Smart Planning Will Drive Replacing the Power from Lower Snake River Dams

NW Energy Coalition – February 2022

Executive Summary

Climate change and a need to reckon with social, cultural, and economic inequities are driving a historic transformation in the Northwest energy system. In the face of these serious challenges, there is an opportunity to create a more resilient and just Northwest electricity system free from greenhouse gas emissions, even as the demand on that system grows. This paper shows that:

- The energy services of the four lower Snake River dams are important for the region, though increasingly variable due to climate change impacted water conditions. They can be replaced with a diverse set of clean energy technologies that will perform better and are rapidly declining in cost.
- Planning for changes in power system generation resources is a routine and well-defined task for the utility sector. There are many examples of generation resource closures with no reliability issues.
- Clean energy resources in the region that are available or under development are more than sufficient to meet commitments to retire fossil fuel projects *as well as* replace the energy services of the four lower Snake River dams.
- Recently passed state policies and developing collaborative efforts across the region will continue to drive down costs while increasing the reliability and flexibility of the grid to meet demand.

With a thoughtful and well-planned strategy, the energy services of the four lower Snake River dams can be replaced. The region can maintain reliable and affordable energy services while creating new economic opportunities, restoring salmon, steelhead, and other species to abundance, and honoring Treaty and other reserved tribal rights to cultural resources, without compromising our climate change obligations.

Introduction

As the imperatives to address advancing climate change and social inequity drive transformations in our environment, our communities, and our energy choices, the Northwest energy system must adapt. Climate change is having a profound negative impact on fish and wildlife, and is challenging the region to rethink its infrastructure to help restore endangered salmon, steelhead, and resident fish. In the face of these challenges, there is opportunity to create a more resilient Northwest electricity system free from greenhouse gas emissions, even as the demand on that system grows to power the transportation sector and serve an increased role in heating buildings and industrial processes.

At the center of the clean energy and salmon recovery debate is the fact that climate change is increasing the near-term extinction risk for Snake River salmon and steelhead stocks and that it is impossible to recover them to healthy, fishable levels without restoring a free-flowing lower Snake River. The scientific evidence is overwhelming that removal of the four federal dams on the lower Snake River is necessary to avoid extinction and recover Snake River salmon and steelhead.

Ensuring reliable, affordable, and carbon free electricity for all communities in the region is as important as recovering Snake River salmon and steelhead. The challenge the region confronts is not choosing

between the two equally compelling goals, but how best to achieve both goals. This paper illuminates how the region can replace the power benefits provided by the lower Snake River dams with reliable, affordable, and clean alternatives.

Planning for changes in power system generation resources is an important and well-defined task for the utility sector. Once a decision has been made to retire or remove a generation resource from service, planning for replacement is a relatively routine business practice. This paper provides an overview of the role of the lower Snake River dams, the ample replacement resources being developed in the region that are carbon-free and declining in cost, and the way utilities plan for and then acquire replacement resources as they prepare for the closure of a generation resource or the end of a contract.

High Level Overview Lower Snake River Hydropower Output

Today, the lower Snake River dams provide limited and important – but replaceable – energy services to the federal hydropower system and the region's power system. The lower Snake River dams produce an average of about 925 average megawatts (aMW) throughout the year and can produce just over 2,200 megawatts (MW) for very short periods during peak energy demand. Their power represents just 4% of the regional electric system and about 10% of the Bonneville Power Administration's entire system generation.

Importantly, the energy profile of these dams is highly seasonal and varies with river flows. In fact, much of the energy is produced during the spring runoff when the much larger Columbia River hydrosystem is flush with power. Below, Figure 1 shows power generation from the Columbia River system and the lower Snake River dams in orange and blue respectively. The purple line is BPA customer demand for electricity across the year. Figure 1 shows that the lower Snake River projects are a modest part of the federal system. When they produce the most output is when the rest of the system is also producing significant output – often in excess of customer demand.

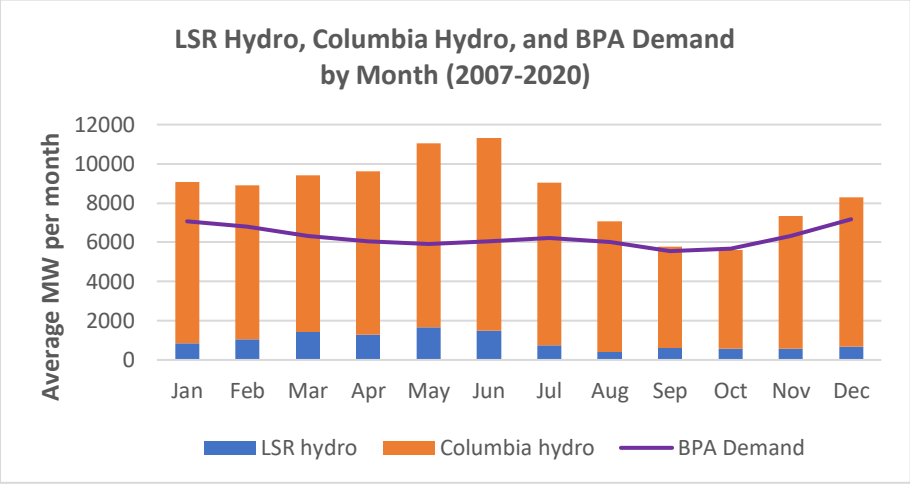

Figure 1: Average monthly power demand, in megawatts, of the Bonneville Power Administration (BPA) system in comparison to power output from the lower Snake River (LSR) dams and Columbia River dams. Data sources: Bonneville Power Administration and US Army Corps of Engineers Dataquery.

The lower Snake River dams also provide important ancillary services, including operating and contingency reserves, grid frequency support, and local voltage regulation. These services are important for supporting grid reliability, balancing, and recovery in the event of an interruption. However, these

dams are not the only resources that can provide these services, nor are they especially effective for this purpose. For example, the dams provide support for reliability in the Tri-Cities area. While hydro can ramp up and down in minutes to provide grid support, inverter-based resources – like wind, solar and batteries – can respond in seconds.

There is already substantial wind development in the lower Snake River region and potential for far more, along with solar, storage, and demand response, both locally and across the Northwest. A thoughtful and well-planned replacement strategy that includes a balanced clean energy resource portfolio, including geographically diverse renewable energy projects, energy storage, energy efficiency, and demand response, can replace the ancillary services provided by the lower Snake River dams and actually provide *better* year-round coverage.

Replacement Resources will be Emissions-free and Affordable

In 2018, the NW Energy Coalition sponsored a study by Energy Strategies, a Salt Lake City based consulting firm, to look at power replacement options if the four lower Snake River dams are removed. The study focused on maintaining reliability and affordability and not increasing greenhouse gas emissions. This study found that a balanced mix of new wind, solar, demand response, and energy efficiency to replace the output of the dams would:

- result in almost no increase in greenhouse gas emissions,
- improve reliability due to a more flexible set of replacement resources, and
- increase customer bills by about $1.28/month for customers across the region, based on conservative assumptions about the cost of renewables.

The energy landscape has changed dramatically since this study was done in 2018. Replacing these resources is now even more feasible and affordable, as the costs of replacement resources (wind, solar, storage) have fallen significantly and are forecast to continue to decline, as shown in Figure 2. Every year the US Department of Energy's National Renewable Energy Lab does a projection of costs for new power generation technologies. The 2021 projection in Figure 2 shows a continuing significant decline in renewable energy and storage costs in the coming decade.

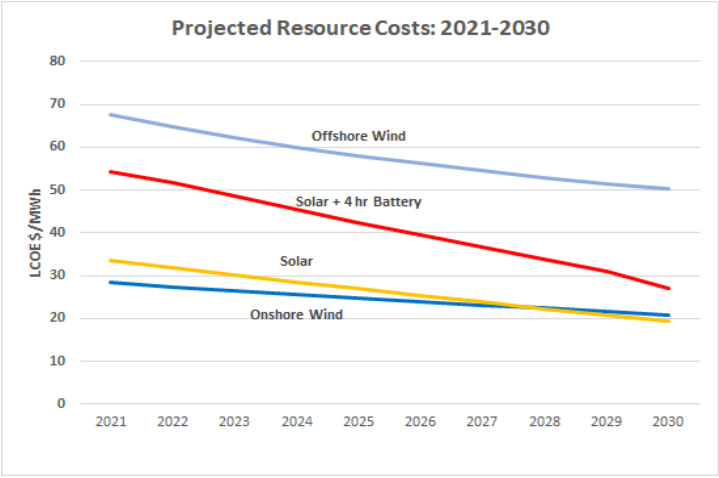

Figure 2: Levelized cost of energy, in dollars per megawatt-hour, across the major clean energy sources (offshore wind, onshore wind, solar, and solar plus battery) from 2021 – 2030. Data Source: NREL 2021 Annual Technology Baseline.

In response to a recent request for proposals (RFP), PacifiCorp selected bids for solar and wind for delivery in 2023-24 that are significantly *below* the cost of the BPA firm price for power ($34.87/MWh). The average prices presented to the Oregon Public Utility Commission are: solar = $27.50/MWh, wind = $31/MWh, and 4-hour duration batteries = $83/kW – which is about half the cost of just a couple years ago, as shown in Figure 3.[1] Many of these renewable energy bids were coupled with battery storage to support shifting their output to the highest demand periods to better match system reliability needs.

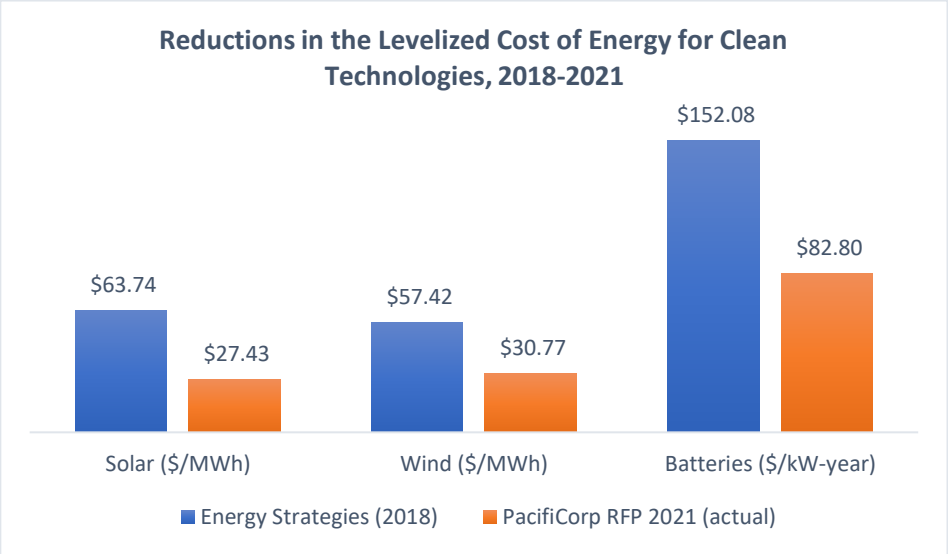

Figure 3: Reductions in the Levelized Cost of Energy for key clean energy technologies (solar, wind, batteries) from 2018 (estimated) to 2021 (actual), adjusted to 2021 dollars. Data sources: 2018 Energy Strategies Lower Snake River Dams Power Replacement Study, 2021 PacifiCorp RFP.

Meanwhile, each of the four lower Snake River dams has six generators, all of which have now been in service for 45 to 60 years. Only the three oldest generators have been rebuilt so far. The cost of updating and operating these dams will only increase as they continue to age. For example, replacing two turbines at Ice Harbor dam cost $58 million. Straight multiplication would put the cost of replacing all the remaining turbines at just over $600 million. Whereas the cost of replacement clean energy resources will continue to fall throughout this decade as shown in the NREL data in Figure 2.

Replacing Generating Resources is Standard Practice for the Power Sector

No energy system is designed to last forever. Changes in customers, economic conditions, weather events, and technology improvements are common in all power systems, and generating resources are retired and replaced to meet changing conditions on a regular basis. This is why utility system operators review all these issues, and many more, as part of regular comprehensive system planning every two to four years. Decades ago, the Northwest and our utilities pioneered the use of Integrated Resource Planning (IRP) to regularly plan for long-term changes in our electricity system. Today, this type of long-term planning is a common practice in the industry, and continues to be a vital tool to support investment decisions.

[1] UM 2059—2020 All-Source Request for Proposals OAR 860-089-0500(5) Compliance Filing

For example, in 2020, almost 2,000 MW of coal-fired generation serving the Northwest was retired. Portland General Electric closed its 550 MW Boardman coal plant, Puget Sound Energy and Talen Energy closed two 350 MW coal units at Colstrip, and TransAlta closed one of its 700 MW coal generators at Centralia. See Figure 4 for a MW comparison of these generating sources, and others.

These significant closures didn't happen without foresight. Analysis and planning was required to make sure that sufficient replacement resources were acquired to meet customer needs. Each utility and facility owner made detailed plans far enough in advance of these coal plant closures to provide replacement resources and services. For example, in December 2021, Idaho Power released a replacement strategy for three of its coal fired generating units between 2025-28. Idaho Power's recently updated resource plan for the coming decade includes 700 MW of wind, 1,105 MW of solar and 585 MW of battery storage by 2030.[2] For comparison, the 2019 plan did not contemplate coal retirements and had no wind and a fraction of the solar and storage. Decisions to close all the other generating units described in Figure 4 were three to ten years in advance of closure (except for the Trojan nuclear plant which was closed for safety concerns), providing adequate planning time to replace the resource.

This kind of planning is not new or unusual. The Trojan nuclear plant (1,100 MW) in Oregon on the banks of the Columbia River went online in the middle of 1976 and was permanently shut down in early 1993. Portland General Electric was the majority owner, Eugene Water and Electric Board had a 30% share of the plant and PacifiCorp had a 2.5% share. Due to reliability, safety, and financial concerns Trojan was closed 19 years before the end of its operating license. Even with the sudden closure of Trojan – 1,100 MW of power suddenly offline – all the utilities were able to plan for and replace the output when this facility closed. The region can and should do similar energy system planning focused on clean, renewable replacement resources as part of mapping a comprehensive solution for Columbia Basin salmon recovery.

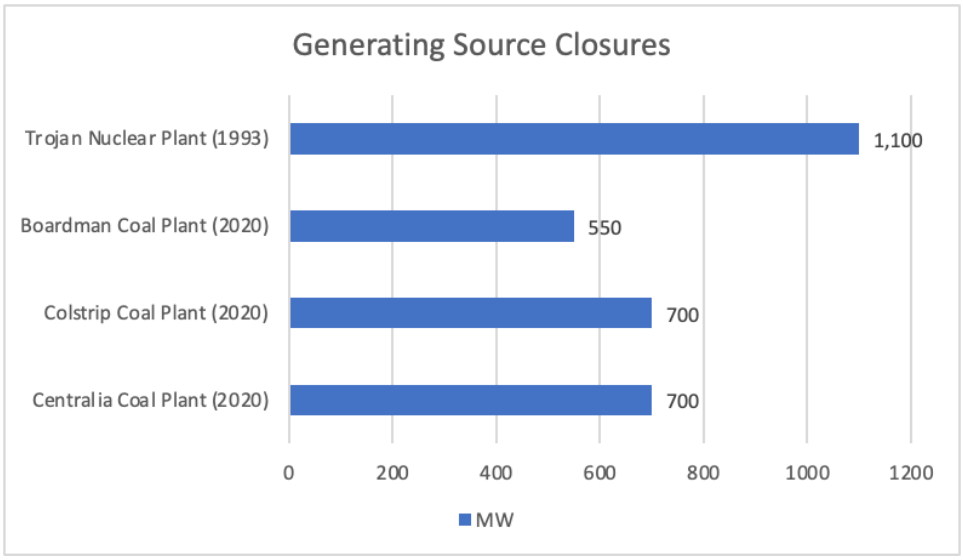

Figure 4: Power output of retired generating sources.

[2] Idaho Power Integrated Resource Plan, Idaho Power, December 2021, https://docs.idahopower.com/pdfs/AboutUs/PlanningforFuture/irp/2021/2021%20IRP_WEB.pdf

The simple fact is that the rapidly improving economics for clean energy technologies will allow us to replace legacy coal resources and the lower Snake River dams by employing the kind of long-term planning that is standard in identifying an affordable, reliable, replacement portfolio of resources.

Understanding Resource Needs and Availability

Securing adequate resources to maintain reliability of our electric system is, of course, essential. Concerns have been raised by some that retiring fossil fuel generation and removing the lower Snake River dams will result in an inadequate system and unreliable energy services. Information available today gives us confidence that these reliability and resource adequacy concerns can be readily addressed with smart, timely planning. It is clear that each facility closure and how it impacts the operation of that utility's system is unique but there are common themes and lessons learned that directly apply here.

Significant new clean resource potential exists, and the current pipeline of projects under development exceeds the region's need. The 2021 Northwest Power Plan recommends the region acquire at least 3,500 MW of renewable energy by 2027 as a cost-effective replacement for retiring fossil fuel generation.[3] Similarly, individual Northwest utilities are anticipating significant clean energy acquisition to replace fossil fuel generation, meet increased demand from electrification, and achieve climate goals. The evidence shows we can meet these needs and replace the power and services of the Snake River dams with reasonable planning and investments in the next few years.

Utility integrated resource plans project a massive build-out of clean energy in the region. During the most recent round of resource and system planning, the six investor-owned electric utilities that serve approximately 50% of the electric load in the Northwest identified a need and are preparing to acquire substantial new resources between 2021 and 2030 of approximately:

- 10,000 MW of wind and solar
- 3,200 MW of storage
- 5,000 MW of customer-side resources (e.g. energy efficiency, demand response, rooftop solar and batteries).[4]

The Northwest is reimagining the energy system in order to create new economic opportunities, meet our climate goals, meet our legal and moral obligations to Northwest Tribes, and utilize a more dynamic and flexible power grid. In this context, replacing the energy services of the lower Snake River dams to restore anadromous fish will be manageable.

The region's clean energy resource potential exceeds the actual need. While planning is important, the region gets a clearer picture of resource potential when utilities issue RFPs for new resources. As seen in

[3] The 2021 Draft Northwest Power Plan, Northwest Power and Conservation Council, September 2021, https://www.nwcouncil.org/sites/default/files/2021powerplan_2021-5.pdf

[4] 2021 Integrated Resource Plan, PacifiCorp, October 2019, https://www.pacificorp.com/energy/integrated-resource-plan.html; 2021 PSE Integrated Resource Plan, Puget Sound Energy, April 2021, https://pse-irp.participate.online/2021-IRP/Reports; 2021 Electric Integrated Resource Plan, Avista Corp, https://www.myavista.com/about-us/integrated-resource-planning; Integrated Resource Plan, Portland General Electric, July 2019, https://portlandgeneral.com/about/who-we-are/resource-planning; Idaho Power Integrated Resource Plan, Idaho Power, December 2021, https://docs.idahopower.com/pdfs/AboutUs/PlanningforFuture/irp/2021/2021%20IRP_WEB.pdf; 2019 Electricity Supply Resource Procurement Plan, Northwestern Energy, August 2019, https://www.northwesternenergy.com/docs/default-source/default-document-library/about-us/regulatory/2019-plan/complete-plan.pdf?sfvrsn=2fe04519_7

Figure 5 below, some of the region's largest utilities have recently issued RFPs. The bids received show that there are considerably *more* resources available to be developed in the region than there is need.

- In 2020 PacifiCorp (PAC) issued an RFP for about 4,300 MW of energy and capacity resources for delivery by 2024. Bids into the RFP totaled over 36,000 MW. PacifiCorp then selected a mix of wind, solar and batteries totaling 4,000 MW.
- In 2021 Puget Sound Energy (PSE) issued an RFP for about 3,200 MW of energy and capacity to be available to the utility in 2025. Bids into the RFP for wind, solar and batteries totaled about 18,000 MW, and PSE is issuing a parallel RFP for distributed energy resources. PSE will finalize its selection for the combined RFPs in mid-2022.
- Idaho Power, Avista Utilities, Portland General Electric, and PacifiCorp have recently released new or draft RFPs to begin to identify the most cost-effective mix of resources to meet their needs. In a few months, Figure 5 can be expanded to show the scope of bids for these requests.

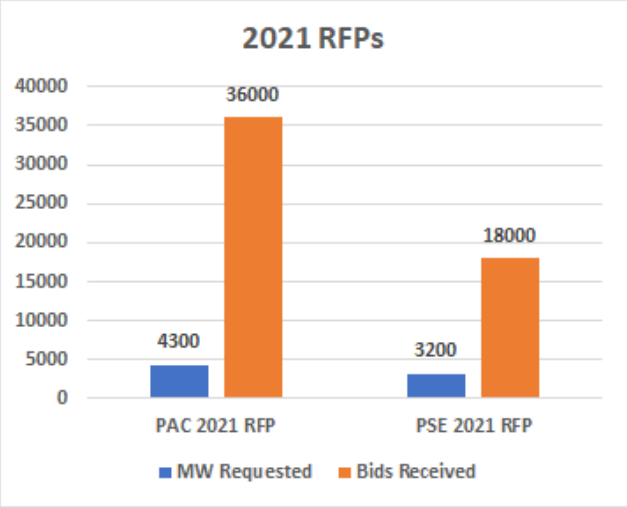

Figure 5: Recent utility RFPs with their corresponding bids, in megawatts. Data sources: PacifiCorp 2021 Integrated Resource Plan, Puget Sound Energy 2021 Integrated Resource Plan.

Another measure of the magnitude of potential resource development is the requests made by resource developers for transmission service (often called a transmission queue) for BPA, PacifiCorp, and other investor-owned utilities. These requests include over 100,000 MW of wind, solar and storage projects that are seeking access to the federal and regional transmission system. BPA's interconnection queue alone accounted for half of these resources. While only a fraction of these projects will get built due to a variety of reasons (e.g. permitting, financial, overbuilt market) the queue reflects the potential and the financial interests that are circling the region. Lead time and planning can help these projects through the development process.

New hybrid renewable energy projects can be built to deliver power when it is needed. The old trope that solar and wind projects can't generate reliable power when the sun isn't shining and the wind isn't blowing is being disproven by the quickening pace of development of hybrid renewable energy projects that combine wind, solar, and storage.

These hybrid projects that combine renewable resources with storage are specifically designed to increase reliability and provide a power resource that better fits utility load. The storage can be used to precisely

time when the renewable energy goes onto the grid when it is most valuable. For example, the hybrid Wheatridge project in Oregon, with ownership shared by Portland General Electric and NextEra, has now gone online with 300 MW of wind, 50 MW of solar and 30 MW of battery storage. Thousands of MW of similar hybrid projects are now lining up for interconnection in the region's transmission queues. Even stand-alone medium duration storage is exploding in growth. The California system operator updated its 2021 battery storage forecast, from 2019, to an almost 7-fold increase in expected growth in battery storage development (1,376 MW to 9,368 MW).[5]

Targeted energy efficiency and demand-side resources can help reduce peak energy use. Energy efficiency has saved the Northwest over 7000 aMW since 1978. This kind of investment has kept Seattle's electricity usage about the same over the past 30 years, despite a huge growth in population. Customer-side resources like energy efficiency, distributed generation and storage, and demand response will have an increasingly important role to play in ensuring a reliable system and reducing the overall cost of the energy transition in the region. Utilities in the region are already ramping up demand response and targeted energy efficiency to reduce peak energy use. The region is forecast to achieve an additional 1,000 aMW of energy efficiency by 2027 – an amount equivalent to the average annual output of the four lower Snake River dams.[6] Policies are also pushing to accelerate this pace.[7] Customer side resources are an important component of a balanced clean energy portfolio to replace the lower Snake River dams as they will reduce peak hourly power usage and protect the reliability of the system.

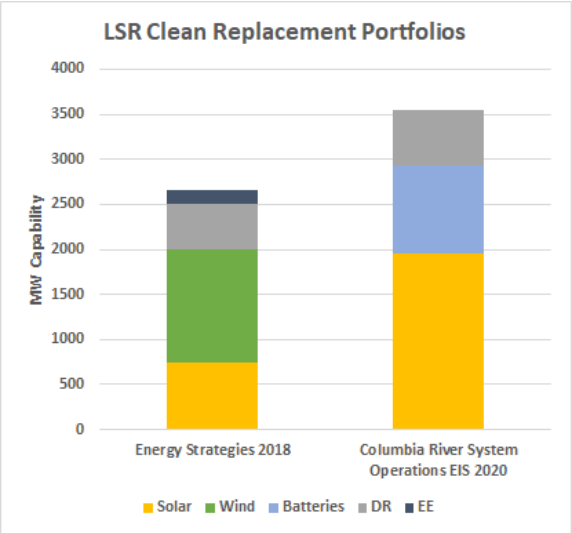

Figure 6: The make-up of two replacement portfolios of clean energy and technology (solar, wind, batteries, demand response (DR), and energy efficiency (EE)) for the lower Snake River dams. Data sources: 2018 Energy Strategies Lower Snake River Dams Power Replacement Study (Balanced Plus Portfolio), 2020 Columbia River System Operations EIS (Non-Carbon Portfolio).

[5] http://www.caiso.com/InitiativeDocuments/Presentation-2021-2022TransmissionPlanningProcess-Nov18-2021.pdf

[6] Regional Technical Forum Conservation Forecast, Sept. 2021

[7] In Oregon, HB 2021 requires investor-owned utilities to consider energy efficiency and demand response in their clean energy plans to eliminate emissions from their portfolios by 2040. In Washington, the Clean Energy Transformation Act (CETA) and Climate Commitment Act (CCA) also support utility investments in energy efficiency and demand response to reduce emissions.

In reviewing the data for resource development, there is little question that clean energy replacement of lower Snake River hydropower can be achieved with already identified resources, with a plethora of new technologies and resources on the horizon. The Energy Strategies 2018 study estimated that the energy services provided by the lower Snake River dams could be replaced with a mix of solar, wind, demand response, and advanced energy efficiency, as seen in Figure 6. A future portfolio would certainly include storage resources. The Columbia River System Operations EIS, on the other hand, did not consider a minimal resource optimization and resulted in a much larger replacement portfolio

Planned and committed new resources being acquired in the Northwest today greatly exceed the levels needed to replace the energy services of the lower Snake River dams. The competitive market for new clean energy resources continues to grow, and costs continue to fall rapidly. In the future, the Bonneville Power Administration could issue an RFP for resources to replace the energy services from the lower Snake River dams or some of these resources could be acquired by other utilities with federal investment support.

Ensuring Reliability

A rapidly advancing, more resilient, and integrated Western grid is also creating new opportunities for renewable energy to deliver clean energy to customers efficiently and affordably. In the past four years, the Western Energy Imbalance Market (EIM) has grown significantly and utilities in the region are seeing record-breaking financial and system benefits.[8] BPA will be joining the EIM in May 2022. Additional market expansions, which are under discussion in the Northwest and the West, will continue to drive down costs and increase system reliability.[9]

In response to the changing resource mix and increasing stresses from climate change and extreme weather, more than 20 utilities and other entities across the west are now joining together in the Western Resource Adequacy Program (WRAP).[10] This collaborative effort will provide coordinated use of capacity resources to meet peak hour needs and maintain reliability. The project is currently in a pilot phase and is expected to advance to a full, binding program in 2024.

Interest is also growing rapidly in expanding the local carrying capacity of the grid. In 2020, Oregon launched a comprehensive distribution system planning (DSP) process.[11] The first DSP filings in October 2021 outlined ways to expand rooftop solar, electric vehicle charging, demand response, and other resources that add flexibility to the grid, while providing more equitable access and service to customers.

Finally, the Infrastructure Investment and Jobs Act signed by President Biden in November 2021, the ongoing development of a comprehensive new transmission planning rule by the Federal Energy Regulatory Commission, and the US Department of Energy's Building a Better Grid Initiative are laying the groundwork for a rapid acceleration of the new transmission needed to support the clean energy transformation of the western grid.

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[8]Western EIM achieves record-setting $739 million in benefits for 2021, California ISO, January 31, 2022, http://www.caiso.com/Documents/Western-EIM-achieves-record-setting-739-million-in-benefits-for-2021.pdf

[9] State Led Market Options Study, September 2021, https://www.energy.gov/eere/articles/new-doe-report-shows-how-continued-western-state-collaboration-can-support-affordable

[10] WRAP Announces Full Participation of Phase 3A, Dec. 7, 2021, https://www.nwpp.org/news/wrap-announces-full-participation-of-phase-3a

[11] Order 20-485, Oregon Public Utility Commission, December 23, 2020, https://apps.puc.state.or.us/orders/2020ords/20-485.pdf

In light of these and other changes, the Northwest Power and Conservation Council 2021 Plan does not anticipate any new investments in natural gas generation to meet regional reliability needs or planned coal plant retirements and, with appropriate advance planning, replacing the power and ancillary services of the Snake River dams will not change this picture.[12]

Conclusion

With effective, timely planning, as utilities routinely do, the Federal Columbia River Power System can continue to serve the Northwest with emissions-free energy without the four lower Snake River dams. The bottom line is this: for Snake River salmon and steelhead to recover to healthy, fishable levels and be resilient to climate change they need a free-flowing lower Snake River; in contrast, with effective and strategic planning the energy benefits of the four lower Snake River dams are replaceable with affordable, non-carbon emitting, reliable alternatives. The Northwest has an abundance of proposed projects waiting to be built and connected. Once we make a decision to proceed, we can develop a comprehensive integrated resource plan with a mix of resources and storage to replace the power and services of these dams with a diverse, affordable, and clean set of energy solutions to meet the needs of the region. Ultimately, these system changes will lead to the development of a more modern and optimized electricity grid that employs energy storage, smart grid technologies, and the full flexibility benefits of an environmentally responsible hydrosystem to help integrate growing amounts of renewable energy.

For more information, please contact Fred Heutte at fred@nwenergy.org *or Chris Connolly at* *chris@nwenergy.org*.

[12] The 2021 Draft Northwest Power Plan, Northwest Power and Conservation Council, September 2021, https://www.nwcouncil.org/sites/default/files/2021powerplan_2021-5.pdf