Bonneville Power Authority

The Role the Lower Snake River Projects

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Energy+Environmental Economics

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Introduction

We appreciate the opportunity to present this proposal to the Bonneville Power Authority (BPA). **Energy and Environmental Economics, Inc. (E3)** is a 100-person energy consulting firm with offices in San Francisco, Boston, New York, and Calgary. Founded in 1989, E3 helps utilities, regulators, policy makers, developers, and investors make the best strategic decisions possible in this period of transition in the electric and gas sectors. Many of E3's projects center around rigorous and transparent modeling analyses that provide a foundation for our strategic advising. Because E3 works with clients from all sectors of the electricity industry across the U.S., we provide a 360-degree understanding of markets, planning, policy, regulation, and environmental factors. Just as important, we are committed to delivering clear, unbiased analyses that help clients make informed decisions often in complex and multi-stakeholder contexts.

E3 has a 30-year track record of completing hundreds of large, analytically complex, multi-stakeholder projects on schedule, within budget, and with exceptional attention to detail. E3's success stems in large measure from its employees, project management, and organizational style. Throughout the organization, from top to bottom, E3 professionals relentlessly pursue objective, technically supportable answers. We believe this will be particularly important with this scope of work for BPA. All key E3 staff have deep expertise in the energy industry, from policy to markets, from finance to business model development, and from technology to economics, with a pragmatic eye toward real-world constraints. E3's project management style gives teams the freedom to create great products while also drawing on the support of the entire resource pool at E3, including our most senior experts.

E3 Operates at a Unique Nexus Across Multiple Clients in the Energy Stakeholder Spectrum

E3 completes over 300 projects per year on behalf of the industry's most diverse client base. Our integrity and reputation for providing high-quality, unbiased work, earned over many years of successful projects, especially in the Pacific Northwest has enabled us to occupy a unique niche in the energy industry: one where we are able to credibly advise a wide array of diverse clients such as investor-owned utilities, public power agencies, federal and state government agencies, independent system operators, power producers, and environmental advocacy organizations on a wide range of energy issues. This expansive breadth of project and client engagement has afforded us the opportunity to understand the perspectives of several different types of utility and energy industry stakeholders. This breadth, which we believe is unmatched by our competitors, speaks to the enthusiasm and dedication of our staff and the respect clients have for E3's high-quality, unbiased analysis.

Scope of Work

Task 1: Top Down and Bottom Up Capacity Need Analysis Highlighting the Role/Need of Hydropower

In this task E3 would perform analysis to level set how :

- Resource analysis of CA, WA, and Oregon from now until 2050
- Analysis of 100% renewable and carbon free mandates in CA, WA, and OR coupled with a technical analysis of achieving those stated goals
    - What does the actual path to 100% look like with technologies that are currently commercially viable and what is the role of hydropower along that pathway?
- Summarize and update research done to date on capacity shortfalls across the West highlighting the role of hydropower

E3 has performed this type of research and analysis a number of times for various clients and is well positioned to deliver a high quality work product under this task. We plan to break this task into two parts.

The first part is performing a holistic analysis from both a top-down and bottom-up perspective on the clean energy goals and targets in the Pacific Northwest, what the plan and potential key decision points are on the techno-economic implementation pathways to achieve those goals, and what the planned and expected resource mix looks like over the next 15- to 30-years based on existing analysis and research. The top-down approach would look at the clean energy targets and work backwards in terms of the ranges around the type, magnitude, and timing of resources needed to meet those targets.

We would also include in that analysis potential alternative implementation pathways including an in-depth analysis on the key implementation barriers and challenges to meet each state's clean energy targets. The bottom up analysis would look at the resource mix in terms of what is likely in the near-term (~5-year horizon) based on existing interconnection queues, existing transmission capacity, and new resource build expectation along with existing resource retirement dates as well as the procurement targets and mechanisms by utilities and other off-takers. We would then analyze the utility IRPs and other key resource plans such as the California Public Utilities Commission to determine whether these add up to what is required to meet the longer-term clean energy targets in each state focusing on the medium to longer term (~5 to 30 year horizon). We would then highlight, examine, and provide narrative around any observed gaps, discrepancies, or other issues that arise from this research and analysis in the context of the Lower Snake River projects.

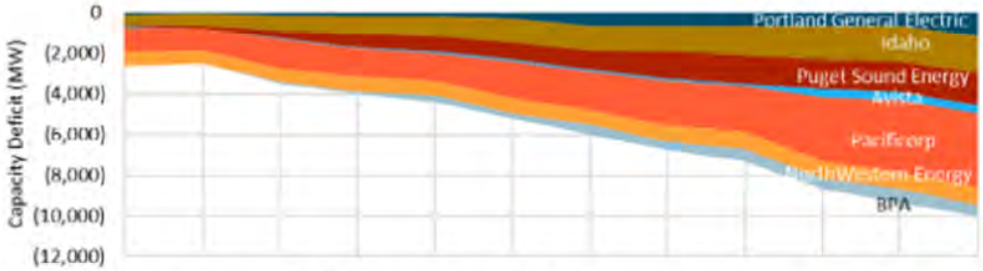
The second part of this task would be to summarize and update the research done on the capacity shortfalls across the West again both on a top down and bottom up basis similar to the work E3 has performed in the past. An example of this kind of analysis[1] can be seen below. This analysis demonstrated an almost 10 GW capacity need by 2030 that among other things highlighted the challenges of filling that

[1] https://www.ethree.com/wp-content/uploads/2019/12/E3-PNW-Capacity-Need-FINAL-Dec-2019.pdf

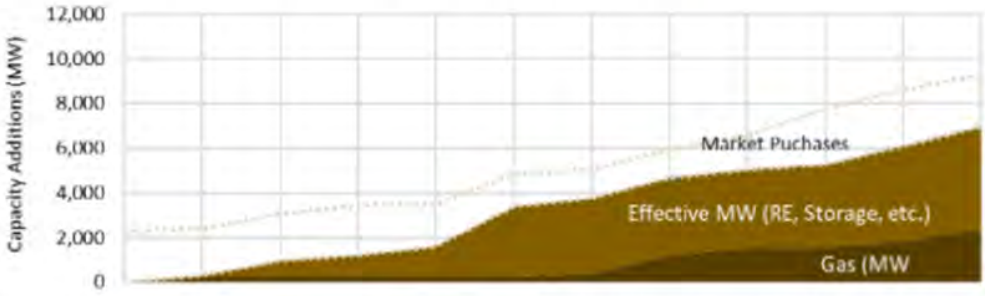
need with new resources. Since this analysis was performed E3 believes the capacity need has grown as well as the competition and cost for clean energy resources to fill that need. We believe this will demonstrate how the region is going to be need all carbon free resources in both the near and longer term in the context both the reliability needs in the shorter to medium term and the achievement of clean energy and decarbonization goals in the longer term.

Capacity Needs of the Pacific Northwest — 2019 to 2030

E3's "top-down" regional assessment finds a capacity need of approximately 7 GW by 2025 and 10 GW by 2030



E3's "bottom-up" review of utility IRPs identifies 10 GW of capacity need by 2030, before planned additions



E3's review of IRP planned resource additions finds only ~7 GW of effective capacity additions, with 2.3 GW of market purchases generally not addressing regional need

Deliverables:

- Multiple PowerPoints and materials tailored to the various stakeholders that summarizes this analysis

Timeline:

- The proposed timeline would be to complete the work by Q3 2022 with an initial draft for the client to review by mid-April 2022.

Budget Estimate:

- E3 proposes to perform this work on a Time and Materials basis under our BPA rates with a not to exceed budget of **$35,000**

Task 2: RESOLVE Analysis

In this task E3 would perform the modeling and analysis along the lines specified by BPA below:

BPA needs an analysis of the region's future power benefits[2] picture if BPA lost this dispatchable, carbon-free hydropower output.

- *Capabilities include:*
  - *Energy*
  - *Capacity, instantaneous and sustained*
  - *Reserves carrying capability*
  - *Fast ramping*
- *Assess what combination of resources would provide these characteristic*
  - *This could include scenarios with different combinations of resources*

Outputs:

- *Portfolio(s) of resources*
- *Full Costs of resources (including transmission and fuel (e.g. gas would need pipeline and storage infrastructure costs included))*
- *Carbon emissions*
- *Reliability*
- *Timing (how fast could replacement resources be sited and producing energy)*
- *Feasibility (e.g. siting constraints, supply chain availability, transmission constraints, availability of balancing services to integrate variable renewable resources)*

Timeline: Draft[3] would need to be completed by April 2022 with a final report provided before July 31, 2022.

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[2] This study would focus on replacing the power supply/reliability characteristics only and not look at navigation or irrigation uses of the projects. It would also not lean on existing resources in the region (such as coal or gas) to make up for the lost capability of the Columbia River System.

[3] Draft report preferred in April, but at a minimum need information in a presentation

To evaluate the system-level value of the Lower Snake River projects, E3 would utilize its RESOLVE modeling tool which has been used for a number of studies in the Pacific Northwest as well as various IRP processes including for the California Public Utilities Commission's IRP process.

RESOLVE is an electricity sector capacity expansion and dispatch model developed by E3. E3 will use the RESOLVE model to estimate least-cost resource portfolios with and without the Lower Snake River projects. This will provide insight around how the Lower Snake River projects fits into a least cost, reliability power system in the Pacific Northwest under various scenarios including meeting the ambitious clean energy policies at the state and Federal levels.

RESOLVE is well-suited to this task, as it is a resource investment model that identifies optimal long-term generation and transmission investments in an electric system, to develop a least-cost resource portfolio. The analysis will be conducted under a range of scenarios, including but not limited to a "current policy" scenario and scenarios that might call for additional procurement beyond current targets to meet additional state goals, such as RPS and reliability needs. The team will also conduct sensitivity analysis to investigate the impact of conservative and optimistic technology price forecast on the optimal portfolio. RESOLVE's optimization capabilities allow it to select from among a wide range of potential new resources including renewables, energy storage, demand-side solutions, and imports. The following are an example of the scenarios and sensitivities we could run in consultation with the BPA team.

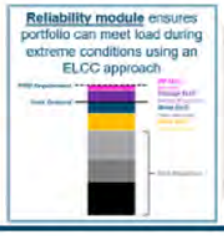
- No policy case as a reference case
- Multiple state policy implementation cases
- Net Zero case
- Absolute Zero case
- Various technology breakthrough cases

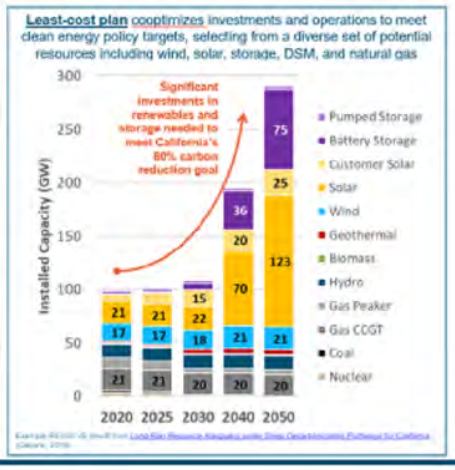
E3's RESOLVE analysis would focus on the Pacific Northwest Region, which E3 has analyzed extensively for various stakeholders (utilities, trade organizations, etc.) and for which E3 has deep understanding of the system- and resource-specific dynamics that inform this type of analysis.

RESOLVE: Optimal Capacity Expansion to Meet Clean Energy Goals

+ Linear optimization model explicitly tailored to the study of electricity systems with high renewable & clean energy policy goals

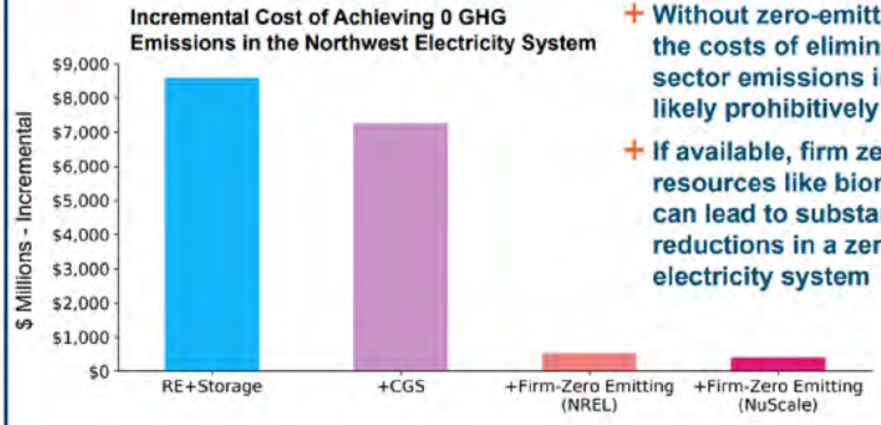
+ Optimization balances fixed costs of new investments with variable costs of system operations, identifying a least-cost portfolio of resources to meet needs across a long time horizon





See below an example how different cases can highlight the role of different generation resources like the Lower Snake River projects in different future states of the world using our RESOLVE model[4]. Note, this example is from analysis performed in the context of examining small modular nuclear reactors in the Pacific Northwest.

Costs relative to Reference of achieving zero-GHG emissions in the Northwest electricity system



+ Without zero-emitting firm capacity, the costs of eliminating electricity sector emissions in the region are likely prohibitively expensive

+ If available, firm zero-emitting resources like biomethane or SMRs can lead to substantial cost reductions in a zero-emissions electricity system

[4] https://www.ethree.com/wp-content/uploads/2020/02/E3-Pacific-Northwest-Zero-Emitting-Resources-Study-Jan-2020.pdf

Deliverables:

- Multiple PowerPoints and materials tailored to the various stakeholders that summarizes this analysis

Timeline:

- The proposed timeline would be to complete the work by Q3 2022 with an initial draft for the client to review by late-April 2022.

Budget Estimate:

- E3 proposes to perform this work on a Time and Materials basis under our BPA rates with a not to exceed budget of **$100,000**