FY 2022-2023 are shown in Table 3 and presented monthly in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 9.1.1 (energy), 9.1.2 (HLH), and 9.1.3 (LLH).

4.4 Federal System 80-Water-Year Load-Resource Balance

To determine the load-resource balance for the Federal system under each of the 80 historical water years, the forecast amount of resources for each year is estimated and compared to loads. The 80 Water Year monthly Federal System surpluses/deficits for FY 2022 and FY 2023 are found in the Power Loads and Resources Study Documentation, BP-22-FS-BPA-03A, Tables 10.1.1 for energy, 10.1.2 for HLH, and 10.1.3 for LLH. These are

used by RevSim in the calculation of secondary energy revenues. *See* Power and Transmission Risk Study, BP-22-FS-BPA-05, § 3.1.2.1.

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SUMMARY TABLES

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Table 1
Regional Dialogue Preference Load Obligations – Forecast By Product
Annual Energy in aMW
(Sums may not be exact due to rounding)

	A	B
	FY 2022	**FY 2023**
Preference Customer Load Obligations		
1. Load-Following Customers *(Includes Federal Agencies and does not include AHWM loads not served by BPA)*	3,275	3,288
2. Block	474	473
3. Slice/Block	2,814	2,836
4. Tier 2 Load *(AHWM loads placed on BPA)*	152	169
5. Total Preference Load Obligations *(sum of Lines 1 through 4)*	**6,716**	**6,766**

Table 2
Loads and Resources – Federal System Summary
Annual Energy in aMW
(Sums may not be exact due to rounding)

	A	B
	FY 2022	**FY 2023**
Firm Obligations		
1. Load Following	3,275	3,288
2. Tier 1 Block	474	473
3. Slice	2,814	2,836
4. Direct Service Industries	12	12
5. Contract Deliveries *(not including Firm Surplus Sale)*	527	475
6. Tier 2 Load Service *(AHWM loads served by BPA, includes Resourse Remarketing)*	152	169
7. Firm Surplus Sale	152	20
8. Total Net Obligations *(sum of Lines 1 through 7)*	**7,407**	**7,273**
Net Resources		
9. Net Hydro Resources	6,286	6,285
10. Non-Hydro Renewables	48	33
11. Thermal	1,116	994
12. Contract Purchases *(not incl Augmentation)*	198	197
13. Tier 1 Augmentation Purchases	0	0
14. Tier 2 Augmentation Purchases	0	0
15. Federal System Transmission Losses	-240	-236
16. Net Total Resources *(sum of lines 9 through 15)*	**7,407**	**7,273**
Surplus/Deficit		
17. Firm Surplus/Deficit *(Line 16 – Line 8)*	**0**	**0**

Table 3
Loads and Resources – Federal System Components
Annual Energy in aMW
(Sums may not be exact due to rounding)

	A	B
	FY 2022	**FY 2023**
Firm Obligations		
1. Load Following *Total*	**3,275**	**3,288**
2. Preference Customers	2,986	2,996
3. Federal Agencies	100	104
4. Reclamation Obligation	188	188
5. Federal Diversity	0	0
6. Tier 1 Block *Total*	**474**	**473**
7. Tier 1 Block Obligation	474	473
8. Slice *Total*	**2,814**	**2,836**
9. Slice Block	1,293	1,344
10. Slice Output from Tier 1 System	1,521	1,491
11. Direct Service Industries *Total*	**12**	**12**
12. DSI Obligation	12	12
13. Contract Deliveries *Total*	**527**	**475**
14. Exports	516	465
15. Intra-Regional Transfers (Out)	11	11
16. Tier 2 Load Service *Total*	**152**	**169**
17. Preference Customers	146	162
18. Federal Agencies	11	11
19. Resource Remarketing	-4	-4
20. Uncomitted Sales *Total*	**152**	**20**
21. Firm Surplus	152	20
22. Total Firm Obligations *(sum of Lines 1+6+8+11+13+16+20)*	**7,407**	**7,273**

Table 3 (continued)
Loads and Resources – Federal System Components
Annual Energy in aMW
(Sums may not be exact due to rounding)

	A	B
	FY 2022	**FY 2023**
Net Resources		
23. Hydro Resources *Total*	**6,286**	**6,285**
24. Regulated Hydro – Net	5,935	5,933
25. Independent Hydro – Net	349	349
26. Small Hydro – Net	3	3
27. Non-Hydro Renewables *Total*	**48**	**33**
28. Wind	48	33
29. Solar	0	0
30. Other	0	0
31. Thermal *Total*	**1,116**	**994**
32. Nuclear	1,116	994
33. Coal	0	0
34. Natural Gas	0	0
35. Patroleum	0	0
36. Biofuel	0	0
37. Cogeneration	0	0
38. Contract Purchases *Total*	**198**	**197**
39. Imports	1	1
40. Intra-Regional Transfers (In)	34	34
41. Non-Federal CER	134	134
42. Slice Transmission Loss Return	29	28
43. Uncommitted Purchases *Total*	**0**	**0**
44. Tier 1 Augmentation	**0**	**0**
45. Tier 2 Augmentation	0	0
46. Reserves & Losses *Total*	**-240**	-236
47. Operating Reserves	0	0
48. Balancing Reserves	0	0
49. Transmission Losses	-240	-236
50. Total Net Resources *(sum of Lines 23+27+31+38+43+46)*	**7,407**	**7,273**
51. Total Firm Surplus/Deficit (Line 50 – Line 22)	**0**	**0**

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