



THE LOWER SNAKE RIVER DAMS POWER REPLACEMENT STUDY

Reliable and affordable clean energy options that can help restore salmon and protect the environment

“The region can remove the four Lower Snake River Dams and replace the power they provide with a portfolio of conservation and renewable energy resources while maintaining grid and transmission reliability at levels equal to or better than the current system and with little or no increase in greenhouse gas emissions.”

Energy Strategies,
Lower Snake River Dams Power Replacement Study (April, 2018)



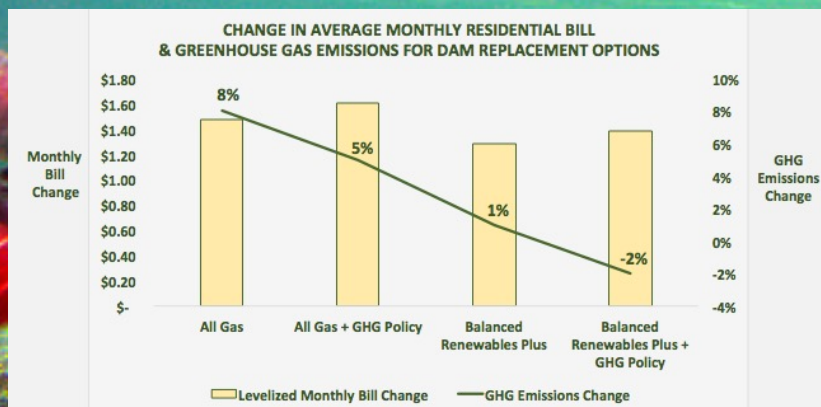
Wild salmon are crucial to the Northwest economy and environment and they’re threatened with extinction. Recovery of their populations would spur growth in our fishing and tourism industries and benefit towns and tribal communities in which they play a central economic and cultural role. Restoration is also essential to saving other species like our endangered orca whales. And it’s required by bedrock environmental laws—the Endangered Species Act (ESA) and the National Environmental Policy Act (NEPA)—as well as by Tribal Treaty obligations.

A promising option for restoring salmon in the Columbia-Snake River basins—once one of the most flourishing wild salmon ecosystems on the planet—would be the removal of four dams on the lower Snake River in southeast Washington. Despite billions of dollars spent trying to mitigate their impact, the dams have played a central role in reducing salmon populations by more than 90%.

At the same time, the dams supply about 4% of the region’s electricity. This study describes how the power and energy services provided by the dams could be reliably replaced with clean and renewable energy at a highly affordable cost.

The study shows that a clean replacement energy portfolio that includes wind, solar, demand-response, energy efficiency, and storage would increase electric system reliability and either decrease greenhouse gas emissions or cause emissions to rise by less than 1% depending on regional energy policies. The cost to the average residential customer would be not much more than a dollar and would not begin until 2026, the year in which the study anticipated the new resources would be implemented. The cost may turn out to be even lower if prices for wind, solar, and storage technologies drop below the conservative assumptions made in the study.

In summary, there is a viable, affordable, and environmentally sound alternative to power from the four lower Snake River dams. And, at present, it’s the only one that holds the promise of actually restoring salmon.



“The study shatters the myth that replacing the lower Snake River dams and restoring our wild salmon would compromise the reliability of our power system and cause major increases in rates and greenhouse gas emissions.”

Nancy Hirsh, Executive Director,
NW Energy Coalition

STUDY METHODOLOGY

Energy Strategies, an independent consulting firm, conducted the study. Their clients include power producers, transmission developers, utilities, and government agencies. The chief investigator was Keegan Moyer, previously transmission planning director for the Western Electricity Coordinating Council (WECC).



STRUCTURE

The study started with a “Reference Case”, which assumes the dams remain in operation under existing state policy and in accordance with the Northwest Power and Conservation Council’s 7th Power Plan issued in 2016. It then considered three different replacement portfolios that would replace the power generated by the dams as follows:

- A Non-Generating Alternative (NGA) with increased energy efficiency, changes to power consumption patterns (aka demand response), battery storage, and incremental market purchases of electricity.
- A Balanced Alternative (Balanced) with a combination of demand response, energy efficiency, and wind and solar generation.
- An All-Gas Alternative (All Gas) with natural gas.

The study territory included the states of Idaho, Montana, Oregon, and Washington and accounted for changes in greenhouse gas emissions within the region for each alternative as well as upcoming coal generation retirements in the region.

PROCESS & METHODOLOGY

The analysis was conducted in three phases:

1. Identification and quantification of the grid services provided by the lower Snake River dams.
2. Development of replacement portfolios that would meet or exceed reliability, energy, and capacity needs.
3. Cost assessment looking at fixed and variable costs to implement the replacement portfolios, production and operating costs, and impact on market prices.

Data for the study were provided by WECC, ColumbiaGrid, and the Northwest Power and Conservation Council.

Thermal Generation or Capacity Market Cost					Demand-side Cost Assumptions			
Resource Type		Capital Cost (\$/kW-ac)		Levelized Fixed Cost (\$/kW-year)		Resource Potential	Average Levelized Fixed Cost (\$/kW-year)	Average Levelized Cost of Energy (\$/MWh)
Gas Combined Cycle		\$1,498		\$213				
Gas Reciprocating Engine		\$1,416		\$206				
Capacity Contract (Market)		\$30/kW-year		---				
Renewable/Storage Cost								
Resource Type		Capacity Factor (%)	Installed cost (\$/kW-ac)	Levelized Fixed Cost (\$/kW-year)	Levelized Cost of Energy (\$/MWh)	“Cost Effective” Energy Efficiency		
Wind (Montana)		44%	\$1,639	\$205	\$53.24	320 aMW	---	\$28
Solar, Single-axis Tracking (Idaho)		26%	\$1,440	\$127	\$59.10	160 aMW	---	\$24
Li-ion Battery (4-hr)		---	\$753	\$141	---	880 aMW	---	\$132
						“Cost Effective” Demand Response		
						~1000 MW	\$68	---
						50% of “Cost Effective Demand Response		
						~ 500 MW	\$29	---

RESOURCE COMPOSITION OF THE REPLACEMENT PORTFOLIOS

The base Balanced and NGA portfolios were enhanced by the addition of extra resources to create “Plus” versions. The resulting portfolios as well as the All Gas portfolio were then modeled for their effects both under current law and under a scenario in which Northwest states adopt carbon-pricing policies.

		Replacement Portfolios					GHG Reduction Policy Sensitivity		
		NGA	NGA Plus	Balanced	Balanced Plus	All Gas	NGA Plus	Balanced Plus	All Gas
Replacement Resources	Demand-side	~1,000 MW DR 320 aMW EE	~1,000 MW DR 880 aMW EE	~500 MW DR 160 aMW EE	~500 MW DR 160 aMW EE	-	~500 MW DR 160 aMW EE	~500 MW DR 160aMW EE	-
	Resource-side	-	-	500 MW wind 250 MW solar	1,250 MW wind 750 MW solar	500 MW NGCC 450 MW recip	500 MW wind 250 MW solar	1,250 MW wind 750 MW solar	500 MW NGCC 450 MW recip
	Capacity Market	100 MW	100 MQ	-	-	-	100 MW	-	-

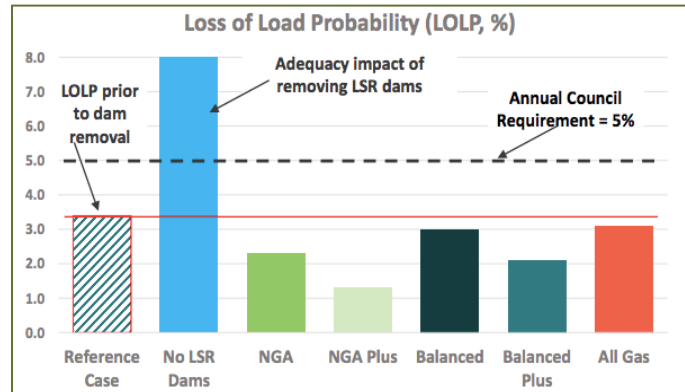
FINDINGS

The analysis indicates that the Northwest can replace the power generated by the four lower Snake River dams with a combination of new wind, solar, and demand-side resources (energy efficiency, demand response, and energy storage) that are all achievable in the next ten years. This balanced replacement portfolio provides better resource adequacy than the four dams and does not create any significant regional reliability issues.

ADEQUACY & RELIABILITY

All replacement portfolios achieved annual Loss of Load Probability results that are superior to those of the reference case with the dams in place, indicating that the likelihood and magnitude of load curtailments is *lower* with the replacement portfolio scenarios.

The chart to the right illustrates system adequacy and reliability, first with the dams in operation, next without the dams, and, finally when the dams are replaced by the different portfolios.



COST

Implementing the Balanced Plus portfolio would increase regional revenue requirements by 3% to 3.21% starting in 2026, depending on whether the Northwest implements greenhouse gas policies. In either case, the revenue requirement to implement the Balanced Plus portfolio is *less* than the requirement for the All Gas portfolio.

The revenue requirement for the Balanced Plus portfolio translates into an increase of not much more than a dollar a month for the average household. If costs for wind and solar power and storage continue current declines, this figure could drop further as shown in the “Balanced Plus w/Low Renewable Cost Sensitivity” column of the following chart.

All changes are relevant to Reference Case that retains the LSR dams		Replacement Portfolios					GHG Reduction Policy Sensitivity			
		NGA	NGA Plus	Balanced	Balanced Plus	Balanced Plus w/Low Renewable Cost Sensitivity	All Gas	NGA Plus	Balanced Plus	All Gas
Costs	Δ Total Ann'l Cost (\$M/year)	\$421	\$1,191	\$396	\$464	\$399	\$535	\$1,224	\$501	\$581
	Δ Region Revenue 2026 Requirement (%)	+2.7%	+7.6%	+2.5%	+3.0%	+2.6%	+3.4%	+7.6%	3.21%	+3.7%
	Δ Levelized Monthly Bill (\$/Month)	\$1.16	\$3.28	\$1.09	\$1.28	\$1.10	\$1.47	\$3.37	\$1.38	\$1.60

EMISSIONS

In years when hydro generation is at or below average, utilities rely more heavily on purchases of energy from fossil fuel resources resulting in increased emissions. The renewable-rich portfolios – Balanced Plus and Balanced Plus + GHG Policy – generate enough clean electricity to limit emission increases to less than 1%, or even reduce regional emissions below predicted levels.

The study shows that regional decreases in emissions would occur if the power from the dams were replaced with a balanced clean energy portfolio implemented in parallel with a regional emissions reduction policy. Even without such a policy, the Balanced Plus clean portfolio would only increase regional emissions by about 1%. That figure could well decline as the costs of clean power continue to drop.

Portfolio	Total CO2 Emissions Including Annual Gross Imports (Short Ton)	Δ (Short Ton, annual)	Δ (%)
Reference	43,299,426	0	0%
Balanced	45,327,168	2,027,741	5%
Balanced Plus	43,659,702	360,275	1%
Balanced Plus + GHG Policy	42,491,591	-807,836	-2%
NGA	45,566,562	2,267,136	5%
NGA Plus	44,267,489	968,063	2%
NGA Plus + GHG Policy	43,351,769	52,342	0%
All Gas	46,928,920	3,629,493	8%
All Gas + GHG Policy	45,357,456	2,058,030	5%

POLICY IMPLICATIONS

In May 2016, a federal district court invalidated for the fifth time in 20 years the federal government's plan for operating the Columbia and Snake River system because it violates the Endangered Species Act, violates the National Environmental Policy Act, and jeopardizes the continued existence of several threatened or endangered salmon runs. The court gave the federal agencies until 2021 to develop a new and legally adequate plan.

The court also directed the federal agencies responsible for the lower Snake River dams to fully consider viable alternatives for fish restoration, specifically including removal of the four lower Snake River dams.

The Lower Snake River Dams Power Replacement Study confirms that clean and renewable resources can provide a viable and effective energy alternative to the continued operation of the dams. We can retire the dams and keep the lights on. The study also offers a framework from which the federal agencies can draw as they develop a new plan for dam operations.

Although this study demonstrates the viability of replacing power from the four lower Snake River dams with clean and renewable resources, it did not seek to identify the optimal clean energy solution. With a new plan in development, the region has a great opportunity to identify even more cost effective and environmentally efficient outcomes than the clean replacement portfolios considered in this analysis. Additional efficiencies and savings will likely be found if future costs for renewable energy resources and storage turn out to be lower than the comparatively conservative figures assumed in this report.

Of course, a full study of dam removal will need to address factors that were beyond the scope of this study, which focused on replacing the power from the lower Snake River dams with a portfolio of clean generation. These factors include the costs of decommissioning the dams, but also significant cost savings from dam removal, including the hundreds of millions of dollars that will be needed in the next few years to refurbish the dams' aging infrastructure as well as the economic benefits of a restored river and healthy salmon populations. A previous NW Energy Coalition study found that the federal agencies would achieve a total net savings once both the costs of dam decommissioning and avoided capital expenditures resulting from removal are taken into account.

As NW Energy Coalition policy director, Wendy Gerlitz, has said, "All stakeholders need to look at up-to-date scientific and economic data and together forge a new plan for the lower Snake River to protect salmon and make up for reduced hydropower with clean, reliable, and affordable energy and energy efficiency." That message is now more compelling than ever.

To see the study report and additional resources visit

NWEnergy.org/LSRDStudy



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