NW Energy Coalition

THE LOWER SNAKE RIVER DAMS POWER REPLACEMENT STUDY

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

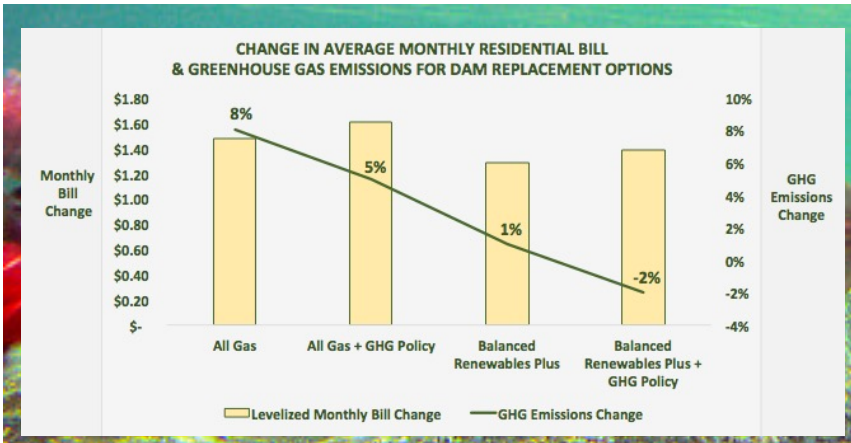
"The region can remove the four Lower Snake River Dams and replace the power they provide with a portfolio of conservation and renewable energy resources while maintaining grid and transmission reliability at levels equal to or better than the current system and with little or no increase in greenhouse 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 that power could be reliably replaced with clean and renewable energy at a highly affordable cost.



"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

The study explored three possible approaches for replacing the power supplied by the four Lower Snake River Dams – increased demand-side resources including energy efficiency and demand response, a balanced portfolio of demand response and new renewable resources, and new natural gas-fired power plants. The study required each replacement portfolio to meet or` exceed current standards for energy system adequacy and reliability.

The study found that balanced portfolios of energy efficiency and new renewable resources are affordable and produce either a decrease in greenhouse gas emissions or a slight increase depending on how regional energy and climate policy unfolds. And the cost may decline as prices for wind, solar, and storage technologies continue to drop. In summary, there is a viable, affordable, and environmentally sound energy alternative to power from the four Lower Snake River Dams.

STUDY METHODOLOGY

Energy Strategies, an independent consulting firm based in Salt Lake City, Utah, conducted the study. Their clients include power producers, transmission developers, utilities, and government agencies throughout North America. 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 for the power actually generated by the dams:

- A Non-Generating Alternative (NGA) that would replace power from the dams with feasible levels of demand response, energy efficiency, battery storage, and incremental market purchases of electricity.
- A Balanced Alternative (Balanced) that would replace the power from the dams with a combination of demand response, energy efficiency, and wind and solar generation.
- An All-Gas Alternative (All Gas) that would replace the power from the dams with a mix of new combined cycle and reciprocating engine gas-fired generators.

The study territory included the states of Idaho, Montana, Oregon, and Washington and accounted for changes in greenhouse gas (GHG) emissions within the region for each alternative as well as all of the announced 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.

Resource adequacy was assessed using the Northwest Power and Conservation Council's GENESYS model. Reliability and power flow characteristics were modeled using PowerWorld. Production costs and grid stability were modeled using ABB's GridView. Wind, solar, and battery storage costs were calculated using the 2017 WECC Capital Cost Model. Data for the study was provided by WECC, ColumbiaGrid, and the Northwest Power and Conservation Council.

Thermal Generation or Capacity Market Cost

Resource Type	Capital Cost ($/kW-ac)	Levelized Fixed Cost ($/kW-year)
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)
Wind (Montana)	44%	$1,639	$205	$53.24
Solar, Single-axis Tracking (Idaho)	26%	$1,440	$127	$59.10
Li-ion Battery (4-hr)	---	$753	$141	---

Demand-side Cost Assumptions

Resource Type (incremental to Reference Case)	Resource Potential	Average Levelized Fixed Cost ($/kW-year)	Average Levelized Cost of Energy ($/MWh)
"Cost Effective" Energy Efficiency	320 aMW	---	$28
50% of "Cost Effective Energy Efficiency	160 aMW	---	$24
"Technical Potential" Energy Efficiency	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	~1000 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 160 aMW EE	-
	Resource-side	-	-	500 MW wind 250 MW solar	1,250 MW wind 250 MW solar	500 MW NGCC 450 MW recip	500 MW wind 250 MW solar	1,250 MW wind 250 MW solar	500 MW NGCC 450 MW recip
	Capacity Market	100 MW	100 MW	-	-	-	100 MW	-	-

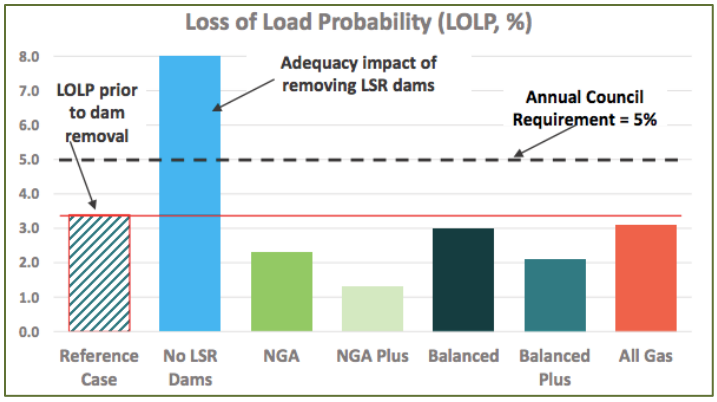
FINDINGS

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 three 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 when and 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 replacement portfolio.

The revenue requirement to implement the Balanced Plus portfolio translates into an increase of about $1.28 per month -- about four cents per day -- for the average household starting in 2026. If costs for wind and solar power and energy storage continue their current decline, this figure would be reduced further.

All are changes relative to Reference Case that retains the LSR Dams		Replacement Portfolios					GHG Reduction Policy Sensitivity		
		NGA	NGA *Plus*	Balanced	Balanced *Plus*	All Gas	NGA *Plus*	Balanced *Plus*	All Gas
Costs	Δ Total Annual Cost ($M/year)	$421	$1,191	$396	$464	$535	$1,224	$501	$581
	Δ Region Revenue Requirement in 2026 (%)	+2.7%	+7.6%	+2.5%	+3.0%	+3.4%	+7.6%	3.21%	+3.7%
	Δ Levelized Monthly Bill ($/Month)	$1.16	$3.28	$1.09	$1.28	$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 GHG 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 GHG emissions would occur if the power from the LSR dams were replaced with a balanced clean energy portfolio implemented in parallel with a regional GHG reduction policy. Even without such a policy, the Balanced Plus clean portfolio would only increase regional emissions by about 1% and that figure could well decline as the costs of clean power continue to drop.

Portfolio	Total CO_2 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 dams because it violates the Endangered Species Act and the National Environmental Policy Act. The court gave the federal agencies until 2021 to develop a new and legally adequate plan.

Noting the expense and failure of current and past efforts to restore wild salmon populations, 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 clean, renewable resources can provide a viable and effective energy alternative to the continued operation of the dams. 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, renewable resources, it did not seek to identify the optimal clean energy solution. With a new plan for dam management in development, we have 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 may 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 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 as well as 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.

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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The NW Energy Coalition
811 1st Avenue, Suite 305
Seattle, WA 98104
www.nwenergy.org
206-621-0094

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