DRAFT 6/24/22

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BPA talking points

E3 lower Snake River dam replacement costs analysis

June 2022

What this is

Earlier this year, BPA contracted with~~engaged~~ electric industry research firm Energy and Environmental Economics, also known as E3, to conduct an independent analysis of the electricity system value of the four lower Snake River (LSR) dams. This new analysis~~to~~ builds on the analysis performed in the Columbia River System Operations Environmental Impact Statement regarding replacement resources and costs associated with a scenario where the four lower Snake River dams may be breached in the future. BPA anticipates E3's study to contribute to the regional dialogue about the future of these publicly-owned assets and help elevate regional understanding of the complexities and expenses involved in exploring replacement resources for the LSR dams.

Key messages and storyline

- ~~Breaching the dams would require resource builds just to get the system back to where it is now rather than replacing fossil-fuel generation.~~
- As states move forward with clean energy policies, fossil-fuel generated power is being removed from the grid. ~~-~~Reducing hydropower would require the ~~resource~~region to build new generation just to get the system back to where it is now. Until all fossil-fuel power plants are retired, reducing hydropower means more CO2 emissions in the region, which is a step backward from the region's carbon reduction goals.
- ~~Also, s~~Some of the lower-cost options for replacing lost hydro power rely on emerging technologies that are not yet developed or available at large-scale. ~~reliance on emerging technologies not yet deployed is assumed for some of the lower-cost options.~~
- Replacing the dams' hydropower energy and capacity services with existing renewable technology would be prohibitively expensive.
- ~~This~~ The E3 study evaluates what is required to maintain ~~the~~ current reliability standards. Assuming different risk levels for reliability, as is done in other studies of LSN dam power replacement, is a policy decision outside the scope of this analysis. That is something BPA, its customers and constituents will have to consider as discussions about the future of the lower Snake River dams continue.
- ~~Replacement~~ New resources to replace the existing lower Snake River dams energy and capacity would cost $xxx per year. If this is not paid for by an outside source, it would result in higher electric bills for millions of Northwest~~W~~ residents.

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Comment [SL(-D1]: Pulled from E3 slide deck

Comment [SL(-D2]: I got hung up on this term. Should we say "region"

Comment [KG(-P3]: Yes, "resources" doesn't make sense here

Comment [SL(-D4]: Could we say "current state" instead?

Comment [PSM(-E5]: This is vetted language from Alissa Kaseweter.

Comment [KG(-P6]: "Prohibitively expensive" is in the eye of the beholder. If this is referring to Scenario 2c, then this is not only existing technology but also deep decarbonization of other sectors of the economy

Comment [SL(-D7]: Decarbonization increases volatility, especially if more dependent on intermittent resources that lack ramping/load following capabilities.

Comment [KG(-P8]: E3 did not study other reliability risks, so this doesn't make sense unless directed to other studies

Comment [KG(-P9]: I doubt we would consider not keeping the lights on as in the amount of replacement in the NWEC study, but we might consider slightly higher risk

- The replacement of the dams' hydropower ~~It wc~~could ~~also~~ take up to approximately 20 years to complete after Congressional approval if Transmission builds were needed and there was not litigation on siting.

Background

With multiple reviews of the future of the lower Snake River dams being conducted by the Council on Environmental Quality, the Columbia Basin Collaborative and Senator Patty Murray (D-WA) and Washington Governor Jay Inslee, BPA felt it necessary to update the potential costs of replacing the energy services from these facilities.

The CRSO EIS analysis examined a series of resource replacement portfolios using the Northwest Power and Conservation Council's latest resource cost estimates to reflect reasonable replacement resource alternatives and associated costs. E3 ~~will include~~used a resource portfolio optimizer model ~~using~~ with their data sets and their criteria and objectives to create least cost replacement portfolios.

E3's independent analysis includes several scenarios for replacement resources, including some with emerging technologies~~,~~ such as ~~offshore wind~~small modular nuclear and gas plants with carbon capture or hydrogen burning capability that are not deployed yet. It also includes use of traditional renewable resources, such as wind, solar, ~~and~~ storage and demand response. All of the scenarios present moderate to significant upward rate pressure for BPA's customers if not paid for by an outside source.

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Questions and answers

1. **What was the scope of the study and what questions did it address?**

   BPA contracted with E3 to answer what resources (one or more portfolios of resources) would be needed to maintain reliability, which is close to replacinge the full energy and other grid services provided by the lower Snake River dams~~?~~. This includes modeling regional grid scenarios with and~~or~~ without th~~os~~e dams. The model is designed to identify one or more replacement resource portfolio(s) and provide a comparison of the forecasted costs associated with each scenario. The analysis also discusses the timeline under which a build-out of replacement resources could occur.

   E3's key study questions are:

   - What additional resources would be needed to replace the power services provided by the LSR Dams through 2045?
   - What is the net cost to BPA ratepayers?
   - How do costs and resource needs change under different types of clean energy futures?

Comment [WP(-D10]: EVE'S COMMENT: Because location and types of replacement resources needed putting a timeline in needs some caveats.

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Comment [KG(-P11]: This may be true, but I don't remember that they used the Council's cost estimates

Comment [EAJ12]: They used Council's latest load forecasts but updated prices from Energy Commodities data. The CRSO EIS used the Council forecasts and price forecasts from the time but E3 uses the most recent power plan

Comment [WP(-D13]: EVE'S COMMENT: The model has offshore wind but never selected it due to the high cost

Comment [KG(-P14]: This is what we asked them to do, per request from the COO. But E3's approach was to see what it would take to maintain grid reliability, which was pretty much a full replacement study.
Given the narrative I saw in the Inslee/Murray report, it might be worth stating this differently. (in the I/M paper, the EIS is described as "full replacement" which comes across as replacing more than is needed.

- How much does replacing the dams rely on emerging, not-yet commercialized technologies?

Comment [SL(-D15]: Per E3's presentation.

2. **What power benefits do the four LSRDs currently provide?**

   These facilities first and foremost provide reliable electricity to help the western interconnection and the Pacific Northwest avoid blackouts. They also provide carbon-free energy ~~to help fight climate changes~~. More specifically, they are capable of providing a short-term peaking capacity of more than 3,000 MWs. They can provide more than 2,000 MW of longer term peaking capacity during cold snaps when Pacific Northwest electricity use is at its highest. ~~The also~~ as well as provide important reserves and ~~provide~~ essential grid reliability services, including voltage support, reactive power and black start ability.

3. **What resources does the study recommend to replace the output of the lower Snake River dams?**

   The study recommends a combination of renewable generation (wind and solar) and "clean firm" resources (such as dual fuel natural gas + hydrogen plants, advanced small modular nuclear, or gas with carbon capture and storage), and energy efficiency.

Comment [KG(-P16]: At least one scenario picks solar. One scenario picks neither wind nor solar

4. **What are the replacement resource scenarios E3 evaluated?**

Scenario	Replacement Resources Selected, Cumulative by 2045 (GW*)
Scenario 1: 100% Clean Retail Sales	+ 2.1 GW dual fuel NG/H2 CCGT + 0.5 GW wind
Scenario 2a: Deep Decarb. (Baseline Technologies)	+ 2.0 GW dual fuel NG/H2 CCGT + 0.3 GW li-ion battery + 0.4 GW wind + 0.05 GW advanced energy efficiency + additional H2 generation**

Scenario 2b: Deep Decarb. (Emerging Technologies)	+ 1.5 GW dual fuel NG/H2 CCGT + 0.7 GW nuclear SMR
Scenario 2c: Deep Decarb. *(No New Combustion)*	+ 10.6 GW wind + 1.4 GW solar

~~Scenario~~	~~Replacement Resources Selected, Cumulative by 2045 (GW*)~~
~~**Scenario 1: 100% Clean Retail Sales**~~	~~+ 2.1 GW dual fuel NG/H2 CCGT~~ ~~+ 0.5 GW wind~~
~~**Scenario 2a: Deep Decarb.**~~ ~~(Baseline Technologies)~~	~~+ 2.0 GW dual fuel NG/H2 CCGT~~ ~~+ 0.3 GW li-ion battery~~ ~~+ 0.4 GW wind~~ ~~+ 0.05 GW advanced energy efficiency~~ ~~+ additional H2 generation**~~
~~**Scenario 2b: Deep Decarb.**~~ ~~(Emerging Technologies)~~	~~+ 1.5 GW dual fuel NG/H2 CCGT~~ ~~+ 0.7 GW nuclear SMR~~
~~***Scenario 2c: Deep Decarb.***~~ ~~*(No New Combustion)*~~	~~+ 10.6 GW wind~~ ~~+ 1.4 GW solar~~

- In scenarios that assume new combustion generation may be permitted in the Northwest, f~~F~~irm capacity is mostly replaced with ~2 GW of dual fuel natural gas + hydrogen turbines. These turbines may initially burn natural gas when needed during reliability challenged periods, but would transition to hydrogen by 2045 to reach zero-emissions.
- If advanced nuclear is available, it ~~replaces~~ is selected in lieu of renewables and some of the gas plants.

Comment [WP(-D17]: I assume this table will be cleaned up – font, size, etc.

Comment [EAJ18]: I re-inserted the table keeping the source formatting so it should be cleaned up now.

Comment [KG(-P19]: "replacement" is a bit confusing since we are replacing the existing LSN dams, not existing renewables

- The "no new combustion" scenario with decarbonization of the broader economy (e.g. electric vehicles and electric heating) requires an impractically large (12 GW) buildout of renewable energy to replace the dams firm capacity contributions and GHG-free energy. This is required because the wind and solar power are not as reliable for serving load as would be firm combustion generation, and thus large quantities are needed to ensure that some generation may be available during the critical periods like winter cold spells. …

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5. What does each option cost?

Comment [WP(-D20]: Why do we have the year 2024 at the breaching year? Much of what I have seen from advocates recently says all replacement resources need to be in place before breaching.

Comment [KG(-P21]: Josh, we wanted to be in line with the CRSO EIS which assumed breaching 2 years out and 10 years out. (It will take even longer than that, but we didn't want to pick an arbitrary date.)

	Total Costs (real 2022 $)	Annual Cost Increase (real 2022 $)			Incremental Public Power Costs [% increase vs. ~8.5 cents/kWh NW average retail rates]
	Net Present Value in year of breaching	2025	2035	2045	2045
Scenario 1: 100% Clean Retail Sales	$7.5 billion		$434 million	$478 million	0.8 cents/kWh [+9%]
Scenario 1: 100% Clean Retail Sales (2024 dam breaching)	$11 billion	$495 million	$466 million	$509 million	0.8 cents/kWh [+9%]
Scenario 2a: Deep Decarb. (Baseline Technologies)	$11.5 billion		$496 million	$860 million	1.5 cents/kWh [+18%]
Scenario 2b: Deep Decarb. (Emerging Technologies)	$7 billion		$415 million	$428 million	0.7 cents/kWh [+8%]
Scenario 2c: Deep Decarb. *(No New Combustion)*	*$46 billion*	*n/a*	*$1,953 million*	*$3,199 million*	*5.5 cents/kWh [+65%]*

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- Cost increases account for replacement energy, capacity, and reserves as well as avoided LSR capital + expense, but do not include any costs for breaching the dams, which would be an additional cost.

- NPV and annual cost increase are shown for the Northwest Region as a whole, but the incremental costs are calculated relative to the BPA Tier I annual sales for public power customers.

- % increase versus average retail rates assumes ~8.5 cents/kWh retail rates (estimated from OR and WA average retail rates). This does not ~~include additional~~account for any other rate increases that will be driven by higher loads or clean energy needs that increase regional rates ~~as shown in the earlier 2045 incremental cost chart~~.

Comment [KG(-P22]: This is in the ppt, but not in the TPs.

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- Annual residential customer cost impact assumes 1,280 kWh/month for average residential customers in Oregon and Washington (current ~1,000 kWh/month average + 28% from electrification load growth).

Comment [WP(-D23]: Does this at all undercut the previous point that the rate increase is solely for replacing the LSRDs?

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- New federal tax credits for hydrogen plants/fuels or ITC/PTC extension for renewables would provide a cost reduction to public power customers from taxpayers

6. **How do the replacement costs compare to the current costs of the lower Snake River dams?**

   The lower Snake River dams cost between $13 and $17/MWh to operate and maintain. Replacement resources, depending on those chosen, are projected to cost between $77 and $139/MWh. Replacement costs rise to more than $500 MWh in the deep economy-wide decarbonization scenario that includes only existing ~~resources~~ technologies (wind, solar, etc.) and no emerging technology, such as hydrogen and small modular nuclear.

7. **What is the projected rate impact to BPA customers?**

   In scenarios 1, 2a and 2b, the rate impact would be between 8% and 18% or ~$100 to $230 per year. In a deep economy-wide decarbonization scenario (2c) with no emerging technologies, the cost would be approximately a 65% increase or $850 per year.

   Note: These costs do not include potential transmission and integration costs associated with interconnection and grid reinforcement that could be necessary to add the new resources.

8. **What is the timeline necessary to add the resources that would be required?**

   E3 estimates that adding additional renewable energy and firm capacity additions would take approximately five to seven years after Congressional approval to breach the dams and possibly up to 10 to 20 years if additional new large-scale transmission was required and there was not litigation on siting..

Comment [WP(-D24]: EVE'S COMMENT: Adding this phrase since it was causing confusion during DOE peer review. The Baseline has the decarbonization policy of OR/WA/CA that basically forces coal off-line but does not assume the load growth that occurs under the economy-wide decarbonization where transportation and building HVACs get electrified.

Comment [KG(-P25]: Is this true for the LSN replacement resources or for the resources that are needed for keeping the grid reliable even without breaching the LSN?

Comment [EAJ26]: I think this note is true for 1,2a,and 2b but not for 2c. That is the reason 2c costs so much is the needed transmission to build out MT and WY wind to replace LSN without new emerging technology to provide the firm capacity during cold events and low solar angles.