LOWER SNAKE RIVER DAMS POWER REPLACEMENT STUDY

Regional power system planning assessment of the technical feasibility and cost implications of replacing the Lower Snake River dams with clean energy portfolios

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Legislative Council on River Governance Annual Meeting
Study commissioned by the NW Energy Coalition

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The NW Energy Coalition sponsored this study investigating the technical feasibility and cost of replacing the four Lower Snake River (LSR) Dams with a portfolio of resources and technologies that minimize increases to the region’s GHG emissions while preserving a reliable and adequate regional power system.

- The driver of the analysis stems from decades of concern as to how the LSR Dams may impact endangered salmon and steelhead species in the Columbia River Basin and the need for an assessment of the feasibility, costs, and benefits of replacing LSR Dam hydropower with other resources.

The study seeks to help Northwestern stakeholders develop a deeper understanding of the options for replacing the grid services the LSR Dams provide the regional power system, while also establishing a framework for conducting this analysis using models and metrics familiar to the Northwest region.

- This study’s scope is limited to the regional power system and is not a benefit-cost analysis evaluating if the dams should be replaced. Rather, the study assumes replacement and looks at the implications and tradeoffs associated with different portfolios.

The purpose of this assessment is not to determine if dam removal is the most appropriate or best option given myriad issues that impact such a decision.

- The study does not take a policy position and is an independent assessment of technical planning issues.

The project was sponsored by the NW Energy Coalition (NWEC) and the views contained in these materials do not necessarily reflect those of the project sponsor.
The study sought answers to four key questions:

1. Can an energy portfolio replace the LSR Dams without compromising the region’s reliability and resource adequacy while minimizing or eliminating increases to regional GHG emissions?
   - How might these replacement portfolios change under different future scenarios?

2. If replacement portfolios of energy storage, renewable resources, and clean market purchases cannot (alone) replace the LSR Dams, what incremental infrastructure (e.g. additional transmission, substation equipment, gas-fired resources) might be required to fill the gap?

3. At what approximate cost might the replacement portfolios be achieved?

4. What additional value might the replacement portfolios offer?
   - For example: Additional capacity under stressed conditions, impact on Northwest energy prices, a better match to seasonal changes in monthly or daily demand?
MODELING FRAMEWORK

Regional Resource Adequacy Analysis (GENESYS model)

Develop and Iterate Replacement Portfolios

Production Cost Model Simulation (WECC 2026 Common Case in ABB GridView™)

Evaluate System Reliability (ColumbiaGrid Summer & Winter powerflow in PowerWorld™)

Estimate Costs and Rate Impacts (annualized cost of portfolio)

Key Study Metrics

- Loss of Load Probability (LOLP)
- Expected Unserved Energy (EUE)
- Steady-state reliability (overloads, voltage, reactive power)
- Transient stability (frequency response, system stability)
- Operating costs ($)
- Regional GHG emissions (tons)
- Annual revenue requirement ($/yr)
- Typical residential bill ($/month)
OVERVIEW OF REPLACEMENT PORTFOLIOS

1. **Reference Case**: LSR Dams remain and system reflects existing state energy policy, 10-year plans for generation and transmission, 5 Year Action Plan from NWPCC 7th Plan for demand response, and 7th Plan 10-year levels of energy efficiency

2. **Non-Generating Alternative (NGA) Portfolio**: LSR Dams are replaced primarily with feasible levels of demand-side resources including demand response, energy efficiency, battery storage, and incremental capacity market purchases

3. **Balanced Portfolio**: LSR dams are replaced with a more balanced portfolio of demand response, energy efficiency, wind and solar generation

4. **All Gas Portfolio**: LSR Dams are replaced with a mix of combined-cycle and reciprocating engine gas-fired generators

- “Plus” versions of Balanced and NGA portfolios included ramped-up levels of clean energy resources to create more data points on portfolio performance
- GHG reduction policy sensitivity captures performed on “Plus” portfolios and All Gas portfolio to capture the impact GHG policy might have on replacement strategies
RESOURCE ADEQUACY

• The target for system adequacy was established as the LOLP prior to dam removal instead of the NWPCC standard of 5%
  - This assumption is conservative and results in portfolios that are well below the 5% planning standard

• All three replacement portfolios achieved annual LOLP and EUE values substantially lower than the 5% LOLP standard and also below the Reference Case value, indicating that the likelihood and magnitude of load curtailments is lower in the replacement portfolio scenarios relative to the Reference case with the LSR dams

• “Plus” replacement portfolios substantially overachieved in terms of system adequacy and enhances regional adequacy
ESTIMATED REVENUE REQUIREMENT IMPACT

• 7th Plan calculates Northwest system revenue requirement of $15.6 billion (in 2017$) for 2026
  ❖ Includes cost of operating/maintaining LSR dams, so decrease in revenue requirement, a benefit, is not captured (while we do capture the cost or replacing the power)
  ❖ Excludes implicit carbon cost

• NGA and Balanced portfolio estimated to increase the going-forward average revenue requirement by ~2.6%, starting in 2026
  ❖ All gas portfolios would increase costs by 3.6%

• Balanced Plus scenario results in 3% increase, with the GHG reduction policy further increasing this cost by 0.25%

• NGA Plus is highest cost portfolio with 7.8% increase
Changes to Regional Regional Costs and CO₂ Emissions

- The initial Balanced, NGA, and Gas portfolios did not meet the study goal of mitigating increase in carbon emissions.
- When the Balanced portfolio was modified to include additional renewable resources and then modified further to include a regional GHG policy, carbon emissions are fully mitigated at a relatively low incremental cost.
- The effect was similar for the NGA case, but because the incremental energy efficiency had a high cost, the iteration of the portfolio had a much higher carbon abatement cost as reflected by the increase in the regional revenue requirement.
- The All Gas portfolio started with much higher emissions and while the GHG policy was effective at reducing those emissions, the portfolio was still more costly and higher emitting than the Balanced portfolio.
- An optimized portfolio may result in an finely tuned balance between emissions and cost tradeoffs.

For example: If the Balanced portfolio was optimized to include slightly more conservation, emission reductions may be further mitigated at a lower cost.
KEY STUDY FINDINGS

1. A portfolio of reasonably available clean energy resources, including solar, wind, energy efficiency, demand-response, and energy storage can effectively replace the most important power attributes the four LSR Dams are forecasted to contribute to the Northwest region.
   - The clean energy portfolios had superior performance to an all gas replacement alternative in terms of resource adequacy, emissions, and total cost.
   - The resource levels required for replacement are readily available in the region.

2. The total costs of the clean energy replacement portfolios, particularly the balanced portfolios that include both new wind/solar and demand-side measures, are relatively small compared to the total projected costs of the Northwest power system.
   - The portfolios increase the region’s costs by 2-3% after accounting for changes in operational costs, transmission costs, and the costs of new resources and programs associated with the portfolio.

3. When a balanced clean energy replacement portfolio is implemented in conjunction with greenhouse gas reduction policy, substantial reductions in emissions can be achieved without the LSR Dams.
   - Absent such policy, the balanced portfolio has a minor impact on greenhouse gas emissions (about 1%) compared to expected emissions with the LSR Dams in service.

4. The clean replacement portfolios met transmission reliability criteria under peak summer and winter conditions and did not create any new reliability issues (but for one minor exception)
   - The exception was identified for all portfolios and was addressed through a minor transmission upgrade.

5. The clean replacement portfolios provide the region with enhanced resource adequacy compared to the LSR Dams, reducing the likelihood of the region not having sufficient power to meet peak demands.
   - New gas-fired generation is not required to address regional capacity needs that arise when the LSR Dams are removed.
# REPLACEMENT PORTFOLIOS AND RESULTS

All are changes relative to Reference Case that retains the LSR Dams

<table>
<thead>
<tr>
<th>Replacement Portfolios</th>
<th>GHG Reduction Policy Sensitivity</th>
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<tbody>
<tr>
<td>NGA</td>
<td>NGA Plus</td>
</tr>
<tr>
<td>Demand-side</td>
<td></td>
</tr>
<tr>
<td>~1,000 MW DR 320 aMW EE</td>
<td>~1,000 MW DR 880 aMW EE</td>
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<tr>
<td>Resource-side</td>
<td></td>
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<tr>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Capacity Market</td>
<td>100 MW</td>
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<tr>
<td>Resource Adequacy (Δ LOLP%)</td>
<td>-1.1%</td>
</tr>
<tr>
<td>Δ Reliability</td>
<td>All met NERC/WECC criteria, but for one reliability issue identified in all replacement portfolios (mitigated w/ transmission upgrade and cost captured)</td>
</tr>
<tr>
<td>Δ GHG Regional Emissions (%)</td>
<td>+5%</td>
</tr>
<tr>
<td>Δ Total Annual Cost ($M/year)</td>
<td>$421</td>
</tr>
<tr>
<td>Δ Region Revenue Requirement in 2026 (%)</td>
<td>+2.7%</td>
</tr>
<tr>
<td>Δ Levelized Monthly Bill ($/Month)</td>
<td>$1.16</td>
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DR = demand response  
EE = energy efficiency  
NGCC = natural gas-fired combined cycle  
Recip = reciprocating engine
THANK YOU

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