Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

FREEDOM OF INFORMATION ACT/PRIVACY PROGRAM

December 31, 2024

In reply refer to: FOIA #BPA-2023-00855-F (Missel)

Andrew Missel
Advocates for the West
3701 SE Milwaukie Ave., Ste. B
Portland, OR 97202
Email: amissel@advocateswest.org

Dear Mr. Missel,

This communication is the Bonneville Power Administration's (BPA) final response to your request for records, submitted to the agency under the Freedom of Information Act, 5 U.S.C. § 552 (FOIA). Your request was received on April 20, 2023, and formally acknowledged on May 11, 2023. A first partial release of records was provided to you on July 31, 2024; a second partial release was provided to you on September 16, 2024; and third partial release was provided to you on October 29, 2024.

Request

"…the records described below concerning the relationship between the Bonneville Power Administration ("BPA") and Energy and Environmental Economics, Inc. ("E3")—specifically, records pertaining to the Lower Snake River Dams Replacement Study ("LSRD Study") commissioned by BPA and prepared by E3 that was released in July 2022:

1. All contracts, statements of work, and similar documents between BPA and E3 that were prepared or executed in connection with the LSRD Study;
2. All communications between BPA and E3 that relate in any way to the LSRD Study, including any communications concerning the LSRD Study's release, press stories about the LSRD Study, etc.;
3. All records that document, memorialize, or refer to any meetings, conversations, or other communications between BPA and E3 concerning the LSRD Study; and
4. All internal BPA memos, emails, etc. that refer to the LSRD Study."

Any reference to an entity—such as "BPA" or "E3"—includes all employees and agents of that entity as well as the entity itself and any division thereof. Requesters seek records from any time up until the time of search."

Fourth Partial Response
The fourth and final release of responsive records accompanies this communication. This release comprises 710 pages of responsive agency records with the following redactions applied:

- 406 redactions under 5 U.S.C. § 552(b)(5) (Exemption 5)
- 238 redactions under 5 U.S.C. § 552(b)(6) (Exemption 6)

Explanation of Exemptions
The FOIA generally requires the release of all agency records upon request. However, the FOIA permits or requires withholding certain limited information that falls under one or more of nine statutory exemptions (5 U.S.C. §§ 552(b)(1-9)).

<u>Exemption 6</u>
Exemption 6 protects Personally Identifiable Information (PII) contained in agency records when no overriding public interest in the information exists. In these records BPA has used Ex. 6 to protect signatures, personal cell phone numbers, meeting pass codes, and a limited amount of communication concerning non-business information and personal opinions. BPA does not find an overriding public interest in a release of the information redacted under Exemption 6. This information sheds no light on the executive functions of the agency. BPA cannot waive these redactions, as the protections afforded by Exemption 6 belong to individuals and not to the agency.

<u>Exemption 5</u>
Exemption 5 protects "inter-agency or intra-agency memorandums or letters which would not be available by law to a party other than an agency in litigation with the agency" (5 U.S.C. § 552(b)(5)). Exemption 5 protects information under a number of privileges, including the deliberative process privilege and the attorney-client privilege.

The deliberative process privilege protects records that reveal the deliberative or decision-making processes of government agencies. Records protectable under this privilege must be both pre-decisional and deliberative. A record is pre-decisional if it is generated before the adoption of an agency policy. A record is deliberative if it reflects the give-and-take of the consultative process, either by assessing the merits of a particular viewpoint, or by articulating the process used by the agency to formulate a decision. Here BPA asserts the deliberative process privilege to redact aspects of discussions about the scope of the study and information sharing, addressing questions from federal partners and stakeholders, coordinating the rollout of the study, and draft communications that differ significantly from the final form of the communication.

BPA asserts attorney-client privilege to protect confidential communications between an attorney and a client relating to a legal matter for which the client has sought professional advice. The privilege encompasses facts provided by the client and opinions provided by the attorney. In this case, BPA asserts Exemption 5 to protect legal advice provided in response to questions that arose during the above discussions.

BPA relies on Exemption 5 here to protect specific internal communications (BPA only) and communications between BPA and other federal parties. Communications between BPA and E3 were not considered for redaction under this exemption.

Records protected by Exemption 5 may be discretionarily released. BPA has considered and declined a discretionary release of some pre-decisional and deliberative information in the responsive records set because disclosure of that information would harm the interests and protections encouraged by Exemption 5.

Certification
Pursuant to 10 C.F.R. § 1004.7, I am the individual responsible for the records search and information release described above. Your FOIA request BPA-2023-00855-F is now closed with the responsive agency information provided.

Appeal
Note that the records release certified above is final. Pursuant to 10 C.F.R. § 1004.8, you may appeal the adequacy of the records search, and the completeness of this final records release, within 90 calendar days from the date of this communication. Appeals should be addressed to:

Director, Office of Hearings and Appeals
HG-1, L'Enfant Plaza
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585-1615

The written appeal, including the envelope, must clearly indicate that a FOIA appeal is being made. You may also submit your appeal by e-mail to OHA.filings@hq.doe.gov, including the phrase "Freedom of Information Appeal" in the subject line. (The Office of Hearings and Appeals prefers to receive appeals by email.) The appeal must contain all the elements required by 10 C.F.R. § 1004.8, including a copy of the determination letter. Thereafter, judicial review will be available to you in the Federal District Court either (1) in the district where you reside, (2) where you have your principal place of business, (3) where DOE's records are situated, or (4) in the District of Columbia.

Additionally, you may contact the Office of Government Information Services (OGIS) at the National Archives and Records Administration to inquire about the FOIA mediation services they offer. The contact information for OGIS is as follows:

Office of Government Information Services
National Archives and Records Administration
8601 Adelphi Road-OGIS
College Park, Maryland 20740-6001
E-mail: ogis@nara.gov
Phone: 202-741-5770
Toll-free: 1-877-684-6448
Fax: 202-741-5769

If you have any questions about the content of this communication, please contact FOIA Program Lead Jason Taylor at jetaylor@bpa.gov or 503-230-3537. You may also contact FOIA Public Liaison James King at jjking@bpa.gov or 503-230-7621.

Sincerely,

Candice D. Palen
Freedom of Information/Privacy Act Officer

Responsive agency records accompany this communication.

From:	James,Eve A L (BPA) - PG-5
Sent:	Friday, June 17, 2022 1:19 PM
To:	Koehler,Birgit G (BPA) - PG-5; Aaron Burdick; Arne Olson
Subject:	[EXTERNAL] RE: DOE slide review feedback

The Council meetings are still virtual.

On Jun 17, 2022 1:03 PM, Arne Olson <arne@ethree.com> wrote:
Will do. Would this be a remote presentation, or in person?

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Friday, June 17, 2022 12:47 PM
To: Arne Olson <arne@ethree.com>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt

Thanks Arne- could you put a hold on your calendar for July 7 8:30 AM – 10:00 AM? That is a tentative slot for agenda time at this point so it may move but wanted to mention that is one of the times that might work for the Council. I let them know you were unavailable on that day from 10 – 1. I will let you know when the timing gets finalized but wanted to give you a heads up to keep that timeslot clear.

From: Arne Olson <arne@ethree.com>
Sent: Thursday, June 16, 2022 11:19 AM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: [EXTERNAL] Re: DOE slide review feedback

Yes I'd be available on July 6-7, but I do have a hold on my calendar from 10-1 for another event.
Sent from my Verizon, Samsung Galaxy smartphone
Get Outlook for Android

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Thursday, June 16, 2022, 9:54 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt

Definitely- great job in the hot seat!
We'll keep you posted on the public rollout. The next Council meeting that Scott mentioned is July 6-7 and I know Aaron is out that week (I am as well). Arne- would you be available during that time or would we need to request to schedule a special meeting?
Thanks,
Eve

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Thursday, June 16, 2022 9:50 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt
Thank you Aaron and Arne!
I think that went well. Was impressed by some of the questions and surprised by others. Quite probing.

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Wednesday, June 15, 2022 4:57 PM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback
Deliberative, FOIA exempt
Here is the updated deck I will present tomorrow morning.
Aaron

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Wednesday, June 15, 2022 3:08 PM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback
Deliberative, FOIA exempt
Hi Aaron-
Attached is our revised slide deck so you have it for reference. We will plan on you presenting and taking as much time for Q&A as you need. If there is still a lot of time left BPA will present our perspective slides. If they are filling the time with questions we will schedule a separate meeting to discuss the BPA perspective on the study. When you are done revising yours could you send it so I have an updated copy?
Thanks,
Eve

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Wednesday, June 15, 2022 9:45 AM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback
Deliberative, FOIA exempt
I sent an invite for 2. I also double checked the capacity value sensitivity and updated a previous error; result is now a higher end of the NPV replacement cost reduction range.

1.5 GW firm capacity value (43%) → ~9-20% lower NPV replacement cost
1.0 GW firm capacity value (29%) → ~14-33% lower NPV replacement cost

Aaron

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Wednesday, June 15, 2022 9:06 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback
Deliberative, FOIA exempt
Thanks Aaron- I am available 2 – 5 PM as well. How about we meet at 2 PM.
Thanks,
Eve

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Tuesday, June 14, 2022 4:51 PM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback
Deliberative, FOIA exempt

Hi Eve,
Thanks for the note on contracting. Sharing an updated deck with key text changes noted in red text.
A few key changes to note:

- In general, we changed the cost metrics to focus on the range of cases S1, S2a, and S2b, then share another datapoint on the impact of case S2c. This addresses DOE's comments on framing of the scenarios. The S2c results are now labeled as "impractical" on other slides.
- New firm capacity value focused slide added (slide 17), showing the validation using BPA provided 2011 generation and sharing that reducing firm capacity value to 1-1.5 GW is estimated to reduce the NPV by ~9-21%. This shows the importance of this assumption, but also frames that the total replacement costs wouldn't change that much even if a much lower value is assumed.
- We recommend removing slide 19 (additional considerations). BPA can make these points as they like in their framing. We didn't feel like this slide added much that folks don't know already and could be misinterpreted as advocacy points by E3.

Happy to chat by phone tomorrow as desired. I'm free 9-10am or 2-5pm.
I've adjusted our conflict on Thursday at 9am, but I'll need to drop right at 9:30am.
All the best,
Aaron
Copying DOE comments w/ responses below.
DOE FEEDBACK:
See below for some feedback on the slides. Some of it may come across a little strident, especially over email, and I apologize for that. I'm sending it along without editing in the interest of time, and with the hope that it will be useful.
Thanks!
Emily
One set of comments:
My apologies but this is all I had time for today. Still getting it in under the wire I hope.
BPA Lower Snake River Dams Power Replacement:
Slide 3: Not to be a stickler for detail but I looked up the LSR dams on the USACE website and they rate the generators as follows:

- Lower Granite – 810MW
- Little Goose – 810MW
- Lower Monumental – 810MW, and
- Ice Harbor – 603MW
- For a total of 3,033MW *not* 3,483MW, they may be using nameplate but that doesn't account for age, field currents, and power factor.

This comment needs to be addressed- I put suggestions in the slide deck in red text for E3's consideration. I didn't realize until tracking this comment down that this is a difference between Nameplate and Overload capacities. Corps websites list nameplate and overload (or they did) but BPA simply uses overload. Hydro facilities traditionally operate above nameplate and closer to overload. FERC recognized many year ago (20+ probably) with licensed hydro facilities and made many hydro facilities adjust ratings to overload or peak generation numbers. Overload is traditionally ~15% above nameplate. The values in the E3 study are the capacity values used in the CRSO EIS so we want to keep that consistent- I suggest renaming the capacity "Full Capacity" instead of Nameplate capacity with a footnote suggestion on slide 5.
Accepted footnote w/ minor changes and added footnote on slide 3 as well.
Slide 3: Discusses energy storage cannot replace hydro capacity due to charging limitations during energy shortfall events. One word – drought. As the drought extends alternatives need to not only be considered, but actively developed since reservoir levels are quickly approaching their lower limits for generator efficiency. (Eve's thoughts- this commenter is most likely thinking of Colorado River not the NW- "drought" or low water conditions were considered using the 2001 water year and the LSN projects (nor Columbia River basin) are in a drought condition- flows on LSN are currently above 100 kcfs and another atmospheric rain event will be hitting the basin this weekend) Agreed that this misses the boat. Droughts tend to drive reliability challenges in the NW. During drought years there are extended energy shortfalls when energy storage would not have charging energy. Hydro capacity value is driven by its energy available during these drought conditions, hence the use of low/drought years for hydro capacity values.

Slide 5: The nameplate capacity is wrong according to the USACE data. I believe it was mentioned that E3 makes their case during the peak river flows and not during the summer, when generation drops significantly and is needed because of air conditioning. Due to drought and other climate events, the hydro generation is becoming out of synch with actual needs in the northwest. See above on the Overload vs nameplate. I think solar buildout means winter is more of an issue than summer but will let E3 address or ignore since I don't think the commenter is correct about hydro out of synch with needs. Does "total capacity" work instead of "full capacity"? Added slides on capacity value and winter vs. summer risk.
Slide 8: My apologies but an all or nothing modeling approach is a disservice to optimization (I don't understand this comment- not sure if they think the generation would come out in stages? I think Slide 8 is good) I'm not clear either.
Key Takeaways: BPA will address these but leaving for your awareness- the presentation to CEQ will just be the E3 results, a different meeting will have BPA perspective I greyed out BPA specific comments
Slide 3: Transmission reliability services – they mention black start, that's usually close held information, even working directly with the Corps they would not reveal this info. I'm thinking they are generalizing here. Also for voltage support, VARs don't travel all that far and if using the generators for VARs it further limits the MW output – can't have it both ways.
Slide 4: Replacement. What is not mentioned is end of life of the generating units or the dam. These were units installed in the mostly in the 70's and some in the 60's. Considering the renewable resource, perhaps the end of life should be considered as well.
Slide 5: A bit of misinformation here. They show 50 square miles at Seattle. Perhaps the same perspective should be in the Lower Snake region itself. Likely this could be expanded or distributed and have greater gains than currently exist. Also must consider the evolving grid and DER. Not mentioned.
Slide 6: See above about generator ratings. Note the peak generation is more in line with the USACE ratings than the E3 study. Also the USACE ratings are ~87% of the E3 study ratings, making it more compatible with the NWEC study.
Slide 7: The northwest was built around hydro so it is no surprise that hydro response would mirror the load response. However, the variability of the wind and solar had a strategy that includes energy storage which is not mentioned. The E3 study is very selective on the material and data they present.
Slide 8: Rational decision making must be considered here. This could be a planned transition based upon end of life, supply chain, or other considerations with a likewise development of replacement generation. Additionally, most of the dams along the Snake and Columbia provide necessary irrigation services. There is no consideration of this in these slides.
Another reviewer wrote:
My largest concern regards messaging and, specifically, what I perceive to be an overly dramatized summary of analysis results. This is especially true in the BPA reflections deck, but also the E3 PPT.
In part this comes from the inclusion of the Deep Decarbonization + No New Combustion scenario. This scenario comes in at an extreme cost premium, and is truly an outlier. As noted in the earlier DOE-Lab comments, this case is simply not realistic practically or politically. But not only is this case still included in the analysis, but the presentation of modeling results often places undue emphasis on the results from this case. The BPA deck, for example, often writes "Up to…." (cost, land use, etc), thereby leading with the results from this unrealistic case (slide 4-5). And when presenting results as a range, the inclusion of this scenario makes the reader think that the true value might be in the middle of that range, when in fact all of the other scenarios show substantially smaller impacts and costs. The overemphasis on this particular scenario is most apparent in the BPA deck, but is also apparent in the E3 deck (e.g., the summary slide, slides 15, 17, etc). I continue to believe that this case should be eliminated, or de-emphasized in the results presentation.
Alternatively, the core results should start with the baseline cases, and only present the results of this case as an extreme 'what if' outlier. (E3 address if needed- the Nat Lab staff perspective is very much working on getting emerging technologies on-line and BPA's focus is on making sure steel in the ground keeps the lights on. How you show results or order the scenarios we'll leave up to you. We'll update some language in our slides to make it clear we are referring to economy-wide decarbonization and without breakthrough technology) E3 slides updated to focus on range w/o the no new combustion case w/ an adder statement on cost impacts in that case
There are a few other ways in which the results feel over-dramatized, and unnecessarily so: BPA will address these:
• The BPA slides also sometimes note "without decarbonization policies" when referencing the lower cost results—but those lower cost results still achieve 100% clean shares at minimum. Greater clarity is needed that the highest cost results presented assume deep decarbonization and very limited technology options. Must lower (but still notable) costs accrue under all other scenarios, including ones that involve deep power sector decarbonization (100% clean) and deep

economy-wide decarbonization (with baseline or emerging tech assumptions). Suggesting that lower costs are only achievable 'without decarbonization policies' is misleading.

• The BPA deck notes the challenges with transmission, driving a possible 35 year replacement timeline. But I see no transmission results in the E3 deck. In fact, since the replacement resources in all of the cases except the outlier noted above focus on H2 (with relatively little wind and solar), it seems unlikely that these cases would require much if any new transmission. On what basis should conclusions about viability be based on purported new transmission, when the study itself includes little emphasis on this—and the transmission needs are likely modest.

• The BPA deck suggests a 35 year timeframe, driven in part by transmission – which as noted above, is problematic. Besides that, I would note that the E3 deck contains some information on timelines, which do not equal 35 years: so a possible discrepancy. It is also not clear why these timelines must be additive = generation + transmission. Some of these times could be happening in parallel, rather than in sequence. While noting timelines is important, the current presentation feels overly dramatic and inconsistent.

• The BPA deck has a slide that covers land use and supply chains. It seems to focus on land use and supply chain concerns for wind, solar, and batteries, including a map implying that the land required for wind/solar would blanket Seattle. But as above, under all of the realistic scenarios, the E3 analysis includes relatively little wind and solar and batteries. So the entire slide seems somewhat off-base, relative to the actual analysis.

• Also in the BPA deck, NWEC does not claim that the LSR dams are 1000 MW nameplate, but they do estimate that the ELCC value of those dams is ~1000 MW. Nor does NWEC perceive wind as a firm resource, as implied by the BPA deck, or at least what was not my impression.

It just feels that the analysis in places is being presented in a one-sided fashion, and not as neutrally as might be desired. It does not feel necessary to take this approach.

I anticipate that, beyond the items listed above, among the most contentious relates to the resource adequacy contribution of the LSR dams and possible replacement resources. BPA-E3 and NWEC disagree on the capacity contribution of the LSR dams. DOE has not independently analyzed the ELCC of these dams, but given the outsized importance of this single assumption, we encourage BPA to conduct a new study on that question. Meantime, we wonder whether the ELCC assumptions of the LSR dams, storage, wind, solar etc are truly comparable. Are all of these marginal ELCC values or are they all average values – or are some average and some marginal? Why the relatively high ELCC of the LSR dams but the low marginal ELCC of 12-hour storage? Are the storage ELCC value assumed by E3 correct—E3 reports that Avista assumes 58% for 12-hour storage and PSE 30% for 4-hour storage, both higher than what E3 assumes for this study after the first small incremental storage deployment. I'm not sure if this commenter read the peer review response. I think the ELCC assumption for LSR dams is good - the other questions are out of my swim lane. I am frustrated they keep pointing to the NWEC study since even the historical data used in their study shows more than 1000 MW of energy/capacity even though that is all the capacity they chose to replace. E3 added slide on capacity benchmarking using 2001 hydro data, noting focus on winter reliability need and estimated LSR dam replacement cost impact of 10-20% if a lower firm capacity of 1-1.5 GW was assumed instead.

As for stakeholder engagement, I fear that the E3 results and BPA reflections will be overly off-putting to regional stakeholders—not necessarily because of the analysis itself, but because of contention over a small number of core assumptions (e.g., ELCC) and how the results are presented (e.g., the high-cost outlier, noted above). I would encourage BPA to think seriously about how to present these results to regional and federal stakeholders in a way that improves understanding and dialogue.

I will not reiterate the earlier DOE-Lab comments, beyond what is noted above. One exception: I continue to believe that some mention of tax credit availability is warranted. The E3 and BPA decks both highlight possible costs to BPA customers; those costs would be lower were tax credits to be extended. Given past tax credit extensions, and current proposals, some note is warranted that tax credits are NOT assumed in the present analysis but IF THEY EXIST would reduce costs for BPA customers. Not sure if you want to add a footnote to slide 15 but there was good language E3 used in the peer review response that could be put on that slide if E3 wants to address. Added in a footnote per Eve's suggestion.

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Tuesday, June 14, 2022 11:11 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt

Hi Aaron,

I reached out to contracting and since the contract was set up as a firm fixed price changing the structure of the contract to a time and materials budget won't work. They are going to review the terms and scope and then set up a meeting where we can discuss what types of options could be used for additional meetings.

Thanks,

Eve

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Friday, June 10, 2022 4:11 PM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback

Deliberative, FOIA exempt

Hi Eve,

Confirming we received the invite for 6/16. We have another client conflict at 9am PST, but I'm seeking to move that meeting.

Thanks for sharing the DOE feedback. Their points provide an important perspective, especially around the framing of the different scenarios and the importance of validating our firm capacity contribution assumption and the summer vs. winter need question. I plan to make updates to the slides Mon and Tue next week. In general, we plan to tone down the current emphasis on the no emerging tech scenario. Let me know if you want to discuss by phone Mon or Tue, otherwise I'll share our updated deck by Tuesday COB in case you have any final feedback on Wednesday.

Regarding the NWPCC presentation, we are happy to present the work there and other venues as needed/useful. I just want to flag that we're already approaching our (expanded) budget and will likely need additional budget to cover these further slide updates and later public presentations. I don't know if it's an option contracting-wise, but the easiest would be just to authorize another $50k but on a time and materials not to exceed basis. Let me know thoughts on this.

Re: the Inslee report, their ~$9b NPV replacement cost of the energy services is fairly in line with our scenarios (except the no emerging tech case), so that's good to see. I haven't reviewed the details, but I suspect our replacement resources and conclusions on that front are different (how much DR and storage can support).

Have a nice weekend!

Aaron

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Thursday, June 9, 2022 3:00 PM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback

And if you haven't seen the release of the Inslee/Murray draft report:

Lower Snake River Dams: Benefit Replacement Draft Report (lsrdoptions.org)

From: James,Eve A L (BPA) - PG-5
Sent: Thursday, June 9, 2022 11:10 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 (bgkoehler@bpa.gov) <bgkoehler@bpa.gov>
Subject: DOE slide review feedback

Deliberative, FOIA exempt

Good Morning-

Below is feedback from DOE on the slide decks we sent over. I left the feedback on the BPA perspective slides for your awareness but grayed them out since we'll be addressing those. I also put some blue text on comments that I'm not compelled to address since they are either incorrect or not clear (but please address if you feel compelled to do so). I highlighted important comments to address in yellow. I also am attaching the slide deck you sent with some edits in red to fix a few typos I found and to address the nameplate comment below.

I haven't heard an exact date on the CEQ meeting yet but know that it is limited to an hour - so just E3 presenting the results. We will schedule a separate meeting with CEQ to discuss BPA's perspective on the E3 study results. As far as public release, BPA would like to get your feedback on proposing to offer a presentation of the E3 study to the Northwest Power and Conservation Council – Power Committee. The next scheduled meeting is the 2nd week of July. A special meeting could be offered as well if that timing doesn't work. I can work with contracting to make contract changes if needed (I can't remember the contract duration off the top of my head).

Thanks,

Eve

DOE FEEDBACK:

See below for some feedback on the slides. Some of it may come across a little strident, especially over email, and I apologize for that. I'm sending it along without editing in the interest of time, and with the hope that it will be useful.

Thanks!

Emily

One set of comments:

My apologies but this is all I had time for today. Still getting it in under the wire I hope.

BPA Lower Snake River Dams Power Replacement:

Slide 3: Not to be a stickler for detail but I looked up the LSR dams on the USACE website and they rate the generators as follows:

- Lower Granite – 810MW
- Little Goose – 810MW
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- Ice Harbor – 603MW
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Slide 5: The nameplate capacity is wrong according to the USACE data. I believe it was mentioned that E3 makes their case during the peak river flows and not during the summer, when generation drops significantly and is needed because of air conditioning. Due to drought and other climate events, the hydro generation is becoming out of synch with actual needs in the northwest. See above on the Overload vs nameplate. I think solar buildout means winter is more of an issue than summer but will let E3 address or ignore since I don't think the commenter is correct about hydro out of synch with needs.

Slide 8: My apologies but an all or nothing modeling approach is a disservice to optimization (I don't understand this comment- not sure if they think the generation would come out in stages? I think Slide 8 is good)

Key Takeaways: BPA will address these but leaving for your awareness- the presentation to CEQ will just be the E3 results, a different meeting will have BPA perspective I greyed out BPA specific comments

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Slide 5: A bit of misinformation here. They show 50 square miles at Seattle. Perhaps the same perspective should be in the Lower Snake region itself. Likely this could be expanded or distributed and have greater gains than currently exist. Also must consider the evolving grid and DER. Not mentioned.
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Another reviewer wrote:

My largest concern regards messaging and, specifically, what I perceive to be an overly dramatized summary of analysis results. This is especially true in the BPA reflections deck, but also the E3 PPT.

In part this comes from the inclusion of the Deep Decarbonization + No New Combustion scenario. This scenario comes in at an extreme cost premium, and is truly an outlier. As noted in the earlier DOE-Lab comments, this case is simply not realistic practically or politically. But not only is this case still included in the analysis, but the presentation of modeling results often places undue emphasis on the results from this case. The BPA deck, for example, often writes "Up to…." (cost, land use, etc), thereby leading with the results from this unrealistic case (slide 4-5). And when presenting results as a range, the inclusion of this scenario makes the reader think that the true value might be in the middle of that range, when in fact all of the other scenarios show substantially smaller impacts and costs. The overemphasis on this particular scenario is most apparent in the BPA deck, but is also apparent in the E3 deck (e.g., the summary slide, slides 15, 17, etc). I continue to believe that this case should be eliminated, or de-emphasized in the results presentation. Alternatively, the core results should start with the baseline cases, and only present the results of this case as an extreme 'what if' outlier. (E3 address if needed- the Nat Lab staff perspective is very much working on getting emerging technologies on-line and BPA's focus is on making sure steel in the ground keeps the lights on. How you show results or order the scenarios we'll leave up to you. We'll update some language in our slides to make it clear we are referring to economy-wide decarbonization and without breakthrough technology)

There are a few other ways in which the results feel over-dramatized, and unnecessarily so: BPA will address these:

• The BPA slides also sometimes note "without decarbonization policies" when referencing the lower cost results—but those lower cost results still achieve 100% clean shares at minimum. Greater clarity is needed that the highest cost results presented assume deep decarbonization and very limited technology options. Must lower (but still notable) costs accrue under all other scenarios, including ones that involve deep power sector decarbonization (100% clean) and deep economy-wide decarbonization (with baseline or emerging tech assumptions). Suggesting that lower costs are only achievable 'without decarbonization policies' is misleading.
• The BPA deck notes the challenges with transmission, driving a possible 35 year replacement timeline. But I see no transmission results in the E3 deck. In fact, since the replacement resources in all of the cases except the outlier noted above focus on H2 (with relatively little wind and solar), it seems unlikely that these cases would require much if any new transmission. On what basis should conclusions about viability be based on purported new transmission, when the study itself includes little emphasis on this—and the transmission needs are likely modest.
• The BPA deck suggests a 35 year timeframe, driven in part by transmission – which as noted above, is problematic. Besides that, I would note that the E3 deck contains some information on timelines, which do not equal 35 years: so a possible discrepancy. It is also not clear why these timelines must be additive = generation + transmission. Some of these times could be happening in parallel, rather than in sequence. While noting timelines is important, the current presentation feels overly dramatic and inconsistent.
• The BPA deck has a slide that covers land use and supply chains. It seems to focus on land use and supply chain concerns for wind, solar, and batteries, including a map implying that the land required for wind/solar would blanket Seattle. But as above, under all of the realistic scenarios, the E3 analysis includes relatively little wind and solar and batteries. So the entire slide seems somewhat off-base, relative to the actual analysis.

• Also in the BPA deck, NWEC does not claim that the LSR dams are 1000 MW nameplate, but they do estimate that the ELCC value of those dams is ~1000 MW. Nor does NWEC perceive wind as a firm resource, as implied by the BPA deck, or at least what was not my impression.

It just feels that the analysis in places is being presented in a one-sided fashion, and not as neutrally as might be desired. It does not feel necessary to take this approach.

I anticipate that, beyond the items listed above, among the most contentious relates to the resource adequacy contribution of the LSR dams and possible replacement resources. BPA-E3 and NWEC disagree on the capacity contribution of the LSR dams. DOE has not independently analyzed the ELCC of these dams, but given the outsized importance of this single assumption, we encourage BPA to conduct a new study on that question. Meantime, we wonder whether the ELCC assumptions of the LSR dams, storage, wind, solar etc are truly comparable. Are all of these marginal ELCC values or are they all average values – or are some average and some marginal? Why the relatively high ELCC of the LSR dams but the low marginal ELCC of 12-hour storage? Are the storage ELCC value assumed by E3 correct—E3 reports that Avista assumes 58% for 12-hour storage and PSE 30% for 4-hour storage, both higher than what E3 assumes for this study after the first small incremental storage deployment. I'm not sure if this commenter read the peer review response. I think the ELCC assumption for LSR dams is good - the other questions are out of my swim lane. I am frustrated they keep pointing to the NWEC study since even the historical data used in their study shows more than 1000 MW of energy/capacity even though that is all the capacity they chose to replace.

As for stakeholder engagement, I fear that the E3 results and BPA reflections will be overly off-putting to regional stakeholders—not necessarily because of the analysis itself, but because of contention over a small number of core assumptions (e.g., ELCC) and how the results are presented (e.g., the high-cost outlier, noted above). I would encourage BPA to think seriously about how to present these results to regional and federal stakeholders in a way that improves understanding and dialogue.

I will not reiterate the earlier DOE-Lab comments, beyond what is noted above. One exception: I continue to believe that some mention of tax credit availability is warranted. The E3 and BPA decks both highlight possible costs to BPA customers; those costs would be lower were tax credits to be extended. Given past tax credit extensions, and current proposals, some note is warranted that tax credits are NOT assumed in the present analysis but IF THEY EXIST would reduce costs for BPA customers. Not sure if you want to add a footnote to slide 15 but there was good language E3 used in the peer review response that could be put on that slide if E3 wants to address.

From:	Arne Olson <arne@ethree.com>
Sent:	Thursday, July 7, 2022 10:12 AM
To:	Koehler,Birgit G (BPA) - PG-5
Cc:	James,Eve A L (BPA) - PG-5; Aaron Burdick
Subject:	[EXTERNAL] RE: latest update, and calendaring

Great, I'll call you then.

Not sure if "accuracy" is the word I would choose to describe a scenario so speculative, but there's no question it's a difficult case to solve...

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Thursday, July 7, 2022 9:46 AM
To: Arne Olson <arne@ethree.com>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: RE: latest update, and calendaring

DELIBERATIVE FOIA EXEMPT

1:30 sounds good. Their questions are largely trying to find creative, out-of-the box ideas to reduce the costs. I don't think they are questioning the accuracy of your analysis.

From: Arne Olson <arne@ethree.com>
Sent: Thursday, July 7, 2022 9:43 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: [EXTERNAL] RE: latest update, and calendaring

OK, interesting. Maybe we can talk around 1:30 Pacific. Is there some additional information we can provide to help contextualize those costs? My understanding is it's pretty much driven by the need to go all the way to zero carbon for the entire region, which exhausts the available supply of good renewables and leaves us with offshore and Rockies wind with expensive new transmission.

I've asked Angineh to put together a table that builds up the costs from their components.

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Thursday, July 7, 2022 9:22 AM
To: Arne Olson <arne@ethree.com>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: RE: latest update, and calendaring

DELIBERATIVE FOIA EXEMPT

Good morning Arne (or just now afternoon on the east coast),

We had a huddle this morning with our administrator, and he suggested that it would be a good idea for me to fill you in a little bit about what's been going on. I'm glad that I finally have the OK to do that.

The short explanation is that CEQ is nervous about the report and alarmed at the high costs, particularly the NPV of scenario 2c. CEQ is also asking a lot of unusual technical questions, but I am trying to field them. DOE has been advocating for us, and the decision on whether to hold or proceed despite CEQ went all the way up to the Secretary of Energy last evening.

Feel free to give me a call. My work phone is below and forwards to my personal cell. I'm mostly available today (except 11-12 PDT) since the results roll-out meetings are canceled.

Cheers,
Birgit

.-
Birgit Koehler, Ph.D. (she/her/hers)
Deputy Director of Power Generation Asset Management
BONNEVILLE POWER ADMINISTRATION
bgkoehler@bpa.gov | O: 503-230-4249

From: Arne Olson <arne@ethree.com>
Sent: Wednesday, July 6, 2022 6:45 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: [EXTERNAL] RE: latest update, and calendaring

Thanks Birgit.

Here is my availability for next week:

Tuesday, 7/12
- 8-11 AM
- 1-5 PM

Wednesday, 7/13
- Anytime

Thursday, 7/14
- After 10 AM

Friday, 7/15
- 8-10 AM

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Wednesday, July 6, 2022 6:23 PM
To: Arne Olson <arne@ethree.com>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: RE: latest update, and calendaring

DELIBERATIVE FOIA EXEMPT

Hello Arne,
Well, here I am one more time with an email. I'm afraid I just received confirmation that we are indeed delaying the presentation.

In hopes that we can reschedule for next week's Council meeting, I'm hoping that you would be free. Would you mind giving me your availability for Tuesday and Wed July 12 and 13 (for the Council). I have not heard what the plans are for Congressional or media, but I would guess that we would try to set that up similar to what was planned today. So if it isn't too much of an ask, would you also share your availability for Thursday and possibly Friday, just in case?

Aaron and Eve might not have missed all the fun afterall.

Birgit

From: Arne Olson <arne@ethree.com>
Sent: Wednesday, July 6, 2022 4:54 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: [EXTERNAL] RE: latest update

OK, understood. I'll wait to hear.

Thanks,

Arne

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Wednesday, July 6, 2022 4:38 PM
To: Arne Olson <arne@ethree.com>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: RE: latest update

DELIBERATIVE FOIA EXEMPT

Because of a need for additional coordination with DC-level executives

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From: Arne Olson <arne@ethree.com>
Sent: Wednesday, July 6, 2022 4:35 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: [EXTERNAL] RE: latest update

Huh. Is this from DOE or from the Council?

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Wednesday, July 6, 2022 4:34 PM
To: Arne Olson <arne@ethree.com>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: latest update

Hello Arne,

Here is the latest information I have.

"The E3 presentation to the Council tomorrow will **likely** be canceled. The current plan is to delay one week, potentially to the full Council meeting, but this still needs to be confirmed and coordinated."

Once I hear that a decision is finalized, I'll send you another email plus let the Council staff know. The Council Chair has already been contacted. On the Council website, I see that the next Council meeting is July 12 and 13th.

(Clearing Up will be an interesting read this weekend.)

Birgit

From: Arne Olson <arne@ethree.com>
Sent: Thursday, June 16, 2022 11:58 AM
To: James,Eve A L (BPA) - PG-5; Koehler,Birgit G (BPA) - PG-5; Aaron Burdick
Subject: [EXTERNAL] Re: DOE slide review feedback

One thing I'm a little worried about is that we focused so much time on the resource adequacy value that we may have inadvertently given short shrift to the other values the dams provide. Perhaps BPA can emphasize that in the E3 results when you have your own debrief with them.

Sent from my Verizon, Samsung Galaxy smartphone
Get Outlook for Android

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Thursday, June 16, 2022 9:53:12 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt

Definitely- great job in the hot seat!
We'll keep you posted on the public rollout. The next Council meeting that Scott mentioned is July 6-7 and I know Aaron is out that week (I am as well). Arne- would you be available during that time or would we need to request to schedule a special meeting?
Thanks,
Eve

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Thursday, June 16, 2022 9:50 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt

Thank you Aaron and Arne!
I think that went well. Was impressed by some of the questions and surprised by others. Quite probing.

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Wednesday, June 15, 2022 4:57 PM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback

Deliberative, FOIA exempt

Here is the updated deck I will present tomorrow morning.
Aaron

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Wednesday, June 15, 2022 3:08 PM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt

Hi Aaron-

Attached is our revised slide deck so you have it for reference. We will plan on you presenting and taking as much time for Q&A as you need. If there is still a lot of time left BPA will present our perspective slides. If they are filling the time with questions we will schedule a separate meeting to discuss the BPA perspective on the study. When you are done revising yours could you send it so I have an updated copy?
Thanks,
Eve

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Wednesday, June 15, 2022 9:45 AM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback

Deliberative, FOIA exempt

I sent an invite for 2. I also double checked the capacity value sensitivity and updated a previous error; result is now a higher end of the NPV replacement cost reduction range.

– 1.5 GW firm capacity value (43%) → ~9-20% lower NPV replacement cost
– 1.0 GW firm capacity value (29%) → ~14-33% lower NPV replacement cost

Aaron

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Wednesday, June 15, 2022 9:06 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt

Thanks Aaron- I am available 2 – 5 PM as well. How about we meet at 2 PM.
Thanks,
Eve

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Tuesday, June 14, 2022 4:51 PM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback

Deliberative, FOIA exempt

Hi Eve,
Thanks for the note on contracting. Sharing an updated deck with key text changes noted in red text.
A few key changes to note:

- In general, we changed the cost metrics to focus on the range of cases S1, S2a, and S2b, then share another datapoint on the impact of case S2c. This addresses DOE's comments on framing of the scenarios. The S2c results are now labeled as "impractical" on other slides.
- New firm capacity value focused slide added (slide 17), showing the validation using BPA provided 2011 generation and sharing that reducing firm capacity value to 1-1.5 GW is estimated to reduce the NPV by ~9-21%. This shows the importance of this assumption, but also frames that the total replacement costs wouldn't change that much even if a much lower value is assumed.
- We recommend removing slide 19 (additional considerations). BPA can make these points as they like in their framing. We didn't feel like this slide added much that folks don't know already and could be misinterpreted as advocacy points by E3.

Happy to chat by phone tomorrow as desired. I'm free 9-10am or 2-5pm.
I've adjusted our conflict on Thursday at 9am, but I'll need to drop right at 9:30am.
All the best,
Aaron
Copying DOE comments w/ responses below.
DOE FEEDBACK:

See below for some feedback on the slides. Some of it may come across a little strident, especially over email, and I apologize for that. I'm sending it along without editing in the interest of time, and with the hope that it will be useful. Thanks!
Emily

One set of comments:

My apologies but this is all I had time for today. Still getting it in under the wire I hope.

BPA Lower Snake River Dams Power Replacement:

Slide 3: Not to be a stickler for detail but I looked up the LSR dams on the USACE website and they rate the generators as follows:

- Lower Granite – 810MW
- Little Goose – 810MW
- Lower Monumental – 810MW, and
- Ice Harbor – 603MW
- For a total of 3,033MW *not* 3,483MW, they may be using nameplate but that doesn't account for age, field currents, and power factor.

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Accepted footnote w/ minor changes and added footnote on slide 3 as well.

Slide 3: Discusses energy storage cannot replace hydro capacity due to charging limitations during energy shortfall events. One word – drought. As the drought extends alternatives need to not only be considered, but actively developed since reservoir levels are quickly approaching their lower limits for generator efficiency. (Eve's thoughts- this commenter is most likely thinking of Colorado River not the NW- "drought" or low water conditions were considered using the 2001 water year and the LSN projects (nor Columbia River basin) are in a drought condition- flows on LSN are currently above 100 kcfs and another atmospheric rain event will be hitting the basin this weekend) Agreed that this misses the boat. Droughts tend to drive reliability challenges in the NW. During drought years there are extended energy shortfalls when energy storage would not have charging energy. Hydro capacity value is driven by its energy available during these drought conditions, hence the use of low/drought years for hydro capacity values.

Slide 5: The nameplate capacity is wrong according to the USACE data. I believe it was mentioned that E3 makes their case during the peak river flows and not during the summer, when generation drops significantly and is needed because of air conditioning. Due to drought and other climate events, the hydro generation is becoming out of synch with actual needs in the northwest. See above on the Overload vs nameplate. I think solar buildout means winter is more of an issue than summer but will let E3 address or ignore since I don't think the commenter is correct about hydro out of synch with needs. Does "total capacity" work instead of "full capacity"? Added slides on capacity value and winter vs. summer risk.

Slide 8: My apologies but an all or nothing modeling approach is a disservice to optimization (I don't understand this comment- not sure if they think the generation would come out in stages? I think Slide 8 is good) I'm not clear either.

Key Takeaways: BPA will address these but leaving for your awareness- the presentation to CEQ will just be the E3 results, a different meeting will have BPA perspective I greyed out BPA specific comments

Slide 3: Transmission reliability services – they mention black start, that's usually close held information, even working directly with the Corps they would not reveal this info. I'm thinking they are generalizing here. Also for voltage support, VARs don't travel all that far and if using the generators for VARs it further limits the MW output – can't have it both ways.

Slide 4: Replacement. What is not mentioned is end of life of the generating units or the dam. These were units installed in the mostly in the 70's and some in the 60's. Considering the renewable resource, perhaps the end of life should be considered as well.

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Slide 6: See above about generator ratings. Note the peak generation is more in line with the USACE ratings than the E3 study. Also the USACE ratings are ~87% of the E3 study ratings, making it more compatible with the NWEC study.
Slide 7: The northwest was built around hydro so it is no surprise that hydro response would mirror the load response. However, the variability of the wind and solar had a strategy that includes energy storage which is not mentioned. The E3 study is very selective on the material and data they present.
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Another reviewer wrote:

My largest concern regards messaging and, specifically, what I perceive to be an overly dramatized summary of analysis results. This is especially true in the BPA reflections deck, but also the E3 PPT.

In part this comes from the inclusion of the Deep Decarbonization + No New Combustion scenario. This scenario comes in at an extreme cost premium, and is truly an outlier. As noted in the earlier DOE-Lab comments, this case is simply not realistic practically or politically. But not only is this case still included in the analysis, but the presentation of modeling results often places undue emphasis on the results from this case. The BPA deck, for example, often writes "Up to…." (cost, land use, etc), thereby leading with the results from this unrealistic case (slide 4-5). And when presenting results as a range, the inclusion of this scenario makes the reader think that the true value might be in the middle of that range, when in fact all of the other scenarios show substantially smaller impacts and costs. The overemphasis on this particular scenario is most apparent in the BPA deck, but is also apparent in the E3 deck (e.g., the summary slide, slides 15, 17, etc). I continue to believe that this case should be eliminated, or de-emphasized in the results presentation. Alternatively, the core results should start with the baseline cases, and only present the results of this case as an extreme 'what if' outlier. (E3 address if needed- the Nat Lab staff perspective is very much working on getting emerging technologies on-line and BPA's focus is on making sure steel in the ground keeps the lights on. How you show results or order the scenarios we'll leave up to you. We'll update some language in our slides to make it clear we are referring to economy-wide decarbonization and without breakthrough technology) E3 slides updated to focus on range w/o the no new combustion case w/ an adder statement on cost impacts in that case

There are a few other ways in which the results feel over-dramatized, and unnecessarily so: BPA will address these:

• The BPA slides also sometimes note "without decarbonization policies" when referencing the lower cost results—but those lower cost results still achieve 100% clean shares at minimum. Greater clarity is needed that the highest cost results presented assume deep decarbonization and very limited technology options. Must lower (but still notable) costs accrue under all other scenarios, including ones that involve deep power sector decarbonization (100% clean) and deep economy-wide decarbonization (with baseline or emerging tech assumptions). Suggesting that lower costs are only achievable 'without decarbonization policies' is misleading.

• The BPA deck notes the challenges with transmission, driving a possible 35 year replacement timeline. But I see no transmission results in the E3 deck. In fact, since the replacement resources in all of the cases except the outlier noted above focus on H2 (with relatively little wind and solar), it seems unlikely that these cases would require much if any new transmission. On what basis should conclusions about viability be based on purported new transmission, when the study itself includes little emphasis on this—and the transmission needs are likely modest.

• The BPA deck suggests a 35 year timeframe, driven in part by transmission – which as noted above, is problematic. Besides that, I would note that the E3 deck contains some information on timelines, which do not equal 35 years: so a possible discrepancy. It is also not clear why these timelines must be additive = generation + transmission. Some of these times could be happening in parallel, rather than in sequence. While noting timelines is important, the current presentation feels overly dramatic and inconsistent.

• The BPA deck has a slide that covers land use and supply chains. It seems to focus on land use and supply chain concerns for wind, solar, and batteries, including a map implying that the land required for wind/solar would blanket Seattle. But as above, under all of the realistic scenarios, the E3 analysis includes relatively little wind and solar and batteries. So the entire slide seems somewhat off-base, relative to the actual analysis.

• Also in the BPA deck, NWEC does not claim that the LSR dams are 1000 MW nameplate, but they do estimate that the ELCC value of those dams is ~1000 MW. Nor does NWEC perceive wind as a firm resource, as implied by the BPA deck, or at least what was not my impression.

It just feels that the analysis in places is being presented in a one-sided fashion, and not as neutrally as might be desired. It does not feel necessary to take this approach.

I anticipate that, beyond the items listed above, among the most contentious relates to the resource adequacy contribution of the LSR dams and possible replacement resources. BPA-E3 and NWEC disagree on the capacity contribution of the LSR dams. DOE has not independently analyzed the ELCC of these dams, but given the outsized importance of this single assumption, we encourage BPA to conduct a new study on that question. Meantime, we wonder whether the ELCC assumptions of the LSR dams, storage, wind, solar etc are truly comparable. Are all of these marginal ELCC values or are they all average values – or are some average and some marginal? Why the relatively high ELCC of the LSR dams but the low marginal ELCC of 12-hour storage? Are the storage ELCC value assumed by E3 correct—E3 reports that Avista assumes 58% for 12-hour storage and PSE 30% for 4-hour storage, both higher than what E3 assumes for this study after the first small incremental storage deployment. I'm not sure if this commenter read the peer review response. I think the ELCC assumption for LSR dams is good - the other questions are out of my swim lane. I am frustrated they keep pointing to the NWEC study since even the historical data used in their study shows more than 1000 MW of energy/capacity even though that is all the capacity they chose to replace. E3 added slide on capacity benchmarking using 2001 hydro data, noting focus on winter reliability need and estimated LSR dam replacement cost impact of 10-20% if a lower firm capacity of 1-1.5 GW was assumed instead.

As for stakeholder engagement, I fear that the E3 results and BPA reflections will be overly off-putting to regional stakeholders—not necessarily because of the analysis itself, but because of contention over a small number of core assumptions (e.g., ELCC) and how the results are presented (e.g., the high-cost outlier, noted above). I would encourage BPA to think seriously about how to present these results to regional and federal stakeholders in a way that improves understanding and dialogue.

I will not reiterate the earlier DOE-Lab comments, beyond what is noted above. One exception: I continue to believe that some mention of tax credit availability is warranted. The E3 and BPA decks both highlight possible costs to BPA customers; those costs would be lower were tax credits to be extended. Given past tax credit extensions, and current proposals, some note is warranted that tax credits are NOT assumed in the present analysis but IF THEY EXIST would reduce costs for BPA customers. Not sure if you want to add a footnote to slide 15 but there was good language E3 used in the peer review response that could be put on that slide if E3 wants to address. Added in a footnote per Eve's suggestion.

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Tuesday, June 14, 2022 11:11 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt

Hi Aaron,

I reached out to contracting and since the contract was set up as a firm fixed price changing the structure of the contract to a time and materials budget won't work. They are going to review the terms and scope and then set up a meeting where we can discuss what types of options could be used for additional meetings.

Thanks,
Eve

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Friday, June 10, 2022 4:11 PM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback

Deliberative, FOIA exempt

Hi Eve,

Confirming we received the invite for 6/16. We have another client conflict at 9am PST, but I'm seeking to move that meeting.

Thanks for sharing the DOE feedback. Their points provide an important perspective, especially around the framing of the different scenarios and the importance of validating our firm capacity contribution assumption and the summer vs. winter need question. I plan to make updates to the slides Mon and Tue next week. In general, we plan to tone down

the current emphasis on the no emerging tech scenario. Let me know if you want to discuss by phone Mon or Tue, otherwise I'll share our updated deck by Tuesday COB in case you have any final feedback on Wednesday.
Regarding the NWPCC presentation, we are happy to present the work there and other venues as needed/useful. I just want to flag that we're already approaching our (expanded) budget and will likely need additional budget to cover these further slide updates and later public presentations. I don't know if it's an option contracting-wise, but the easiest would be just to authorize another $50k but on a time and materials not to exceed basis. Let me know thoughts on this.
Re: the Inslee report, their ~$9b NPV replacement cost of the energy services is fairly in line with our scenarios (except the no emerging tech case), so that's good to see. I haven't reviewed the details, but I suspect our replacement resources and conclusions on that front are different (how much DR and storage can support).
Have a nice weekend!
Aaron

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Thursday, June 9, 2022 3:00 PM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback
And if you haven't seen the release of the Inslee/Murray draft report:
Lower Snake River Dams: Benefit Replacement Draft Report (lsrdoptions.org)

From: James,Eve A L (BPA) - PG-5
Sent: Thursday, June 9, 2022 11:10 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 (bgkoehler@bpa.gov) <bgkoehler@bpa.gov>
Subject: DOE slide review feedback

Deliberative, FOIA exempt

Good Morning-
Below is feedback from DOE on the slide decks we sent over. I left the feedback on the BPA perspective slides for your awareness but grayed them out since we'll be addressing those. I also put some blue text on comments that I'm not compelled to address since they are either incorrect or not clear (but please address if you feel compelled to do so). I highlighted important comments to address in yellow. I also am attaching the slide deck you sent with some edits in red to fix a few typos I found and to address the nameplate comment below.
I haven't heard an exact date on the CEQ meeting yet but know that it is limited to an hour - so just E3 presenting the results. We will schedule a separate meeting with CEQ to discuss BPA's perspective on the E3 study results. As far as public release, BPA would like to get your feedback on proposing to offer a presentation of the E3 study to the Northwest Power and Conservation Council – Power Committee. The next scheduled meeting is the 2nd week of July. A special meeting could be offered as well if that timing doesn't work. I can work with contracting to make contract changes if needed (I can't remember the contract duration off the top of my head).
Thanks,
Eve

DOE FEEDBACK:
See below for some feedback on the slides. Some of it may come across a little strident, especially over email, and I apologize for that. I'm sending it along without editing in the interest of time, and with the hope that it will be useful.
Thanks!
Emily

One set of comments:
My apologies but this is all I had time for today. Still getting it in under the wire I hope.

BPA Lower Snake River Dams Power Replacement:

Slide 3: Not to be a stickler for detail but I looked up the LSR dams on the USACE website and they rate the generators as follows:

- Lower Granite – 810MW
- Little Goose – 810MW
- Lower Monumental – 810MW, and
- Ice Harbor – 603MW

- For a total of 3,033MW *not* 3,483MW, they may be using nameplate but that doesn't account for age, field currents, and power factor.

This comment needs to be addressed- I put suggestions in the slide deck in red text for E3's consideration. I didn't realize until tracking this comment down that this is a difference between Nameplate and Overload capacities. Corps websites list nameplate and overload (or they did) but BPA simply uses overload. Hydro facilities traditionally operate above nameplate and closer to overload. FERC recognized many year ago (20+ probably) with licensed hydro facilities and made many hydro facilities adjust ratings to overload or peak generation numbers. Overload is traditionally ~15% above nameplate. The values in the E3 study are the capacity values used in the CRSO EIS so we want to keep that consistent- I suggest renaming the capacity "Full Capacity" instead of Nameplate capacity with a footnote suggestion on slide 5.

Slide 3: Discusses energy storage cannot replace hydro capacity due to charging limitations during energy shortfall events. One word – drought. As the drought extends alternatives need to not only be considered, but actively developed since reservoir levels are quickly approaching their lower limits for generator efficiency. (Eve's thoughts- this commenter is most likely thinking of Colorado River not the NW- "drought" or low water conditions were considered using the 2001 water year and the LSN projects (nor Columbia River basin) are in a drought condition- flows on LSN are currently above 100 kcfs and another atmospheric rain event will be hitting the basin this weekend)

Slide 5: The nameplate capacity is wrong according to the USACE data. I believe it was mentioned that E3 makes their case during the peak river flows and not during the summer, when generation drops significantly and is needed because of air conditioning. Due to drought and other climate events, the hydro generation is becoming out of synch with actual needs in the northwest. See above on the Overload vs nameplate. I think solar buildout means winter is more of an issue than summer but will let E3 address or ignore since I don't think the commenter is correct about hydro out of synch with needs.

Slide 8: My apologies but an all or nothing modeling approach is a disservice to optimization (I don't understand this comment- not sure if they think the generation would come out in stages? I think Slide 8 is good)

Key Takeaways: BPA will address these but leaving for your awareness- the presentation to CEQ will just be the E3 results, a different meeting will have BPA perspective I greyed out BPA specific comments

Slide 3: Transmission reliability services – they mention black start, that's usually close held information, even working directly with the Corps they would not reveal this info. I'm thinking they are generalizing here. Also for voltage support, VARs don't travel all that far and if using the generators for VARs it further limits the MW output – can't have it both ways.

Slide 4: Replacement. What is not mentioned is end of life of the generating units or the dam. These were units installed in the mostly in the 70's and some in the 60's. Considering the renewable resource, perhaps the end of life should be considered as well.

Slide 5: A bit of misinformation here. They show 50 square miles at Seattle. Perhaps the same perspective should be in the Lower Snake region itself. Likely this could be expanded or distributed and have greater gains than currently exist. Also must consider the evolving grid and DER. Not mentioned.

Slide 6: See above about generator ratings. Note the peak generation is more in line with the USACE ratings than the E3 study. Also the USACE ratings are ~87% of the E3 study ratings, making it more compatible with the NWEC study.

Slide 7: The northwest was built around hydro so it is no surprise that hydro response would mirror the load response. However, the variability of the wind and solar had a strategy that includes energy storage which is not mentioned. The E3 study is very selective on the material and data they present.

Slide 8: Rational decision making must be considered here. This could be a planned transition based upon end of life, supply chain, or other considerations with a likewise development of replacement generation. Additionally, most of the dams along the Snake and Columbia provide necessary irrigation services. There is no consideration of this in these slides.

Another reviewer wrote:

My largest concern regards messaging and, specifically, what I perceive to be an overly dramatized summary of analysis results. This is especially true in the BPA reflections deck, but also the E3 PPT.

In part this comes from the inclusion of the Deep Decarbonization + No New Combustion scenario. This scenario comes in at an extreme cost premium, and is truly an outlier. As noted in the earlier DOE-Lab comments, this case is simply not realistic practically or politically. But not only is this case still included in the analysis, but the presentation of modeling results often places undue emphasis on the results from this case. The BPA deck, for example, often writes "Up to…." (cost, land use, etc), thereby leading with the results from this unrealistic case (slide 4-5). And when presenting results as a range, the inclusion of this scenario makes the reader think that the true value might be in the middle of that range, when in fact all of the other scenarios show substantially smaller impacts and costs. The overemphasis on this particular scenario is most apparent in the BPA deck, but is also apparent in the E3 deck (e.g., the summary slide, slides 15, 17, etc). I continue to believe that this case should be eliminated, or de-emphasized in the results presentation. Alternatively, the core results should start with the baseline cases, and only present the results of this case as an extreme 'what if' outlier. (E3 address if needed- the Nat Lab staff perspective is very much working on getting emerging technologies on-line and BPA's focus is on making sure steel in the ground keeps the lights on. How you show results or order the scenarios we'll leave up to you. We'll update some language in our slides to make it clear we are referring to economy-wide decarbonization and without breakthrough technology)

There are a few other ways in which the results feel over-dramatized, and unnecessarily so: BPA will address these:

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From: Pidot, Justin R. EOP/CEQ
Sent: Mon Jul 18 06:56:29 2022
Required: Aaron Burdick
Subject: FW: Interagency briefing on E3 study and salmon report
Location: [redacted]
Start time: Mon Jul 18 10:00:00 2022
End time: Mon Jul 18 11:00:00 2022
Importance: Normal

Microsoft Exchange Server;converted from html;
Hi Aaron- I'm sorry this meeting got scheduled late. Hopefully you are still available to participate.
Thanks,
Eve
-----Original Appointment-----
From: Pidot, Justin R. EOP/CEQ <Justin.R.Pidot@ceq.eop.gov>
Sent: Sunday, July 17, 2022 1:46 PM
To: Pidot, Justin R. EOP/CEQ; Koehler,Birgit G (BPA) - PG-5; James,Eve A L (BPA) - PG-5; Gonzalez-Rothi, Sara R. EOP/CEQ; Olander, Lydia P. EOP/CEQ; Beck, Nico D. EOP/NSC; Ceronsky, Megan M. EOP/WHO; scott.rumsey@noaa.gov; janet.coit@noaa.gov; walker.smith@noaa.gov; mike.tehan@noaa.gov; SmailJR@state.gov; hannah.reid@hq.doe.gov; emily.hammond@hq.doe.gov; jeremiah.baumann@hq.doe.gov; Leary,Jill C (BPA) - LN-7; rose.stephens-booker@hq.doe.gov; Baskerville,Sonya L (BPA) - AIN-WASH; Zelinsky,Benjamin D (BPA) - E-4; Hairston,John L (BPA) - A-7; Armentrout,Scott G (BPA) - E-4; Godwin,Mary E (BPA) - LN-7; Robert.Anderson@sol.doi.gov; matthew_strickler@ios.doi.gov; rspringer@usbr.gov; Elizabeth_Klein@ios.doi.gov; tanya_trujillo@ios.doi.gov; jeremiah.williamson@sol.doi.gov; Jason.R.Chester@usace.army.mil; craig.r.schmauder.civ@mail.mil; Geoffrey.r.VanEpps@usace.army.mil; David.r.Cooper@usace.army.mil; Milt.Boyd@usace.army.mil; robyn.s.colosimo.civ@army.mil; Frances.E.Coffey@usace.army.mil; jennifer.a.rashel.civ@army.mil; Peter.D.Dickerson@usace.army.mil; Todd.Kim@usdoj.gov; frederick.turner@usdoj.gov; Scth.Barsky@usdoj.gov; Michacl.Eitcl@usdoj.gov; Jcan.Williams@usdoj.gov; Burden.Walker2@usdoj.gov; Schmauder, Craig R SES (USA); Pfaeffle, Frederick; Zachary Penney - NOAA Federal; Philip, Brendan T. EOP/CEQ; Donahue, Deirdre F. EOP/CEQ; Govindan, Jay (ENRD); mbrain@usbr.gov; Sloan, Megan N. EOP/CEQ; Daly, Gabriel; Thompson, Bradley E CIV USARMY CENWO (USA)
Subject: Interagency briefing on E3 study and salmon report
When: Monday, July 18, 2022 1:00 PM-2:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where:
[redacted]
-----Original Appointment-----
From: Pidot, Justin R. EOP/CEQ < Justin.R.Pidot@ceq.eop.gov>
Sent: Sunday, July 17, 2022 10:54 AM
To: Pidot, Justin R. EOP/CEQ; Gonzalez-Rothi, Sara R. EOP/CEQ; Olander, Lydia P. EOP/CEQ; Beck, Nico D. EOP/NSC; Ceronsky, Megan M. EOP/WHO; scott.rumsey@noaa.gov; janet.coit@noaa.gov; walker.smith@noaa.gov; mike.tehan@noaa.gov; SmailJR@state.gov; hannah.reid@hq.doe.gov; emily.hammond@hq.doe.gov; jeremiah.baumann@hq.doe.gov; Leary,Jill C

(BPA) - LN-7; rose.stephens-booker@hq.doe.gov; Baskerville,Sonya L (BPA) - AIN-WASH; Zelinsky,Benjamin D (BPA) - E-4; Hairston,John L (BPA) - A-7; Armentrout,Scott G (BPA) - E-4; Godwin,Mary E (BPA) - LN-7; Robert.Anderson@sol.doi.gov; matthew_strickler@ios.doi.gov; rspringer@usbr.gov; Elizabeth_Klein@ios.doi.gov; tanya_trujillo@ios.doi.gov; jeremiah.williamson@sol.doi.gov; Jason.R.Chester@usace.army.mil; craig.r.schmauder.civ@mail.mil; Geoffrey.r.VanEpps@usace.army.mil; David.r.Cooper@usace.army.mil; Milt.Boyd@usace.army.mil; robyn.s.colosimo.civ@army.mil; Frances.E.Coffey@usace.army.mil; jennifer.a.rashel.civ@army.mil; Peter.D.Dickerson@usace.army.mil; Todd.Kim@usdoj.gov; frederick.turner@usdoj.gov; Seth.Barsky@usdoj.gov; Michael.Eitel@usdoj.gov; Jean.Williams@usdoj.gov; Burden.Walker2@usdoj.gov; Schmauder, Craig R SES (USA); Pfaeffle, Frederick; Zachary Penney - NOAA Federal; Philip, Brendan T. EOP/CEQ; Donahue, Deirdre F. EOP/CEQ; Govindan, Jay (ENRD); mbrain@usbr.gov; Sloan, Megan N. EOP/CEQ; Daly, Gabriel; Thompson, Bradley E CIV USARMY CENWO (USA)
Subject: [EXTERNAL] Interagency briefing on E3 study and salmon report
When: Monday, July 18, 2022 1:00 PM-2:00 PM (UTC-05:00) Eastern Time (US & Canada).
Where:
(b)(6) [redacted]
Colleagues,
With everything going on last week, we were not able to fully lock a time for an interagency briefing on the E3 study and NOAA's salmon report. E3 and DOE have confirmed availability to brief D/As on the E3 report tomorrow at 1. I am hoping NOAA will be able to brief at that time too. If not, we will cut his meeting to 30 minutes and find an alternate time for the salmon report briefing.
I know folks are receiving questions about these releases so this briefing will hopefully be helpful.
Best,
Justin

https://www.zoomgov.com/static/6.1.7105/image/new/ZoomLogo_110_25.png
INCLUDEPICTURE
"https://www.zoomgov.com/static/6.1.7105/image/new/ZoomLogo_110_25.png" \d *
MERGEFORMATfillColor14286846fillOpacity16384fFilled1wzDescriptionhttps://www.zoomgov.com/static/6.1.7105/image/new/ZoomLogo_110_25.png0100090000032100000000000050000000000
0400000003010800050000000b0200000000050000000c02020002000300000001e00040000002
701ffff030000000000

Hi there,

Justin Pidot (he/him) is inviting you to a scheduled ZoomGov meeting.

Join Zoom Meeting

One tap mobile:

US: [redacted]

Meeting URL:

[redacted]

Meeting ID:

[redacted]

Passcode:

[redacted]

Join by Telephone

For higher quality, dial a number based on your current location.

Dial:

US: [redacted]

Meeting ID:

[redacted]

Passcode:

[redacted]

International numbers

Join from an H.323/SIP room system

H.323:

[redacted] (US West)
(US East)

Meeting ID:

[redacted]

Passcode:

[redacted]

SIP:

[redacted]@sip.zoomgov.com

Passcode:

[redacted]

From: Pidot, Justin R. EOP/CEQ
Sent: Thu Jun 09 15:23:52 2022
Required: Aaron Burdick; Arne Olson
Subject: FW: E3 briefing
Location: [redacted]
Start time: Thu Jun 16 08:00:00 2022
End time: Thu Jun 16 09:30:00 2022
Importance: Normal

Microsoft Exchange Server;converted from html;
-----Original Appointment-----
From: Pidot, Justin R. EOP/CEQ <Justin.R.Pidot@ceq.eop.gov>
Sent: Thursday, June 9, 2022 3:23 PM
To: Pidot, Justin R. EOP/CEQ; Godwin,Mary E (BPA) - LN-7; James,Eve A L (BPA) - PG-5; Koehler,Birgit G (BPA) - PG-5; Armentrout,Scott G (BPA) - E-4; Gonzalez-Rothi, Sara R. EOP/CEQ; Donahue, Deirdre F. EOP/CEQ; Cordan, R. Nicole N. EOP/OMB; Leary,Jill C (BPA) - LN-7; Hammond, Emily
Subject: E3 briefing
When: Thursday, June 16, 2022 11:00 AM-12:30 PM (UTC-05:00) Eastern Time (US & Canada).
Where: [redacted]
Eve, can you forward this to the E3 folks?
-----Original Appointment-----
From: Pidot, Justin R. EOP/CEQ < Justin.R.Pidot@ceq.eop.gov>
Sent: Thursday, June 9, 2022 11:23 AM
To: Pidot, Justin R. EOP/CEQ; Gonzalez-Rothi, Sara R. EOP/CEQ; Donahue, Deirdre F. EOP/CEQ; Cordan, R. Nicole N. EOP/OMB; Leary,Jill C (BPA) - LN-7; Hammond, Emily
Subject: E3 briefing
When: Thursday, June 16, 2022 11:00 AM-12:30 PM (UTC-05:00) Eastern Time (US & Canada).
Where: [redacted]
Join ZoomGov Meeting
[redacted]
Meeting ID: [redacted]
Passcode: [redacted]
One tap mobile
[redacted] US (San Jose)
US (New York)
Dial by your location
+1 669 [redacted] (San Jose)
+1 646 (New York)
+1 669 (San Jose)
+1 551
Meeting ID: [redacted]
Passcode [redacted]
Find your local number: [redacted]
Join by SIP

[redacted]
Join by H.323
[redacted] (US West)
(US East)
Meeting ID: [redacted]
Passcode: [redacted]

From: James,Eve A L (BPA) - PG-5
Sent: Wednesday, June 22, 2022 12:52 PM
To: Arne Olson; Koehler,Birgit G (BPA) - PG-5; Aaron Burdick
Subject: RE: DOE slide review feedback

I heard back from Council staff this morning and the agenda time for July 7 from 8:30 – 10 AM has been finalized. I will make sure you get the virtual meeting information when it's available.

Thanks,
Eve

From: Arne Olson <arne@ethree.com>
Sent: Friday, June 17, 2022 1:03 PM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: [EXTERNAL] RE: DOE slide review feedback

Will do. Would this be a remote presentation, or in person?

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Friday, June 17, 2022 12:47 PM
To: Arne Olson <arne@ethree.com>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt
Thanks Arne- could you put a hold on your calendar for July 7 8:30 AM – 10:00 AM? That is a tentative slot for agenda time at this point so it may move but wanted to mention that is one of the times that might work for the Council. I let them know you were unavailable on that day from 10 – 1. I will let you know when the timing gets finalized but wanted to give you a heads up to keep that timeslot clear.

From: Arne Olson <arne@ethree.com>
Sent: Thursday, June 16, 2022 11:19 AM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>
Subject: [EXTERNAL] Re: DOE slide review feedback

Yes I'd be available on July 6-7, but I do have a hold on my calendar from 10-1 for another event.

Sent from my Verizon, Samsung Galaxy smartphone
Get Outlook for Android

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Thursday, June 16, 2022, 9:54 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson

<arne@ethree.com>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt
Definitely- great job in the hot seat!

We'll keep you posted on the public rollout. The next Council meeting that Scott mentioned is July 6-7 and I know Aaron is out that week (I am as well). Arne- would you be available during that time or would we need to request to schedule a special meeting?

Thanks,
Eve

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Thursday, June 16, 2022 9:50 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt

Thank you Aaron and Arne!

I think that went well. Was impressed by some of the questions and surprised by others. Quite probing.

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Wednesday, June 15, 2022 4:57 PM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback

Deliberative, FOIA exempt

Here is the updated deck I will present tomorrow morning.

Aaron

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Wednesday, June 15, 2022 3:08 PM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt
Hi Aaron-
Attached is our revised slide deck so you have it for reference. We will plan on you presenting and taking as much time for Q&A as you need. If there is still a lot of time left BPA will present our perspective slides. If they are filling the time with questions we will schedule a separate meeting to discuss the BPA perspective on the study. When you are done revising yours could you send it so I have an updated copy?

Thanks,
Eve

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Wednesday, June 15, 2022 9:45 AM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback

Deliberative, FOIA exempt

I sent an invite for 2. I also double checked the capacity value sensitivity and updated a previous error; result is now a higher end of the NPV replacement cost reduction range.

1.5 GW firm capacity value (43%) → ~9-20% lower NPV replacement cost
1.0 GW firm capacity value (29%) → ~14-33% lower NPV replacement cost

Aaron

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Wednesday, June 15, 2022 9:06 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt
Thanks Aaron- I am available 2 – 5 PM as well. How about we meet at 2 PM.

Thanks,
Eve

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Tuesday, June 14, 2022 4:51 PM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback

Deliberative, FOIA exempt

Hi Eve,

Thanks for the note on contracting. Sharing an updated deck with key text changes noted in red text.

A few key changes to note:

- In general, we changed the cost metrics to focus on the range of cases S1, S2a, and S2b, then share another datapoint on the impact of case S2c. This addresses DOE's comments on framing of the scenarios. The S2c results are now labeled as "impractical" on other slides.
- New firm capacity value focused slide added (slide 17), showing the validation using BPA provided 2011 generation and sharing that reducing firm capacity value to 1-1.5 GW is estimated to reduce the NPV by ~9-21%. This shows the importance of this assumption, but also frames that the total replacement costs wouldn't change that much even if a much lower value is assumed.

- We recommend removing slide 19 (additional considerations). BPA can make these points as they like in their framing. We didn't feel like this slide added much that folks don't know already and could be misinterpreted as advocacy points by E3.

Happy to chat by phone tomorrow as desired. I'm free 9-10am or 2-5pm.

I've adjusted our conflict on Thursday at 9am, but I'll need to drop right at 9:30am.

All the best,
Aaron

Copying DOE comments w/ responses below.

DOE FEEDBACK:

See below for some feedback on the slides. Some of it may come across a little strident, especially over email, and I apologize for that. I'm sending it along without editing in the interest of time, and with the hope that it will be useful.

Thanks!

Emily

One set of comments:

My apologies but this is all I had time for today. Still getting it in under the wire I hope.

BPA Lower Snake River Dams Power Replacement:
Slide 3: Not to be a stickler for detail but I looked up the LSR dams on the USACE website and they rate the generators as follows:

- Lower Granite – 810MW
- Little Goose – 810MW
- Lower Monumental – 810MW, and
- Ice Harbor – 603MW
- For a total of 3,033MW *not* 3,483MW, they may be using nameplate but that doesn't account for age, field currents, and power factor.

This comment needs to be addressed- I put suggestions in the slide deck in red text for E3's consideration. I didn't realize until tracking this comment down that this is a difference between Nameplate and Overload capacities. Corps websites list nameplate and overload (or they did) but BPA simply uses overload. Hydro facilities traditionally operate above nameplate and closer to overload. FERC recognized many year ago (20+ probably) with licensed hydro facilities and made many hydro facilities adjust ratings to overload or peak generation numbers. Overload is traditionally ~15% above nameplate. The values in the E3 study are the capacity values used in the CRSO EIS so we want to keep that consistent- I suggest renaming the capacity "Full Capacity" instead of Nameplate capacity with a footnote suggestion on slide 5. Accepted footnote w/ minor changes and added footnote on slide 3 as well.

Slide 3: Discusses energy storage cannot replace hydro capacity due to charging limitations during energy shortfall events. One word – drought. As the drought extends alternatives need to not only be considered, but actively developed since reservoir levels are quickly approaching their lower limits for generator efficiency. (Eve's thoughts- this commenter is most likely thinking of Colorado River not the NW- "drought" or low water conditions were considered using the 2001 water year and the LSN projects (nor Columbia River basin) are in a drought condition- flows on LSN are currently above

100 kcfs and another atmospheric rain event will be hitting the basin this weekend) Agreed that this misses the boat. Droughts tend to drive reliability challenges in the NW. During drought years there are extended energy shortfalls when energy storage would not have charging energy. Hydro capacity value is driven by its energy available during these drought conditions, hence the use of low/drought years for hydro capacity values.

Slide 5: The nameplate capacity is wrong according to the USACE data. I believe it was mentioned that E3 makes their case during the peak river flows and not during the summer, when generation drops significantly and is needed because of air conditioning. Due to drought and other climate events, the hydro generation is becoming out of synch with actual needs in the northwest. See above on the Overload vs nameplate. I think solar buildout means winter is more of an issue than summer but will let E3 address or ignore since I don't think the commenter is correct about hydro out of synch with needs. Does "total capacity" work instead of "full capacity"? Added slides on capacity value and winter vs. summer risk.

Slide 8: My apologies but an all or nothing modeling approach is a disservice to optimization (I don't understand this comment- not sure if they think the generation would come out in stages? I think Slide 8 is good) I'm not clear either.

Key Takeaways: BPA will address these but leaving for your awareness- the presentation to CEQ will just be the E3 results, a different meeting will have BPA perspective I greyed out BPA specific comments

Slide 3: Transmission reliability services – they mention black start, that's usually close held information, even working directly with the Corps they would not reveal this info. I'm thinking they are generalizing here. Also for voltage support, VARs don't travel all that far and if using the generators for VARs it further limits the MW output – can't have it both ways.

Slide 4: Replacement. What is not mentioned is end of life of the generating units or the dam. These were units installed in the mostly in the 70's and some in the 60's. Considering the renewable resource, perhaps the end of life should be considered as well.

Slide 5: A bit of misinformation here. They show 50 square miles at Seattle. Perhaps the same perspective should be in the Lower Snake region itself. Likely this could be expanded or distributed and have greater gains than currently exist. Also must consider the evolving grid and DER. Not mentioned.

Slide 6: See above about generator ratings. Note the peak generation is more in line with the USACE ratings than the E3 study. Also the USACE ratings are ~87% of the E3 study ratings, making it more compatible with the NWEC study.

Slide 7: The northwest was built around hydro so it is no surprise that hydro response would mirror the load response. However, the variability of the wind and solar had a strategy that includes energy storage which is not mentioned. The E3 study is very selective on the material and data they present.

Slide 8: Rational decision making must be considered here. This could be a planned transition based upon end of life, supply chain, or other considerations with a likewise development of replacement generation. Additionally, most of the dams along the Snake and Columbia provide necessary irrigation services. There is no consideration of this in these slides.

Another reviewer wrote:

My largest concern regards messaging and, specifically, what I perceive to be an overly dramatized summary of analysis results. This is especially true in the BPA reflections deck, but also the E3 PPT.

In part this comes from the inclusion of the Deep Decarbonization + No New Combustion scenario. This scenario comes in at an extreme cost premium, and is truly an outlier. As noted in the earlier DOE-Lab comments, this case is simply not realistic practically or politically. But not only is this case still included in the analysis, but the presentation of modeling results often places undue emphasis on the results from this case. The BPA deck, for example, often writes "Up to...." (cost, land use, etc), thereby leading with the results from this unrealistic case (slide 4-5). And when presenting results as a range, the inclusion of this scenario makes the reader think that the true value might be in the middle of that range, when in fact all of the other scenarios show substantially smaller impacts and costs. The overemphasis on this particular scenario is most apparent in the BPA deck, but is also apparent in the E3 deck (e.g., the summary slide, slides 15, 17, etc). I continue to believe that this case should be eliminated, or de-emphasized in the results presentation. Alternatively, the core results should start with the baseline cases, and only present the results of this case as an extreme 'what if' outlier. (E3 address if needed- the Nat Lab staff perspective is very much working on getting emerging technologies on-line and BPA's focus is on making sure steel in the ground keeps the lights on. How you show results or order the scenarios we'll leave up to you. We'll update some language in our slides to make it clear we are referring to economy-wide decarbonization and without breakthrough technology) E3 slides updated to focus on range w/o the no new combustion case w/ an adder statement on cost impacts in that case

There are a few other ways in which the results feel over-dramatized, and unnecessarily so: BPA will address these:

• The BPA slides also sometimes note "without decarbonization policies" when referencing the lower cost results—but those lower cost results still achieve 100% clean shares at minimum. Greater clarity is needed that the highest cost results presented assume deep decarbonization and very limited technology options. Must lower (but still notable) costs accrue under all other scenarios, including ones that involve deep power sector decarbonization (100% clean) and deep economy-wide decarbonization (with baseline or emerging tech assumptions). Suggesting that lower costs are only achievable 'without decarbonization policies' is misleading.

• The BPA deck notes the challenges with transmission, driving a possible 35 year replacement timeline. But I see no transmission results in the E3 deck. In fact, since the replacement resources in all of the cases except the outlier noted above focus on H2 (with relatively little wind and solar), it seems unlikely that these cases would require much if any new transmission. On what basis should conclusions about viability be based on purported new transmission, when the study itself includes little emphasis on this—and the transmission needs are likely modest.

• The BPA deck suggests a 35 year timeframe, driven in part by transmission – which as noted above, is problematic. Besides that, I would note that the E3 deck contains some information on timelines, which do not equal 35 years: so a possible discrepancy. It is also not clear why these timelines must be additive = generation + transmission. Some of these times could be happening in parallel, rather than in sequence. While noting timelines is important, the current presentation feels overly dramatic and inconsistent.

• The BPA deck has a slide that covers land use and supply chains. It seems to focus on land use and supply chain concerns for wind, solar, and batteries, including a map implying that the land required for wind/solar would blanket Seattle. But as above, under all of the realistic scenarios, the E3 analysis includes relatively little wind and solar and batteries. So the entire slide seems somewhat off-base, relative to the actual analysis.

• Also in the BPA deck, NWEC does not claim that the LSR dams are 1000 MW nameplate, but they do estimate that the ELCC value of those dams is ~1000 MW. Nor does NWEC perceive wind as a firm resource, as implied by the BPA deck, or at least what was not my impression.

It just feels that the analysis in places is being presented in a one-sided fashion, and not as neutrally as might be desired. It does not feel necessary to take this approach.

I anticipate that, beyond the items listed above, among the most contentious relates to the resource adequacy contribution of the LSR dams and possible replacement resources. BPA-E3 and NWEC disagree on the capacity contribution of the LSR dams. DOE has not independently analyzed the ELCC of these dams, but given the outsized importance of this single assumption, we encourage BPA to conduct a new study on that question. Meantime, we wonder whether the ELCC assumptions of the LSR dams, storage, wind, solar etc are truly comparable. Are all of these marginal ELCC values or are they all average values – or are some average and some marginal? Why the relatively high ELCC of the LSR dams but the low marginal ELCC of 12-hour storage? Are the storage ELCC value assumed by E3 correct—E3 reports that Avista assumes 58% for 12-hour storage and PSE 30% for 4-hour storage, both higher than what

E3 assumes for this study after the first small incremental storage deployment. I'm not sure if this commenter read the peer review response. I think the ELCC assumption for LSR dams is good - the other questions are out of my swim lane. I am frustrated they keep pointing to the NWEC study since even the historical data used in their study shows more than 1000 MW of energy/capacity even though that is all the capacity they chose to replace. E3 added slide on capacity benchmarking using 2001 hydro data, noting focus on winter reliability need and estimated LSR dam replacement cost impact of 10-20% if a lower firm capacity of 1-1.5 GW was assumed instead.

As for stakeholder engagement, I fear that the E3 results and BPA reflections will be overly off-putting to regional stakeholders—not necessarily because of the analysis itself, but because of contention over a small number of core assumptions (e.g., ELCC) and how the results are presented (e.g., the high-cost outlier, noted above). I would encourage BPA to think seriously about how to present these results to regional and federal stakeholders in a way that improves understanding and dialogue.

I will not reiterate the earlier DOE-Lab comments, beyond what is noted above. One exception: I continue to believe that some mention of tax credit availability is warranted. The E3 and BPA decks both highlight possible costs to BPA customers; those costs would be lower were tax credits to be extended. Given past tax credit extensions, and current proposals, some note is warranted that tax credits are NOT assumed in the present analysis but IF THEY EXIST would reduce costs for BPA customers. Not sure if you want to add a footnote to slide 15 but there was good language E3 used in the peer review response that could be put on that slide if E3 wants to address. Added in a footnote per Eve's suggestion.

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Tuesday, June 14, 2022 11:11 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback

Deliberative, FOIA exempt

Hi Aaron,
I reached out to contracting and since the contract was set up as a firm fixed price changing the structure of the contract to a time and materials budget won't work. They are going to review the terms and scope and then set up a meeting where we can discuss what types of options could be used for additional meetings.

Thanks,
Eve

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Friday, June 10, 2022 4:11 PM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: DOE slide review feedback

Deliberative, FOIA exempt

Hi Eve,

Confirming we received the invite for 6/16. We have another client conflict at 9am PST, but I'm seeking to move that meeting.

Thanks for sharing the DOE feedback. Their points provide an important perspective, especially around the framing of the different scenarios and the importance of validating our firm capacity contribution assumption and the summer vs. winter need question. I plan to make updates to the slides Mon and Tue next week. In general, we plan to tone down the current emphasis on the no emerging tech scenario. Let me know if you want to discuss by phone Mon or Tue, otherwise I'll share our updated deck by Tuesday COB in case you have any final feedback on Wednesday.

Regarding the NWPCC presentation, we are happy to present the work there and other venues as needed/useful. I just want to flag that we're already approaching our (expanded) budget and will likely need additional budget to cover these further slide updates and later public presentations. I don't know if it's an option contracting-wise, but the easiest would be just to authorize another $50k but on a time and materials not to exceed basis. Let me know thoughts on this.

Re: the Inslee report, their ~$9b NPV replacement cost of the energy services is fairly in line with our scenarios (except the no emerging tech case), so that's good to see. I haven't reviewed the details, but I suspect our replacement resources and conclusions on that front are different (how much DR and storage can support).

Have a nice weekend!

Aaron

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Thursday, June 9, 2022 3:00 PM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: DOE slide review feedback

And if you haven't seen the release of the Inslee/Murray draft report:
Lower Snake River Dams: Benefit Replacement Draft Report (lsrdoptions.org)

From: James,Eve A L (BPA) - PG-5
Sent: Thursday, June 9, 2022 11:10 AM
To: Aaron Burdick <aaron.burdick@ethree.com>; Arne Olson <arne@ethree.com>
Cc: Koehler,Birgit G (BPA) - PG-5 (bgkoehler@bpa.gov) <bgkoehler@bpa.gov>
Subject: DOE slide review feedback

Deliberative, FOIA exempt
Good Morning-
Below is feedback from DOE on the slide decks we sent over. I left the feedback on the BPA perspective slides for your awareness but grayed them out since we'll be addressing those. I also put some blue text on comments that I'm not compelled to address since they are either incorrect or not clear (but please address if you feel compelled to do so). I highlighted important comments to address in yellow. I also am attaching the slide deck you sent with some edits in red to fix a few typos I found and to address the nameplate comment below.

I haven't heard an exact date on the CEQ meeting yet but know that it is limited to an hour - so just E3 presenting the results. We will schedule a separate meeting with CEQ to discuss BPA's perspective on the E3 study results. As far as public release, BPA would like to get your feedback on proposing to offer a presentation of the E3 study to the Northwest Power and Conservation Council – Power Committee. The next scheduled meeting is the 2nd week of July. A special meeting could be offered as well if that timing doesn't work. I can work with contracting to make contract changes if needed (I can't remember the contract duration off the top of my head).

Thanks,
Eve

DOE FEEDBACK:

See below for some feedback on the slides. Some of it may come across a little strident, especially over email, and I apologize for that. I'm sending it along without editing in the interest of time, and with the hope that it will be useful.

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• The BPA slides also sometimes note "without decarbonization policies" when referencing the lower cost results—but those lower cost results still achieve 100% clean shares at minimum. Greater clarity is needed that the highest cost results presented assume deep decarbonization and very limited technology options. Must lower (but still notable) costs accrue under all other scenarios, including ones that involve deep power sector decarbonization (100% clean) and deep economy-wide decarbonization (with baseline or emerging tech assumptions). Suggesting that lower costs are only achievable 'without decarbonization policies' is misleading.

• The BPA deck notes the challenges with transmission, driving a possible 35 year replacement timeline. But I see no transmission results in the E3 deck. In fact, since the replacement resources in all of the cases except the outlier noted above focus on H2 (with relatively little wind and solar), it seems unlikely that these cases would require much if any new transmission. On what basis should conclusions about viability be based on purported new transmission, when the study itself includes little emphasis on this—and the transmission needs are likely modest.

• The BPA deck suggests a 35 year timeframe, driven in part by transmission – which as noted above, is problematic. Besides that, I would note that the E3 deck contains some information on timelines, which do not equal 35 years: so a possible discrepancy. It is also not clear why these timelines must be additive = generation + transmission. Some of these times could be happening in parallel, rather than in sequence. While noting timelines is important, the current presentation feels overly dramatic and inconsistent.

• The BPA deck has a slide that covers land use and supply chains. It seems to focus on land use and supply chain concerns for wind, solar, and batteries, including a map implying that the land required for wind/solar would blanket Seattle. But as above, under all of the realistic scenarios, the E3 analysis includes relatively little wind and solar and batteries. So the entire slide seems somewhat off-base, relative to the actual analysis.

• Also in the BPA deck, NWEC does not claim that the LSR dams are 1000 MW nameplate, but they do estimate that the ELCC value of those dams is ~1000 MW. Nor does NWEC perceive wind as a firm resource, as implied by the BPA deck, or at least what was not my impression.

It just feels that the analysis in places is being presented in a one-sided fashion, and not as neutrally as might be desired. It does not feel necessary to take this approach.

I anticipate that, beyond the items listed above, among the most contentious relates to the resource adequacy contribution of the LSR dams and possible replacement resources. BPA-E3 and NWEC disagree on the capacity contribution of the LSR dams. DOE has not independently analyzed the ELCC of these dams, but given the outsized importance of this single assumption, we encourage BPA to conduct a new study on that question. Meantime, we wonder whether the ELCC assumptions of the LSR dams, storage, wind, solar etc are truly comparable. Are all of these marginal ELCC values or are they all average values – or are some average and some marginal? Why the relatively high ELCC of the LSR dams but the low marginal ELCC of 12-hour storage? Are the storage ELCC value assumed by E3 correct—E3 reports that Avista assumes 58% for 12-hour storage and PSE 30% for 4-hour storage, both higher than what E3 assumes for this study after the first small incremental storage deployment. I'm not sure if this commenter read the peer review response. I think the ELCC assumption for LSR dams is good - the other questions are out of my swim lane. I am frustrated they keep pointing to the NWEC study since even the historical data used in their study shows more than 1000 MW of energy/capacity even though that is all the capacity they chose to replace.

As for stakeholder engagement, I fear that the E3 results and BPA reflections will be overly off-putting to regional stakeholders—not necessarily because of the analysis itself, but because of contention over a small number of core assumptions (e.g., ELCC) and how the results are presented (e.g., the high-cost outlier, noted above). I would encourage BPA to think seriously about how to present these results to regional and federal stakeholders in a way that improves understanding and dialogue.

I will not reiterate the earlier DOE-Lab comments, beyond what is noted above. One exception: I continue to believe that some mention of tax credit availability is warranted. The E3 and BPA decks both highlight possible costs to BPA customers; those costs would be lower were tax credits to be extended. Given past tax credit extensions, and current proposals, some note is warranted that tax credits are NOT assumed in the present analysis but IF THEY EXIST would reduce costs for BPA customers. Not sure if you want to add a footnote to slide 15 but there was good language E3 used in the peer review response that could be put on that slide if E3 wants to address.

From:	Armentrout,Scott G (BPA) - E-4
Sent:	Friday, February 11, 2022 10:47 AM
To:	Koehler,Birgit G (BPA) - PG-5
Cc:	Leary,Jill C (BPA) - LN-7; Baskerville,Sonya L (BPA) - AIN-WASH; James,Eve A L (BPA) - PG-5; Zelinsky,Benjamin D (BPA) - E-4; Godwin,Mary E (BPA) - LN-7
Subject:	RE: PNW Hydropower and BPA

I think this is a very good response. Scott

SCOTT G ARMENTROUT
Executive Vice President, Environment, Fish & Wildlife, SES | E-4
BONNEVILLE POWER ADMINISTRATION
bpa.gov | P 503-230-3076 | C (b)(6) [redacted]

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Friday, February 11, 2022 10:32 AM
To: Armentrout,Scott G (BPA) - E-4 <sgarmentrout@bpa.gov>
Cc: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>
Subject: RE: PNW Hydropower and BPA

Good morning Scott,

(b)(5) [redacted]

[redacted]

Cheers,
Birgit

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Thursday, February 10, 2022 2:45 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: PNW Hydropower and BPA

[redacted]

Sonya Baskerville
BPA National Relations
[redacted]

On Feb 10, 2022 5:38 PM, "Leary,Jill C (BPA) - LN-7" <jcleary@bpa.gov> wrote:

[redacted]

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Thursday, February 10, 2022 2:31 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: PNW Hydropower and BPA

[redacted]

Sonya Baskerville
BPA National Relations
[redacted]

On Feb 10, 2022 5:29 PM, "Leary,Jill C (BPA) - LN-7" <jcleary@bpa.gov> wrote:
Confidential and privileged attorney client communication/FOIA-exempt
Thanks, Birgit.

[redacted]

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Thursday, February 10, 2022 2:21 PM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: FW: PNW Hydropower and BPA

Confidential and privileged attorney client communication/FOIA-exempt

(b)(5)

[redacted]

Birgit

From: Hoffman, Patricia <pat.hoffman@hq.doe.gov>
Sent: Thursday, February 10, 2022 12:23 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] FW: PNW Hydropower and BPA

Sorry just realized I forgot to cc you on this…. Carl Mas will be OE support to the study work…. He has done very detailed analysis for NY under Nyserda.

Contact information: Carl.mas@hq.doe.gov

From: Hoffman, Patricia
Sent: Monday, February 7, 2022 1:22 PM
To: Capanna, Steve <steve.capanna@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>
Cc: Muse, Whitney <whitney.muse@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>
Subject: FW: PNW Hydropower and BPA

We would like Carl Mas to be the OE participant for this study. Carl is on an IPA from NYSERDA and is considered a Fed under this agreement.

pat

From: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Sent: Thursday, February 3, 2022 2:01 PM

To: Hammond, Emily <emily.hammond@hq.doe.gov>; Hoffman, Patricia <pat.hoffman@hq.doe.gov>; Muse, Whitney <whitney.muse@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Capanna, Steve <steve.capanna@hq.doe.gov>
Cc: Garson, Jennifer <jennifer.garson@ee.doe.gov>; Jackson, Kathryn <kathryn.jackson@ee.doe.gov>; Spitsen, Paul <paul.spitsen@ee.doe.gov>; Bockenhauer, Samuel <samuel.bockenhauer@ee.doe.gov>; Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Subject: PNW Hydropower and BPA

Hi all

I'm pleased to report that as and if the BPA/EFI Lower Snake River analysis proceeds, EERE-WPTO is prepared to offer strategic support to BPA.

Jenn Garson has indicated that, at DOE, Sam Bockenhauer and Katie Jackson can run point at WPTO. I've cc'd all three here. As well, Lab support could come from any number of experts, depending on the ultimate direction of the study. But Greg Stark (NREL, power-sector planning) and TJ Heibel (PNNL, hydro valuation) have been identified as perhaps the two Lab folks to start with.

Presuming that the study does proceed, we should find a way to introduce the BPA group to this DOE-Lab team.

As well, maybe Pat and Whitney should think some more about how OE might want to participate as advisors to the study—in addition to the EERE crew.

Obviously all useful to discuss and amend as things move forward.

Best

Ryan

Ryan Wiser
Senior Scientist
Office of Policy (detail)
U.S. Department of Energy

From: Leary,Jill C (BPA) - LN-7
Sent: Friday, February 11, 2022 9:19 AM
To: Baskerville,Sonya L (BPA) - AIN-WASH; Koehler,Birgit G (BPA) - PG-5; Godwin,Mary E (BPA) - LN-7; James,Eve A L (BPA) - PG-5
Subject: RE: PNW Hydropower and BPA

Confidential and privileged attorney client communication/FOIA-exempt

Hi Birgit,

(b)(5) [redacted]

Thanks,
Jill

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Friday, February 11, 2022 8:51 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: PNW Hydropower and BPA

(b)(5) [redacted]

Thanks!

Sonya Baskerville
BPA National Relations
(b)(6) [redacted] m

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Friday, February 11, 2022 10:51 AM
To: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: PNW Hydropower and BPA

Confidential, Attorney-Client Communication, Do Not Release under FOIA

(b)(5) [redacted]

(b)(5) [redacted]

Cheers,
Birgit

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Thursday, February 10, 2022 2:45 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: PNW Hydropower and BPA

(b)(5) [redacted]

Sonya Baskerville
BPA National Relations
(b)(6) [redacted]

On Feb 10, 2022 5:38 PM, "Leary,Jill C (BPA) - LN-7" <jcleary@bpa.gov> wrote:

(b)(5) [redacted]

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Sent: Thursday, February 10, 2022 2:31 PM
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Subject: RE: PNW Hydropower and BPA

(b)(5) [redacted]

Sonya Baskerville
BPA National Relations
(b)(5) [redacted]

On Feb 10, 2022 5:29 PM, "Leary,Jill C (BPA) - LN-7" <jcleary@bpa.gov> wrote:
Confidential and privileged attorney client communication/FOIA-exempt
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(b)(5) [redacted]

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Confidential and privileged attorney client communication/FOIA-exempt

(b)(5) [redacted]

Birgit

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Sent: Thursday, February 10, 2022 12:23 PM

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Sent: Thursday, February 3, 2022 2:01 PM
To: Hammond, Emily <emily.hammond@hq.doe.gov>; Hoffman, Patricia <pat.hoffman@hq.doe.gov>; Muse, Whitney <whitney.muse@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Capanna, Steve <steve.capanna@hq.doe.gov>
Cc: Garson, Jennifer <jennifer.garson@ee.doe.gov>; Jackson, Kathryn <kathryn.jackson@ee.doe.gov>; Spitsen, Paul <paul.spitsen@ee.doe.gov>; Bockenhauer, Samuel <samuel.bockenhauer@ee.doe.gov>; Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Subject: PNW Hydropower and BPA

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Best

Ryan

Ryan Wiser
Senior Scientist
Office of Policy (detail)
U.S. Department of Energy

From: Leary,Jill C (BPA) - LN-7
Sent: Tuesday, July 5, 2022 5:13 PM
To: Baskerville,Sonya L (BPA) - AIN-WASH
Cc: Hairston,John L (BPA) - A-7; Godwin,Mary E (BPA) - LN-7; Koehler,Birgit G (BPA) - PG-5; James,Eve A L (BPA) - PG-5; Armentrout,Scott G (BPA) - E-4; Zelinsky,Benjamin D (BPA) - E-4; Senters,Anne E (BPA) - LN-7; Chong Tim,Marcus H (BPA) - L-7
Subject: DOE coordination for July 6

Confidential and privileged attorney client communication/FOIA-exempt
Hi Sonya,
(b)(5) [redacted]

Thanks,
Jill

From:	Leary,Jill C (BPA) - LN-7
Sent:	Tuesday, August 9, 2022 9:53 AM
To:	Hairston,John L (BPA) - A-7; Baskerville,Sonya L (BPA) - AIN-WASH; James,Eve A L (BPA) - PG-5; Koehler,Birgit G (BPA) - PG-5; Cook,Joel D (BPA) - K-7
Cc:	Godwin,Mary E (BPA) - LN-7; Senters,Anne E (BPA) - LN-7; Chong Tim,Marcus H (BPA) - L-7; Marker,Douglas R (BPA) - AIR-7; Armentrout,Scott G (BPA) - E-4; Zelinsky,Benjamin D (BPA) - E-4; Sweet,Jason C (BPA) - EW-4
Subject:	Congressional letters on E3 Study
Attachments:	Letter to BPA Hairston.pdf; Letter to DOE, Granholm.pdf

Confidential and privileged attorney client communication/FOIA-exempt
Hi John,
As you know, Senator Risch along with seven other members of the NW delegation sent a letter to you requesting responses by August 15, 2022 to six questions related to E3 study (attached).

Secretary Granholm also received the same letter, including the same questions and requested deadline (attached). (b)(5) [redacted]
(b)(5) [redacted]

(b)(5) [redacted]

(b)(5) [redacted]

(b)(5) [redacted]

Thanks,
Jill

Congress of the United States
Washington, DC 20515

Received by BPA Administrator's
OFC-LOG #: ECO-2022-0003
Receipt Date: 8/04/2022
Due Date: 8/15/2022

August 4, 2022

Administrator John Hairston
Chief Executive Officer, Bonneville Power Administration
PO Box 3621
Portland, OR 97208

Dear Administrator Hairston,

As members of the Northwest delegation, we write to express our deep concern about recent actions taken by this administration which have demonstrated a seeming disregard for scientific integrity. Specifically, we were appalled by the lack of transparency and obvious political intervention in processes regarding the recent release of the National Oceanic and Atmospheric Administration (NOAA) draft "report" relating to the Columbia River Basin. Even more alarming, we have received further indication of political maneuvering by this administration to prevent information on the costs of replacing the power generated by the lower Snake River dams on the Federal Columbia River Power System from being made public prior to the release of the previously mentioned NOAA draft "report."

While the Columbia River System Operations (CRSO) Environmental Impact Statement (EIS) and Record of Decision (ROD) took four years to complete, included multiple comment periods, and cost over $50 million and countless staff hours, the recent NOAA draft "report" appears to have been released without process, prior Congressional notification, or any triggering action. Even more troubling, the NOAA draft "report" cites plaintiffs in *National Wildlife Federation et al. v. National Marine Fisheries Service et al. [01-640]* as sources without referencing non-plaintiff co-managers. Given the extreme and potentially damaging nature of these actions, we request your response to the following questions related to the draft "report" titled *Rebuilding Interior Columbia Basin Salmon and Steelhead* and the *BPA Lower Snake River Dams Power Replacement Study* no later than August 15, 2022:

1. When did Energy and Environmental Economics (E3) transmit its study to BPA?
2. Please outline the process by which this report moved through review and approval by federal agencies and entities before its public release.
3. Is it correct that the Northwest Power and Conservation Council members were scheduled to be briefed on the E3 Study on July 7, 2022?
4. Was the briefing rescheduled at the direction or influence of anyone outside of BPA? If so, who?
5. What was the reasoning behind rescheduling the briefing?

6. There were changes made to the E3 Study between the time an embargoed version was released to Congress on July 11, 2022, and when the report was made public on July 12, 2022.
    a. Was there any direction external from E3 and BPA that led to these changes?
    b. Was anyone external to E3 or BPA involved in the consideration of these changes?

The infrastructure on the Columbia River System provides invaluable benefits to the Pacific Northwest, including carbon-free energy, flood control mitigation, irrigation, navigation, and recreation benefits. Balancing these vital interests with species conservation is not an easy task. It is made significantly more difficult when science and collaboration is replaced by politically-motivated intervention.

The recent actions by this administration have sewn complete distrust in this administration's ability to lead with facts, science, and transparency regarding the Columbia River System. These actions will undoubtedly have long-term and damaging effects on this administration's ability to bring diverse stakeholders together to chart a path forward on species recovery and preservation of the vital benefits of the Columbia River System.

Sincerely,

James E. Risch
United States Senator

Cathy McMorris Rodgers
Member of Congress

Mike Crapo
United States Senator

Dan Newhouse
Member of Congress

Steve Daines
United States Senator

Russ Fulcher
Member of Congress

Jaime Herrera Beutler
Member of Congress

Cliff Bentz
Member of Congress

Congress of the United States
Washington, DC 20515

August 4, 2022

The Honorable Jennifer M. Granholm
Secretary, U.S. Department of Energy
1000 Independence Ave, SW
Washington, DC 20585

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United States Senator

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United States Senator

Dan Newhouse
Member of Congress

Steve Daines
United States Senator

Russ Fulcher
Member of Congress

Jaime Herrera Beutler
Member of Congress

Cliff Bentz
Member of Congress

From: Leary,Jill C (BPA) - LN-7
Sent: Wednesday, July 6, 2022 2:20 PM
To: Koehler,Birgit G (BPA) - PG-5
Cc: Godwin,Mary E (BPA) - LN-7; James,Eve A L (BPA) - PG-5
Subject: RE: Back to CEQ questions

Thanks!

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Wednesday, July 6, 2022 2:14 PM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Cc: Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: Back to CEQ questions

Confidential and privileged attorney client communication/FOIA-exempt

(b)(5) [redacted]

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Wednesday, July 6, 2022 2:01 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Cc: Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: Back to CEQ questions

Confidential and privileged attorney client communication/FOIA-exempt
Hi Birgit,

(b)(5) [redacted]

Also, I will call you in a bit after I talk to Gabe, thanks.

Jill

(b)(5) [redacted]

(b)(5) [redacted]

From: Sullivan,Leah S (BPA) - EWP-4
Sent: Tuesday, July 5, 2022 11:22 AM
To: Leary,Jill C (BPA) - LN-7
Cc: Zelinsky,Benjamin D (BPA) - E-4; Godwin,Mary E (BPA) - LN-7; Koehler,Birgit G (BPA) - PG-5
Subject: RE: Barging question

Confidential and privileged attorney client communication/FOIA-exempt

(b)(5) [redacted]

My two cents (maybe jumping the gun with this communication).

Leah

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Tuesday, July 5, 2022 11:02 AM
To: Holm, Leanne V CIV USARMY CENWD (USA) <Leanne.V.Holm2@usace.army.mil>
Cc: Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Sullivan,Leah S (BPA) - EWP-4 <lssullivan@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: Barging question

Confidential and privileged attorney client communication/FOIA-exempt
Hi Leanne,

(b)(5) [redacted]

(b)(5) [redacted]

(b)(5) [redacted]

Thoughts?

Thanks,
Jill

From: Leary,Jill C (BPA) - LN-7
Sent: Tuesday, August 9, 2022 1:50 PM
To: Hairston,John L (BPA) - A-7; Baskerville,Sonya L (BPA) - AIN-WASH; James,Eve A L (BPA) - PG-5; Koehler,Birgit G (BPA) - PG-5; Cook,Joel D (BPA) - K-7
Cc: Godwin,Mary E (BPA) - LN-7; Senters,Anne E (BPA) - LN-7; Chong Tim,Marcus H (BPA) - L-7; Marker,Douglas R (BPA) - AIR-7; Armentrout,Scott G (BPA) - E-4; Zelinsky,Benjamin D (BPA) - E-4; Sweet,Jason C (BPA) - EW-4
Subject: RE: Congressional letters on E3 Study

Thanks, John – I will loop back with Melissa.

From: Hairston,John L (BPA) - A-7 <jlhairston@bpa.gov>
Sent: Tuesday, August 9, 2022 1:37 PM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Cook,Joel D (BPA) - K-7 <jdcook@bpa.gov>
Cc: Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Senters,Anne E (BPA) - LN-7 <aesenters@bpa.gov>; Chong Tim,Marcus H (BPA) - L-7 <mhchongtim@bpa.gov>; Marker,Douglas R (BPA) - AIR-7 <drmarker@bpa.gov>; Armentrout,Scott G (BPA) - E-4 <sgarmentrout@bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Sweet,Jason C (BPA) - EW-4 <jcsweet@bpa.gov>
Subject: RE: Congressional letters on E3 Study

Thanks Jill,

I would like to issue a separate letter consistent with DOE.

Thanks
John

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Tuesday, August 9, 2022 9:53 AM
To: Hairston,John L (BPA) - A-7 <jlhairston@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Cook,Joel D (BPA) - K-7 <jdcook@bpa.gov>
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Subject: Congressional letters on E3 Study

Confidential and privileged attorney client communication/FOIA-exempt
Hi John,
As you know, Senator Risch along with seven other members of the NW delegation sent a letter to you requesting responses by August 15, 2022 to six questions related to E3 study (attached).

Secretary Granholm also received the same letter, including the same questions and requested deadline (attached). (b)(5) [redacted]

(b)(5) [redacted]

Thanks,
Jill

From:	Leary,Jill C (BPA) - LN-7
Sent:	Tuesday, July 5, 2022 7:57 AM
To:	Baskerville,Sonya L (BPA) - AIN-WASH; Koehler,Birgit G (BPA) - PG-5
Subject:	RE: E3 Study roll out plan_6.30 - GJD_v2

Gabe and I just spoke, and he missed the attachment with the talking points I sent him on Thursday, I believe.

Sonya, he received your v4 talking points email, but I am going to verify with Doug J. that is the latest version since Eve and others were editing with Doug and Summer on Friday.

Birgit, there is a $75 billion figure CEQ noticed in the report, that they thought should be $45B, so I will need your help digging into this, thanks.

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Tuesday, July 5, 2022 7:31 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: FW: E3 Study roll out plan_6.30 - GJD_v2

I guess we have a few bullets somewhere? Frankly, we should not be doing a lot of explaining about the analysis and let it speak for itself where possible. Should we just send him Doug Johnson's draft? Thought we did already. Thanks.

Sonya Baskerville
BPA National Relations
(b)(6) [redacted] m

From: Daly, Gabriel <gabriel.daly@hq.doe.gov>
Sent: Tuesday, July 5, 2022 9:19 AM
To: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>; Ardis, Melissa <melissa.ardis@hq.doe.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>
Subject: RE: E3 Study roll out plan_6.30 - GJD_v2

The rollout plan itself includes some background, but I think the talking points will need to include more specific discussion of the E3 study and its results. In particular, it will be important to contextualize the results (particularly the very large $ figures associated with scenario 2c).

Thanks,
Gabe

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Tuesday, July 5, 2022 10:13 AM
To: Ardis, Melissa <melissa.ardis@hq.doe.gov>; Daly, Gabriel <gabriel.daly@hq.doe.gov>; Godwin, Mary E <megodwin@bpa.gov>; Leary, Jill C <jcleary@bpa.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>
Subject: RE: E3 Study roll out plan_6.30 - GJD_v2

They are in the roll out plan. Those are the talking points, correct?

Sonya Baskerville
BPA National Relations
(b)(6) [redacted] m

On Jul 5, 2022 9:07 AM, "Daly, Gabriel" <gabriel.daly@hq.doe.gov> wrote:
Hi All,

According to the schedule we've proposed, we're expected to circulate talking points for NWPCC and congressional briefings Today. Are there draft talking points in the works? If so, please let me know if/when I can take a look.

Thanks,

Gabe

From: Ardis, Melissa <melissa.ardis@hq.doe.gov>
Sent: Thursday, June 30, 2022 8:43 PM
To: Leary, Jill C <jcleary@bpa.gov>; Daly, Gabriel <gabriel.daly@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin, Mary E <megodwin@bpa.gov>; slbaskerville@bpa.gov
Subject: RE: E3 Study roll out plan_6.30 - GJD_v2

Thanks Jill – I will add 7/15 for now and we can revise as needed.

Melissa Ardis
Senior Advisor, Power Marketing Administrations
(b)(6) [redacted]

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Thursday, June 30, 2022 6:17 PM
To: Ardis, Melissa <melissa.ardis@hq.doe.gov>; Daly, Gabriel <gabriel.daly@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin, Mary E <megodwin@bpa.gov>; slbaskerville@bpa.gov
Subject: RE: E3 Study roll out plan_6.30 - GJD_v2

Hi Melissa,
Gabe and I discussed adding July 15 as the date, but I need to run that date by a few folks who have already left for the day. I will try to get you an answer early tomorrow morning (early for me).

Thanks,
Jill

From: Ardis, Melissa <melissa.ardis@hq.doe.gov>
Sent: Thursday, June 30, 2022 4:24 PM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Daly, Gabriel <gabriel.daly@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Subject: [EXTERNAL] RE: E3 Study roll out plan_6.30 - GJD_v2

Thank you all. I am attaching the latest version. As you will see – the final bullet is still blank. What is our target for posting the Study in its entirety?

Melissa Ardis
Senior Advisor, Power Marketing Administrations
(b)(6) [redacted]

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Thursday, June 30, 2022 5:10 PM
To: Daly, Gabriel <gabriel.daly@hq.doe.gov>; Ardis, Melissa <melissa.ardis@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin, Mary E <megodwin@bpa.gov>; slbaskerville@bpa.gov
Subject: RE: E3 Study roll out plan_6.30 - GJD_v2

Nothing else from us, thanks.

From: Daly, Gabriel <gabriel.daly@hq.doe.gov>
Sent: Thursday, June 30, 2022 4:08 PM
To: Ardis, Melissa <melissa.ardis@hq.doe.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Subject: [EXTERNAL] RE: E3 Study roll out plan_6.30 - GJD_v2

Thanks, Jill. Anything further from the power folks, or does this look good to BPA?

Gabe

From: Ardis, Melissa <melissa.ardis@hq.doe.gov>
Sent: Thursday, June 30, 2022 6:50 PM
To: Leary, Jill C <jcleary@bpa.gov>; Daly, Gabriel <gabriel.daly@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin, Mary E <megodwin@bpa.gov>; slbaskerville@bpa.gov
Subject: RE: E3 Study roll out plan_6.30 - GJD_v2

Absolutely. Thank you!

Melissa Ardis
Senior Advisor, Power Marketing Administrations
(b)(6) [redacted]

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Thursday, June 30, 2022 4:49 PM
To: Daly, Gabriel <gabriel.daly@hq.doe.gov>; Ardis, Melissa <melissa.ardis@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin, Mary E <megodwin@bpa.gov>; slbaskerville@bpa.gov
Subject: RE: E3 Study roll out plan_6.30 - GJD_v2

Eve confirmed Arne from E3 is available during that time, so Melissa, you can add that information to the roll out plan, thanks!

From: Daly, Gabriel <gabriel.daly@hq.doe.gov>
Sent: Thursday, June 30, 2022 1:50 PM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Ardis, Melissa <melissa.ardis@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-

WASH <slbaskerville@bpa.gov>
Subject: [EXTERNAL] RE: E3 Study roll out plan_6.30 - GJD_v2

I think it probably makes most sense to aim to have that briefing at the next Deputies meeting, which is scheduled for 7/11 from 9-11am ET. Do we think that could work? If so, can we work that into the rollout plan draft?

Thanks,
Gabe

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Thursday, June 30, 2022 3:03 PM
To: Ardis, Melissa <melissa.ardis@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Daly, Gabriel <gabriel.daly@hq.doe.gov>; Godwin, Mary E <megodwin@bpa.gov>; slbaskerville@bpa.gov
Subject: RE: E3 Study roll out plan_6.30 - GJD_v2

Thanks, Melissa – I will have our power folks review too, in addition to Sonya's notes.

We heard from CEQ on today's conference call that they would also like another presentation to the CEQ group, so will ask my folks when they think they could schedule that.

From: Ardis, Melissa <melissa.ardis@hq.doe.gov>
Sent: Thursday, June 30, 2022 11:49 AM
To: Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Daly, Gabriel <gabriel.daly@hq.doe.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Subject: [EXTERNAL] E3 Study roll out plan_6.30 - GJD_v2

Good afternoon – I am attaching the draft E3 roll out plan for review. We wanted to use the same format as the salmon paper roll out plan circulated by CEQ. Please provide me with any comments or edits by COB today if at all possible.

Thank you,

Melissa Ardis
Senior Advisor, Power Marketing Administrations
Office of the Undersecretary for Infrastructure
U.S. Department of Energy
Energy.gov/bil
(b)(6) [redacted]

From: Hairston,John L (BPA) - A-7
Sent: Friday, July 1, 2022 8:48 PM
To: Koehler,Birgit G (BPA) - PG-5; Johnson,G Douglas (BPA) - DK-7; Goodwin,Summer G (BPA) - DKS-7; James,Eve A L (BPA) - PG-5; Leary,Jill C (BPA) - LN-7
Cc: Baskerville,Sonya L (BPA) - AIN-WASH; Chong Tim,Marcus H (BPA) - L-7; Zelinsky,Benjamin D (BPA) - E-4; Godwin,Mary E (BPA) - LN-7; Senters,Anne E (BPA) - LN-7
Subject: RE: E3 Study roll out plan_6.30 - GJD_v2

Thanks Summer,

John

On Jul 1, 2022 12:22 PM, "Goodwin,Summer G (BPA) - DKS-7" <sggoodwin@bpa.gov> wrote:
I just updated the DOE plan with the most recent dates that I saw. For those who are looking for the sequencing of events, here you go.

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Thursday, June 30, 2022 11:57 AM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Johnson,G Douglas (BPA) - DK-7 <gdjohnson@bpa.gov>; Goodwin,Summer G (BPA) - DKS-7 <sggoodwin@bpa.gov>
Cc: Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Senters,Anne E (BPA) - LN-7 <aesenters@bpa.gov>; Chong Tim,Marcus H (BPA) - L-7 <mhchongtim@bpa.gov>; Hairston,John L (BPA) - A-7 <jlhairston@bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Subject: FW: E3 Study roll out plan_6.30 - GJD_v2

Confidential and privileged attorney client communication/FOIA-exempt
Hello,
DOE would like to use CEQ's format for the E3 rollout, so please review this document by 4pm, so I can turn edits around to DOE by COB.

Eve and team, one comment we received from CEQ is they would like a presentation on the final report to the CEQ group, so will need to think of when to add that to the schedule.

Thanks,
Jill

From: Ardis, Melissa <melissa.ardis@hq.doe.gov>
Sent: Thursday, June 30, 2022 11:49 AM
To: Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Daly, Gabriel <gabriel.daly@hq.doe.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Subject: [EXTERNAL] E3 Study roll out plan_6.30 - GJD_v2

Good afternoon – I am attaching the draft E3 roll out plan for review. We wanted to use the same format as the salmon paper roll out plan circulated by CEQ. Please provide me with any comments or edits by COB today if at all possible.

Thank you,

Melissa Ardis
Senior Advisor, Power Marketing Administrations
Office of the Undersecretary for Infrastructure
U.S. Department of Energy
Energy.gov/bil
[redacted] (b)(6)

From: Leary,Jill C (BPA) - LN-7
Sent: Wednesday, July 6, 2022 8:11 AM
To: Koehler,Birgit G (BPA) - PG-5
Subject: RE: Incoming questions from CEQ

Will review these soon – still sorting through all of the DOE emails.

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Tuesday, July 5, 2022 5:28 PM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: RE: Incoming questions from CEQ

(b)(5) [redacted]

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Tuesday, July 5, 2022 4:52 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Sullivan,Leah S (BPA) - EWP-4 <lssullivan@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
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Subject: Incoming questions from CEQ

Confidential and privileged attorney client communication/FOIA-exempt
Hello,

(b)(5) [redacted]

(b)(5) [redacted]

(b)(5)

[redacted]

Thanks,
Jill

From: Johnson,G Douglas (BPA) - DK-7
Sent: Tuesday, July 5, 2022 3:47 PM
To: Koehler,Birgit G (BPA) - PG-5; Goodwin,Summer G (BPA) - DKS-7; James,Eve A L (BPA) - PG-5; Leary,Jill C (BPA) - LN-7
Cc: Baskerville,Sonya L (BPA) - AIN-WASH; Chong Tim,Marcus H (BPA) - L-7; Hairston,John L (BPA) - A-7; Zelinsky,Benjamin D (BPA) - E-4; Godwin,Mary E (BPA) - LN-7; Senters,Anne E (BPA) - LN-7
Subject: RE: E3 Study roll out plan_6.30 - GJD_v2

All good. Keep us posted.

On Jul 5, 2022 3:31 PM, "Leary,Jill C (BPA) - LN-7" <jcleary@bpa.gov> wrote:
Confidential and privileged attorney client communication/FOIA-exempt
Good afternoon,

(b)(5) [redacted]

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Subject: FW: E3 Study roll out plan_6.30 - GJD_v2

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Jill

From: Ardis, Melissa <melissa.ardis@hq.doe.gov>
Sent: Thursday, June 30, 2022 11:49 AM
To: Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Daly, Gabriel <gabriel.daly@hq.doe.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Subject: [EXTERNAL] E3 Study roll out plan_6.30 - GJD_v2

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Thank you,

Melissa Ardis
Senior Advisor, Power Marketing Administrations
Office of the Undersecretary for Infrastructure
U.S. Department of Energy
Energy.gov/bil
(b)(6) [redacted]

From:	Leary,Jill C (BPA) - LN-7
Sent:	Wednesday, July 6, 2022 7:40 AM
To:	Koehler,Birgit G (BPA) - PG-5
Subject:	RE: Incoming questions from CEQ

Thanks.

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Tuesday, July 5, 2022 5:28 PM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: RE: Incoming questions from CEQ

(b)(5) [redacted]

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Tuesday, July 5, 2022 4:52 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Sullivan,Leah S (BPA) - EWP-4 <lssullivan@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Cc: Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Armentrout,Scott G (BPA) - E-4 <sgarmentrout@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>; Senters,Anne E (BPA) - LN-7 <aesenters@bpa.gov>
Subject: Incoming questions from CEQ

Confidential and privileged attorney client communication/FOIA-exempt
Hello,

(b)(5) [redacted]

(b)(5) [redacted]

(b)(5)

[redacted]

Thanks,
Jill

From: Leary,Jill C (BPA) - LN-7
Sent: Wednesday, July 6, 2022 8:30 AM
To: Koehler,Birgit G (BPA) - PG-5
Subject: RE: Incoming questions from CEQ

Confidential and privileged attorney client communication/FOIA-exempt

(b)(5) [redacted]

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Sent: Tuesday, July 5, 2022 5:28 PM
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From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Tuesday, July 5, 2022 4:52 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Sullivan,Leah S (BPA) - EWP-4 <lssullivan@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Cc: Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Armentrout,Scott G (BPA) - E-4 <sgarmentrout@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>; Senters,Anne E (BPA) - LN-7 <aesenters@bpa.gov>
Subject: Incoming questions from CEQ

Confidential and privileged attorney client communication/FOIA-exempt
Hello,

(b)(5) [redacted]

(b)(5)
[redacted]

(b)(5)
[redacted]

Thanks,
Jill

From:	Koehler,Birgit G (BPA) - PG-5
Sent:	Wednesday, July 6, 2022 8:22 AM
To:	Leary,Jill C (BPA) - LN-7
Subject:	RE: LSRCP question on magnitude of obligation

Confidential and privileged attorney client communication/FOIA-exempt

(b)(5) [redacted]

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Wednesday, July 6, 2022 8:13 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: LSRCP question on magnitude of obligation

Confidential and privileged attorney client communication/FOIA-exempt
Here is CEQ's email:

(b)(5) [redacted]

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Wednesday, July 6, 2022 8:02 AM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: RE: LSRCP question on magnitude of obligation

Confidential and privileged attorney client communication/FOIA-exempt

(b)(5) [redacted]

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Wednesday, July 6, 2022 7:56 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: FW: LSRCP question on magnitude of obligation

Confidential and privileged attorney client communication/FOIA-exempt

[redacted]

From: Ashby,Gordon S (BPA) - PGA-6 <gsashby@bpa.gov>
Sent: Tuesday, July 5, 2022 5:49 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Welch,Dorothy W (BPA) - E-4 <dwwelch@bpa.gov>
Cc: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: RE: LSRCP question on magnitude of obligation

Confidential and Privileged, Work Performed at the Request of an Attorney, Do Not Release under FOIA

[redacted]

Gordon

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Tuesday, July 5, 2022 5:33 PM
To: Ashby,Gordon S (BPA) - PGA-6 <gsashby@bpa.gov>; Welch,Dorothy W (BPA) - E-4 <dwwelch@bpa.gov>
Cc: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: LSRCP question on magnitude of obligation

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[redacted]

Thanks,
Birgit

From:	Koehler,Birgit G (BPA) - PG-5
Sent:	Wednesday, July 6, 2022 8:26 AM
To:	Welch,Dorothy W (BPA) - E-4; Leary,Jill C (BPA) - LN-7; Ashby,Gordon S (BPA) - PGA-6
Subject:	RE: LSRCP question on magnitude of obligation

Confidential and Privileged, Work Performed at the Request of an Attorney, Do Not Release under FOIA

Works for me too.

Dorie, thanks for the useful info.

From: Welch,Dorothy W (BPA) - E-4 <dwwelch@bpa.gov>
Sent: Wednesday, July 6, 2022 8:22 AM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Ashby,Gordon S (BPA) - PGA-6 <gsashby@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: LSRCP question on magnitude of obligation

Confidential and Privileged, Work Performed at the Request of an Attorney, Do Not Release under FOIA

Works for me

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Wednesday, July 6, 2022 8:19 AM
To: Welch,Dorothy W (BPA) - E-4 <dwwelch@bpa.gov>; Ashby,Gordon S (BPA) - PGA-6 <gsashby@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: RE: LSRCP question on magnitude of obligation

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(b)(5) [redacted]

Does this work?

(b)(5) [redacted]

(b)(5) [redacted]

(b)(5) [redacted]

From: Welch,Dorothy W (BPA) - E-4 <dwwelch@bpa.gov>
Sent: Wednesday, July 6, 2022 8:16 AM
To: Ashby,Gordon S (BPA) - PGA-6 <gsashby@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Cc: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: RE: LSRCP question on magnitude of obligation

Confidential and Privileged, Work Performed at the Request of an Attorney, Do Not Release under FOIA

(b)(5) [redacted]

(b)(5) [redacted]

From: Ashby,Gordon S (BPA) - PGA-6 <gsashby@bpa.gov>
Sent: Tuesday, July 5, 2022 5:49 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Welch,Dorothy W (BPA) - E-4 <dwwelch@bpa.gov>
Cc: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: RE: LSRCP question on magnitude of obligation

Confidential and Privileged, Work Performed at the Request of an Attorney, Do Not Release under FOIA

(b)(5) [redacted]

Gordon

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Tuesday, July 5, 2022 5:33 PM
To: Ashby,Gordon S (BPA) - PGA-6 <gsashby@bpa.gov>; Welch,Dorothy W (BPA) - E-4 <dwwelch@bpa.gov>
Cc: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: LSRCP question on magnitude of obligation

Confidential and Privileged, Work Performed at the Request of an Attorney, Do Not Release under FOIA

(b)(5) [redacted]

Thanks,
Birgit

From: Leary,Jill C (BPA) - LN-7
Sent: Thursday, July 7, 2022 8:17 AM
To: Koehler,Birgit G (BPA) - PG-5
Cc: Godwin,Mary E (BPA) - LN-7; James,Eve A L (BPA) - PG-5
Subject: RE: New day, another CEQ question

Thank you!

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Thursday, July 7, 2022 8:06 AM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Cc: Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: New day, another CEQ question

Confidential and privileged attorney client communication/FOIA-exempt

I think I can answer this one.

(b)(5) [redacted]

(b)(5) [redacted]

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Thursday, July 7, 2022 7:48 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Cc: Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: New day, another CEQ question

Confidential and privileged attorney client communication/FOIA-exempt
Hi Birgit,
CEQ shared another question they would like answered with about the E3 study:

(b)(5) [redacted]

Can you answer this, and if not, would you coordinate with E3?

Thank you for everything,
Jill

From: Baskerville,Sonya L (BPA) - AIN-WASH
Sent: Thursday, August 25, 2022 8:29 AM
To: Koehler,Birgit G (BPA) - PG-5; Marker,Douglas R (BPA) - AIR-7; Chong Tim,Marcus H (BPA) - L-7; Godwin,Mary E (BPA) - LN-7; Leary,Jill C (BPA) - LN-7
Cc: Jones,Sheron M (BPA) - AIN-WASH; James,Eve A L (BPA) - PG-5
Subject: RE: congressional - rewritten Congressional E3 response

That works and is accurate.

Sonya Baskerville
BPA National Relations
(b)(6) [redacted]

On Aug 25, 2022 11:27 AM, "Chong Tim,Marcus H (BPA) - L-7" <mhchongtim@bpa.gov> wrote:
I agree with the concerns. How about this (emphasis added):

To allow for coordinated briefings on both E3's study and the report by the National Oceanic and Atmospheric Administration (NOAA) entitled *Rebuilding Interior Columbia Basin Salmon and Steelhead* studies, including the briefing for Members of Congress held on July 11, the **Council on Environmental Quality requested** that E3's presentation to the Northwest Power and Conservation Council be delayed until July 12. BPA, in coordination with the Department of Energy, relayed the **Council on Environmental Quality's request** to the Northwest Power and Conservation Council.

Marcus H. Chong Tim
Executive V.P. and General Counsel
BPA Office of General Counsel
503-230-4083

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Thursday, August 25, 2022 8:11 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Marker,Douglas R (BPA) - AIR-7 <drmarker@bpa.gov>; Chong Tim,Marcus H (BPA) - L-7 <mhchongtim@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Cc: Jones,Sheron M (BPA) - AIN-WASH <smjones@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: congressional - rewritten Congressional E3 response

I totally agree with Birgit. The language I saw last night doesn't work and I let Alicia know we have that concern. Thanks.

Sonya Baskerville
BPA National Relations
(b)(6) [redacted]

On Aug 25, 2022 11:09 AM, "Koehler,Birgit G (BPA) - PG-5" <bgkoehler@bpa.gov> wrote:
I would still call that distorting the truth. It ultimately was CEQ that asked for the delay. We were just the messenger.

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Thursday, August 25, 2022 8:01 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>; Marker,Douglas R (BPA) - AIR-7 <drmarker@bpa.gov>; Chong Tim,Marcus H (BPA) - L-7 <mhchongtim@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>
Cc: Jones,Sheron M (BPA) - AIN-WASH <smjones@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: congressional - rewritten Congressional E3 response

John called the Council folks, so my edit captures that, but it could also be "after coordination with CEQ and DOE," BPA…

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Thursday, August 25, 2022 7:20 AM
To: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>; Marker,Douglas R (BPA) - AIR-7 <drmarker@bpa.gov>; Chong Tim,Marcus H (BPA) - L-7 <mhchongtim@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Cc: Jones,Sheron M (BPA) - AIN-WASH <smjones@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: congressional - rewritten Congressional E3 response

I am coming late to the game. I am willing to change some wording in response to CEQ and DOE input, but are we willing *to distort the truth*? I would rather be truthful. BPA did NOT request the delay! (unless you go with the technicality that we were the one informing the Council that the Fed gov't asked for a delay.)

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Wednesday, August 24, 2022 3:19 PM
To: Marker,Douglas R (BPA) - AIR-7 <drmarker@bpa.gov>; Chong Tim,Marcus H (BPA) - L-7 <mhchongtim@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Jones,Sheron M (BPA) - AIN-WASH <smjones@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: congressional - rewritten Congressional E3 response

I agree - it looks like it was our idea, which it clearly was not.

Sonya Baskerville
BPA National Relations
(b)(6) [redacted]

On Aug 24, 2022 5:57 PM, "Leary,Jill C (BPA) - LN-7" <jcleary@bpa.gov> wrote:
Looping in Eve and Birgit, too.

I had two clean-up edits and responded to Alicia's and Gabe's question. I do not like the absence of DC coordination at the bottom of page 1 because it makes it look like BPA asked for this delay alone.

Eve and Birgit, on Alicia's and Gabe's comment – Gabe does not recall E3 making changes during this time, so I am going to send you a separate email with him cc'd so you can explain what occurred on or around July 11.

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Wednesday, August 24, 2022 2:24 PM

To: Chong Tim,Marcus H (BPA) - L-7 <mhchongtim@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Marker,Douglas R (BPA) - AIR-7 <drmarker@bpa.gov>
Cc: Jones,Sheron M (BPA) - AIN-WASH <smjones@bpa.gov>
Subject: Fwd: congressional - rewritten Congressional E3 response
Importance: High

Here is the rewritten document. Comments? I haven't opened it yet. Thanks.

Sonya Baskerville
BPA National Relations
[redacted]

---------- Forwarded message ----------
From: "deForest, Alicia" <alicia.deforest@hq.doe.gov>
Date: Aug 24, 2022 5:21 PM
Subject: congressional
To: "Baskerville,Sonya L (BPA) - AIN-WASH" <slbaskerville@bpa.gov>
Cc:
Hi Sonya,

Please let me know your thoughts.

Thanks,

Alicia

From: Baskerville,Sonya L (BPA) - AIN-WASH
Sent: Thursday, August 25, 2022 7:26 AM
To: Koehler,Birgit G (BPA) - PG-5; Marker,Douglas R (BPA) - AIR-7; Chong Tim,Marcus H (BPA) - L-7; Godwin,Mary E (BPA) - LN-7; Leary,Jill C (BPA) - LN-7
Cc: Jones,Sheron M (BPA) - AIN-WASH; James,Eve A L (BPA) - PG-5
Subject: RE: congressional - rewritten Congressional E3 response

That's exactly what I told Alicia deForest at DOE. BPA does not want to have this response suggest in any way that we wanted this delay - it was all CEQ. Hopefully there is some redrafting of that language happening now. Thanks.

Sonya Baskerville
BPA National Relations
(b)(6) [redacted]

On Aug 25, 2022 10:20 AM, "Koehler,Birgit G (BPA) - PG-5" <bgkoehler@bpa.gov> wrote:

I am coming late to the game. I am willing to change some wording in response to CEQ and DOE input, but are we willing *to distort the truth*? I would rather be truthful. BPA did NOT request the delay! (unless you go with the technicality that we were the one informing the Council that the Fed gov't asked for a delay.)

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Wednesday, August 24, 2022 3:19 PM
To: Marker,Douglas R (BPA) - AIR-7 <drmarker@bpa.gov>; Chong Tim,Marcus H (BPA) - L-7 <mhchongtim@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Cc: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Jones,Sheron M (BPA) - AIN-WASH <smjones@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: congressional - rewritten Congressional E3 response

I agree - it looks like it was our idea, which it clearly was not.

Sonya Baskerville
BPA National Relations
(b)(6) [redacted]

On Aug 24, 2022 5:57 PM, "Leary,Jill C (BPA) - LN-7" <jcleary@bpa.gov> wrote:
Looping in Eve and Birgit, too.

I had two clean-up edits and responded to Alicia's and Gabe's question. I do not like the absence of DC coordination at the bottom of page 1 because it makes it look like BPA asked for this delay alone.

Eve and Birgit, on Alicia's and Gabe's comment – Gabe does not recall E3 making changes during this time, so I am going to send you a separate email with him cc'd so you can explain what occurred on or around July 11.

From: Baskerville,Sonya L (BPA) - AIN-WASH <slbaskerville@bpa.gov>
Sent: Wednesday, August 24, 2022 2:24 PM

To: Chong Tim,Marcus H (BPA) - L-7 <mhchongtim@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Marker,Douglas R (BPA) - AIR-7 <drmarker@bpa.gov>
Cc: Jones,Sheron M (BPA) - AIN-WASH <smjones@bpa.gov>
Subject: Fwd: congressional - rewritten Congressional E3 response
Importance: High

Here is the rewritten document. Comments? I haven't opened it yet. Thanks.

Sonya Baskerville
BPA National Relations
[redacted] (b)(6)

---------- Forwarded message ----------
From: "deForest, Alicia" <alicia.deforest@hq.doe.gov>
Date: Aug 24, 2022 5:21 PM
Subject: congressional
To: "Baskerville,Sonya L (BPA) - AIN-WASH" <slbaskerville@bpa.gov>
Cc:
Hi Sonya,

Please let me know your thoughts.

Thanks,

Alicia

From: Hammond, Emily <emily.hammond@hq.doe.gov>
Sent: Wednesday, March 30, 2022 5:39 AM
To: Wiser, Ryan (CONTR); Koehler,Birgit G (BPA) - PG-5
Cc: Capanna, Steve
Subject: [EXTERNAL] RE: Updates on BPA-E3 analysis

Thanks! I got an email from Jill about it and will send momentarily. I'm in Idaho this week so email is a bit limited while I'm onsite, just fyi.

From: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Sent: Tuesday, March 29, 2022 6:35 PM
To: Koehler, Birgit G <bgkoehler@bpa.gov>
Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>
Subject: RE: Updates on BPA-E3 analysis

Got it – thanks!

Emily, happy to get any guidance you might have. Steve and I are scheduled to talk to Nancy on Friday this week, so would be good to receive any feedback and guidance before then.

Ryan

Ryan Wiser
Senior Scientist
Office of Policy (detail)
U.S. Department of Energy

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Tuesday, March 29, 2022 3:30 PM
To: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>
Subject: RE: Updates on BPA-E3 analysis

Deliberative; FOIA-exempt

Hello Ryan,

Emily and Jill (from our Office of General Counsel, OGC) coordinated, so I'm closing the loop with you myself, but will let Emily work with you on particulars for your meeting with Nancy. Let us know if you still need further input from us.

Birgit

From: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Sent: Monday, March 28, 2022 8:58 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>

Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>
Subject: [EXTERNAL] RE: Updates on BPA-E3 analysis

Perfect, thanks Birgit.

Ryan

Ryan Wiser
Senior Scientist
Office of Policy (detail)
U.S. Department of Energy

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Monday, March 28, 2022 8:53 AM
To: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>
Subject: RE: Updates on BPA-E3 analysis

Deliberative; FOIA-exempt

Hello Ryan,

To date, we have not shared the SOW with anyone except DOE and maybe CEQ. But I will certainly touch base with our Office of General Counsel and plan to get back to you before Thursday.

Birgit

From: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Sent: Monday, March 28, 2022 8:29 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>; Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Subject: [EXTERNAL] RE: Updates on BPA-E3 analysis

Hi Birgit

Nancy Hirsh reached out to Steve Capanna and me in the Office of Policy, hoping to talk to us about the E3 study.

After a brief exchange with DOE GC, we've decided to take Nancy's call, but be in active listening mode – so as not to overstep given the legal and other sensitivities.

If there is anything specific that you think we CAN share on the E3 study, please let us know the specifics of what is shareable. I think we will schedule the short discussion with Nancy late this week, so anything before Thursday should work.

Related, I know Nancy has expressed interest in seeing the actual SOW between BPA and E3, and asked John H whether that could be made available. So this is another tangible ask for you and the legal folks at BPA/DOE to consider. Any immediate idea whether that might be feasible?

Ryan

Ryan Wiser
Senior Scientist
Office of Policy (detail)
U.S. Department of Energy

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Thursday, March 24, 2022 6:07 AM
To: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Subject: RE: Updates on BPA-E3 analysis

Deliberative; FOIA-exempt

Good morning Ryan,

Yes, the news is now public. We coordinated very high-level talking points with CEQ (and likely with DOE, perhaps Emily).

Clearing Up, a widely-read west-coast energy newsletter, ran a story last Friday about White House and Congressional attention on the lower Snake River Dams and included this statement:

Meanwhile, BPA has hired Energy and Environmental Economics to look at what resources it would take to replace the dams. "We're going to use the info [from E3] to help inform our participation with the [Biden] administration in discussions with regional entities related to the Columbia River system," BPA spokesman Doug Johnson told Clearing Up.

Birgit

From: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Sent: Wednesday, March 23, 2022 5:06 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: Updates on BPA-E3 analysis

Birgit

One additional question – and just emailing you here, as maybe the answer is common knowledge and I don't want to annoy others. Based on the email below, it sounds like knowledge of the E3 analysis is now public. Is that right? Just wondering what NWPCC as well as various other NW stakeholders know, or do not know, about the study's existence, scope and timing.

Thx,

Ryan

Ryan Wiser
Senior Scientist
Office of Policy (detail)
U.S. Department of Energy

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Wednesday, March 23, 2022 11:46 AM
To: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hoffman, Patricia <pat.hoffman@hq.doe.gov>; Muse, Whitney <whitney.muse@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin, Mary E <megodwin@bpa.gov>; Leary, Jill C <jcleary@bpa.gov>; James, Eve A L <eajames@bpa.gov>; slbaskerville@bpa.gov
Subject: RE: Updates on BPA-E3 analysis

Privileged and Confidential; FOIA Exempt; Do Not Distribute

Hello Ryan and team DOE,

We signed the **contract with E3** in early March. The SOW includes four **tasks**:

1. Gather and summarize the latest resource information for the West including state mandates for renewable and carbon-free goals, highlighting the role/need for hydropower
2. Run E3's model, Resolve with and without the four lower Snake River dams to show the regional resources needed in the region, with and without the four lower Snake River dams.
3. Qualitative assessment of other services the four lower Snake River hydroprojects provide that are not captured in the Resolve model
4. Brief written report

Timeline:
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While this email exchange is the fastest way for me to reply with an update, we'd be happy to have a meeting if you want to discuss. (Next week or after April 11 would work. I'm on leave April 4-11.)

Cheers,
Birgit

From: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Sent: Wednesday, March 23, 2022 8:48 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hoffman, Patricia <pat.hoffman@hq.doe.gov>; Muse, Whitney <whitney.muse@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Subject: [EXTERNAL] Updates on BPA-E3 analysis

Hi Birgit

I'm emailing on behalf of the DOE team, wondering if there are any updates on the earlier-proposed E3 Lower Snake River work to share. Has that work gotten underway?

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We'd be happy to set up a brief call to discuss, or start with a short email exchange on the E3 study status.

Let us know, and all the best,

Ryan Wiser

Ryan Wiser
Senior Scientist

Office of Policy (detail)
U.S. Department of Energy

From: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Sent: Monday, March 28, 2022 8:58 AM
To: Koehler,Birgit G (BPA) - PG-5
Cc: Capanna, Steve; Hammond, Emily
Subject: [EXTERNAL] RE: Updates on BPA-E3 analysis

Perfect, thanks Birgit.

Ryan

Ryan Wiser
Senior Scientist
Office of Policy (detail)
U.S. Department of Energy

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Monday, March 28, 2022 8:53 AM
To: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>
Subject: RE: Updates on BPA-E3 analysis

Deliberative; FOIA-exempt

Hello Ryan,

To date, we have not shared the SOW with anyone except DOE and maybe CEQ. But I will certainly touch base with our Office of General Counsel and plan to get back to you before Thursday.

Birgit

From: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Sent: Monday, March 28, 2022 8:29 AM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>; Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Subject: [EXTERNAL] RE: Updates on BPA-E3 analysis

Hi Birgit

Nancy Hirsh reached out to Steve Capanna and me in the Office of Policy, hoping to talk to us about the E3 study.

After a brief exchange with DOE GC, we've decided to take Nancy's call, but be in active listening mode – so as not to overstep given the legal and other sensitivities.

If there is anything specific that you think we CAN share on the E3 study, please let us know the specifics of what is shareable. I think we will schedule the short discussion with Nancy late this week, so anything before Thursday should work.

Related, I know Nancy has expressed interest in seeing the actual SOW between BPA and E3, and asked John H whether that could be made available. So this is another tangible ask for you and the legal folks at BPA/DOE to consider. Any immediate idea whether that might be feasible?

Ryan

Ryan Wiser
Senior Scientist
Office of Policy (detail)
U.S. Department of Energy

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Thursday, March 24, 2022 6:07 AM
To: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Subject: RE: Updates on BPA-E3 analysis

Deliberative; FOIA-exempt

Good morning Ryan,

Yes, the news is now public. We coordinated very high-level talking points with CEQ (and likely with DOE, perhaps Emily).

Clearing Up, a widely-read west-coast energy newsletter, ran a story last Friday about White House and Congressional attention on the lower Snake River Dams and included this statement:

Meanwhile, BPA has hired Energy and Environmental Economics to look at what resources it would take to replace the dams. "We're going to use the info [from E3] to help inform our participation with the [Biden] administration in discussions with regional entities related to the Columbia River system," BPA spokesman Doug Johnson told Clearing Up.

Birgit

From: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Sent: Wednesday, March 23, 2022 5:06 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Subject: [EXTERNAL] RE: Updates on BPA-E3 analysis

Birgit

One additional question – and just emailing you here, as maybe the answer is common knowledge and I don't want to annoy others. Based on the email below, it sounds like knowledge of the E3 analysis is now public. Is that right? Just wondering what NWPCC as well as various other NW stakeholders know, or do not know, about the study's existence, scope and timing.

Thx,

Ryan

Ryan Wiser
Senior Scientist
Office of Policy (detail)
U.S. Department of Energy

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Wednesday, March 23, 2022 11:46 AM
To: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hoffman, Patricia <pat.hoffman@hq.doe.gov>; Muse, Whitney <whitney.muse@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin, Mary E <megodwin@bpa.gov>; Leary, Jill C <jcleary@bpa.gov>; James, Eve A L <eajames@bpa.gov>; slbaskerville@bpa.gov
Subject: RE: Updates on BPA-E3 analysis

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Hello Ryan and team DOE,

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Senior Scientist
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U.S. Department of Energy

From:	Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Sent:	Wednesday, March 23, 2022 2:15 PM
To:	Koehler,Birgit G (BPA) - PG-5
Cc:	Capanna, Steve; Hoffman, Patricia; Muse, Whitney; Hammond, Emily; Baumann, Jeremiah; Godwin,Mary E (BPA) - LN-7; Leary,Jill C (BPA) - LN-7; James,Eve A L (BPA) - PG-5; Baskerville,Sonya L (BPA) - AIN-WASH
Subject:	[EXTERNAL] Re: Updates on BPA-E3 analysis

Birgit

Thanks for this Update - very helpful.

At a minimum, DOE folks would be very pleased to review interim products and engage in whatever form is helpful.

Best,

Ryan

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Wednesday, March 23, 2022 11:46:04 AM
To: Wiser, Ryan (CONTR) <ryan.wiser@hq.doe.gov>
Cc: Capanna, Steve <steve.capanna@hq.doe.gov>; Hoffman, Patricia <pat.hoffman@hq.doe.gov>; Muse, Whitney <whitney.muse@hq.doe.gov>; Hammond, Emily <emily.hammond@hq.doe.gov>; Baumann, Jeremiah <jeremiah.baumann@hq.doe.gov>; Godwin, Mary E <megodwin@bpa.gov>; Leary, Jill C <jcleary@bpa.gov>; James, Eve A L <eajames@bpa.gov>; slbaskerville@bpa.gov <slbaskerville@bpa.gov>
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Ryan Wiser

Ryan Wiser
Senior Scientist
Office of Policy (detail)
U.S. Department of Energy

From:	James,Eve A L (BPA) - PG-5
Sent:	Tuesday, April 26, 2022 1:30 PM
To:	Leary,Jill C (BPA) - LN-7; Godwin,Mary E (BPA) - LN-7
Cc:	Koehler,Birgit G (BPA) - PG-5
Subject:	2022-04-26-EarthJusticeQ
Attachments:	2022-04-26-EarthJusticeQ.docx

Confidential and privileged attorney client communication/FOIA-exempt
Edited version

(b)(5)

[redacted]

(b)(5)

[redacted]

(b)(5)

[redacted]

From: Koehler,Birgit G (BPA) - PG-5
Sent: Wednesday, May 18, 2022 1:47 PM
To: James,Eve A L (BPA) - PG-5
Cc: Leary,Jill C (BPA) - LN-7; Godwin,Mary E (BPA) - LN-7
Subject: 22.5.16_DOE-Lab Review Comments on E3 Analysis, bk
Attachments: 22.5.16_DOE-Lab Review Comments on E3 Analysis, bk.docx

Confidential and Privileged, Attorney-Client Communication, Do Not Release under FOIA

Eve,
Here are my notes, including from our discussion just now, to supplement the notes you took.

Mary and Jill,
I'm writing a separate email to a slightly larger group that will give you more info. If you haven't yet read the DOE review, but plan to, you might as well look at this version with some comments from us.

Birgit

Follow-up Thoughts

(b)(5)

[redacted]

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DOE-National Lab Comments on Draft E3 Study:

"BPA Lower Snake River Dams Project Draft Final Results"

DOE commends BPA for engaging E3 in this study and appreciates the accelerated schedule within which it was conducted. A technical review of the study was conducted by DOE and National Lab staff. Following are consolidated comments.

Note that some of this feedback, if addressed, would require substantive new work, and time. This is especially true for our comments on the scenarios, and on ELCC treatment and assumptions. We encourage discussions in the near term to determine whether and how to address those comments.

LARGER COMMENTS

Scenarios

- Several of the Modeled Scenarios Appear Implausible: We question the inclusion of the two "Limited Technology" scenarios, as well as the "2024 LSR Replacement" scenario. On the latter, even with an extremely accelerated process that leads to dam removal, would a 2024 removal-and-replacement scenario be feasible? If not, we recommend revising this scenario to include a more realistic yet still accelerated assumption—2027 replacement, or whatever makes sense. On the former, the two "Limited Technology" cases not only eliminate or severely restrict combustion technologies, but they also offer the model no other realistic 'long duration' storage options. Yet several options exist, most obviously producing electricity still with hydrogen but using fuel cells as the conversion mechanism. Alternatively, a wide variety of emerging longer-duration storage technologies could prove viable. The result are two scenarios that are implausible in design, and equally implausible in future likelihood. The scenarios should be eliminated or revised. If BPA-E3 feel that these scenarios, as designed, offer some value as 'bogeys', at a minimum we recommend that they be presented solely as "what if" scenarios in the "with LSR" section of the presentation. These scenarios should not be used to estimate replacement costs of LSR removal (slides 39 on).
- A Tax Credit Extension Scenario Should Be Considered: Based on the appendix slides, the analysis appears to assume that existing tax credits phase out—as per current statute. Alternatively, it is also plausible that existing tax credits will be extended, and that new ones may be created. We recommend at least one scenario that assumes extended and possibly expanded tax credit availability. Even if BPA is unable to directly access such credits through ownership, their availability for private entities should reduce the effective cost of LSR replacement. Running a scenario or side analysis to investigate these possible cost-reducing effects of longer-term clean energy tax credits would usefully supplement the current analysis.

Input Assumptions

- ELCC Values and Influence on Overall Results Deserve Attention: The capacity credit assumptions and results are likely extremely important in estimating the costs of having to replace the LSR dams' grid benefits. One of the footnotes states "…a significant portion of the costs is capacity costs to replace the dams' RA capacity contributions". We have a few comments and concerns:
    - Cost Reporting: Can the fraction of the 'cost of LSR replacement' that comes from capacity needs be calculated? Based on the low raw LCOE costs of wind and solar, it seems logical that the capacity credit costs might make up half or even more of the total cost. If true, then all capacity-credit related assumptions and results are extremely important.
    - Capacity Credit of LSR Dams Should be Investigated, and Possibly Revised: The analysis assumes that the LSR dams have, in effect, a 65% ELCC and so a resource adequacy value of 2.2 GW. Since the estimated replacement costs is driven in large measure by resource adequacy, confidence is needed on the capacity credit assigned to the LSR dams. As well, given the importance of resource adequacy to the analysis, it is important that ELCC estimates employed for the LSR dams use similar methods to those used for other resources. Some advocates in the Northwest have presented data and analysis suggesting that a much lower capacity credit is warranted, maybe half that assumed in the E3 study, see: Addressing-the-LSR-Peaking-Capacity.pdf (nwenergy.org). DOE has not independently assessed the linked paper, or the capacity credit of the Lower Snake River dams. But given the critical nature of this single input parameter, we recommend that E3 evaluate the linked paper and LSR output data during periods of system stress to either validate or revise the

assumed 65% capacity credit. If a proper ELCC-type study for these facilities has not been conducted, then a review of historical output during periods of peak historical winter and summer (net) load could be used as an approximation. Under the decarbonization scenarios, a focus on the winter period or maybe the early fall (lower PV, so potentially high net load) may be relevant. Overall, more work is needed to validate these assumptions.

  - Storage ELCC: The capacity credit of storage seems to be substantially lower than what has been calculated in other regions, particularly for the 12-hr storage duration, after the first few GW of storage is deployed. We did not review the referenced study, but details on how these assumptions were created would be important within this slide deck. Information that would be helpful would include: (1) What does the winter peak look like? (time of day, duration, etc.); (2) What do resource profiles look like on that day, such that a combination of wind, solar, and 12-hour storage cannot contribute significantly? (3) Are interactions between wind, solar, and storage considered at all? (4) Are the scenarios in the referenced study similar enough to the scenarios in the LSR study to apply the same parameterization? Finally, are such low ELCC values for storage, even 12-hour storage, consistent with the 65% ELCC assumption made for the LSR dams?
  - ELCC Implementation--Exogenous or Endogenous: It appears that ELCC values are exogenous to the scenarios, but that fails to capture the impact of load—both load shape and load level—in determining ELCC. Can E3 provide more information on how these values are implemented? As well, the ELCC values on slide 22 depict ELCC by capacity deployed. When operationalized in the Resolve model, are these ELCC values linked to capacity amounts, or percent of energy? The deep decarbonization cases represent larger power systems, with higher amounts of load. One would anticipate, in such a case, that the ELCCs would drop more slowly relative to deployed GW--does Resolve appropriately capture that?

- Technologies Considered: (1) Why are dedicated H2 plants excluded in most of the scenarios while dual fuel is available—what is the rationale based on technology maturity or resource availability? (2) How can the CCS and dual fuel techs be used under the 0 MMT by 2045 scenarios without CDR offset? (3) The table shows 90-100% capture rate for CCS, but can 100% truly be achieved? (4) Why is offshore wind considered alongside CCS and Nuclear-SMR? Floating offshore wind is less mature than fixed-bottom, to be sure, but should at least be considered as a possible baseline technology.
- Hydrogen Cost Appears Overly Conservative: The assumed cost of delivered hydrogen declines to ~$40/mmBTU by 2045. This is a conservative assumption. Current biodiesel is $20-30/MMBtu. Even with conservative H2, the lack of availability of other renewable/biomass fuels results in high replacement costs in these scenarios. The cost of hydrogen-CCGTs in the model may be largely driven by CapEx, so perhaps this conservatism does not greatly impact modeled results. Nonetheless, given the importance of hydrogen in the analysis, we recommend a review of this assumption and possible development of a less conservative input assumption.
- Additional Resolve Inputs: Why are 90% and 100% capture rate CCS so similar in $/kW-yr costs on slide 65? Why are H2 peakers and combined-cycle units almost identical in cost?
- Transmission Representation: Are the system-wide benefits of transmission (assumed to be needed for out of region wind and solar) considered? Is there any assumed resource adequacy contribution from this transmission, which could be provided from external “clean firm” resources? Also unclear more broadly how opportunity for imports and exports of all electricity services (energy, capacity, ancillary services) are being treated.

Presentation

- The Cost Reporting on Slides 39-42 Should be Expanded: Cost results can usefully be presented in numerous ways, depending on context. Given varying contexts, we recommend presenting these costs in numerous ways. The NPV results may be relevant if Congressional appropriations were to be used to cover replacement costs. The percentage increase in BPA Tier 1 rates is relevant if BPA's Tier 1 customers were to fully pick up the tab. We recommend presenting the results in at least one additional way: as a percentage increase in retail electricity rates among all customers in the NW. As well, then presenting the annual results on slide 40, we presume these are presented in real terms, and are not discounted: please clarify in slide as appropriate.

External Review

- External Review Process: Does BPA anticipate issuing the final report without an opportunity for external stakeholder review of a draft? It may be productive to discuss the possible value, advantages, and disadvantages of offering regional stakeholders an opportunity to review and comment on the draft—recognizing that conducting such a review would entail time and budget.

ADDITIONAL (SMALLER) COMMENTS

- Focus on the Core NW Region: The study is focused on a region of the Northwest that includes Washington, Oregon, and portions of Idaho and Montana. Yet the policy review early in the PPT includes California and lacks any discussion of the policy context in Montana and Idaho. At a minimum, this seemingly incongruous treatment deserves explanation.
- Slide 6: "Decarbonization is creating a current and deepening need for capacity." This isn't strictly true. There's always a need for firm capacity. But if that capacity is emitting and there exists a requirement to get to zero or very low carbon, then just like energy services, capacity services need to be replaced. Statement should be clarified for accuracy.
- Slides 9-10: For clarity, might wish to note that the company specific data here come from an E3 review of the latest vintage of each company's IRP. This is implied, but at least one reviewer was confused as to the source of those data.
- Slide 11: May want to add a little bit of additional information on *why* the power cuts were made, based on CAISO's report on these outages. http://www.caiso.com/Documents/Preliminary-Root-Cause-Analysis-Rotating-Outages-August-2020.pdf.
- Slide 20-21: "RESOLVE resource adequacy constraint requires capacity to meet peak demand + a 16% planning reserve margin". Why 16%, and why is that different from 15% shown on slide 20?
- Slide 25: (1) "Reaching a zero emissions electric system with high electrification and reasonable levels of renewable additions requires new technologies such as hydrogen combustion turbines or nuclear SMRs." This is then followed by sub-bullets focused on SMR and H2. Those sub-bullets make it sound like one strictly requires EITHER SMR or H2, but there may be other longer-duration storage options or flexibility options such as fossil-CCS that could fill those needs as well. Recommend being less technology prescriptive, especially since only a subset of options are modeled, and focusing more on the services needed, with examples of SMR and H2 technologies. As well, are new technologies really "required" or just "cost-effective" if they exist. (2) It is not decarbonization that

drives peak needs, it's electrification when paired with the CO2 constraint. (3) "Additional renewables backed by dispatchable hydrogen plants are needed". Renewable energy technologies are not "backed up" by hydrogen, any more than nuclear plants are backed up by peakers, or peakers backed up by baseload. They provide different services.

- Slide 36: This slide or others ideally would show load and how storage is being charged/discharged to help meet load. In addition, as per an earlier comment, we suggest adding slides showing why storage (and VRE) resources have such low ELCCs.
- Slide 49: "Inverter based generation cannot inherently provide inertia, but may still be able to provide fast frequency response via grid forming inverters." Two comments: (1) Inverters do not need to be "grid-forming" to provide FFR, so should alter text accordingly. (2) A lot of research is happening in this space. What is missed is the inertia requirements of the grid in various forecasted years and how any deficit would be mitigated via technology.
- Slide 50: "Large hydro is historically a major provider of black start services when required." This would be better stated as declared hydro. Many facilities have the capability but don't offer it since it puts them within specific requirements of black start units.

From: Leary,Jill C (BPA) - LN-7
Sent: Tuesday, April 26, 2022 9:50 AM
To: James,Eve A L (BPA) - PG-5
Cc: Godwin,Mary E (BPA) - LN-7; Koehler,Birgit G (BPA) - PG-5; Diffely,Robert J (BPA) - PGPL-5; Greene,Richard A (BPA) - LP-7
Subject: E3 Talking Points Edits from DOJ
Attachments: CRS_DOJ_comments_on_talking points for call with EJ.docx

Confidential and privileged attorney client communication/FOIA-exempt

Hi Eve,

We received comments from DOJ on the proposed E3 talking points. Other than the question on whether the study will be public, would you review their edits/comments and accept the ones you agree with and let us know if there are others you want to discuss or not accept. I put a placeholder on our calendars at 1pm to discuss.

(b)(5) [redacted]

(b)(5) [redacted]

Thanks,
Jill

(b)(5)

[redacted]

(b)(5)

[redacted]

(b)(5)

[redacted]

From: Leary,Jill C (BPA) - LN-7
Sent: Friday, July 1, 2022 9:13 PM
To: James,Eve A L (BPA) - PG-5; Koehler,Birgit G (BPA) - PG-5
Cc: Godwin,Mary E (BPA) - LN-7
Subject: FW: E3?
Attachments: E3 final report and public presentation

FYI

From: Leary,Jill C (BPA) - LN-7
Sent: Friday, July 1, 2022 9:11 PM
To: Daly, Gabriel <gabriel.daly@hq.doe.gov>
Cc: Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>
Subject: RE: E3?

Hi Gabe,
Finally, the E3 report has arrived. Sorry for the late hour, thanks.

Jill

From: Daly, Gabriel <gabriel.daly@hq.doe.gov>
Sent: Friday, July 1, 2022 8:49 PM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: [EXTERNAL] Re: E3?

Hi Jill,

I assume it hasn't come in yet, right? I'm about to head for bed, so just wanted to be sure. Sorry to be pestering you so late!

Thanks,
Gabe

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Friday, July 1, 2022 6:52 PM
To: Daly, Gabriel <gabriel.daly@hq.doe.gov>
Subject: RE: E3?

E3 is still finalizing it, but Eve is going to text me when it is available, and I will forward it to you.

Do you want me to text the 617 to give you a heads up? It is looking like it may technically still arrive on July 1, but likely on the later side.

From: Daly, Gabriel <gabriel.daly@hq.doe.gov>
Sent: Friday, July 1, 2022 3:42 PM

To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: [EXTERNAL] Re: E3?

Awesome. Thank you!

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Friday, July 1, 2022 6:39:46 PM
To: Daly, Gabriel <gabriel.daly@hq.doe.gov>
Subject: RE: E3?

Still waiting on it, but just checked in with Eve, so will get you an ETA soon.

From: Daly, Gabriel <gabriel.daly@hq.doe.gov>
Sent: Friday, July 1, 2022 2:20 PM
To: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Subject: [EXTERNAL] E3?

Jill,

Sorry — one more thing. Has the E3 study come in yet? If so, can you share that with me?

Thanks,
Gabe

From: James,Eve A L (BPA) - PG-5

Sent: Fri Jul 01 21:05:14 2022

To: Leary,Jill C (BPA) - LN-7; Godwin,Mary E (BPA) - LN-7

Cc: Koehler,Birgit G (BPA) - PG-5

Subject: E3 final report and public presentation

Importance: Normal

Attachments: E3 BPA LSR Dams Report_070122.pdf; E3 BPA LSR Dams_070122.pdf

Confidential and privileged attorney client communication/FOIA-exempt

Hi Jill-

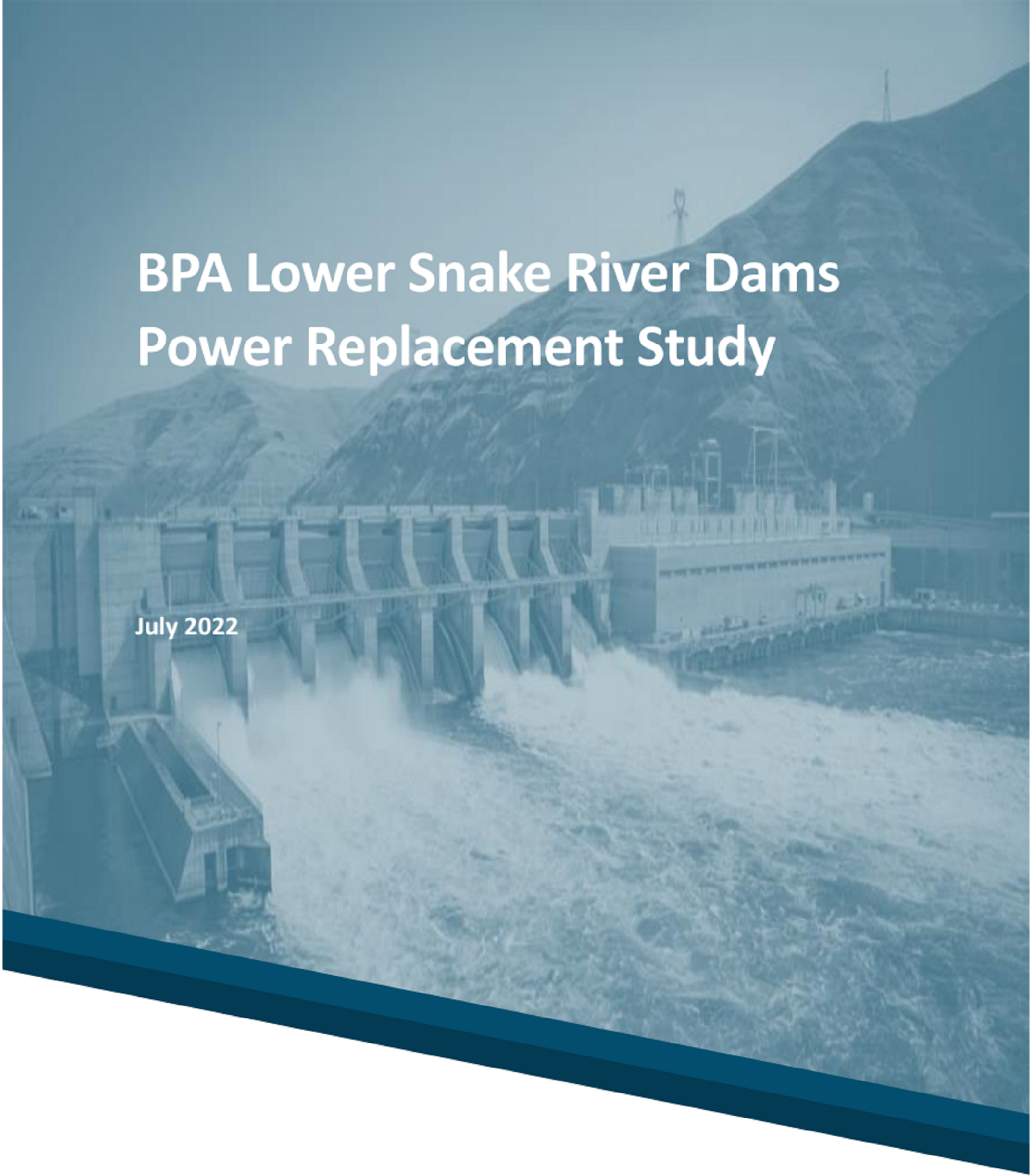
Attached is the final report from E3 and the public presentation to share with DOE.

Thanks,

Eve

BPA Lower Snake River Dams Power Replacement Study

July 2022



Energy+Environmental Economics

BPA Lower Snake River Dams Power Replacement Study

July 2022

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San Francisco, CA 94104

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Aaron Burdick

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Sierra Spencer

Sam Kramer

Jack Moore

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Acronym Definitions

Acronym	Definition
BPA	Bonneville Power Administration
BTM Solar	Behind-the-meter Solar
CA	California
CCGT	Combined cycle gas turbine
CCS	Carbon capture and storage
CES	Clean Energy Standard
CRSO EIS	Columbia River System Operations Environmental Impact Statement
DR	Demand response
EE	Energy efficiency
EIA	Energy Information Administration
ELCC	Effective load carrying capability
HDV	Heavy-duty vehicles
H2	Hydrogen
LDV	Light-duty vehicles
LSR	Lower Snake River
NERC	North American Electric Reliability Corporation
NG	Natural Gas
NV	Nevada
NW	Northwest
PNUCC	Pacific Northwest Utilities Conference Committee
PRM	Planning Reserve Margin
RM	Rocky Mountains
RPS	Renewable Energy Standard
SMR	Small modular reactor
SW	Southwest
WECC	Western Electricity Coordinating Council

Executive Summary

E3 was contracted by the Bonneville Power Administration to conduct an independent study of the value of the lower Snake River dams ("LSR dams") to the Northwest power system. The dams provide approximately 3,500 megawatts ("MW") of total capacity[1] and approximately 2,300 MW of firm peaking capability[2] to support regional reliability. They also generate approximately 900 average MW of zero-carbon energy each year[3], provide essential grid services such as operating reserves and voltage support, and operational flexibility to support renewable integration. If the dams are breached, these power services will need to be replaced to ensure the Northwest power system can continue to provide reliable electricity service. Replacing the dams is complicated by the clean energy policies adopted either statutorily or voluntarily by jurisdictions and utilities throughout the region, which will necessitate a transformation of the power system over time toward non-emitting resources even as electricity demand grows substantially due to electrification of the transportation and building sectors.

This study uses E3's Northwest RESOLVE model to study optimal capacity expansion scenarios with and without the lower Snake River dams, to determine the replacement resources and cost impacts to replace the dams' power output. RESOLVE is an optimal capacity expansion and dispatch model that determines a least-cost set of investment and operational strategies to enable the "Core Northwest" region – consisting of Washington, Oregon, Northern Idaho, and Western Montana – to achieve its long-term clean energy policy goals at least-cost, while ensuring resource adequacy and operational reliability. RESOLVE has been used in several prior studies of electricity sector decarbonization in the Pacific Northwest[4]. Using RESOLVE allows for a dynamic optimization that considers replacement resource needs in the context of long-term system load and policy drivers, not just the near-term resource mix and needs of the system today. The dams are assumed to be breached in 2032, except for one sensitivity that considered 2024 breaching.

[1] Hydro traditionally operates above nameplate and closer to overload capacity (~15% above nameplate) and FERC uses these peak generation values in hydro licensing. The "total capacity" refers to the overload capacity, not the nameplate capacity. Historical peak generation was 3,431 MW.

[2] LSR dam firm capacity contributions are estimated using the PNUCC regional hydropower 65% capacity value, which was validated by looking at LSR Dam wintertime power and reserve provision during low hydro conditions. Additionally, E3 considered estimates on the impact of a lower firm capacity value in the results chapter.

[3] The data for the LSR dams was adjusted to reflect the Preferred Alternative operations defined in the Columbia River Systems Operation Environmental Impact Statement (CRSO EIS). E3's RESOLVE model uses 2001, 2005, and 2011 hydro years, which resulted in ~700 average MW of lower Snake River dams generation, making it a conservative estimate of the dams' GHG-free energy value.

[4] Pacific Northwest Low Carbon Scenario Analysis, December 2017, https://www.ethree.com/projects/study-policies-decarbonize-electric-sector-northwest-public-generating-pool-2017-present/; Pacific Northwest Zero-Emitting Resources Study, January 2020, https://www.ethree.com/e3-examines-role-of-nuclear-power-in-a-deeply-decarbonized-pacific-northwest/

This study's scenario design focuses on three key variables – clean energy policy, load growth, and emerging technology availability – that impact the cost to replace the dams. The scenarios and key assumptions are show in Table 1.

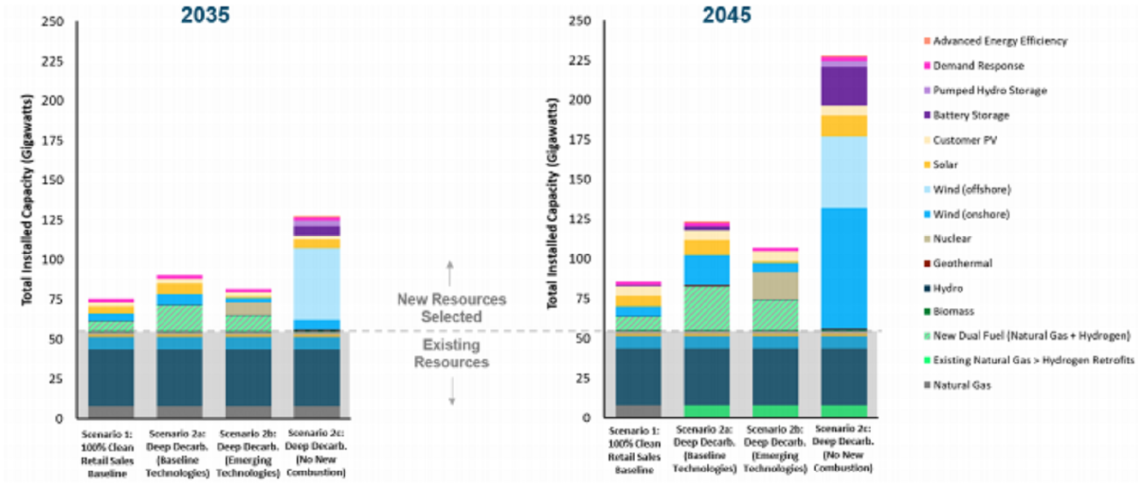
Table 1. Scenario Design

Scenario	Clean Energy Policy	Load Growth	Technology Availability
1 100% Clean Retail Sales[1]	100% retail sales (85% carbon reduction)	8th Power Plan Baseline	Baseline (incl. natural gas / hydrogen dual fuel plants)
2a Deep Decarbonization (Baseline Tech.)	100% carbon reduction	High Electrification	Baseline
2b Deep Decarbonization (Emerging Tech.)	100% carbon reduction	High Electrification	Baseline + offshore wind, gas w/ CCS, nuclear SMR
2c Deep Decarbonization (No New Combustion)	100% carbon reduction	High Electrification	Baseline (excluding natural gas / hydrogen dual fuel plants

Even with the dams in place, the region's clean energy goals and potential electrification load growth drive a significant need for new resources. In all scenarios, significant energy efficiency and customer solar is embedded into the load forecast, based on the NWPCC's 8th Power Plan. Additionally, 6 gigawatts ("GW" or 6,000 MW) of coal capacity is retired by 2030, while increasing carbon prices incent further clean energy resource additions. In Scenario 1, the regional power system is required to meet a goal of generating enough clean energy to provide 100% of retail electricity sales, on an average basis over a calendar year. This requires an additional 5 GW of solar and 5 GW of wind by 2045 to achieve the clean energy goal; 0.6 GW of battery storage, 2 GW of demand response, and 9 GW of dual fuel natural gas + hydrogen combustion plants are also added to meet the region's resource adequacy needs.

Though all scenarios require more "firm" resources – resources that can start when needed and operate for as long as needed – to meet peak loads, these resources are in higher demand in Scenario 2, in which all greenhouse gas emissions are eliminated from the regional power system by 2045. This scenario also assumes that electrification results in much higher electric loads, particularly in wintertime due to electrification of natural gas space heating in buildings. The baseline scenario (2a) selects additional wind, solar, and geothermal to meet clean energy needs as well as demand response, some battery storage, and 27 GW natural gas and hydrogen dual fuel combustion plants to meet reliability needs. An alternative "emerging technology" scenario selects 17 GW of advanced nuclear technology (small modular reactors or "SMRs") by 2045, in place of the firm capacity provided by natural gas generators while reducing the required quantities of wind, solar and batteries that are needed. The "no new combustion" scenario does not allow clean firm technologies such as hydrogen combustion turbines, gas generation with carbon capture and sequestration (CCS) or SMRs. As a result, it requires impractically high levels of additional onshore wind, offshore wind, and battery storage to meet firm capacity and carbon reduction needs, quadrupling the total installed MW of the Northwest grid by 2045.

Figure 1. Northwest Installed Capacity Mix in Scenarios with the Lower Snake River Dams



When the power services provided by the dams are removed from the regional power system, RESOLVE selects an optimal, i.e., least-cost portfolio of replacement resources that meets the Northwest's clean energy and system reliability needs. These replacement resources require a large investment and come at a substantial cost that increase over time as the region's clean energy goals become more stringent. In the latter years, the replacement costs are highly dependent on scenario-specific assumptions about the availability of emerging technologies. RESOLVE primarily replaces the carbon-free energy from the dams with additional wind power and the firm capacity with dual fuel natural gas and hydrogen combustion plants. Small amounts of additional energy efficiency and battery storage are also selected in some scenarios. By 2045, the dual fuel plants added burn additional hydrogen on low wind days to replace the carbon-free energy provided by the dams. Scenario 2b selects additional nuclear SMRs in lieu of some of the wind and gas resources. Scenario 2c disallows the new combustion plants, even those that would burn green hydrogen, and other emerging technologies, requiring a very large buildout of wind and solar power to replace both the firm capacity and the carbon-free energy of the dams.

The long-term emissions impact of removing the generation of the lower Snake River dams will depend on the implementation of the Oregon and Washington electric clean energy policies. Both a 100% clean retail sales and a zero-carbon emissions target require replacement of most or all of the LSR dams' GHG-free energy. However, without additional earlier carbon-free resource investments beyond those modeled in this study to meet clean energy policy trajectories, carbon emissions may increase initially when the dams are breached, before declining by 2045 as the carbon policy becomes more stringent.

Table 2. Summary of LSR Dams Replacement Resources and Cost Impacts (costs in the table below and throughout this report are shown in real 2022 dollars)

Scenario	Replacement Resources Selected, Cumulative by 2045 (GW)	NPV Replacement Costs[5]	Annual Replacement Costs[6]			Public Power Rate Impact[7]
			2025	2035	2045	2045
Scenario 1: 100% Clean Retail Sales	+ 2.1 GW dual fuel NG/H2 CCGT + 0.5 GW wind	$11.8 Billion	-	$434 million/yr	$478 million/yr	0.8 ₵/kWh [+9%]
Scenario 1b: 100% Clean Retail Sales (2024 dam removal)	+ 2.1 GW dual fuel NG/H2 CCGT + 0.5 GW wind	$12.8 Billion	$495 million/yr	$466 million/yr	$509 million/yr	0.8 ₵/kWh [+9%]
Scenario 2a: Deep Decarbonization (Baseline Technologies)	+ 2.0 GW dual fuel NG/H2 CCGT + 0.3 GW li-ion battery + 0.4 GW wind + 0.05 GW advanced EE + 1.2 TWh H2-fueled generation	$19.0 Billion	-	$496 million/yr	$860 million/yr	1.5 ₵/kWh [+18%]
Scenario 2b: Deep Decarbonization (Emerging Technologies)	+ 1.5 GW dual fuel NG/H2 CCGT + 0.7 GW nuclear SMR	$10.7 Billion	-	$415 million/yr	$428 million/yr	0.7 ₵/kWh [+8%]
Scenario 2c: Deep Decarbonization (No New Combustion)	+ 10.6 GW wind + 1.4 GW solar	$75.2 billion	-	$1,953 million/yr	$3,199 million/yr	5.5 ₵/kWh [+65%]

KEY FINDINGS:

- ***Replacing the four lower Snake River dams while meeting clean energy goals and system reliability is possible but comes at a substantial cost***, even assuming emerging technologies are available:
  - Requires 2,300 – 2,700 MW of replacement resources
  - An annual cost of $415 million – $860 million by 2045
  - Total net present value cost of $10.7-19.0 billion based on 3% discounting over a 50-year time horizon following the date of breaching
  - Increase in costs for public power customers of $100 – 230 per household per year (an 8 – 18% increase) by 2045
- The biggest cost drivers for replacement resources are the need to replace the lost ***firm capacity for regional resource adequacy*** and the need to replace the lost ***zero-carbon energy***
- Replacement becomes ***more costly over time*** due to increasingly stringent clean energy standards and electrification-driven load growth

[5] These NPV values are calculated assuming a 3% discount rate to represent the public power cost of capital, discounting 50-year of costs starting from the year of breaching (either 2032 or 2024).

[6] Replacement resource costs are calculated assuming project financing per E3's pro forma calculator, rather than assuming upfront congressional appropriation.

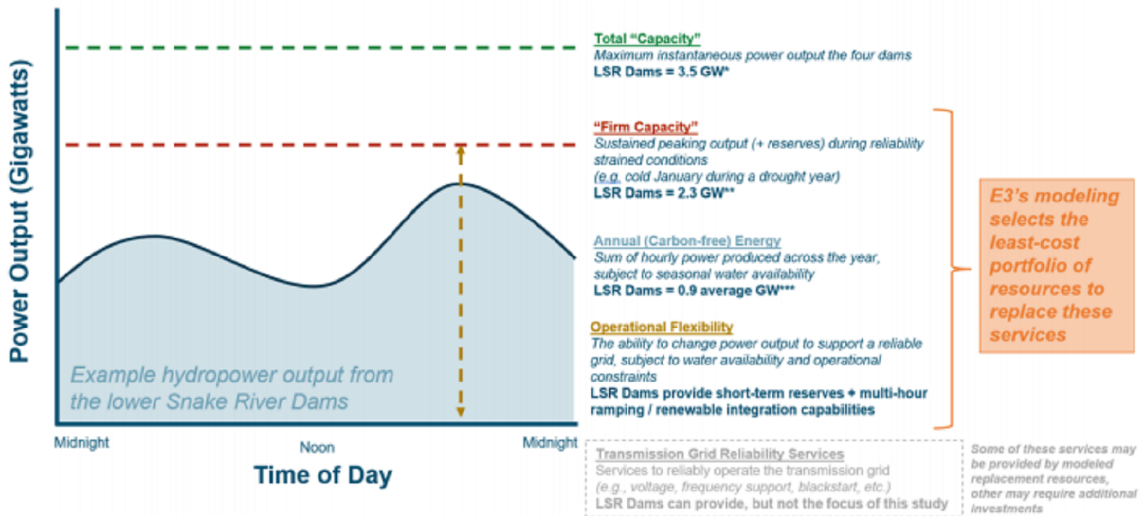
[7] This assumes that the annual replacement costs will be borne by BPA's Tier I public power customers. Percentage changes are shown relative to today's average OR + WA retail rate of ~8.5 ₵/kWh.

+ ***Emerging technologies*** such as hydrogen, advanced nuclear, and carbon capture ***can limit the cost of replacement resources*** to meet a zero emissions electric system, but the pace of their commercialization is highly uncertain
    - In economy-wide deep decarbonization scenarios, ***replacement without any emerging technologies requires very large renewable resource additions at a very high cost*** (12 GW of wind and solar at $75.2 billion NPV cost)

Background

E3 was contracted by the Bonneville Power Administration to conduct an independent study of the value of the lower Snake River dams ("LSR dams") to the Northwest power system. The dams provide approximately 3,500 megawatts ("MW") of total capacity[8] and approximately 2,300 MW of firm peaking capability[9] to support regional reliability. They also generate approximately 900 average MW of zero-carbon energy each year, provide essential grid services such as operating reserves and voltage support, and operational flexibility to support renewable integration. Figure 2 shows the power services that are the focus of this study and those that are out of scope.

Figure 2. Power Services Considered for Replacement in this Study



* Hydro traditionally operates above nameplate and closer to overload capacity (~15% above nameplate) and FERC uses these peak generation values in hydro licensing. Historical peak generation was 3,431 MW.

** Firm capacity assumed in this study is consistent with the ~65% Northwest hydro capacity value assumed by PNUCC (the Pacific Northwest Utilities Conference Committee).

*** Average GW means that on average across an average year the plant generated at 0.9 GW, though its hourly output may be above or below that amount. The data for the LSR dams was adjusted to reflect the Preferred Alternative operations defined in the Columbia River Systems Operation Environmental Impact Statement ("CRSO EIS"). E3's RESOLVE model uses 2001, 2005, and 2011 hydro years, which resulted in ~700 average MW of lower Snake River dams generation, making it a conservative estimate of the dams' GHG-free energy value.

If the dams are breached, these power services will need to be replaced to ensure the Northwest power system can continue to provide reliable electricity service. Replacing the dams is complicated by the clean energy policies adopted either statutorily or voluntarily by jurisdictions and utilities throughout the region,

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[8] Hydro traditionally operates above nameplate and closer to overload capacity (~15% above nameplate) and FERC uses these peak generation values in hydro licensing. The "total capacity" refers to the overload capacity, not the nameplate capacity. Historical peak generation was 3,431 MW.

[9] LSR dam firm capacity contributions are estimated using the PNUCC regional hydropower 65% capacity value, which was validated by looking at LSR Dam wintertime power and reserve provision during low hydro conditions. Additionally, E3 considered estimates on the impact of a lower firm capacity value in the results chapter.

which will necessitate a transformation of the power system over time toward non-emitting resources even as electricity demand grows substantially due to electrification of the transportation and building sectors.

This study uses E3's Northwest RESOLVE model to study optimal capacity expansion scenarios with and without the lower Snake River dams, to determine the replacement resources and cost impacts to replace the dams' power output. RESOLVE is an optimal capacity expansion and dispatch model that determines a least-cost set of investment and operational strategies to enable the "Core Northwest" region – consisting of Washington, Oregon, Northern Idaho and Western Montana – to achieve its long-term clean energy policy goals at least-cost, while ensuring resource adequacy and operational reliability. RESOLVE has been used in several prior studies of electricity sector decarbonization in the Pacific Northwest[10]. Using RESOLVE allows for a dynamic optimization that considers replacement resource needs in the context of long-term system load and policy drivers, not just the near-term resource mix and needs of the system today. The dams are assumed to be breached in 2032, except for one sensitivity that considered 2024 breaching.[11]

Key Study Questions:

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

This study builds off previous LSR dams replacement analysis by using a least-cost optimization-based modeling framework to replace the dams' power services. This optimization ensures that the region meets its aggressive clean energy policy goals, including both decarbonization of electricity as well as high electrification load growth consistent with economy-wide decarbonization goals set by Oregon and Washington.

The other key component of the optimization is maintaining resource adequacy for the region to ensure a reliable electricity supply to existing and any newly electrified loads. This is done using a planning reserve margin constraint and counting non-firm resources like solar, wind, battery storage, pumped hydro storage, and demand response at their effective load carrying capability ("ELCC"), based on E3's prior detailed loss of load probability modeling of the Northwest region.[12]

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[10] Pacific Northwest Low Carbon Scenario Analysis, December 2017, https://www.ethree.com/projects/study-policies-decarbonize-electric-sector-northwest-public-generating-pool-2017-present/; Pacific Northwest Zero-Emitting Resources Study, January 2020, https://www.ethree.com/e3-examines-role-of-nuclear-power-in-a-deeply-decarbonized-pacific-northwest/

[11] The study examines LSRD breaching in 10 years (2032) and in 2 years (2024), based on with the approach used in the CRSO EIS.

[12] Resource Adequacy in the Pacific Northwest, March 2019, https://www.ethree.com/wp-content/uploads/2019/03/E3_Resource_Adequacy_in_the_Pacific-Northwest_March_2019.pdf

This modeling framework ensures that when the LSR dams are removed from the Northwest power system, a least-cost replacement mix of new investments and operational changes is found. Through the constraints of the optimization, this least-cost replacement mix meets the same clean energy policy and level of reliability as a system with the LSR dams still intact. This dynamic approach considers replacement resource needs in the context of the evolving long-term system load and policy drivers, not just the near-term resource mix and needs of the system today. It recognizes that significant levels of new renewable energy and other resources are already needed to meet long-term regional needs, ensuring that the replacement resource mix selected is incremental to the long-term buildout, not just an interim solution before clean energy policies reach their apex in the 2040s.

Scenario Design

Regional Policy Landscape

To properly understand the resources needed to replace the power services of the lower Snake River dams, it is critical to consider the regional policy landscape of the Pacific Northwest. In the last few years, the states of Oregon and Washington have adopted some of the most aggressive clean energy policies in the nation. While the Pacific Northwest was already a leader in renewable energy production due to its abundant hydropower resource, these aggressive policies will require key changes to the region. First, coal power must be phased out in the Northwest during this decade and, at least in Washington, carbon will be priced via a market-based cap-and-trade mechanism[13]. Second, additional zero-carbon generation must be added to replace that coal power and to displace remaining emissions from natural gas resources whose firm capacity may still be needed by the region, but which will operate less over time as electric carbon emissions are reduced. Ultimately, to reach a zero-carbon system, those natural gas plants must retire, be converted to zero-carbon fuels (such as green hydrogen), or their emissions be offset in some other manner. Third, economy-wide carbon reduction goals will drive the transformation of the Northwest transportation, building, and industrial sectors, with the general expectation of significant electric load growth in annual energy and peak demand. Key policies in the Northwest and California are summarized in Table 3.

Table 3. Policy landscape in Washington, Oregon, and California

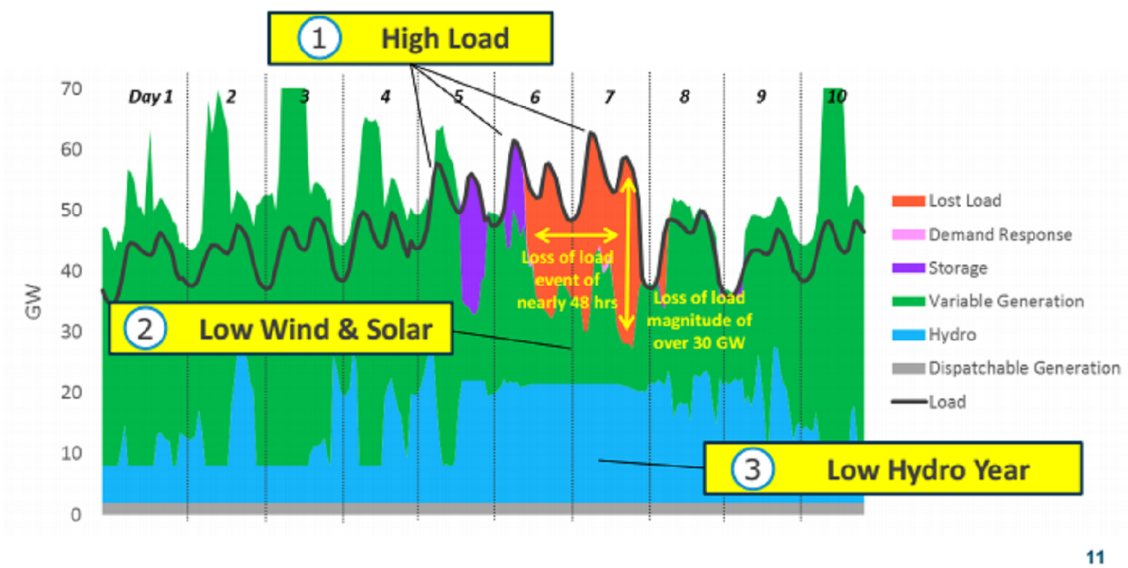
	RPS or Clean Energy Standard?	Coal Prohibition?	Cap-and-Trade?	New Gas?	Economy-Wide Carbon Reduction?
WA	✓ Carbon neutral by 2030, 100% carbon free electricity by 2045	✓ Eliminate by 2025	✓ Cap-and-invest program established in 2021, SCC in utility planning	✓	✓ 95% GHG emission reduction below 1990 levels and achieve net zero emissions by 2050
OR	✓ 50% RPS by 2040, 100% GHG emission reduction by 2040, relative to 2010 levels	✓ Eliminate by 2030	✓ Climate Protection Plan adopted by DEQ in 2021 (power sector not included)	✕ HB 2021 bans expansion or construction of power plants that burn fossil fuels	✓ 90% GHG emission reduction from fossil fuel usage relative to 2022 baseline
CA	✓ 60% RPS by 2030, 100% clean energy by 2045	✓ Coal-fired electricity generation already phased out	✓	✕ CPUC IRP did not allow in recent procurement order	✓ 40% GHG emission reduction below 1990 levels by 2030 and 80% by 2050

[13] For simplicity, this study assumes a uniform carbon price across the Core Northwest region beginning in 2023.

Maintaining Resource Adequacy in Low-carbon Grids

Like other regions pursuing aggressive climate policies, the Northwest faces a key decarbonization challenge: how to maintain a reliable electricity supply, while simultaneously increasing electric loads and retiring the firm, but emitting, capacity that currently supports regional reliability. In 2019, E3 used its RECAP loss of load probability model to study how decarbonizing the electricity supply impacts regional reliability. [14] This study found that clean energy resources such as solar, wind, batteries, and demand response can each provide a certain amount of reliable capacity and that combinations of them can provide even more by capturing "diversity benefits" (such as solar shifting the reliability risk into evening hours when wind output is higher). However, these resources also have limits to the amount of reliable capacity they can provide, and their contributions decline as more of them are added (the decline in capacity contributions of these resources is known as "saturation effects"). Figure 3 shows a graph from E3's 2019 study that illustrates the key drivers of reliability in a decarbonized grid: high load, low renewables, and low hydro conditions. Unlike a summer peaking *capacity constrained* system like the desert southwest, these conditions make it particularly challenging for battery storage to replace the Northwest's firm capacity resources, since batteries are unable to charge during *energy constrained* periods of low renewable energy and low hydro availability. The study concluded therefore that additional firm generating capacity may be needed, even in scenarios that add significant amounts of non-firm solar, wind, batteries, and demand response. The resource adequacy modeling approach is described further in the section *Resource Adequacy Needs and Resource Contributions*.

Figure 3. Key Drivers of Pacific Northwest Reliability Events in a Decarbonized Grid



[14] E3, 2019. *Resource Adequacy in the Pacific Northwest*. https://www.ethree.com/wp-content/uploads/2019/03/E3_Resource_Adequacy_in_the_Pacific-Northwest_March_2019.pdf

Since the 2019 study, "emerging" technologies are increasingly seen as potentially viable options to reduce all of the carbon emissions in the Northwest. "Clean firm" resources like green hydrogen, gas with carbon capture and storage, and nuclear small modular reactors provide the firm capacity necessary to backup renewable resources and can provide the zero-carbon energy needed on low renewable days to operate a zero-carbon grid. While their costs and commercialization trajectories remain uncertain, this LSR dams replacement study considers various scenarios of their availability.

Table 4. Summary of Resource Adequacy Capacity Contributions of LSR Dam Replacement Resource Options

Replacement Resource Option	RA Capacity Contributions
Battery storage	Sharply declining ELCCs[15]
Pumped storage	Sharply declining ELCCs
Solar	Declining ELCCs
Wind	Declining ELCCs
Demand Response	Declining ELCCs
Energy Efficiency	Limited potential vs. cost
Small Hydro	Limited potential
Geothermal	Limited potential
Natural gas to H2 retrofits	Clean firm, but not fully commercialized
New dual fuel natural gas + H2 plants	Clean firm, but not fully commercialized
New H2 only plants	Clean firm, but not fully commercialized
Gas w/ 90-100% carbon capture + storage	Clean firm, but not fully commercialized
Nuclear Small Modular Reactors	Clean firm, but not fully commercialized

Scenarios Modeled

This study focuses on three key variables (clean energy policy, load growth, and emerging technology availability) that impact the cost to replace the dams.

Clean Energy Policy

Clean energy policy for the electric sector is modeled at either 100% clean retail sales or zero-carbon by 2045. A 100% clean retail sales policy requires serving 100% of electricity sold on an annual basis to be met by clean energy resources. This allows generation not used to serve retail sales (i.e., transmission and distribution losses) to be met by emitting resources. It also allows emitting generation or unspecified

[15] E3 performed a sensitivity with battery ELCCs that do not decline so sharply. This sensitivity shows minor changes in the LSR dam replacement resources, but little to no change in the replacement costs.

imports in one hour to be offset by exported generation in another hour of the year. In the baseline load scenario, reaching 100% clean retail sales by 2045 results in ~85% carbon reduction compared to 1990 levels. The zero-carbon scenario ensures that all electricity generated in the Northwest or imported from other regions emits no carbon emissions in every hour of the year.

Load Growth

With aggressive clean energy policies, load growth determines the amount of new zero-emitting resources that must be added to the Northwest power system. A baseline load growth scenario is modeled, based on the forecast in the NWPCC 8th Power Plan. A second high electrification scenario is developed based on the high electrification case in the Washington State Energy Strategy.[16] Based on E3's analysis of the electrification of transportation, buildings, and industry in that study, this scenario results in an additional annual energy demand increase of 28% by 2045 (above the baseline scenario) and an additional winter peak demand increase of 68%. The peak demand increase is high due to the electrification of space heating end uses, which requires replacing the significant quantities of energy provided by the natural gas system during extreme wintertime cold weather events with electricity.

Technology Availability

It is expected that the availability of emerging technologies may be critically important for replacing the LSR dam power services while reaching a deeply decarbonized grid. All scenarios include "mature technologies" such as solar, wind, battery storage, pumped hydro storage, demand response, energy efficiency, small hydro, and geothermal. Three scenarios of emerging technology availability are developed as follows:

A. **Baseline technologies**: mature technologies and dual fuel natural gas + hydrogen combustion plants
B. **Emerging technologies**: mature technologies, dual fuel natural gas + hydrogen combustion plants, small modular nuclear reactors, natural gas with carbon capture and storage, and floating offshore wind
C. **No new combustion (limited technologies)**: mature technologies and floating offshore wind

All scenarios assume that the existing natural gas capacity fleet can convert to green hydrogen, i.e., hydrogen produced using zero-carbon electricity. However, new firm resources are needed in all scenarios to replace retiring resources and meet growing electric loads.

Table 5 shows a summary of the four scenarios that are the focus of this study.

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[16] See Washington State's *2021 State Energy Strategy*, https://www.commerce.wa.gov/growing-the-economy/energy/2021-state-energy-strategy/

Table 5. Scenario Design

Scenario	Clean Energy Policy	Load Growth	Technology Availability
1 100% Clean Retail Sales[1]	100% retail sales (85% carbon reduction)	8th Power Plan Baseline	Baseline (incl. natural gas / hydrogen dual fuel plants)
2a Deep Decarbonization (Baseline Tech.)	100% carbon reduction	High Electrification	Baseline
2b Deep Decarbonization (Emerging Tech.)	100% carbon reduction	High Electrification	Baseline + offshore wind, gas w/ CCS, nuclear SMR
2c Deep Decarbonization (No New Combustion)	100% carbon reduction	High Electrification	Baseline (excluding natural gas / hydrogen dual fuel plants)

Modeling Approach

RESOLVE Model

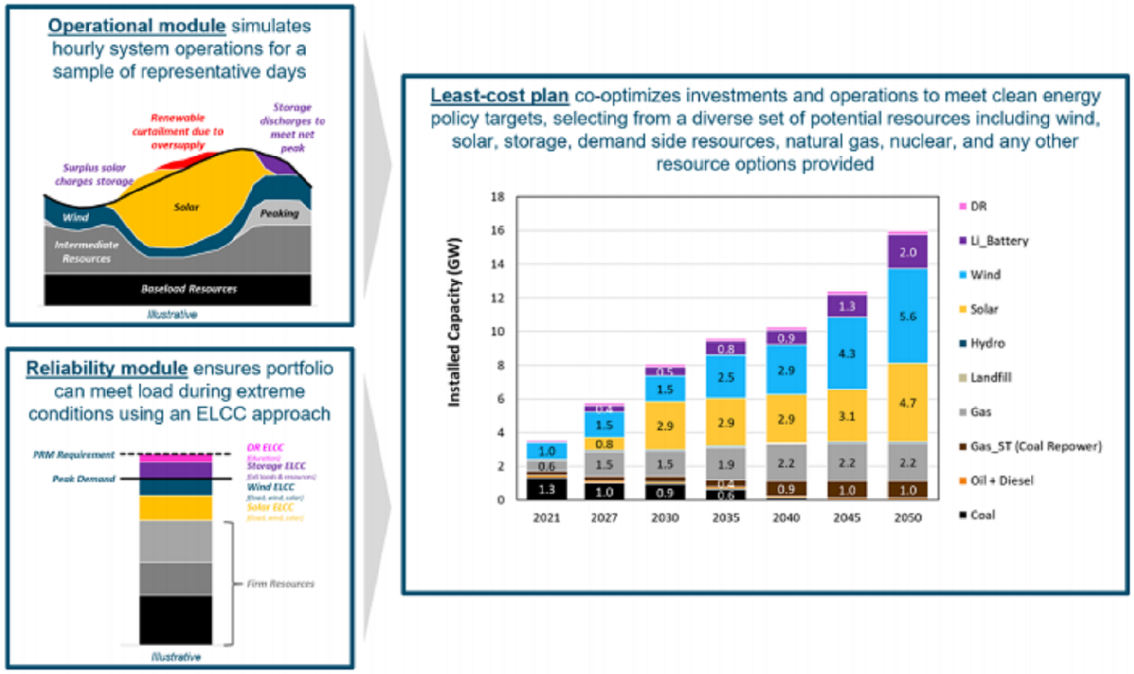
E3's Renewable Energy Solutions Model (RESOLVE) is used to perform a portfolio optimization of Northwest system's electric generating resource needs between 2025 and 2045. RESOLVE is an optimal capacity expansion and dispatch model that uses linear programming to identify optimal long-term generation and transmission investments in an electric system, subject to reliability, operational, and policy constraints. Designed specifically to address the capacity expansion questions for systems seeking to integrate large quantities of variable energy resources, RESOLVE layers capacity expansion logic on top of a production cost model to determine the least-cost investment plan, accounting for both the up-front capital costs of new resources and the variable costs to operate the grid reliably over time. In an environment in which most new investments in the electric system have fixed costs significantly larger than their variable operating costs, this type of model provides a strong foundation to identify potential investment benefits associated with alternative scenarios.

The three primary drivers of optimized resource portfolios include:

+ **Reliability:** all portfolios ensure system meets resource adequacy requirements. In this case, the target reliability need is to meet 1-in-2 system peak plus additional 15% of planning reserve margin (PRM) requirement.
+ **Clean Energy Standard ("CES") and/or carbon reduction targets:** all portfolios meet the clean energy standard and/or a carbon-reduction trajectory
+ **Least cost**: the model's optimization develops a portfolio that minimizes costs

Figure 4 illustrates the use of RESOLVE's operational module, which tracks hourly system operations including cost and greenhouse gas emissions across a representative set of days, and RESOLVE's reliability module, that uses exogenously calculated input parameters to characterize system reliability of candidate portfolios using effective load carrying capability (ELCC) for solar and wind resources.

Figure 4. Schematic Representation of the RESOLVE Model Functionality



RESOLVE develops least-cost portfolios using key inputs and assumptions including loads, existing resources, new resource options, retirement or repowering resource options, resource costs, resource operating characteristics including resource adequacy contributions, a zonal transmission transfer topology, and new resource transmission costs.

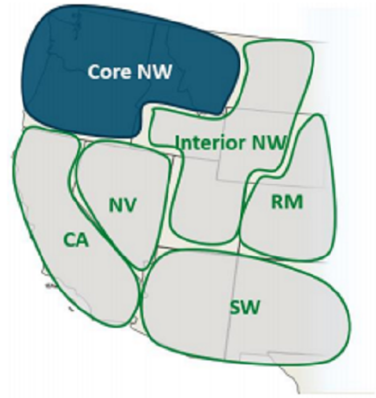
Northwest RESOLVE Model

The Northwest RESOLVE model was developed in 2017 for E3's *Pacific Northwest Low Carbon Scenario Analysis* study.[17] It uses a zonal transmission topology to simulate flows among the various regions in the Western Interconnection. In this study, RESOLVE is designed to include six zones: the Core Northwest region and five external areas that represent the loads and resources of utilities throughout the rest of the Western Interconnection (see Figure 5). This study focuses on the Core Northwest region as the "Primary Zone"—the zone for which RESOLVE makes resource investment decisions. This zone covers Washington, Oregon, Northern Idaho and Western Montana. The remaining balancing authorities outside of the Core Northwest are grouped into five additional zones: (1) Other Northwest, (2) California, (3) Southwest, (4) Nevada and (5) Rockies. For these zones, investments are not optimized; rather, the trajectory of new builds is established based on regional capacity needs to meet PRM targets, as well as renewable needs to comply with existing RPS and GHG policies in their respective regions, and held

[17] Pacific Northwest Low Carbon Scenario Analysis - Achieving Least-Cost Carbon Emissions Reductions in the Electricity Sector, 2017. https://www.ethree.com/wp-content/uploads/2018/01/E3_PGP_GHGReductionStudy_2017-12-15_FINAL.pdf

constant across all scenarios. E3's WECC-wide resource mix incorporates aggressive climate policy across the interconnection, as described in section *Baseline resources*.

Figure 5. RESOLVE Northwest zonal representation



The Northwest RESOLVE model simulates the operations of the WECC system for 41 independent days sampled from the historical meteorological record of the period 2007-2009. An optimization algorithm is used to select the 41 days and identify the weight for each day such that distributions of load, net load, wind, and solar generation match long-run distributions. Daily hydro conditions are sampled separately from dry (2001), average (2005), and wet (2011) hydro years to provide a complete distribution of potential hydro conditions. This allows RESOLVE to approximate annual operating costs and dynamics while limiting detailed operational simulations of grid operations to 41 days.

LSR Dams Modeling Approach

The LSR dams' capacity and operation are characterized with several input parameters that are presented in Section *Hydro parameters*. The approach taken in this analysis is to model LSR dams as an *in/out* resource to determine the dams' replacement costs and replacement portfolio. In other words, "in" scenarios include LSR dams in the existing resource portfolio of Core Northwest throughout the entire modeling period (i.e., 2025-2045); whereas "out" scenarios exclude LSR dams with preset retirement dates of 2032. An earlier retirement of LSR dams, 2024, is considered in a sensitivity case. The difference between the costs and resource portfolios for in and out cases reveals the value of LSR dams, as shown in Figure 6. Total NPV costs of resources replacing LSR dams are estimated in the year of breaching the dams.[18] NPV replacement costs are calculating using a 3% discount rate to represent the public power cost of capital.

[18] I.e. when the dams are removed in 2032, future costs after 2032 are discounted to the year 2032 to calculate the NPV replacement costs.

Figure 6. Modeling Approach to Calculate the LSR Dams Replacement Resources and Costs

1. ***With the lower Snake River dams***, **optimize long-term resource needs and operations for the Pacific Northwest**
   - Produces necessary resource additions and total system costs and emissions
2. ***Remove the lower Snake River dam generating capacity, then re-optimize*** **long-term resource needs and operations for the Pacific Northwest**
   - Produces a second set of resource additions and total system costs and emissions
   - All scenarios breach the dams in 2032, except for one scenario in 2024
3. ***Calculate additional resources and investment + operational costs*** **required to replace the dams**
   - Calculated as the difference between steps 1 and 2 above

This modeling approach inherently considers the benefits of avoiding the LSR dams ongoing fixed and variable costs. The costs associated with breaching the LSR dams themselves are not included in this study. Other power services (i.e., transmission grid reliability services provided by the dams) are also not included but are summarized qualitatively in the Appendix.

Key Input Assumptions

Load forecast

Base load forecast is from NWPCC 2021 Plan and is adjusted to E3's boundary of Core Northwest which roughly represents 87.5% of load of the Northwest system in the NWPCC 2021 Plan. Additionally, a high electrification scenario is modeled which takes Washington's State Energy Strategy high electrification load, scaled up and benchmarked to the Core Northwest region. The baseline high electrification load trajectories are displayed in Figure 7. It is notable that in the high electrification scenario, electric energy demand grows by about 28% by 2045 across all sectors, most noticeably in the commercial building and transportation sectors, to meet net-zero emissions by 2050. In the commercial and residential space heating sectors, electrification indicates a switch to high electric resistance and heat pump adoption, which will significantly impact load profiles and ultimately peak load. Hourly loads are modeled in RESOLVE by scaling normalized hourly shapes with annual energy forecasts. The normalized shapes are adopted from E3's 2017 study *Pacific Northwest Low Carbon Scenario Analysis.*[19]

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[19] Pacific Northwest Low Carbon Scenario Analysis - Achieving Least-Cost Carbon Emissions Reductions in the Electricity Sector, 2017. https://www.ethree.com/wp-content/uploads/2018/01/E3_PGP_GHGReductionStudy_2017-12-15_FINAL.pdf

Figure 7. Annual energy load forecasts for Core Northwest

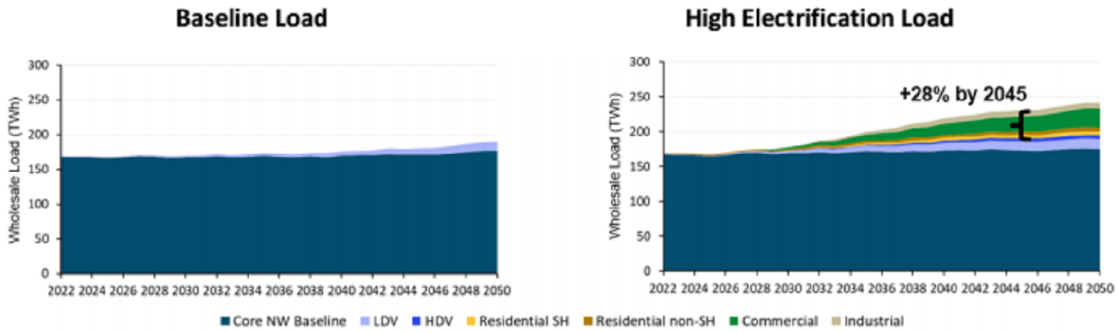
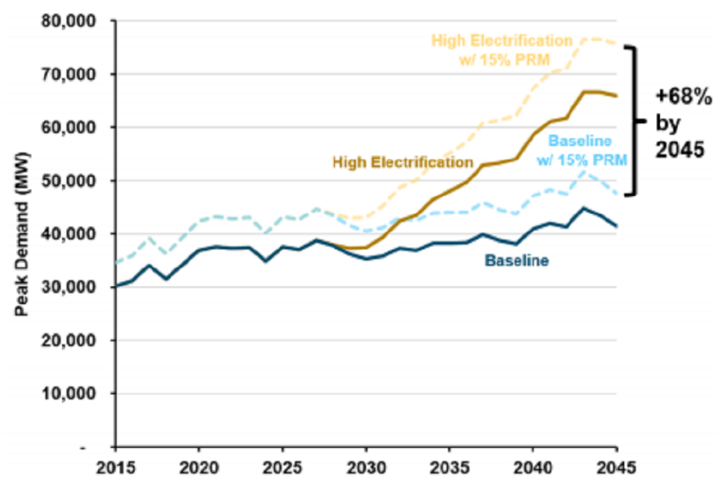


Figure 8 shows the peak demand impacts (including the 15% planning reserve margin) of the high electrification case relative to the baseline, showing a 68% increase by 2045. This high growth is driven by the winter peaking capacity required to replace the gas system peaking capacity to serve peak space heating needs.

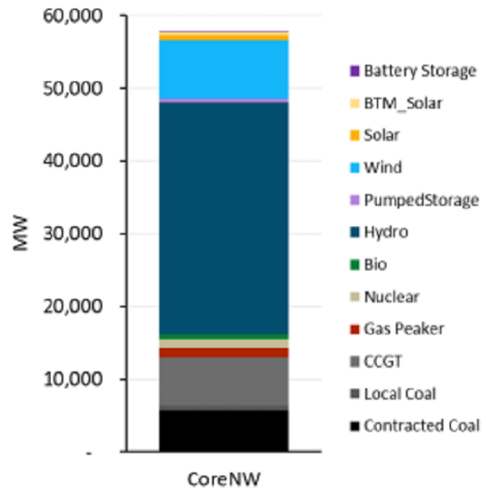
Figure 8. Peak demand forecasts for Core Northwest



Baseline resources

Baseline resources include the existing conventional resources such as natural gas and coal-fired technologies, existing nuclear capacity, hydro as well as pumped storage, battery storage, solar PV, BTM PV and onshore wind technologies. As shown in Figure 9, today's Northwest system has 58 GW capacity. The 1,185 MW nuclear capacity in the Northwest zone remains active throughout the modeling period while the 670 MW local coal capacity is retired by 2025 and the 5,700 MW contracted out of region coal capacity is retired by 2030. The WECC 2020 Anchor Data Set is used for Northwest's existing and planned resources. By 2045, about 5.8 GW additional customer PV is included as planned capacity to capture the growth in behind-the-meter generation forecasted in NWPCC 2021 Power Plan.

Figure 9. Northwest resource capacity in 2022



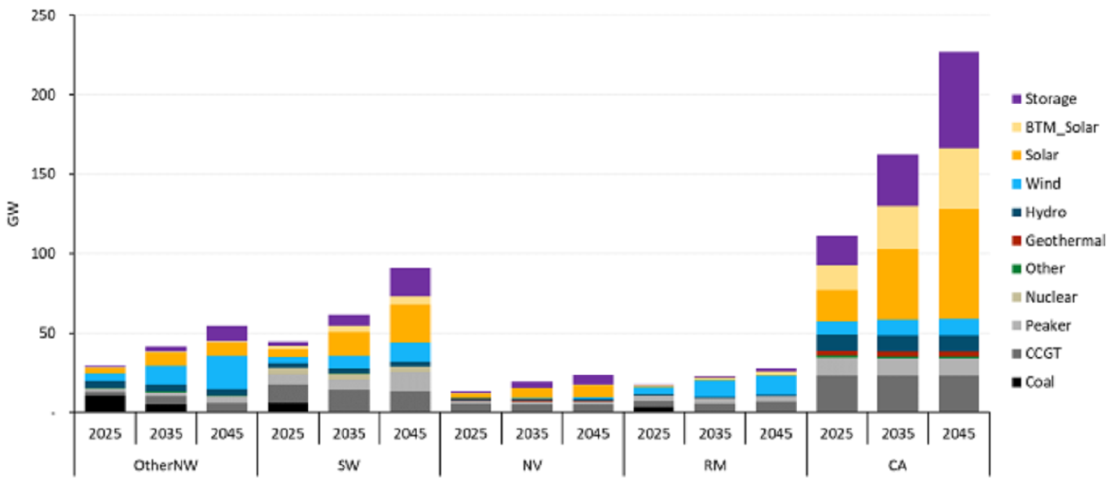
The investment decisions for external zones are pre-determined based on capacity expansion analysis completed by E3 that accounts for policy targets in each zone as summarized in Table 6. The new builds consist of significant increases in solar and battery capacity additions due to the more aggressive RPS targets, assumed electrification, and the decline of technology cost forecasts (see Figure 10). All future builds in these zones include mature technologies but as discussed in the next section, emerging technologies are made available for RESOLVE to optimize the future resource portfolios in the Northwest zone. There is significant solar and battery storage growth in California, the Southwest, and Nevada that generally lower the marginal value of solar energy produced across the WECC.

Table 6. Policy targets for builds in external zones

State	Requirement	Policy	2050 Renewable Target
AZ	40% by 2030; 60% by 2045	Transitions to CES[20]	70%
CA	60% by 2030; 100% by 2045	Transitions to CES	100%
CO	30% by 2020; 50% by 2030, 76% by 2050 (Xcel reaches 100% while other utilities stay at 50%)	Transitions to CES	75%
ID	90% by 2045 (ID Power's announced utility goals)	RPS	90%
MT	87% by 2045 (state carbon reduction goal)	RPS	87%
NM	40% by 2025; 100% by 2045	Transitions to CES	100%
NV	50% by 2030; 100% by 2050	Transitions to CES	95%
UT	50% by 2030; 55% by 2045 (PacifiCorp's IRP)	RPS	55%
WY	50% by 2030, 55% by 2045 (PacifiCorp's IRP)	RPS	55%

[20] CES = "Clean Energy Standard", an annual based clean generation standard.

Figure 10. Total installed capacity for external zones



Candidate resource options, potential, and cost

A wide range of technologies and resources are made available in RESOLVE, including mature and emerging technologies. The list of technologies made available in each modeled scenario is presented in Table 7. Some technologies such as solar and onshore wind are low-cost zero-carbon energy resources with limited resource potential and declining capacity values. Storage resources such as battery storage and pumped hydro support renewable integration but show limited capacity value given the large shares of hydro in the Northwest region. Demand response supports peak reduction but also faces declining ELCCs. Energy efficiency supports energy and peak reduction but increasingly competes against low-cost renewables. Geothermal is relatively high cost and has limited potential but provides highly valuable "clean firm" capacity.

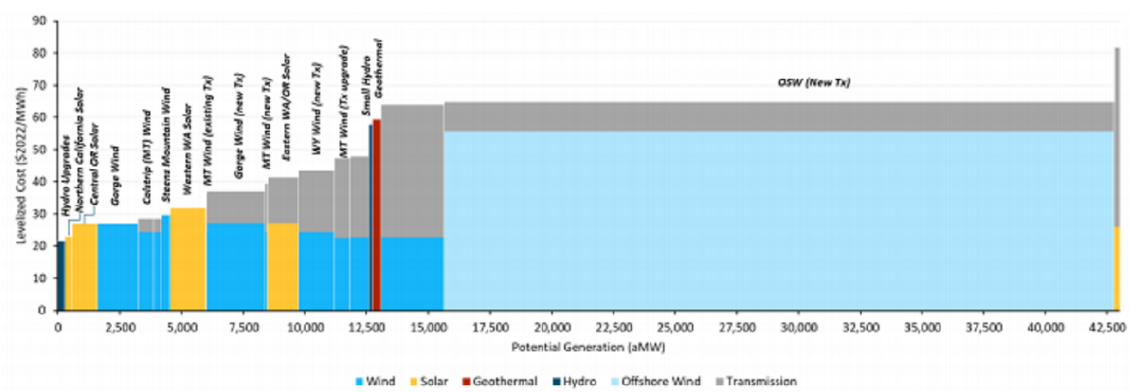
Some emerging technologies are also made available in several scenarios to allow for firm zero-carbon technologies to be selected from. Hydrogen-capable generators such as dual fuel combustion turbines and combined cycles (i.e., capable of burning both natural gas and hydrogen) as well as retrofits of existing gas generators to burn hydrogen are modeled. These technologies provide low-cost capacity options with very high energy cost when burning expensive hydrogen fuel, therefore RESOLVE selects them for firm capacity needs but limits their hydrogen energy production. Natural gas with carbon capture and storage (CCS) technologies are moderately high cost in terms of both energy and capacity. Nuclear SMR provides moderately high capital cost but low operating cost for firm zero-carbon energy generation. This technology is made available to the model after 2035, to account for the time needed for technology development, licensing, and installation. Floating offshore wind is also modeled as an emerging technology which address onshore resource and land constraints, but is generally higher cost than onshore wind while providing a similar annual capacity factor to high quality Montana and Wyoming wind.

Table 7. Available technologies in each modeled scenario

Resource	A. Baseline	B. Emerging Tech	C. No New Combustion (Limited Tech)
Mature resources: solar, wind, battery storage, pumped storage, demand response, energy efficiency, small hydro, geothermal	✓	✓	✓
Natural gas to hydrogen retrofits	✓	✓	✓
Dual fuel natural gas + hydrogen plants	✓	✓	×
Natural gas with 90-100% carbon capture and storage	×	✓	×
Nuclear small modular reactors	×	✓	×
Floating offshore wind	×	✓	✓

There are physical limits to the quantity of renewable resources that can be developed in a given location; RESOLVE enforces limits on the maximum potential of each new resource that can be included in the portfolio. Moreover, some new resources will need extensive transmission upgrades which are accounted for in the renewable energy supply curve.[21] Figure 11 shows a "supply curve" for renewables in the year 2045, ordered by total generation plus transmission cost. While the quantity of solar and onshore wind energy is limited, offshore wind potential is effectively unlimited in the model although its cost remains high relative to land-based renewables through 2045. It should be noted that RESOLVE doesn't select resources based on their cost alone; it also considers the value these resources provide as part of a regional portfolio. More detail information on technology cost trajectories and data sources can be found in the Appendix.

Figure 11. Renewable resource supply curve in 2045, including transmission cost adders



[21] Note: certain solar resources (i.e., Western WA solar) might require transmission upgrades to bring the supply to load centers, which are not captured.

Clean energy policy targets

RESOLVE enforces a clean energy standard ("CES") requirement as a percentage of retail sales to ensure that the total quantity of energy procured from renewable resources meets the CES target in each year. The clean energy standard percentage is calculated as follows, and the target values are summarized in Table 2:

$$CES\ \% = \frac{Annual\ Renewable\ Energy\ or\ Zero\ Emitting\ Generation}{Annual\ CoreNW\ Retail\ Electric\ Sales}$$

Eligible renewable energy and zero-emitting resources include: solar, wind, geothermal, hydropower, nuclear, biomass, green hydrogen, and natural gas with carbon capture and storage.

Regarding GHG emissions, RESOLVE enforces a greenhouse gas constraint on the CoreNW region such that total annual emission generated in the zone must be less than or equal to the emissions cap. The greenhouse gas accounting for the Northwest zone follows the rules established by the California Air Resources Board. The CoreNW carbon emissions baseline is set as 33 MMT at the 1990 level. The total greenhouse gas emissions attributed to the Core Northwest region include:

+ **In-region generation:** all greenhouse gas emissions emitted by fossil generators (coal and natural gas) within the region, based on the simulated fuel burned and fuel-specific CO_2 emissions intensity;
+ **External resources owned/contracted by Core Northwest utilities:** greenhouse gas emissions emitted by resources located outside the Core Northwest but currently owned or contracted by utilities that serve load within the region, based on fuel burn and fuel-specific CO_2 emissions intensity; and
+ **"Unspecified" imports to the Core Northwest:** assumed emissions associated with economic imports to the Core Northwest that are not attributed to a specific resource but represent unspecified flows of power into the region, based on a deemed emissions rate of 0.43 tons/MWh.

Table 8. Annual CES and carbon emissions targets modeled for CoreNW in RESOLVE

Resource	2025	2030	2035	2040	2045
Clean energy standard % (used in Scenarios 1 and 2[22])	29%	49%	68%	88%	100%
Carbon reduction emissions target (used only in Scenario 2)	22.7 MMT	17.0 MMT	11.3 MMT	5.7 MMT	0 MMT

Hydro parameters

RESOLVE characterizes the generation capability of the hydroelectric system by including three types of constraints from actual operational data: (1) daily energy budgets, which limit the amount of hydro generation in a day; (2) maximum and minimum hydro generation levels, which constrain the hourly hydro

[22] While a clean energy standard is modeled in scenario 2, the mass-based carbon reduction target constraint is a more binding constraint, pushing the model beyond the minimum CES %'s shown here.

generation; and (3) multi-hour ramp rates, which limit the rate at which the output of the collective hydro system can change from one to four hours. Combined, these constraints limit the generation of the hydro fleet to reflect realistic seasonal limits on water availability, downstream flow requirements, and non-power factors that impact the operations of the hydro system.

In this analysis, hydro operating data are parameterized using conditions for three different hydrological years, i.e., 2001 for dry, 2005 for average and 2011 for wet conditions. For LSR dams, we use hourly generation data provided by BPA, which are adjusted for latest fish protection and spill constraints. For the remainder of the northwest hydro fleet, we rely on historical hydro dispatch data used to develop the TEPPC 2022 Common Case dataset. Using muti-year historical hydro operational data allows capturing the complete set of physical and institutional factors, such as cascading hydro, streamflow constraints, fish protection, navigation, irrigation, and flood control, that limit the amount of flexibility in the hydro system.

For each RESOLVE sampled day, the hydro daily energy budget is calculated as the average of daily electricity generated in the month of each sampled RESOLVE day in its corresponding matched hydro year.[23] The maximum and minimum hydro generation levels (P_{min} and P_{max}) are calculated as the absolute min and max of generation in the month of each sampled RESOLVE day in its corresponding matched year. Multi-hour ramp rates are estimated based on the 99th percentile of upward ramps observed across the three hydrological years of hourly data. In addition, for non-LSR Northwest hydro, the model allows 5% of the hydro energy in each day to be shifted to a different day within two months to capture additional flexibility for day-to-day hydro energy shift.

[23] LSR dams generate about 900 average MW of energy during an average hydro year. However, during the three years modeled in RESOLVE, the LSR dams produced only ~700 average MW generation for LSR dams. This means our estimate of the replacement cost of the dams is quite conservative relative to a longer-term expected average of ~900 MW.

Figure 12. RESOLVE Hydro inputs for LSR Dams and other Northwest hydro

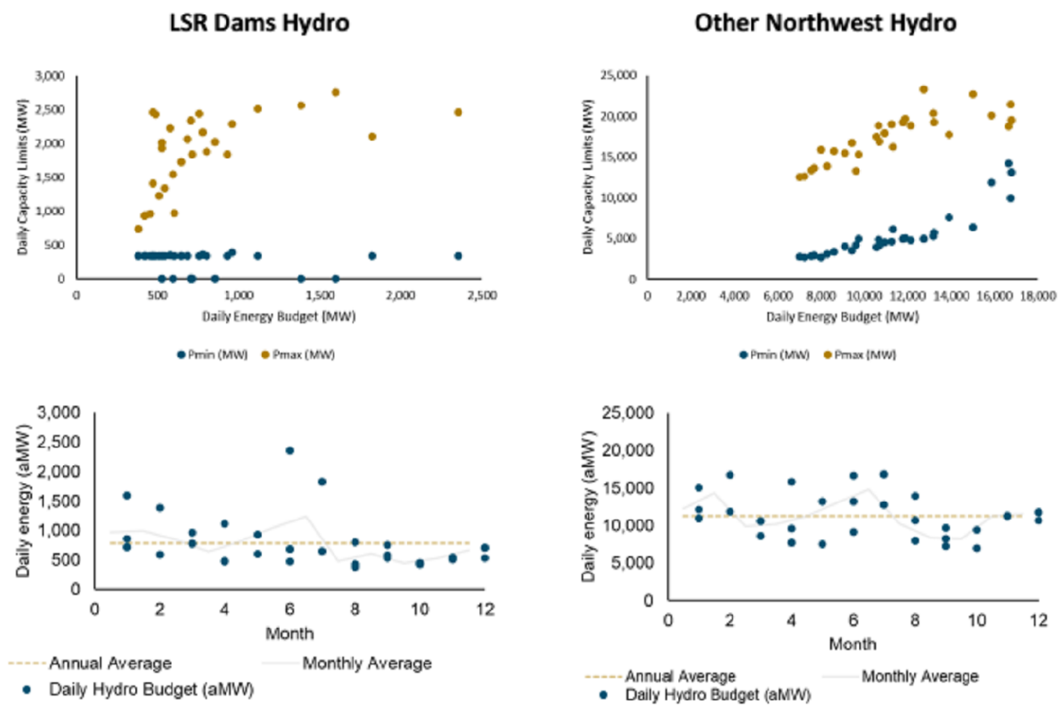


Table 9. Multi-hour ramping constraints applied to Northwest hydro

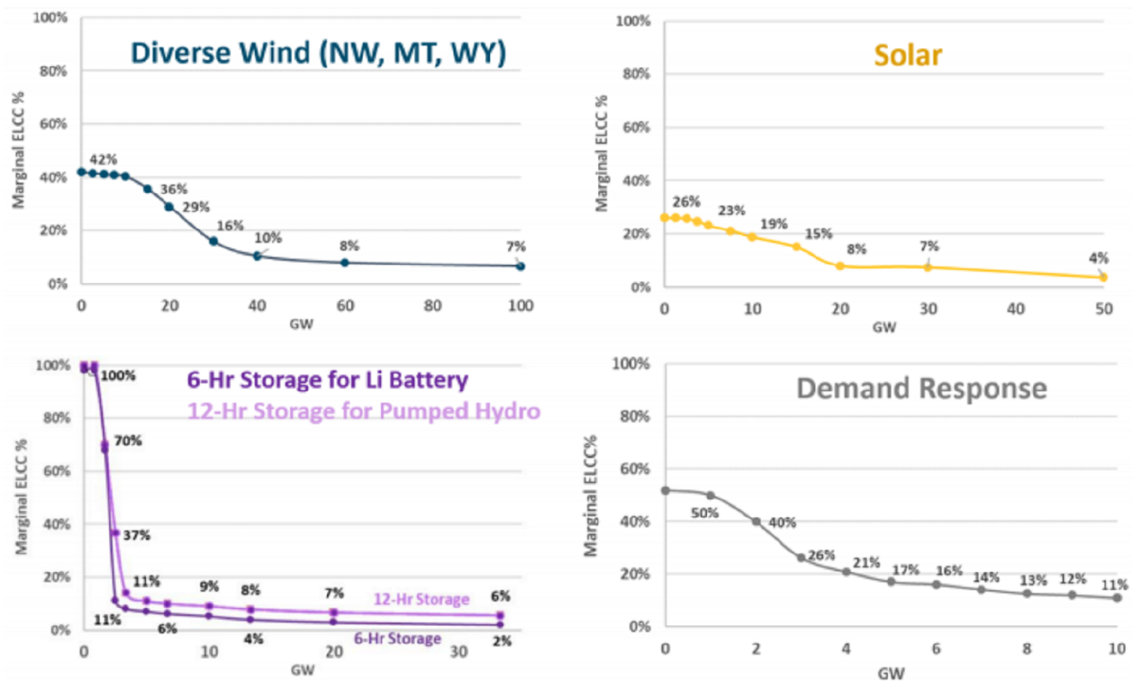
	One hour	Two hours	Three hours	Four hours
LSR Dams Hydro	36%	43%	45%	48%
Other Northwest Hydro	14%	23%	29%	32%

Resource Adequacy Needs and Resource Contributions

Hydro firm capacity contribution for both LSR dams and other Northwest hydro is assumed to be 65% of nameplate, per PNUCC methodology (based on 10-hr sustaining peaking capacity). This means that the LSR dams provide 2,284 MW of firm capacity that must be replaced if the dams are breached. This assumption was validated based on BPA modeled LSR dam performance data during the 2001 dry hydro year, as described in the section *Key Uncertainties for the Value of the Lower Snake River Dams*, which also describes estimates of the NPV impact of assuming a lower firm capacity value for the dams.

Resource adequacy needs are captured in RESOLVE by ensuring that all resource portfolios have enough capacity to meet the peak Core Northwest median peak demand plus a 15% planning reserve margin. Firm capacity resources are counted at their installed capacity. Hydro resources are counted at the 65% regional value used in PNUCC's 2021 resource adequacy analysis. Solar, wind, battery storage, pumped hydro storage, and demand response are counted at their effective load carrying capability ("ELCC") based on E3's RECAP modeling from its 2019 *Resource Adequacy in the Pacific Northwest* study.[24] Figure 13 shows the initial capacity values for these resources, as well as the declining marginal contributions as more of the resource is added. RESOLVE uses these data points to develop tranches of energy storage and demand response resources with declining marginal ELCCs for each tranche. Solar and wind ELCCs are input into RESOLVE using a 2-dimensional ELCC surface that captures the interactive benefits of adding various combinations of solar and wind together. Resources on the surface (such as different wind zones) are scaled in their ELCC based on their capacity factor relative to the base capacity factor assumed in the surface, and the entire surface is scaled as peak demand grows.

Figure 13. Solar, Wind, Storage, and Demand Response Capacity Values



The capacity value for energy storage resources shown in Figure 13 are very different from those in other regions, such as California or the Desert Southwest, declining much more quickly as a function of penetration. There are two reasons for this. First, the Pacific Northwest is a winter peaking region in which loss-of-load events are primarily expected to occur during extreme cold weather events that occur under drought conditions in which the region faces an energy shortfall. These events, such as the one illustrated in Figure 3 above, result in multi-day periods in which there is insufficient energy available to charge storage resources, severely limiting their usefulness. This is unlike the Southwest, where the most stressful system conditions occur on hot summer days in which solar power is expected to be abundant and batteries can recharge on a diurnal cycle. Second, the Pacific Northwest already has a very substantial amount of reservoir storage which can shift energy production on a daily or even weekly basis. Thus, the

[24] Resource Adequacy in the Pacific Northwest, 2019. https://www.ethree.com/wp-content/uploads/2019/03/E3_Resource_Adequacy_in_the_Pacific-Northwest_March_2019.pdf

Pacific Northwest is already much closer to the saturation point where additional diurnal energy shifting has limited value.

Nevertheless, recognizing that the capacity value of energy storage is still being researched, in the Northwest and elsewhere, we include a sensitivity case in which energy storage resources are assumed to have much higher ELCC values, similar to what is expected in the Southwest at comparable penetrations. This test case was used to assess whether a higher energy storage ELCC would change the replacement resources and replacement cost of the LSR dams. The results are presented in the section *Replacement Resources Firm Capacity Counting*.

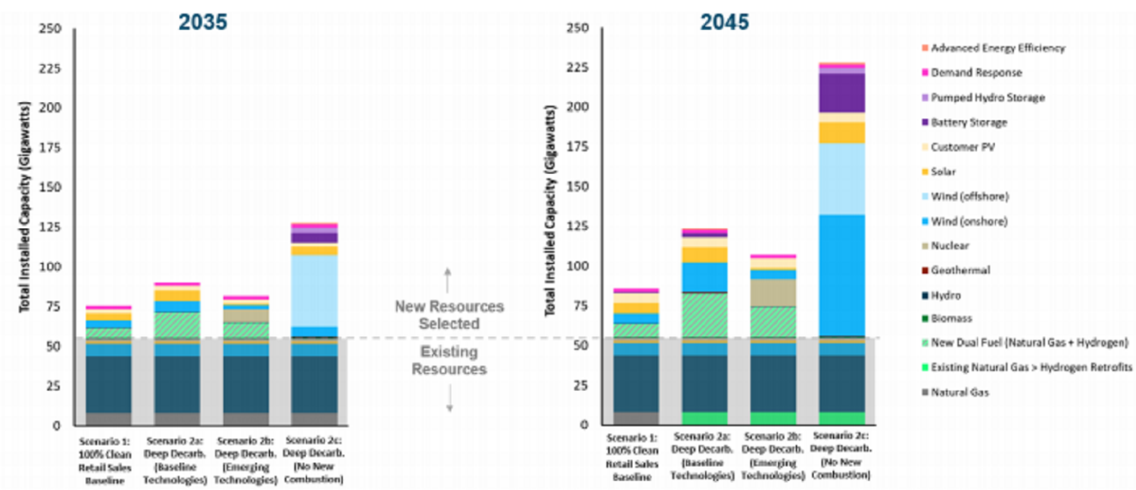
Results

RESOLVE model runs for the 2025-2045 period produce optimal resource portfolios of additions and retirements by resource type, as well as metrics of annual and hourly resource generation, carbon emissions, and total system costs. This section presents the RESOLVE modeling results, focused on the years of 2035 and 2045 to highlight the mid-term and long-term resource needs. Following that, the result of the RESOLVE runs with the LSR dams breached are presented, with the replacement resource and costs to replace the dams' power services.

Electricity Generation Portfolios With the Lower Snake River Dams Intact

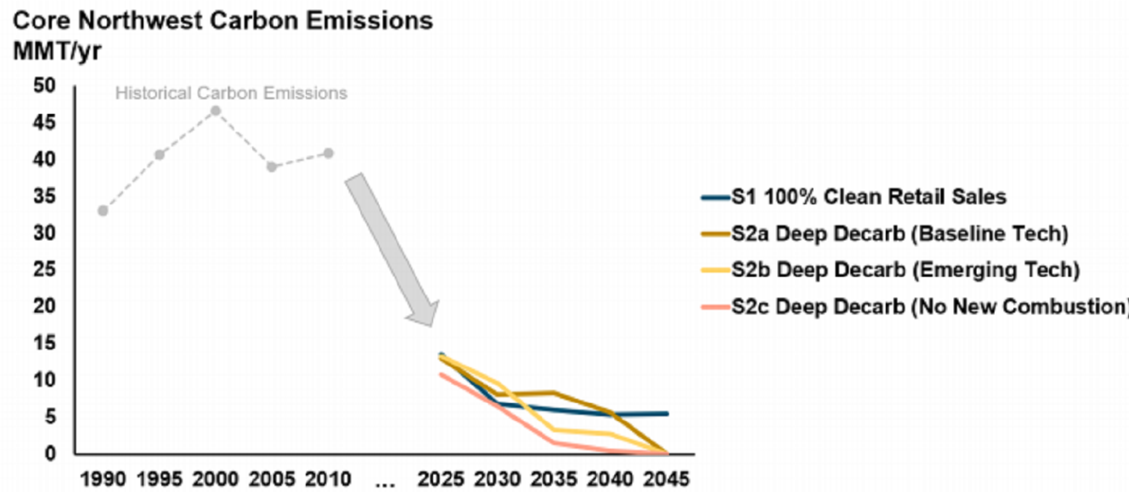
In the scenarios that do not assume breaching of the LSR dams, large amounts of utility-scale solar PV, onshore wind, offshore wind, hydrogen-capable combined cycle, and some amounts of energy efficiency and demand response are selected to meet the growing electricity demand, PRM, and emissions reductions. Electrification load growth along with zero emissions targets drive higher needs in deep decarbonization scenarios (i.e., S2a, S2b and S2c) compared to the reference scenario (S1) in both snapshot years of 2035 and 2045. In S2b, clean firm technologies such as SMR nuclear are selected in place of additional onshore wind, solar and dual-fuel CCGT selected in S2a. In the absence of clean firm technologies (no new combustion) in S2c, massive amounts of offshore wind (~45 GW) as well as more battery storage, pumped storage, demand response, and energy efficiency are selected as early as 2035 such that in this scenario, the new resource additions are almost five time the new builds in S1. These capacity additions increase even more substantially by 2045.

Figure 14. Large levels of new resource additions to meet the growing load, PRM needs and emissions reductions (assumes LSR Dams are NOT breached)



As shown in Figure 15 below, all four scenarios result in a sharp near-term decline in carbon emissions, driven by Washington and Oregon policies that drive coal retirement this decade. By 2045, Scenario 1, which requires 100% clean retail sales, shows an ~85% decline in carbon emissions relative to 1990 levels. Scenario 2 eliminates all carbon emissions by 2045.

Figure 15. Northwest Carbon Emissions



To put cost impacts in context, a "No Policy Reference" case uses the baseline load forecast and removes all electric clean energy policies, retaining the region's coal power with little emissions decline. The four clean energy futures modeled are compared against this Reference Case on A) their cost impacts, measured in incremental cents/kWh relative to the Reference, and B) their carbon emissions reductions, relative to 1990 levels. By 2045, as shown in Figure 16, with the region's aggressive carbon policies in place, emissions can be reduced by over 80% with a relatively small cost impact (+0.6 cents/kWh relative to the region's current average retail rate of 8-9 cents/kWh). Reaching a zero-carbon grid with increasing electric loads requires significantly more investment, increasing carbon reductions to 100% of 1990 levels, but also increasing costs by 3.3-14.8 cents/kWh. This range is highly dependent upon the availability of emerging technologies and their assumed costs. The low end assumes that low-cost small modular nuclear reactors become commercialized by 2035. The high end assumes no new combustion resources (such as green hydrogen)[25] or other emerging technologies are available[26], showing that relying only on non-firm resource additions (renewable energy, demand side resources, and short- to medium-duration storage) leads to much higher costs.

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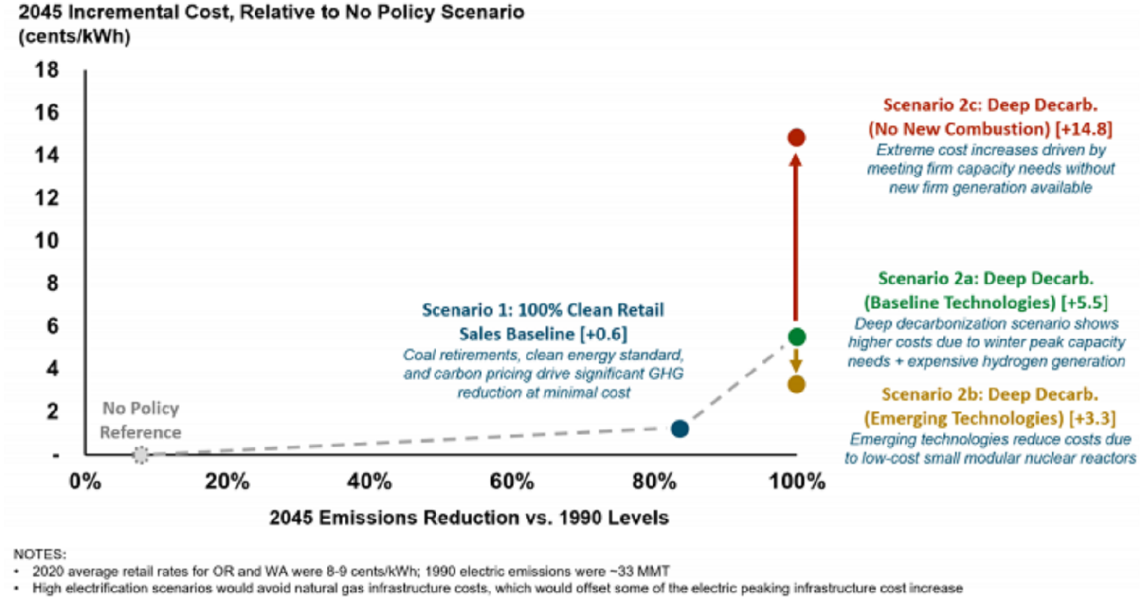
[25] The authors recognize that hydrogen can be used to generate electricity by fuel cells instead of combustion turbines. That scenario would look similar to Scenario 2a, where the combustion plant additions are replaced with many GW of fuel cells for firm capacity needs.

[26] Floating offshore wind was allowed in the no new combustion case since it was required to allow a feasible solution without making any other firm capacity additions available in the model.

Figure 16. Cost Impacts Compared to Emissions Reduction Impacts



LSR Dams Replacement

The resource replacement portfolios and costs of replacing the LSR dams are reported in this section, which is also focused on the midterm (2035) and long term (2045).

Capacity and energy replacement

In the midterm, given the expectations of load growth and coal capacity retirements resource adequacy needs are a primary driver of LSR dam replacement needs, with around 2 GW of additional firm dual fuel natural gas and hydrogen combustion plants selected to replace the LSR dams' capacity in Scenarios 1, 2a, and 2b (see Table 10). (Note that, 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 as assumed in Scenario 2b, it replaces renewables and some of the combustion resource builds. In addition to firm resources, some of the LSR capacity is replaced by renewables in Scenarios 1 and 2a, mostly by wind resources and some battery storage. In Scenario 2c, with no combustion or advanced nuclear available, a very large buildout of renewable capacity (in the order of 12 GW) is required to replace the capacity of LSR dams, due to resource availability and the fast decline in solar and wind ELCCs as early as 2035. Small amount of geothermal capacity is also part of the portfolio in 2035.

In the long term, the dam's carbon-free energy is replaced by a combination of wind power and another "clean firm" resource when available. Scenario 2a shows additional hydrogen generation, as well as small levels of energy efficiency and battery storage. In Scenario 2b, the LSR dams are entirely replaced by clean firm capacity of hydrogen combustion plants and nuclear SMRs, whereas in Scenario 2c, a large capacity of wind and solar is relied upon to replace both the carbon-free energy and firm capacity of the LSR dams. Overall, the magnitude of replacement portfolio capacities is close in both snapshot years (2035 and 2045) meaning that immediate capacity additions are necessary to replace LSR dams given the retirement year of 2032 while the capacity needs sustain throughout the modeling period. The early removal of LSR dams (i.e., by 2024) moves up the timing of the replacement portfolio to 2025 instead of 2035 in S1b, but the replacement portfolio remains similar.

Table 10. Optimal portfolios to replace the LSR dams

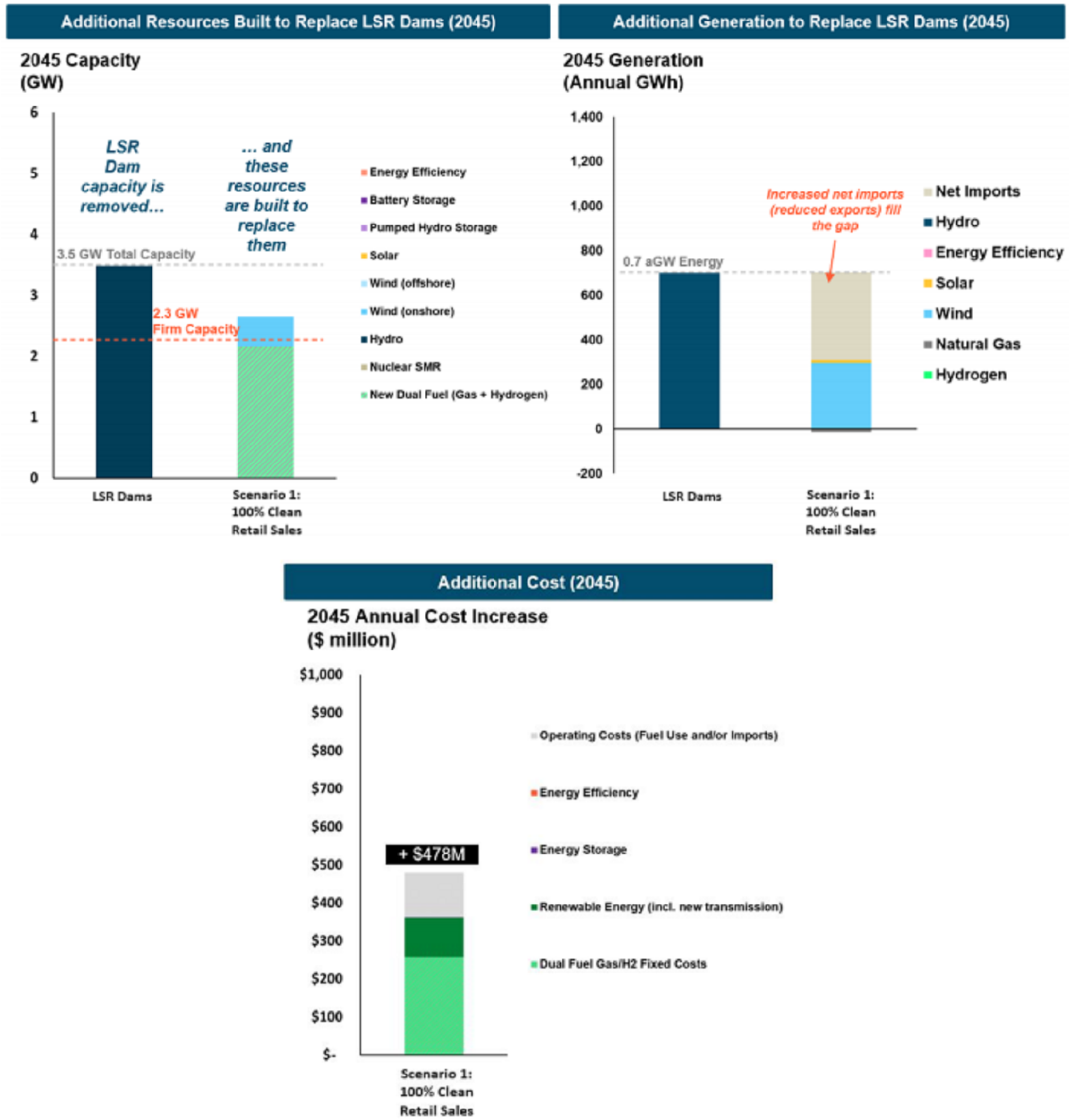
Scenario	Replacement Resources Selected, Cumulative by 2035[27] (GW)	Replacement Resources Selected, Cumulative by 2045 (GW)
Scenario 1: 100% Clean Retail Sales	+ 1.8 GW dual fuel NG/H2 CCGT - 0.5 GW solar + 1.3 GW wind + 0.1 GW li-ion battery	+ 2.1 GW dual fuel NG/H2 CCGT + 0.5 GW wind
S1b: 100% Clean Retail Sales (2024 dam removal)	+ 1.8 GW dual fuel NG/H2 CCGT - 0.5 GW solar + 1.4 GW wind + 0.1 GW li-ion battery	+ 2.1 GW dual fuel NG/H2 CCGT + 0.5 GW wind
Scenario 2a: Deep Decarbonization (Baseline Technologies)	+ 2.0 GW dual fuel NG/H2 CCGT + 0.6 GW wind + 0.1 GW li-ion battery	+ 2.0 GW dual fuel NG/H2 CCGT + 0.3 GW li-ion battery + 0.4 GW wind + 0.05 GW advanced EE + 1.2 TWh H2-fueled generation
Scenario 2b: Deep Decarbonization (Emerging Technologies)	+ 1.7 GW dual fuel NG/H2 CCGT + 0.6 GW nuclear SMR	+ 1.5 GW dual fuel NG/H2 CCGT + 0.7 GW nuclear SMR
Scenario 2c: Deep Decarbonization (No New Combustion)	+ 9.1 GW offshore wind + 0.1 GW wind + 1.0 GW solar + 0.3 GW geothermal + 1.5 GW li-ion battery	+ 10.6 GW wind + 1.4 GW solar

Figure 17 through Figure 20 show details of the capacity replacement, energy replacement, and cost breakdown for Scenarios 1 and 2a. LSR dams energy in these scenarios is replaced with wind, net imports (i.e. reduced exports of hydropower outside the Core NW), and – in Scenario 2a – additional hydrogen generation, which is necessary in 2045 to meet the zero-carbon goal without the flexible LSR dam winter generation. The cost charts show that the dual fuel gas plants make up approximately half of the 2045

[27] Replacement resources are calculated by comparing the "with LSR dams" RESOLVE portfolio to the "without LSR dams" RESOLVE portfolio. This means some resources may be built in 2035, such as 0.3 GW of geothermal in scenario 2c, that are not built when the dams are included. However, those resources may have already been selected in the "with LSR dams" case by 2045, hence do not show up as additional resource replacement needs in 2045. This explains the different resource changes between 2035 and 2045.

annual costs in Scenario 1 and approximately a quarter of the 2045 annual costs in Scenario 2a, which includes additional costs for energy efficiency and hydrogen generation.

Figure 17. Scenario 1: Capacity Replacement, Energy Replacement, and Costs[28]



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[28] Regarding the "net imports" component of the energy replacement, this refers to either increased imports, decreased exports (generally of carbon-free energy), or a combination of both, such that RESOLVE does not need to build enough new generation to fully replace the LSR dams output. For instance, the region could export less hydropower to California and other neighbors to replace the LSR dams output without necessarily increasing Northwest carbon emissions in Scenario 1.

Figure 18. Scenario 2a Capacity Replacement, Energy Replacement, and Costs

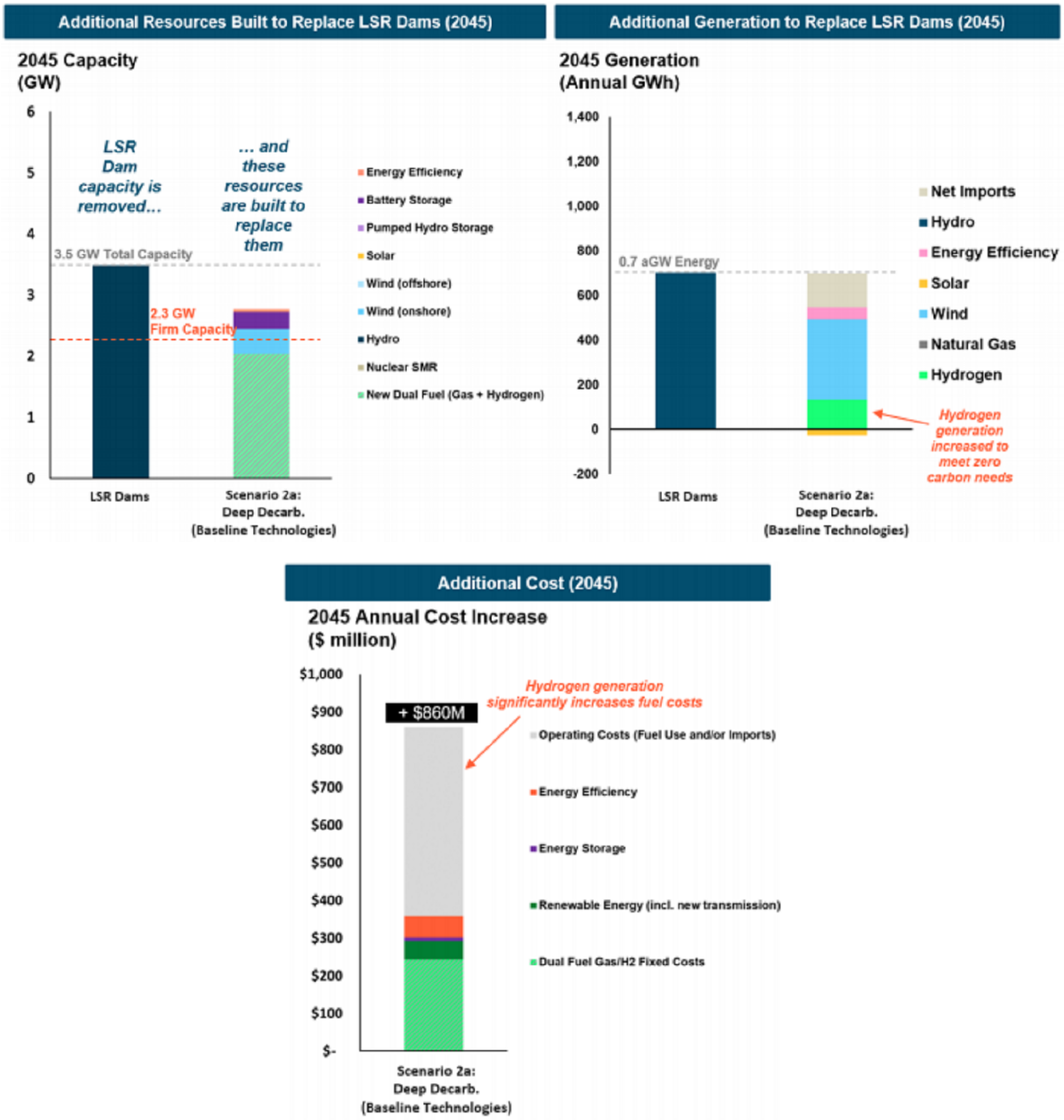

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Figure 19. Scenario 2b Capacity Replacement, Energy Replacement, and Costs

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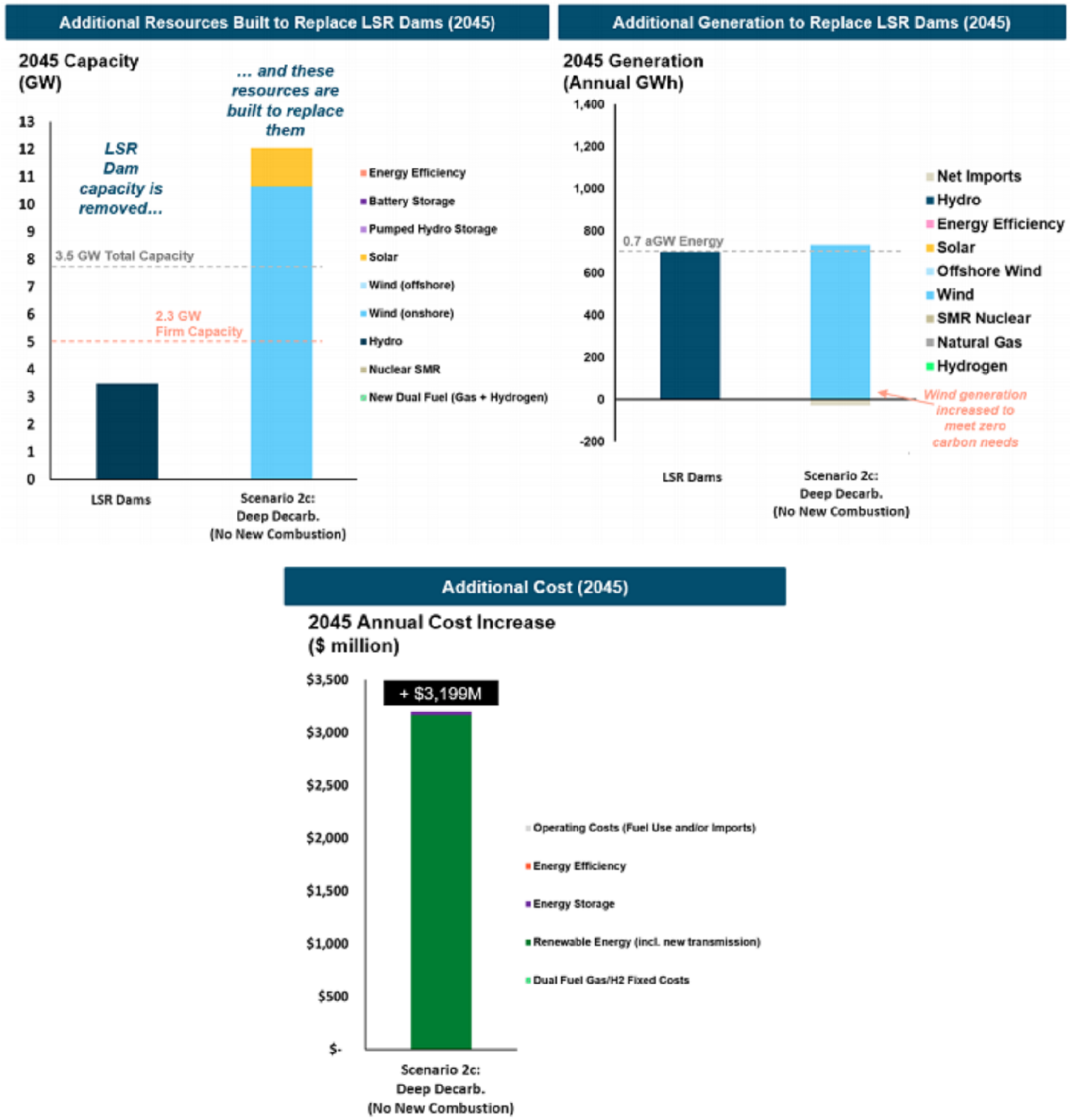
Figure 20. Scenario 2c Capacity Replacement, Energy Replacement, and Costs[29]



Replacement costs

The LSR dams provide a relatively low-cost source of GHG-free energy and firm capacity. Incremental costs for replacement resources are summarized in this section. All costs are shown in real 2022 dollars.

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[29] NOTE: the energy replacement does not show the total potential energy output of the wind built to replace the dams, because much of the potential energy output is curtailed due to oversupply of wind built for resource adequacy needs.

Incremental costs to replace the power services of the LSR dams ranges from $69-139/MWh across most scenarios. Scenario 2c, however, shows a much higher replacement power cost of $517/MWh. These incremental costs are much higher than costs of maintaining the LSR dams (i.e., $13-17 per MWh[30]); they are calculated by taking the incremental fixed and variable investment costs for the no LSR RESOLVE runs and dividing them by the LSR annual generation being replaced. See the details in Table 11.

Table 11. Incremental costs to replace LSR generation in 2045

Scenario	Incremental net costs in 2045[31], including avoided LSR dam costs (Real 2022 $/MWh)	Incremental gross costs in 2045[32], excluding $17/MWh avoided LSR dam costs (Real 2022 $/MWh)
Scenario 1: 100% Clean Retail Sales	$77/MWh	$94/MWh
Scenario 1: 100% Clean Retail Sales (2024 dam breaching)	$82/MWh	$99/MWh
Scenario 2a: Deep Decarb. (Baseline Technologies)	$139/MWh	$156/MWh
Scenario 2b: Deep Decarb. (Emerging Technologies)	$69/MWh	$86/MWh
Scenario 2c: Deep Decarb. (No New Combustion)	$517/MWh	$534/MWh

The LSR dams' total replacement costs (in net present value) and annual replacement costs for 2025, 2035, and 2045 are shown in Table 12. NPV replacement costs are calculated based on discounting at a 3% discount rate, representative of the approximate public power cost of capital, over a 50-year time horizon following the date of breaching. Scenario 1 (100% clean retail sales) replacement costs are approximately $11.8 billion in net present value (NPV) in the year of breaching (in 2032); costs increase to $12.8 billion NPV if breached in 2024. Total replacement costs are similar in the economy-wide deep decarbonization scenario when emerging technology is available (scenario 2b), showing $10.7 billion NPV. Replacement costs are significantly higher in scenario 2c where no new combustion resources are allowed ($75.2 billion NPV). The economy-wide deep decarbonization (baseline technology scenario), 2a, shows more costly replacement ($19.0 billion NPV) than when nuclear SMRs are available, but lower costs than scenario 2c, due to the availability of hydrogen-enabled gas plants.

Annual costs increase by $415-860 million after LSR dams' removal in scenarios 1, 2a, and S2b. In Scenario 2c, the cost increase is in the order of $1.9-3.2 billion per year. Replacement costs generally increase over time due to increasingly stringent clean energy standards and electrification-driven load growth. The 2045

[30] BPA directly funds the annual operations and maintenance of the Lower Snake River Compensation Plan (LSRCP) facilities. The cost of generation at the lower Snake River dams is in the range of $13/MWh without LSRCP and $17/MWh with LSRCP. Congress authorized the LSRCP as part of the Water Resources Development Act of 1976 (90 Stat.2917) to offset fish and wildlife losses caused by construction and operation of the four lower Snake River projects.

[31] The generation replacement costs are calculated using the incremental RESOLVE's Core Northwest revenue requirement increase with LSR dams breached divided by the annual MWh of the LSR dams assuming 706 average MW generation.

[32] The generation replacement costs are calculated using the incremental RESOLVE's Core Northwest revenue requirement increase with LSR dams breached divided by the annual MWh of the LSR dams assuming 706 average MW generation.

cost increases translate to 8-18% growth in BPA's public power customers costs in scenarios 1, 2a and 2b (assuming current retail rates are about 8.5 ₵/kWh based on OR and WA average retail rates). In these scenarios, public power households would see an increase in annual electricity costs of $100-230/yr in 2045. In Scenario 2c, rate impacts could be as high as 65%, which is equivalent to annual residential electricity bills raising by up to $850 per year.[33]

Note that these incremental cost increases include the ongoing LSR dams costs, such as operations and maintenance costs, avoided by breaching the dams, but do not include the costs of breaching. The rate impacts shown are only for the LSR dams' replacement, they do not include the additional rate increases driven by higher loads or clean energy needs (that are covered in the section *Electricity Generation Portfolios With the Lower Snake River Dams Intact* above), which apply even without removing generation from the LSR dams.

Table 12. Total LSR Dams replacement costs

	NPV Total Costs (Real 2022 $)[34]	Annual Costs Increase (Real 2022 $)			Incremental Public Power Costs[35]
	In the year of breaching (2032 or 2024)	2025	2035	2045	2045
Scenario 1: 100% Clean Retail Sales	$11.8 billion	n/a	$434 million	$478 million	0.8 ₵/kWh [+9%]
Scenario 1: 100% Clean Retail Sales (2024 dam breaching)	$12.8 billion	$495 million	$466 million	$509 million	0.8 ₵/kWh [+9%]
Scenario 2a: Deep Decarb. (Baseline Technologies)	$19.0 billion	n/a	$496 million	$860 million	1.5 ₵/kWh [+18%]
Scenario 2b: Deep Decarb. (Emerging Technologies)	$10.7 billion	n/a	$415 million	$428 million	0.7 ₵/kWh [+8%]
Scenario 2c: Deep Decarb. (No New Combustion)	$75.2 billion	n/a	$1,953 million	$3,199 million	5.5 ₵/kWh [+65%]

33 Annual residential customer cost impact assumes 1,000 kWh per month for average residential customers in Oregon and Washington in scenario 1 and 1,280 kWh per month for scenario 2, per the 28% retail sales increase due to electrification load growth.

34 NPV replacement costs are based on discounting at a 3% discount rate, representative of the approximate public power cost of capital, over a 50-year time horizon following the date of breaching.

35 Incremental public power costs are calculated assuming that all the replacement costs are paid by BPA Tier I customer, using the assumed 2022 Tier I annual sales of 58,686 GWh.

Carbon emissions impacts

LSR dams provide emissions-free generation for Northwest and depending on what these dams are replaced with, may impact the emissions associate with the electricity systems. The removal of LSR dams may potentially cause an increase in emissions over the near- or mid-term horizon. In Scenario 1, the 2024 LSR dam breaching scenario results in substantial increases to carbon emissions through 2030, in the range of 1-2.8 MMT/yr or 15-25% of the annual Northwest emissions. This scenario does not have a binding GHG constraint, and the region meets its clean energy goals in the near term without the dams. RESOLVE therefore does not replace all the LSR dam energy with clean resources.

Under 2032 breaching scenarios, small carbon emissions increases are observed in the mid-term (0.7 MMT/yr. or 8-10% of the region's carbon emissions in 2035). The economy-wide deep decarbonization cases all reach zero carbon emissions by 2045, so breaching the dams does not increase emissions in that year; RESOLVE instead builds the resources needed to replace all of the GHG-free energy.

Additional considerations

Depending on how the future of the electric grid evolves, there might be significant land-use associated with renewables expansion, more so if LSR dams are removed in conditions similar to Scenario 2c where significant capacity additions from solar and wind resources would be necessary.

In terms of costs, while this study considered the replacement costs of LSR dams from the electricity system perspective, there are other types of services that LSR dams provide that would need additional cost assessment. LSR dams are used for irrigation, recreation, navigation, and transportation. Breaching LSD dams could impact these services and therefore, should be considered alongside the electricity services replacement costs. Moreover, breaching the dams itself would be an additional cost. These factors are addressed in more detail in the report prepared by Senator Murray and Governor Inslee.[36]

Key Uncertainties for the Value of the Lower Snake River Dams

This study explicitly captures the following key drivers of the LSR dams power service replacement needs:

- Replacing the **GHG-free energy**, **firm capacity**, **operating reserves**, and **operational flexibility** of the dams

Uncertainty of the LSR dam value is considered under scenarios of:

- **Clean energy policy**: replacement of carbon-free power becomes increasingly critical to reach a zero-emissions electricity grid
- **Load growth**: replacement energy and capacity needs may change with increased electrification and peak higher winter space heating needs

[36] Lower Snake River Dams: Benefit Replacement Draft Report by U.S. Sen. Patty Murray, and Washington Gov. Jay Inslee, 2022. [Lower Snake River Dams: Benefit Replacement Draft Report (senate.gov)]

- **Technology availability**: replacement is more expensive with fewer emerging technology resource options
- **Timing**: replacement was focused on breaching in 2032, but a 2024 sensitivity was also considered

Additional uncertainties regarding the value of the dams are:

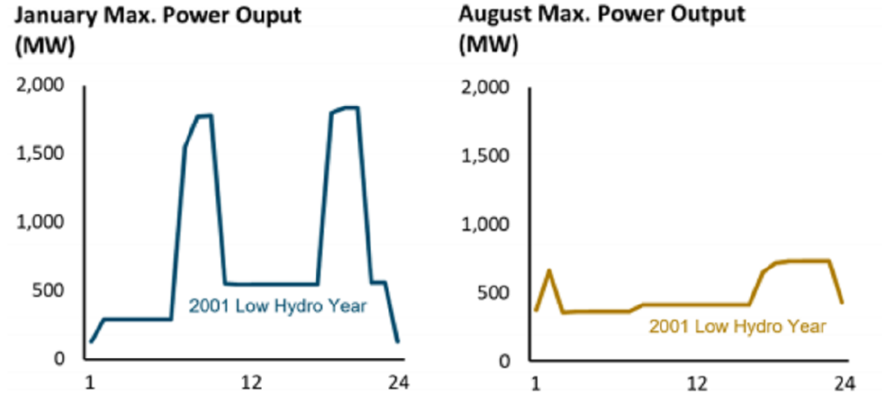
- **LSR dams annual energy output**: E3's existing RESOLVE model data uses historical hydro years 2001, 2005, and 2011 as representative of the regional long-term average low/mid/high hydro year conditions. The data for the Columbia River System dams was adjusted to reflect the Preferred Alternative operations defined in the CRSO EIS. However, for the LSR dams, these selected historical hydro years resulted in a relatively low output of ~700 average MW, whereas the dams may generate ~900 average MW on average across the full historical range of hydro conditions. Therefore, E3's analysis likely underestimates the energy value of the dams and costs for replacing that extra GHG-free energy.
- **LSR dams firm capacity counting**: as resource adequacy is found to be a key driver of future resource needs, the firm capacity contributions of the LSR dams is a key driver of their value. See below for further discussion of this uncertainty.
- **Replacement resource capacity contributions**: if Northwest reliability challenges dramatically shift into the summer, this would also impact the capacity value of replacement resources. Directionally, this would likely increase the capacity value of energy storage, and change the relative value of solar and wind. It is expected that additional battery storage would be part of the regional capacity additions in lieu of dual fuel natural gas + hydrogen plants. See below for further discussion of this uncertainty.
- **Replacement of transmission grid services:** this study does not focus on the transmission grid reliability services provided by the LSR dams. These services likely can be replaced by a combination of the new resources selected by RESOLVE and additional local transmission system investments. A qualitative summary of the transmission grid reliability services of the dams is summarized in the appendix of this report.

LSR Dams Firm Capacity Counting

Since resource adequacy is found to be a key driver of future resource needs, the firm capacity contribution of the LSR dams is a key driver of their value. E3 uses a regional hydro capacity value estimate for the LSR dams in this study, based on the PNUCC regional hydro capacity value assumption. More detailed follow-on ELCC studies could be done to confirm the LSR dams' capacity value, though proper and coordinated dispatch of the Northwest hydro fleet would be necessary to develop an accurate and fair value of the LSR dams within the context of the overall hydro fleet.

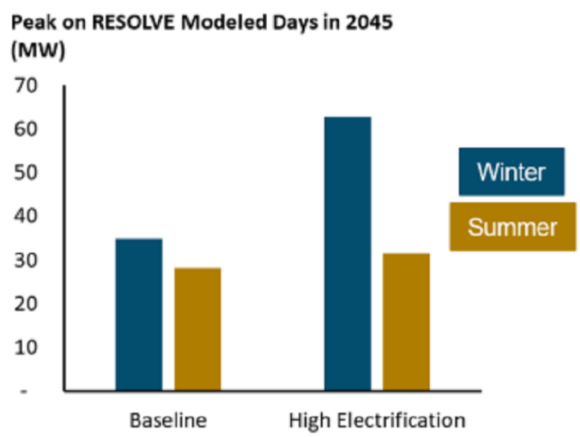
This study validated the assumed 2.28 GW of firm capacity from the LSR dams by considering BPA modeled LSR dams dispatch under 2001 dry hydro year conditions using the CRSO EIS spill constraint adjusted hourly modeling provided by BPA. Maximum January output (plus 100-250 MW of operating reserves) was 1.9-2.1 GW (~56-60% of total capacity), slightly less but close to the 65% regional hydro value the study assumes.

Figure 21. BPA-Modeled LSR Dam Output During the 2001 Low Hydro Year with CRSO EIS Preferred Alternative operations



The other capacity value uncertainty is whether the Northwest will remain winter reliability challenged or whether reliability events will shift to the summer due to climate impacts on load patterns and hydro output. If reliability challenges did shift to the summer, the LSR dam firm capacity contribution would be significantly lower than assumed. However, E3 believes it is reasonable to assume under high electrification scenarios that the region will remain winter challenged due to peak space heating needs, as shown in figure below.

Figure 22. Winter vs. Summer Peak Loads

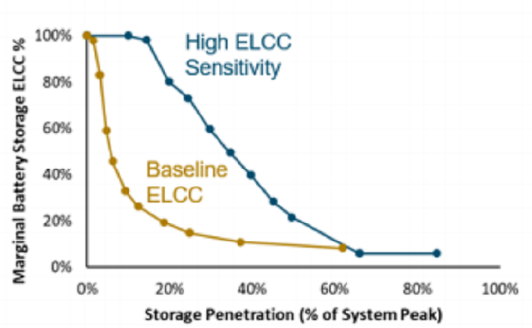


To address the capacity value uncertainty, a post-processing analysis was performed based on the replacement resources selected for firm capacity replacement. Based on this analysis performed on scenarios 1 and 2a, relative to the 2.28 GW assumption used in this study, it is estimated that a 1.5 GW firm capacity value (43%) for the dams would lower the NPV replacement costs by 9-20% and a 1.0 GW firm capacity value (29%) would lower the NPV replacement costs by 14-33%.

Replacement Resources Firm Capacity Counting

If Northwest reliability challenges dramatically shift into the summer, this would also impact the capacity value of replacement resources. One key input assumption this would change is the capacity value of battery storage additions, which were previously limited due to the Northwest wintertime energy-constrained reliability events causing charging sufficiency challenges for energy storage resources. To test whether higher energy storage ELCCs would impact the LSR dams replacement resources and replacement costs, a high storage ELCC sensitivity scenario was analyzed, per the ELCC inputs shown in Figure 23 below. This analysis was performed on scenarios 1 and 2a.

Figure 23. Inputs for High Battery Storage ELCC Sensitivity



In Scenario 1, with the LSR dams intact, higher battery ELCCs cause another 1.5 GW of batteries to be selected and 1.4 GW less dual fuel natural gas and hydrogen plants. In Scenario 2a, with the LSR dams intact, higher battery ELCCs cause another 2.4 GW of batteries and another 0.3 GW of wind to be selected, with 3.6 GW less dual fuel natural gas and hydrogen plants.

When the LSR dams are assumed to be breached, the differences in replacement resources are relatively small. In Scenario 1, an additional ~0.2 GW of battery storage, an additional 0.2 GW of wind, and 0.2 GW less dual fuel natural gas and hydrogen plants are selected to replace the dams. In Scenario 2a, an 0.3 GW less battery storage, 0.3 GW less wind, and an additional 0.1 GW of dual fuel natural gas and hydrogen plants are selected to replace the dams. This is because scenario 2a builds more wind and batteries in the base case already with the dams not breached, so the model prefers to select fewer of those resources for LSR dams replacement. Annual replacement costs in 2045 are 2% lower in scenario 1 and the same in scenario 2a. These results indicate that higher storage ELCCs would allow the region to build less dual fuel natural gas and hydrogen plants, but because energy storage ELCCs eventually saturate in either case, the replacement resources for the dam are not significantly changed and there is little impact on the replacement costs.

Conclusions and Key Findings

This study uses E3's Northwest RESOLVE model to study optimal capacity expansion scenarios with and without the lower Snake River dams, to determine the replacement resources and cost impacts to replace the dams' power output. RESOLVE is an optimal capacity expansion and dispatch model that determines a least-cost set of investment and operational strategies to enable the "Core Northwest" region – consisting of Washington, Oregon, Northern Idaho, and Western Montana – to achieve its long-term clean energy policy goals at least-cost, while ensuring resource adequacy and operational reliability. RESOLVE has been used in several prior studies of electricity sector decarbonization in the Pacific Northwest[37]. Using RESOLVE allows for a dynamic optimization that considers replacement resource needs in the context of long-term system load and policy drivers, not just the near-term resource mix and needs of the system today. The dams are assumed to be breached in 2032, except for one sensitivity that considered 2024 breaching.

This study's scenario design focuses on three key variables – clean energy policy, load growth, and emerging technology availability – that impact the cost to replace the dams.

Even with the dams in place, the region's clean energy goals and potential electrification load growth drive a significant need for new resources. In all scenarios, significant energy efficiency and customer solar is embedded into the load forecast, based on the NWPCC's 8th Power Plan. Additionally, 6 gigawatts ("GW" or 6,000 MW) of coal capacity is retired by 2030, while increasing carbon prices incent further clean energy resource additions. In Scenario 1, the regional power system is required to meet a goal of generating enough clean energy to provide 100% of retail electricity sales, on an average basis over a calendar year. This requires an additional 5 GW of solar and 5 GW of wind by 2045 to achieve the clean energy goal; 0.6 GW of battery storage, 2 GW of demand response, and 9 GW of dual fuel natural gas + hydrogen combustion plants are also added to meet the region's resource adequacy needs.

Though all scenarios require more "firm" resources – resources that can generate when needed and operate for as long as needed – to meet peak loads, these resources are in higher demand in Scenario 2, in which all greenhouse gas emissions are eliminated from the regional power system by 2045. This scenario also assumes that electrification results in much higher electric loads, particularly in wintertime due to electrification of natural gas space heating in buildings. The baseline scenario (2a) selects additional wind, solar, and geothermal to meet clean energy needs as well as demand response, some battery storage, and 27 GW natural gas and hydrogen dual fuel combustion plants to meet reliability needs. An alternative "emerging technology" scenario selects 17 GW of advanced nuclear technology (small modular reactors or "SMRs") by 2045, in place of the firm capacity provided by natural gas generators while reducing the required quantities of wind, solar and batteries that are needed. The "no new combustion" scenario does not allow emerging clean firm technologies such as hydrogen combustion turbines, gas generation with carbon capture and sequestration (CCS) or SMRs. As a result, it requires

[37] Pacific Northwest Low Carbon Scenario Analysis, December 2017, https://www.ethree.com/projects/study-policies-decarbonize-electric-sector-northwest-public-generating-pool-2017-present/; Pacific Northwest Zero-Emitting Resources Study, January 2020, https://www.ethree.com/e3-examines-role-of-nuclear-power-in-a-deeply-decarbonized-pacific-northwest/

impractically high levels of additional onshore wind, offshore wind, and battery storage to meet firm capacity and carbon reduction needs, quadrupling the total installed MW of the Northwest grid by 2045.

When the power services provided by the dams are removed from the regional power system, RESOLVE selects an optimal, i.e., least-cost portfolio of replacement resources that meets the Northwest's clean energy and system reliability needs. These replacement resources require a large investment and come at a substantial cost that increase over time as the region's clean energy goals become more stringent. In the latter years, the replacement costs are highly dependent on scenario-specific assumptions about the availability of emerging technologies. RESOLVE primarily replaces the carbon-free energy from the dams with additional wind power and the firm capacity with dual fuel natural gas and hydrogen combustion plants. Small amounts of additional energy efficiency and battery storage are also selected in some scenarios. By 2045, the dual fuel plants added burn additional hydrogen on low wind days to replace the carbon-free energy provided by the dams. Scenario 2b selects additional nuclear SMRs in lieu of some of the wind and gas resources. Scenario 2c disallows the new combustion plants, even those that would burn green hydrogen, and other emerging technologies, requiring a very large buildout of wind and solar power to replace both the firm capacity and the carbon-free energy of the dams.

The long-term emissions impact of removing the generation of the lower Snake River dams will depend on the implementation of the Oregon and Washington electric clean energy policies. Both a 100% clean retail sales and a zero-carbon emissions target require replacement of most or all of the LSR dams' GHG-free energy. However, without additional earlier carbon-free resource investments beyond those modeled in this study to meet clean energy policy trajectories, carbon emissions may increase initially when the dams are breached, before declining by 2045 as the carbon policy becomes more stringent.

KEY FINDINGS:

- ***Replacing the four lower Snake River dams while meeting clean energy goals and system reliability is possible but comes at a substantial cost***, even assuming emerging technologies are available:
    - Requires 2,300 – 2,700 MW of replacement resources
    - An annual cost of $415 million – $860 million by 2045
    - Total net present value cost of $10.7-19 billion based on 3% discounting over a 50-year time horizon following the date of breaching
    - Increase in costs for public power customers of $100 – 230 per household per year (an 8 – 18% increase) by 2045
- The biggest cost drivers for replacement resources are the need to replace the lost ***firm capacity for regional resource adequacy*** and the need to replace the lost ***zero-carbon energy***
- Replacement becomes ***more costly over time*** due to increasingly stringent clean energy standards and electrification-driven load growth
- ***Emerging technologies*** such as hydrogen, advanced nuclear, and carbon capture ***can limit the cost of replacement resources*** to meet a zero emissions electric system, but the pace of their commercialization is highly uncertain
    - In economy-wide deep decarbonization scenarios, ***replacement without any emerging technologies requires very large renewable resource additions at a very high cost*** (12 GW of wind and solar at $75 billion NPV cost)

Appendix

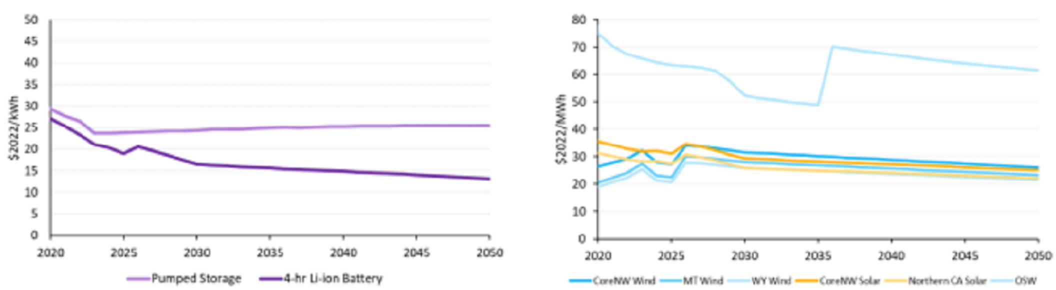
Additional Inputs Assumptions and Data Sources

Candidate resource costs

The technology fixed costs trajectories for candidate resource options are shown in Figure 24 and use the following data sources:

+ **Battery Storage:** Costs derived from Lazard LCOS 7.0 and E3 modeling
+ **Pumped Storage:** Costs derived from Lazard's last published PHS costs (LCOS 4.0)
+ **Renewables (solar, onshore, and offshore wind):** Costs derived from E3's inhouse Pro Forma which integrates the NREL 2021 Annual Technology Baseline
+ **Geothermal:** Costs derived from E3's inhouse Pro Forma which integrates the NREL 2021 Annual Technology Baseline
+ **Energy Efficiency and Demand Response:** Costs supply curve adjusted for cost effective energy efficiency and DR potential from the 2021 Northwest Power Plan
+ **Carbon Capture and Storage (CCS):** Costs derived from E3's inhouse "Emerging Tech" Pro Forma using the NREL 2021 Annual Technology Baseline and Feron et al., 2019.[38]
+ **Nuclear Small Modular Reactor (SMR):** Costs are derived from the vendor NuScale, for an "nth of a kind" installation of the technology they are developing
+ **Gas and Hydrogen-Capable Technologies:** CCGT and peaker costs are derived from E3's inhouse ProForma which integrates NREL 2021 Annual Technology Baseline. New Hydrogen or natural gas to hydrogen upgrades include a ~10% additional cost that converges with standard CCGT and peaker costs by 2050

Figure 24. All-in fixed costs for candidate resource options[39]



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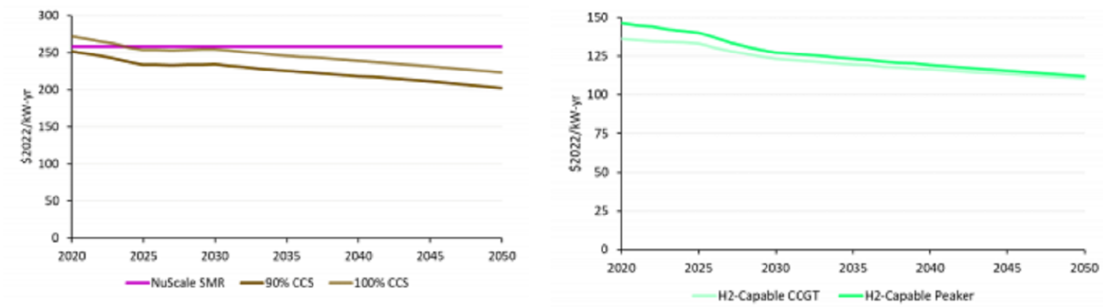
[38] Feron, P., Cousins, A., Jiang, K., Zhai, R., Thiruvenkatachari, R., & Burnard, K. (2019). Towards zero emissions from fossil fuel power stations. International Journal of Greenhouse Gas Control, 87, 188–202.

[39] Storage costs are shown in $/kWh of energy storage. Renewable costs are shown in $/MWh. Clean firm resources (nuclear, CCS, hydrogen CCGT or peakers) are shown in $/kW-yr, since their $/MWh costs are a function of their runtime that RESOLVE would determine endogenously.

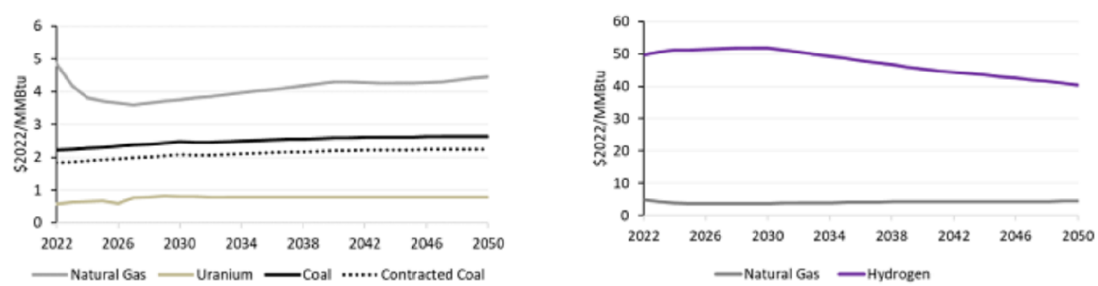


Fuel prices

The fuel price forecasts used in this study are derived from a combination of market data and fundamentals-based modeling of natural gas supply and demand. Wholesale gas prices are pulled from forward contracts from NYMEX (Henry Hub) and Amerex and MI Forwards (all other hubs) for the next five years, after which the Henry Hub forecast trends towards EIA's AEO natural gas price by 2040. All other hubs forecast after the first five years are based on the average 5-year relationship between their near-term forward contracts and that of Henry Hub. Data sources used for fuel price forecasts used in modeling are as follows and the trajectories are presented in Figure 25:

+ **Natural gas prices:** In near term, SNL NG price forecasts (i.e., for 2022-2026); and in long term, the EIA's AEO 2040 forecasts are used. Recent fuel cost increases due to market disruptions are excluded from the price trajectory.
+ **Coal prices:** EIA's AEO forecast are used
+ **Uranium prices:** E3's in-house analysis
+ **Hydrogen prices:** Conservative prices are used assuming no large-scale hydrogen economy, and thus electrolyzer capital costs and efficiencies are assumed to improve over time only slightly. Other assumptions include above ground hydrogen storage tanks and delivery via trucks from about 225 miles distance. Electrolyzers use dedicated off-grid Core NW wind power to produce hydrogen.

Figure 25. Fuel price forecasts for natural gas, coal, uranium, and hydrogen

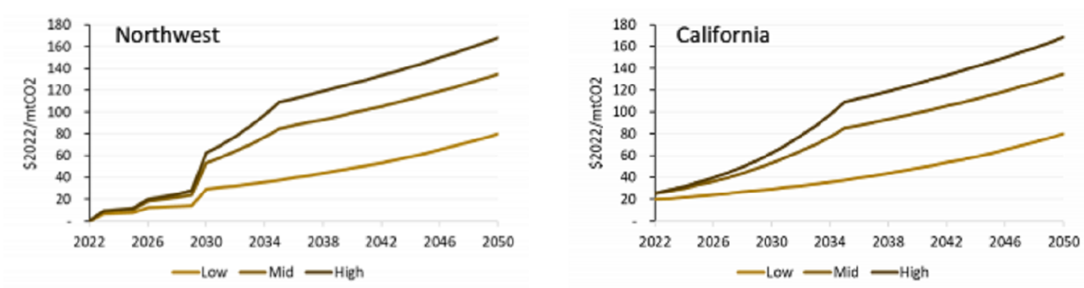


Annual average gas prices are further shaped according to a monthly profile to capture seasonal trends in the demand for natural gas and the consequent impact on pricing.

Carbon prices

For carbon pricing, it is assumed that Washington's cap-and-trade program starts in 2023 at around 50% of California carbon prices. For Oregon, it is assumed that a carbon price policy will be effective by 2026 for the electric sector. Prior to 2026, the Northwest carbon price is a load weighted share of carbon prices in WA and OR. Additionally, it is assumed that both states will converge to California's floor price by 2030. California's carbon prices are adopted from the Final 2021 IEPR GHG Allowance Price Projections (December 2021). Mid carbon prices presented in Figure 26 are used in modeled cases.

Figure 26. Carbon price forecasts for Northwest and California



Operating Reserves

It is assumed that all coal, gas, hydro, and storage resources within the Northwest zone can provide operating reserves. Additionally, RESOLVE allows renewable generation to contribute to meeting the needs for load following down; to allow for variable renewable generation curtailment to balance forecast error and sub-hourly variability. The following three types of operating reserve requirements are considered within the Core Northwest to ensure that in the event of a contingency, sufficient resources are available to respond and stabilize the electric grid:

+ **Spinning reserves:** Modeled as 3% of hourly load in agreement with WECC and NWPP operating standards
+ **Regulation up and down:** Modeled as 1% of hourly load
+ **Load following up and down:** Modeled as 3% of hourly load

Modeling of Imports and Exports

The Northwest RESOLVE model includes a zonal representation of the WECC. In modeling hourly dispatch during representative days, it considers the least-cost dispatch solution across the WECC, based on resource economics, resource operational limits, fuel and carbon prices, operating reserve requirements, and zonal transmission transfer limits. Imports to the CoreNW zone can occur from other neighboring zones; when they do a carbon adder is included for unspecified imports, while specified imports do not receive a carbon adder. Exports from the CoreNW zone may occur as deemed economic by RESOLVE, subject to other model constraints.

Minimum and maximum capacity limits are applied to the zonal representation of transmission between connected zones. These zonal transfer limits are shown in Table 13. Transmission hurdle rates as well as carbon hurdle rates (with regional carbon price adders) are applied to imports and exports.

Table 13. Transmission Capacity Limits between the CoreNW and other Zones

Transmission Constraint	Transmission from	Transmission to	Min Flow (MW)	Max Flow (MW)
CoreNW to OtherNW	CoreNW	OtherNW	-6,036	2,550
CoreNW to CA	CoreNW	CA	-6,820	5,433
CoreNW to SW	CoreNW	SW	0	0
CoreNW to NV	CoreNW	NV	-300	300
CoreNW to RM	CoreNW	RM	0	0

Contracted imports (such as imported coal and/or wind power) are included in the resource adequacy accounting captured in the planning reserve margin constraint. New remote resources include transmission cost adders to deliver them into the CoreNW zone. Additional unspecified imports are not assumed in RESOLVE's resource adequacy accounting.

Additional LSR Dam Power System Benefits (not modeled)

As described in this report, RESOLVE covers replacement of most power services provided by the LSR dams. However, RESOLVE does not model transmission grid operations (power flow, voltage and frequency, dynamic stability, etc.). Therefore, E3 notes that the LSR dams may provide the following additional essential reliability services to the transmission grid. In general, E3 expects that the replacement of these services can be achieved either through siting and operations of the incremental replacement capacity selected or by additional local transmission investments. The scale of these transmission investments requires more detailed study.

- **Reactive power and voltage control**: the LSR dams, like hydropower resources generally in the Northwest, provide significant reactive power capabilities that supports reliable power flow by optimally controlling voltage levels. Replacing this function likely requires siting additional resources with reactive power capabilities in a similar section of the transmission grid as the LSR dams.
- **Frequency response and inertia**: the LSR dams provide both primary and secondary frequency response capabilities. As synchronous generators they also provide system inertia that would be lost if the LSR dams are removed and as other synchronous generators retire. New efforts are underway to allow renewable generators or battery storage to provide "synthetic inertia" (or equivalent fast frequency response services), but this provision has not yet been proven to date at scale. The LSR dams are also highly tolerant of operating during high and low frequency events without sustaining blade damage.
- **Blackstart**: Large hydro resources have the capability to provide black start services when required, though not all hydro plants are chosen to provide this capability.

- **Participation in remedial action schemes**: Hydropower is a robust resource for participation in remedial action schemes because it can withstand being suddenly tripped off-line as part of a RAS action.
- **Short circuit and grounding contribution**: Synchronous generators (like hydropower) provide a large short circuit current that is important for the proper operation of protective relaying schemes.

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BPA Lower Snake River Dams Power Replacement Study

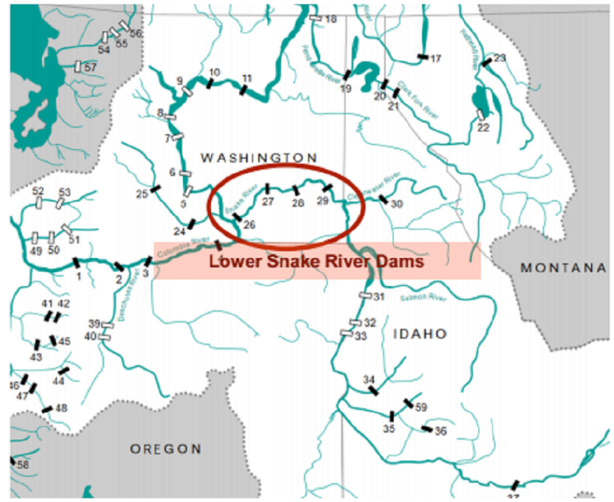
Executive Summary

July 2022

Arne Olson, Sr. Partner
Aaron Burdick, Associate Director
Dr. Angineh Zohrabian, Consultant
Sierra Spencer, Sr. Consultant
Sam Kramer, Consultant
Jack Moore, Sr. Director

About this study

- **BPA contracted with E3 to conduct an independent analysis of the electricity system value of the four lower Snake River (LSR) dams**
- **E3 utilized our RESOLVE optimal capacity expansion model to identify least-cost portfolios of electricity resources needed to replace the electric energy and grid services provided by the dams through 2045**
- **Replacement costs are considered within the context of the Northwest region's aggressive, long-run decarbonization goals**



Key Study Questions:

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

What would it take to replace the output of the four lower Snake River dams?

- **What energy services are lost if the dams are breached?**
  - **3,483 MW of total capacity***, including approximately **2,300 MW of firm peaking** capability to avoid power shortages during extreme cold weather events
  - **~900** annual average MW of low-cost, zero-carbon energy** (enough energy to support ~450,000 households or 1.7x the City of Portland) as well as **operational flexibility** services
- **How much would it cost to replace the power benefits of the four lower Snake River dams in E3's study with breaching in 2032?**
  - In E3's **baseline scenario**, total net present value (NPV)*** replacement costs would be **$11.8 billion**
  - In a **deep decarbonization scenario** with higher loads and zero emissions electricity by 2045, NPV costs range from **$10.7-19 billion** with at least one emerging technology
    - Reaching deep decarbonization **absent breakthroughs in not-yet-commercialized emerging technologies**, NPV costs could increase to **$75 billion**
- **What are the long-term rate impacts to ~2 million public power households in 2045?**
  - Public power costs increase by **8-18% or ~$100-230 per year across most scenarios**
    - Costs increase by **65% or ~$850 per year** under deep decarbonization scenario **absent emerging technology breakthroughs**
- **What resources are needed to replace the dams?**
  - A combination of **renewable generation** (wind), **"clean firm" resources** (such as dual fuel natural gas + hydrogen plants, advanced nuclear, or gas with carbon capture and storage), and **energy efficiency**
  - Battery storage cannot cost-effectively replace hydro capacity in the Northwest due to charging limitations during energy shortfall events
- **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 5-7 years after congressional approval to breach the dams and possibly up to 10-20 years if additional new large-scale transmission was required. E3 assumed transmission would be built as needed for renewable additions.

Plant	Total Capacity (MW)
Lower Granite	930
Little Goose	930
Lower Monumental	930
Ice Harbor	693

Total = 3,483 MW

* Hydro traditionally operates above nameplate and closer to overload capacity (~15% above nameplate) and FERC uses these peak generation values in hydro licensing. Historical peak generation was 3,431 MW.
** E3's RESOLVE model uses 2001, 2005, and 2011 hydro years, which resulted in ~700 aMW of lower Snake River dams generation, making it a conservative estimate of the dams' GHG-free energy value
*** NPV calculated over a 50-year period following the date of breaching, using a 3% discount rate based on the approximate public power cost of capital.

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Study Approach

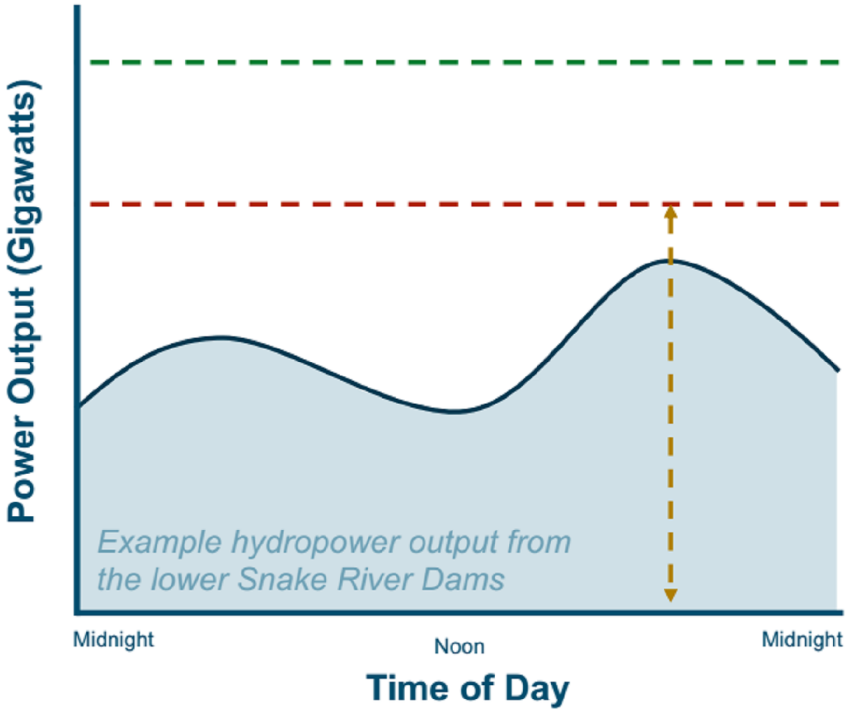
What grid services do the lower Snake River dams provide?

Little Goose

Lower Granite

Lower Monumental

Ice Harbor



Total "Capacity"
Maximum instantaneous power output the four dams
LSR Dams = 3.5 GW*

"Firm Capacity"
Sustained peaking output (+ reserves) during reliability strained conditions
(e.g. cold January during a drought year)
LSR Dams = 2.3 GW**

Annual (Carbon-free) Energy
Sum of hourly power produced across the year, subject to seasonal water availability
LSR Dams = 0.9 average GW***

Operational Flexibility
The ability to change power output to support a reliable grid, subject to water availability and operational constraints
LSR Dams provide short-term reserves + multi-hour ramping / renewable integration capabilities

E3's modeling selects the least-cost portfolio of resources to replace these services

Transmission Grid Reliability Services
Services to reliably operate the transmission grid
(e.g., voltage, frequency support, blackstart, etc.)
LSR Dams can provide, but not the focus of this study

Some of these services may be provided by modeled replacement resources, other may require additional investments

* Hydro traditionally operates above nameplate and closer to overload capacity (~15% above nameplate) and FERC uses these peak generation values in hydro licensing. Historical peak generation was 3,431 MW.
** Firm capacity assumed in this study is consistent with the ~65% Northwest hydro capacity value assumed by PNUCC (the Pacific Northwest Utilities Conference Committee).
*** Average GW means that on average across an average year the plant generated at ~0.9 GW, though its hourly output may be above or below that amount. LSR output was adjusted to reflect increased spill requirements of the EIS. However, E3's RESOLVE model uses 2001, 2005, and 2011 hydro years, which resulted in ~0.7 aMW of lower Snake River dams generation, making it a conservative estimate of the dams' GHG-free energy value.

What's the focus in this study compared to the CRSO EIS?

The study uses an optimization model to determine the least-cost replacement resources for the four lower Snake River dams subject to A) policy and B) reliability constraints

- **Least-cost optimization: includes updated resource pricing and new emerging technologies**
- **Policy: E3's modeling considers the effects of regional policies such as Washington's Clean Energy Transformation Act (CETA) and Oregon's 100% clean electricity standard**
  - Aggressive clean energy laws drive coal power plant retirements, price carbon emissions, and require long-term **carbon emissions reductions** by 2045
  - Study includes significant **electrification** that increases demand for electricity to support carbon-reduction in other sectors such as transportation, buildings, and industry, consistent with Washington's Energy Strategy
- **Reliability: E3's modeling captures the need for the Northwest system to meet peak load during extreme weather and low hydro conditions (known as "resource adequacy").**
  - Captures the abilities and limits of different technologies to serve load during reliability challenging conditions
    - E.g. during extended cold-weather periods with high load, low hydropower availability, and low wind and solar production
  - Resources with high energy production costs may be selected for reliability needs but then run sparsely only during extreme conditions (e.g. natural gas + hydrogen combustion turbines)
- **LSR operations: incorporates preferred alternative operations selected in the EIS**
  - Increases spill from the dams, lowering available annual energy and changing operational flexibility

Policy landscape: Washington, Oregon, California

+ **The study includes the impacts from clean energy policies in the Pacific states**

	RPS or Clean Energy Standard?	Coal Prohibition?	Cap-and-Trade?	New Natural Gas?	Economy-Wide Carbon Reduction?
WA	✓ Carbon neutral by 2030, 100% carbon free electricity by 2045	✓ Eliminate by 2025	✓ Cap-and-invest program established in 2021, SCC in utility planning	✓	✓ 95% GHG emission reduction below 1990 levels and achieve net zero emissions by 2050
OR	✓ 50% RPS by 2040, 100% GHG emission reduction by 2040, relative to 2010 levels	✓ Eliminate by 2030	✓ Climate Protection Plan adopted by DEQ in 2021 (power sector not included)	✕ HB 2021 bans expansion or construction of power plants that burn fossil fuels	✓ 90% GHG emission reduction from fossil fuel usage relative to 2022 baseline
CA	✓ 60% RPS by 2030, 100% clean energy by 2045	✓ Coal-fired electricity generation already phased out	✓	✕ CPUC IRP did not allow in recent procurement order	✓ 40% GHG emission reduction below 1990 levels by 2030 and 80% by 2050

Modeling approach involves a three-step process

1 ***With the lower Snake River dams*, optimize long-term resource needs and operations for the Pacific Northwest**

- Produces necessary resource additions and total system costs and emissions

2 ***Remove the lower Snake River dam generating capacity, then re-optimize* long-term resource needs and operations for the Pacific Northwest**

- Produces a second set of resource additions and total system costs and emissions
- All scenarios breach the dams in 2032, except for one scenario in 2024

3 ***Calculate additional resources and investment + operational costs* required to replace the dams**

- Calculated as the difference between steps 1 and 2 above

Key modeling assumptions

Element	Study Approach	Impact on Dams Replacement Needs
Study Years	• 2025 through 2045*, including fuel price forecasts and declining renewable + storage costs	Considers long-term needs
Clean Energy Policy Scenarios	• Aggressive OR+WA legislation reflected, including coal retirements + carbon pricing • Two electric emissions scenarios considered: 1. **100% clean retail sales** (~85% carbon reduction**) 2. **Zero-emissions** (100% carbon reduction)	Clean energy policy requires long-term **replacement of LSR dams with GHG-free energy**
Load Growth Scenarios	• Two load scenarios: 1. **Baseline** (per NWPCC 8th Power Plan) 2. **High electrification** load growth (to support economy-wide decarbonization) • Significant quantities of energy efficiency are embedded in all scenarios	Higher load scenarios **increase the value of LSR dams energy + firm capacity**
Reliability Needs	• Modeling ensures reliability needs during extreme conditions (e.g. high loads + low hydro) • Captures ability (and limits) of renewables, battery storage, and demand response to support system reliability	Reliability needs require **replacement of LSR dams firm capacity contributions**
Technologies Modeled, including "Emerging" Technologies	• Broad range of dam replacement technology options considered: • **Baseline technologies**: solar, wind, battery + pumped storage, energy efficiency, demand response, dual fuel natural gas + hydrogen combustion plants • **Sensitivities** include Emerging Technologies and Limited Technologies (No New Combustion) scenarios • Resource costs developed by E3 using NREL 2021 ATB, Lazard Cost of Storage v.7, NuScale Power (for small modular reactor costs)	**Technology available for LSR dams replacement** determines replacement cost
Distributed Energy Resource Options	• Energy efficiency, demand response, and customer solar embedded into modeling inputs • Additional energy efficiency and demand response can be selected	**Demand resource can help replace LSR dams**, though low-cost supply is limited

* 20-years of end effects are considered (2045-2065)
** A 100% clean retail sales target allows emissions for electric generation beyond that needed to serve "retail sales", i.e. losses during transmission to retail loads and exported energy

Scenarios

+ Scenario 1: 100% Clean Retail Sales

- Northwest resources produce enough clean energy to meet **100% of retail electricity sales** on an annual average basis
- Some gas generation is retained for reliability, but carbon emissions are reduced **85% below 1990 levels**
- **Business-as-usual** load growth

+ Scenario 2: Deep Decarbonization

- **Zero carbon emissions** by 2045
- **High electrification** of buildings, transportation, and industry to reduce carbon emissions in other sectors
- **Emerging technologies** become available to provide firm, carbon-free power

Emerging Technologies

Technology	S1 100% Clean	S2a Deep Decarb Baseline	S2b Deep Decarb Emerging Tech.	S2c Deep Decarb No New Combustion
Mature technologies (solar, wind, battery + pumped storage, energy efficiency, demand response)	Available	Available	Available	Available
Hydrogen (existing natural gas retrofits)	Available	Available	Available	Available
Hydrogen (new dual fuel natural gas + hydrogen)	Available	Available	Available	Not available
Nuclear (small modular reactors)	Not available	Not available	Available	Not available
Natural Gas w/ Carbon Capture and Storage	Not available	Not available	Available	Not available
Offshore Wind (floating)	Not available	Not available	Available	Available

Available
Not available

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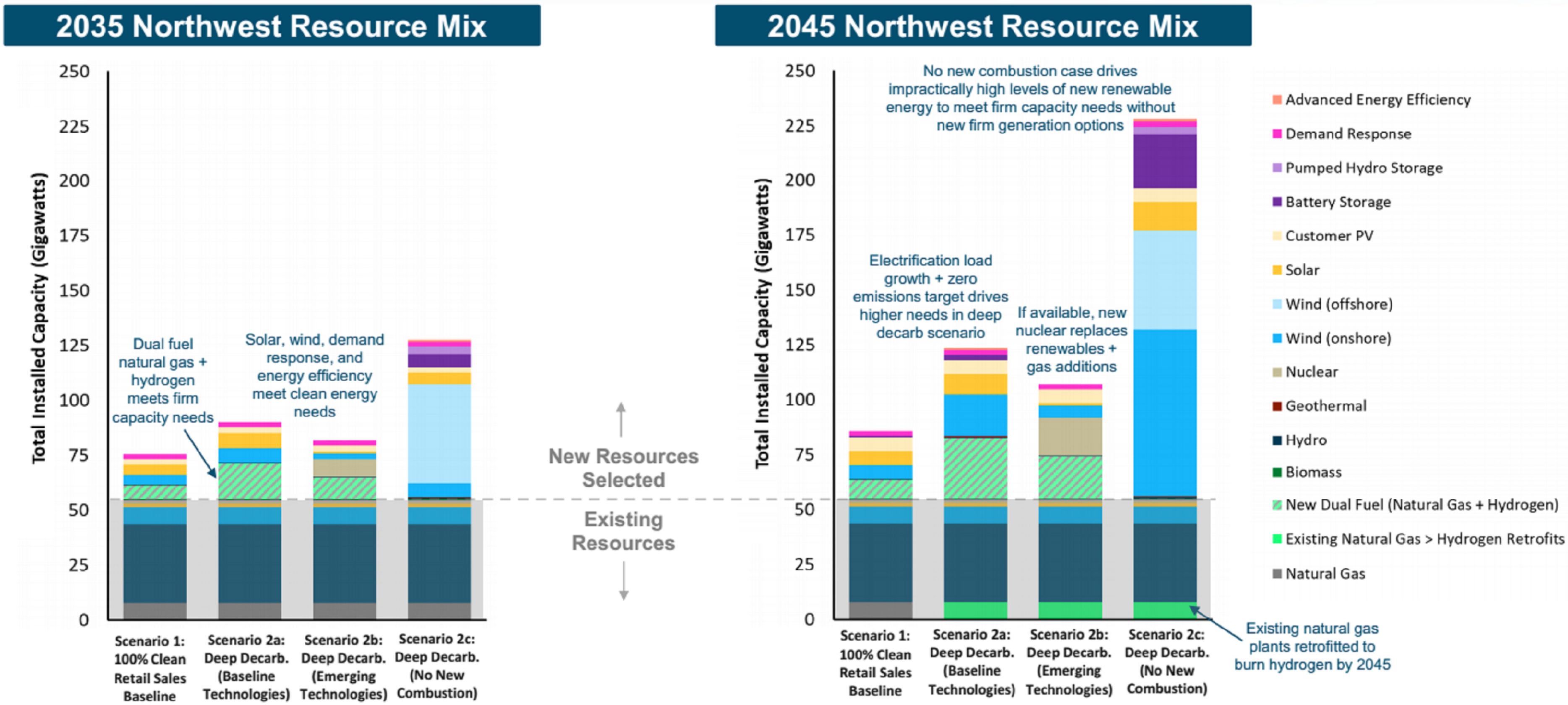
Northwest Resource Needs in Scenarios With the Lower Snake River Dams

Even without breaching the dams, all scenarios show large levels of new resource additions



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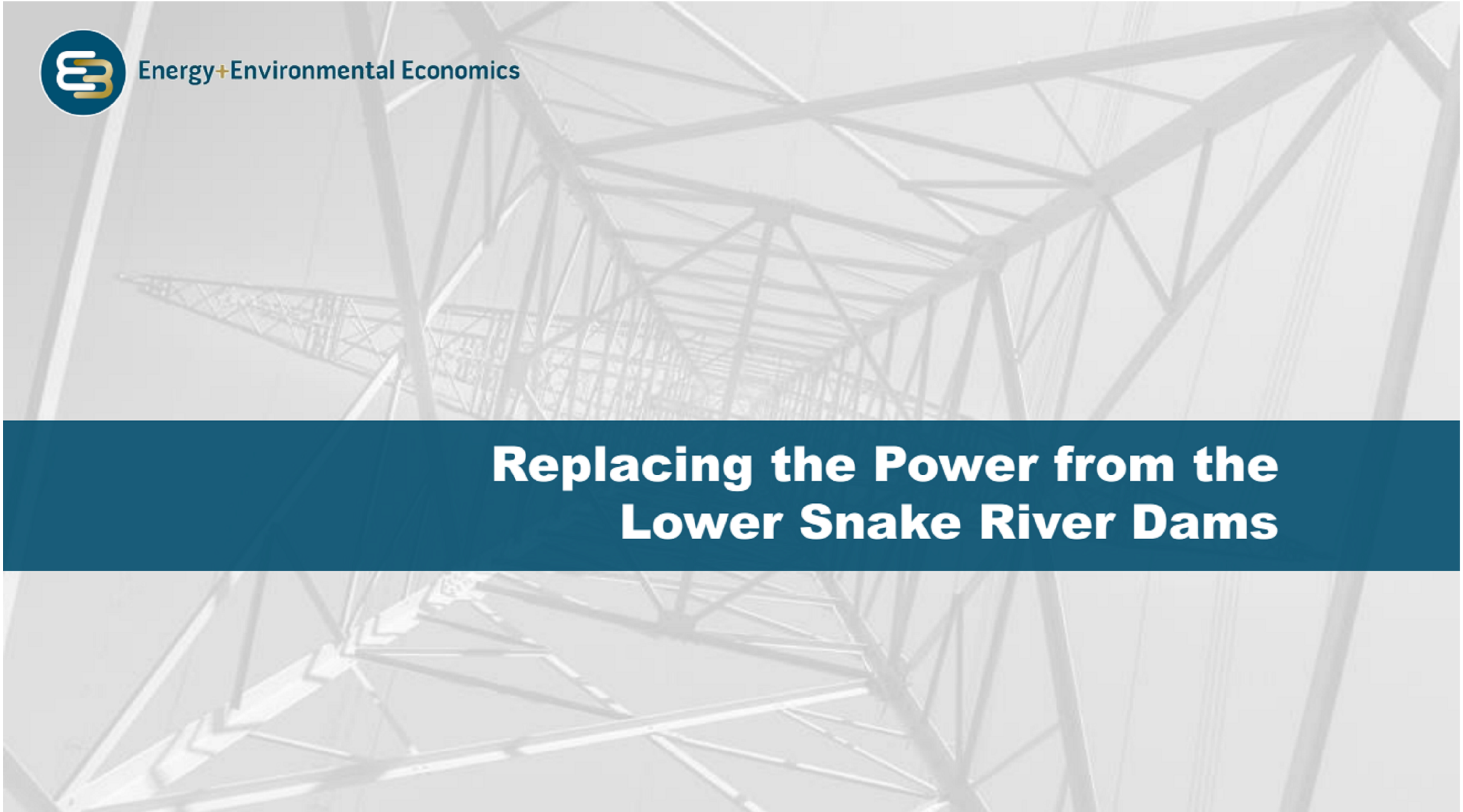


Replacing the Power from the Lower Snake River Dams

Replacement resources selected to replace the lower Snake River dams

- **RESOLVE selects an optimal portfolio of replacement resources including additional advanced energy efficiency, wind, solar, green hydrogen, and/or advanced nuclear**
- **Firm 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 renewables and some of the gas plants**
- **The "no new combustion" scenario requires impractically large (~12 GW) buildout of renewable energy to replace the dams' firm capacity contributions and GHG-free energy**

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

* 1 GW = 1,000 MW
** Replacing LSR dams GHG-free energy at least-cost leads RESOLVE to generate an additional 1.2 TWh of hydrogen generation during low renewable conditions (or 0.14 average GW).

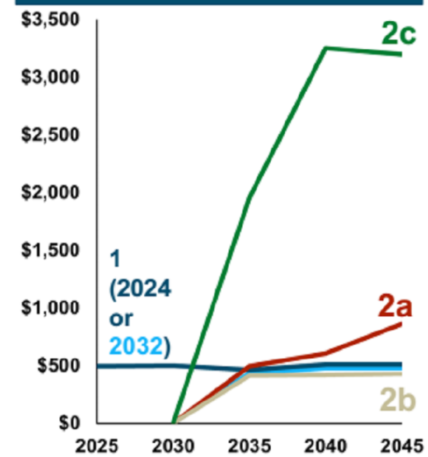
Total costs for replacing the lower Snake River dams

+ Costs are expected to fall on Bonneville Power Administration's public power customers

- Costs could **increase public power retail costs** by 8-18%, or up to 65% absent emerging technologies
- Costs could **raise annual residential electricity bills** by up to $100-230/year, or up to $850/yr absent emerging technologies

	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	$11.8 billion	n/a	$434 million	$478 million	0.8 cents/kWh [+9%]
Scenario 1: 100% Clean Retail Sales (2024 dam breaching)	$12.8 billion	$495 million	$466 million	$509 million	0.8 cents/kWh [+9%]
Scenario 2a: Deep Decarb. (Baseline Technologies)	$19.0 billion	n/a	$496 million	$860 million	1.5 cents/kWh [+18%]
Scenario 2b: Deep Decarb. (Emerging Technologies)	$10.7 billion	n/a	$415 million	$428 million	0.7 cents/kWh [+8%]
Scenario 2c: Deep Decarb. *(No New Combustion)*	*$75.2 billion*	*n/a*	*$1,953 million*	*$3,199 million*	*5.5 cents/kWh [+65%]*

Annual Cost Increase ($M)



Deep decarbonization without emerging technologies drives impractically high costs

Cost differences driven primarily by 2045 carbon policy and availability of emerging technologies

Costs increase over time as loads grow and carbon policy becomes more stringent

- 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. NPV calculated over a 50-year period following the date of breaching, using a 3% discount rate based on the public power cost of capital.
- % 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 rate increases driven by higher loads or clean energy needs that increase regional rates as shown in the earlier 2045 incremental cost chart.
- 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).
- 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

Cost of generation for lower Snake River dams replacement resources (using common utility metric of $/MWh)

+ **The lower Snake River dams provide a low-cost source of GHG-free energy and firm capacity**
+ **Even in a best-case scenario, replacement power would cost several times as much as the lower Snake River dams costs**
  - This is driven by both energy replacement as well as replacement of firm capacity and operational flexibility
+ **Compared to ~$13-17/MWh for the lower Snake River dams, replacement resources cost between $77-139/MWh**
  - Replacement costs rise to over $500/MWh in a deep decarbonization scenario absent emerging technology

Incremental LSR Dam Replacement Resource Costs

Lower Snake River Dams All-in Generation Costs (2022 $/MWh)
$13/MWh w/o LSRCP*
$17/MWh w/ LSRCP*

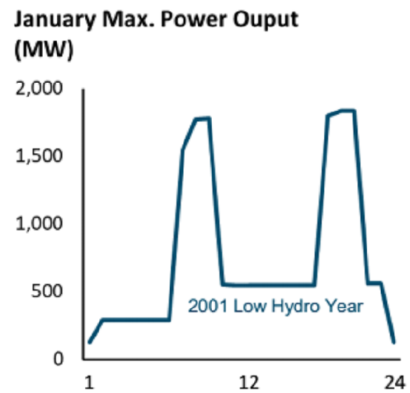
Scenario	2045 Costs to replace LSR Generation** (real 2022 $/MWh)
S1: 100% Clean Retail Sales	$77/MWh
S1b: 100% Clean Retail Sales (2024 dam breaching)	$82/MWh
S2a: Deep Decarb	$139/MWh
S2b: Deep Decarb, w/ Emerging Tech	$69/MWh
S2c: Deep Decarb, Limited Tech (no new combustion)	$517/MWh

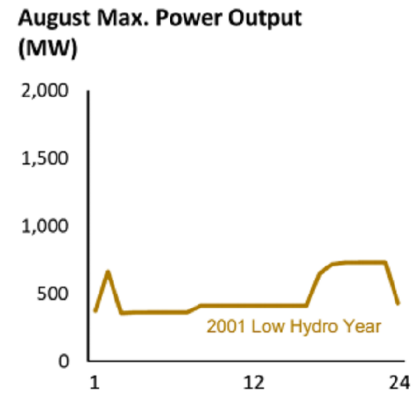
* BPA directly funds the annual operations and maintenance of the Lower Snake River Compensation Plan (LSRCP) fish hatcheries and satellite facilities. Congress authorized the LSRCP as part of the Water Resources Development Act of 1976 (90 Stat.2917) to offset fish and wildlife losses caused by construction and operation of the four lower Snake River projects.

** Replacement $/MWh costs are calculated as CoreNW revenue requirement increase with LSR dams breached divided by the annual MWh of the LSR dams assumed in E3's modeling (~700 aMW). These costs includes replacement of the LSR dam energy, capacity, and reserve provision. A significant portion of the costs is capacity costs to replace the dams' RA capacity contributions.

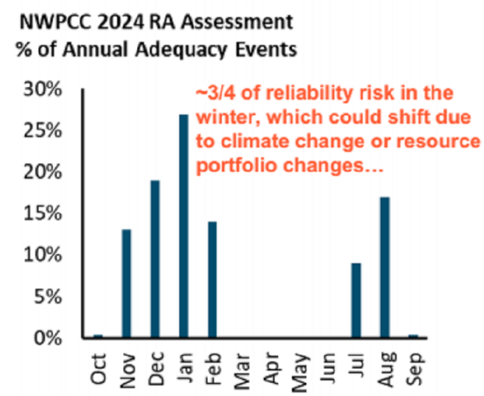
Firm capacity value of the lower Snake River dams

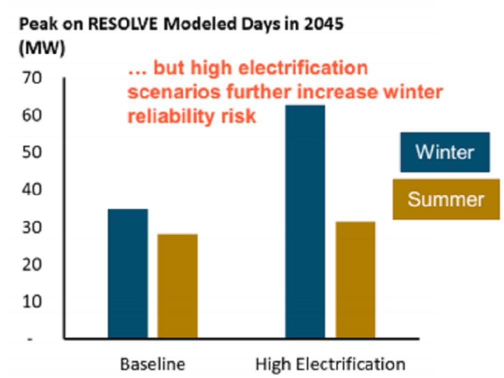
- **The firm capacity value is a significant driver of replacements costs**
- **PNUCC 2021 estimate of NW hydro sustained peaking capacity was used for the lower Snake River dams' firm capacity value (65% or 2.3 GW)**
- **E3 also analyzed modeled hourly LSR dam output during the 2001 low hydro year (using BPA data post EIS spill requirements)**
  - Suggests a winter firm capacity value of ~56-60%
- **E3 predicts a continued concentration of risk in the winter in deep decarbonization scenarios with high space heating electrification**
  - However, in a system with higher summer reliability risk, the LSR firm capacity value would be lower
  - E3 estimates the impact of a lower firm capacity value for S1 and S2a scenarios to be:
    - 1.5 GW firm capacity value (43%) → ~9-20% lower NPV replacement cost
    - 1.0 GW firm capacity value (29%) → ~14-33% lower NPV replacement cost





Assuming the Northwest remains winter reliability challenged, LSR Dams could have contributed ~56-60% of total capacity or 1.9-2.1 GW* in the 2001 low hydro year





* Includes 100-250 MW reserve provision on top of maximum power output

Key conclusions

1. **Replacing the four lower Snake River dams comes at a substantial cost, even assuming emerging technologies are available**
   - Require 2,300 – 2,700 MW of replacement resources
   - An annual cost of $415 million – $860 million by 2045*
   - Total net present value replacement cost of $10.7 – 19.0 billion based on 3% discounting over a 50-year time horizon following the date of breaching
   - Increase in costs for public power customers of $100 – 230 per household per year (an 8 – 18% increase) by 2045
2. **The biggest cost drivers for replacement resources are the need to replace the lost firm capacity and the need to replace the lost zero-carbon energy**
3. **Replacement resources become more costly over time due to increasingly stringent clean energy standards and electrification-driven load growth**
4. **Emerging technologies such as hydrogen, advanced nuclear, and carbon capture can limit the cost of replacement resources to meet a zero emissions electric system, but the pace of their commercialization is highly uncertain**
   - Replacing the dams in deep decarbonization scenarios without any emerging technologies requires impractical levels of renewable additions at a very high cost ($75 billion NPV cost)

* Replacement resource costs are calculated assuming project financing per E3's pro forma calculator, rather than assuming upfront congressional appropriation

Energy+Environmental Economics

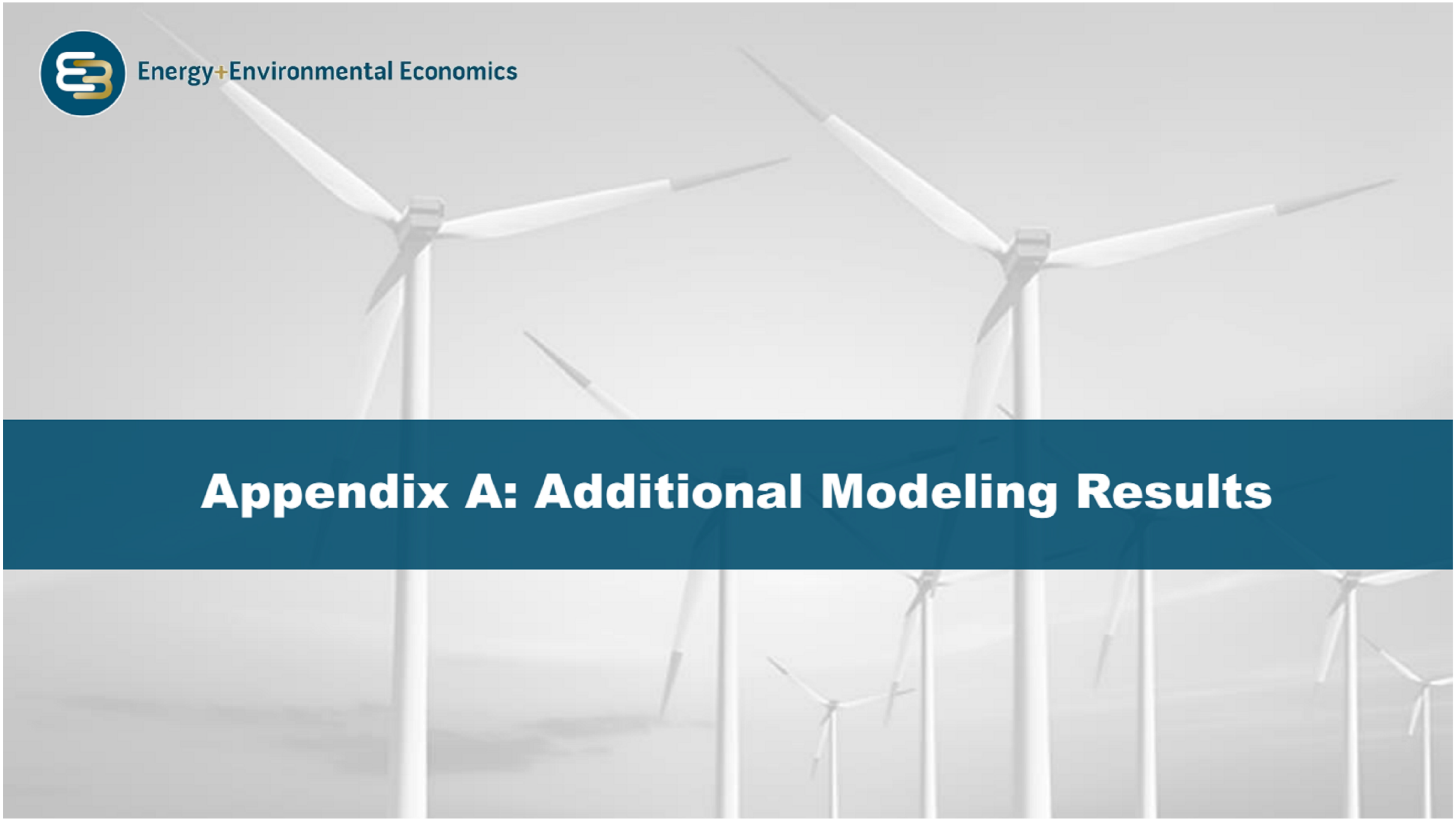
Thank you

Questions, please contact:

Arne Olson, arne@ethree.com

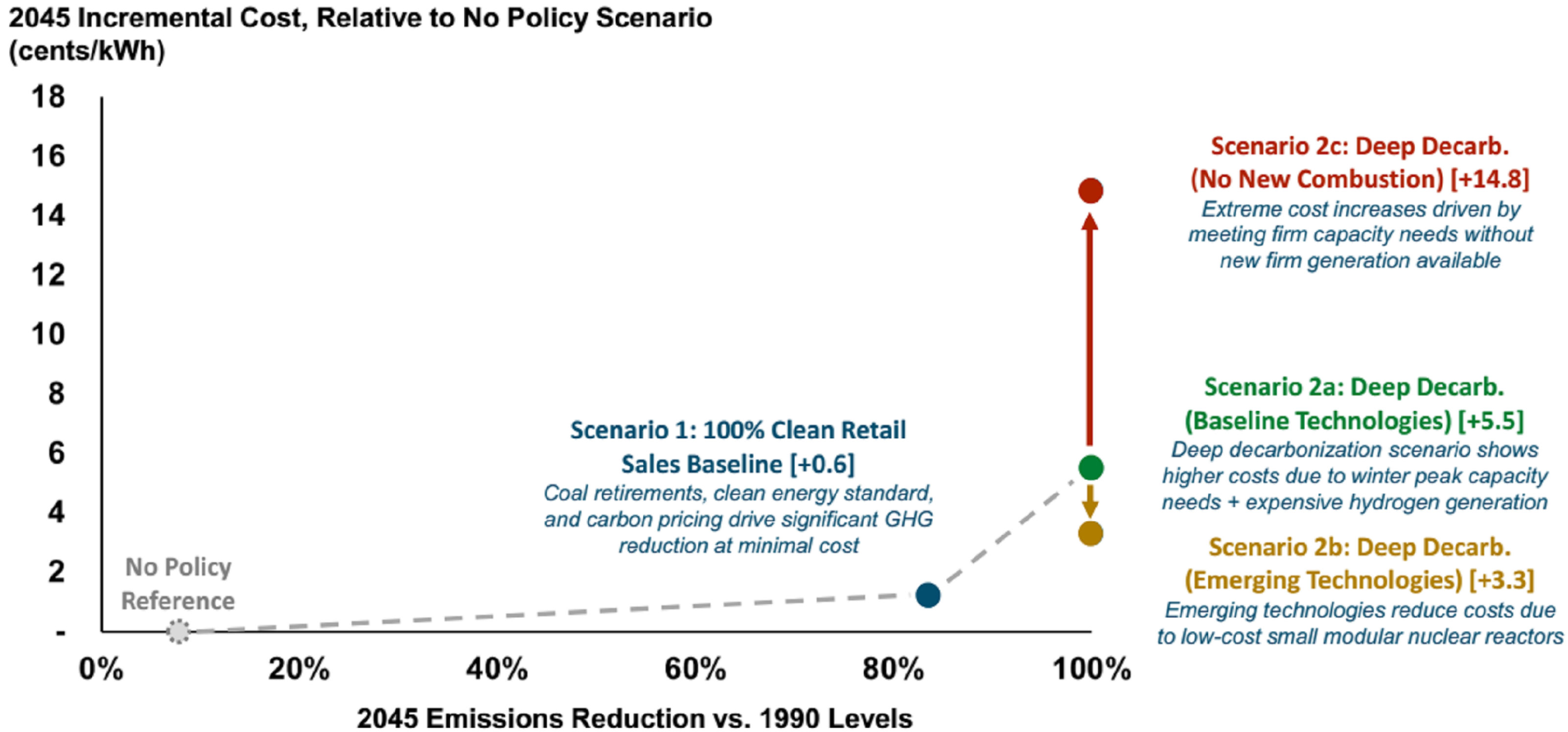
Aaron Burdick, aaron.burdick@ethree.com

Energy+Environmental Economics



Appendix A: Additional Modeling Results

Significant carbon reductions are possible, but the cost of reaching zero emissions depends on technologies available

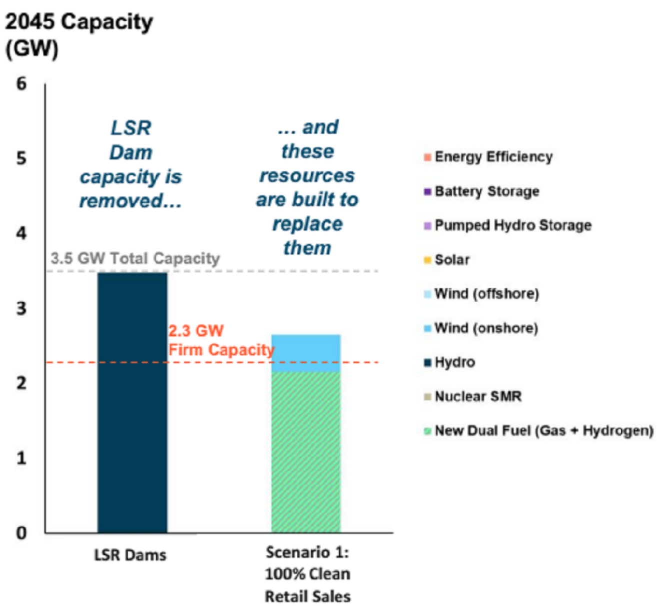


NOTES:
- 2020 average retail rates for OR and WA were 8-9 cents/kWh; 1990 electric emissions were ~33 MMT
- High electrification scenarios would avoid natural gas infrastructure costs, which would offset some of the electric peaking infrastructure cost increase

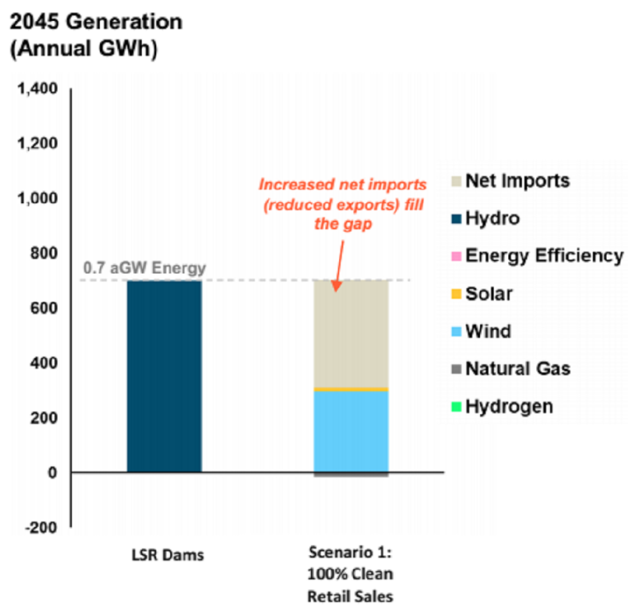
Replacing the Lower Snake River Dams
Scenario 1: 100% Clean Retail Sales

+ Capacity replaced with 2.2 GW of dual fuel natural gas + hydrogen turbines and 0.5 GW wind
+ Wind and imports provide the most energy replacement, but gas plant is needed for meeting extreme weather peak load events to avoid power shortages
+ 2045 GHG emissions increase ~11% as not all LSR generation needs to be replaced to still meet 100% clean retail sales target

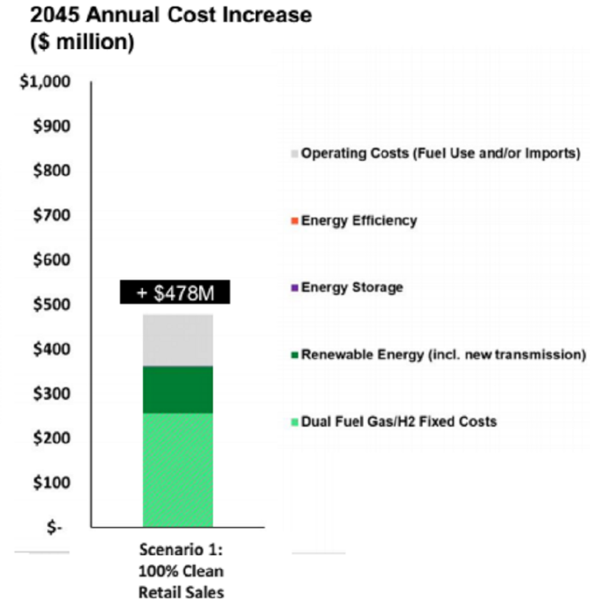
Additional Resources Built to Replace LSR Dams (2045)



Additional Generation to Replace LSR Dams (2045)



Additional Cost (2045)

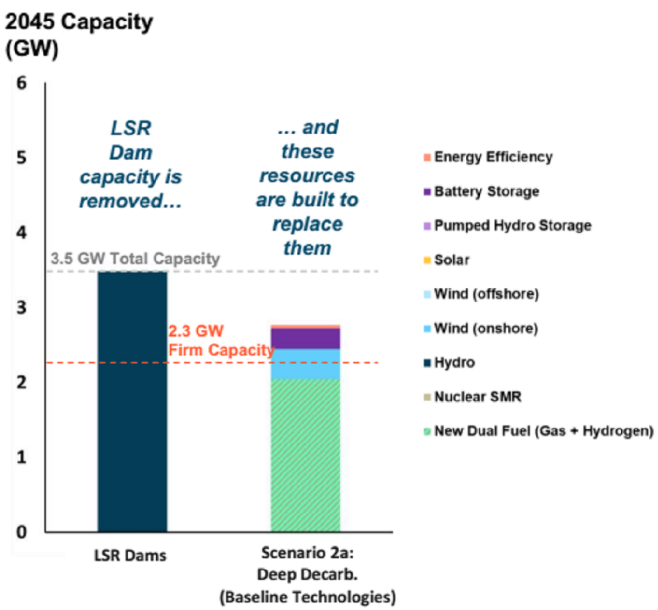


27690982 BPA-2023-008550F-00000039

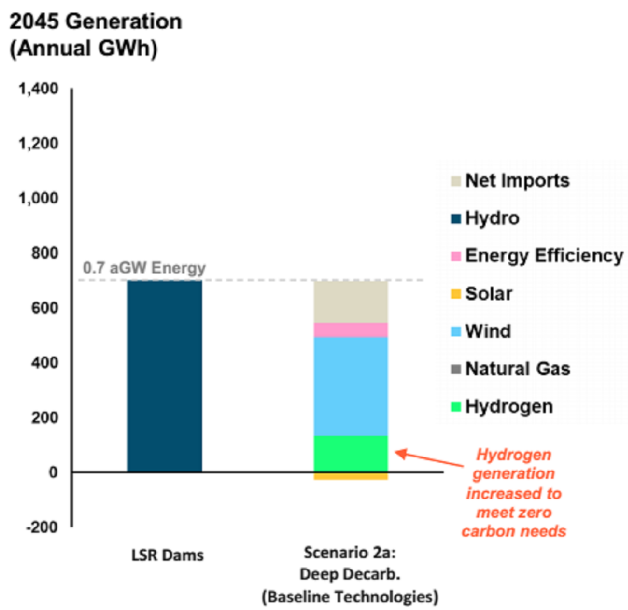
Replacing the Lower Snake River Dams
Scenario 2a: Deep Decarbonization (Baseline Technologies)

+ Scenario includes electric load increases for transportation and other sectors
+ In 2045, hydrogen generation is a key replacement resource and is assumed to be available, though not commercially available today
+ This scenario would cost $860 million dollars per year in 2045, driven by high hydrogen fuel costs (~$40/MMbtu)

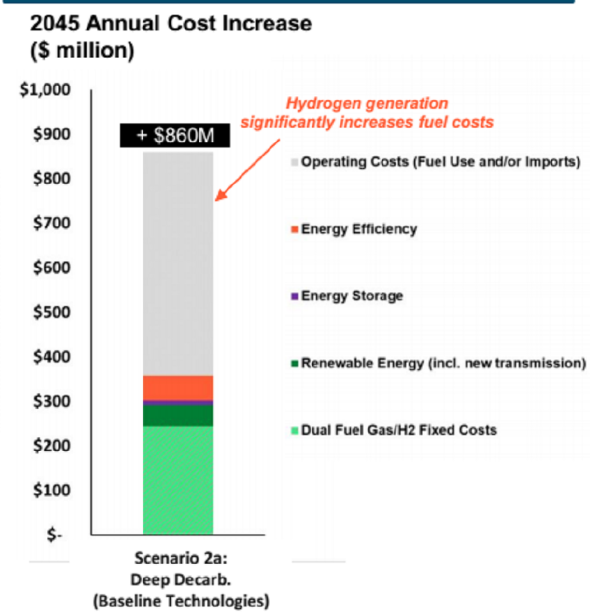
Additional Resources Built to Replace LSR Dams (2045)



Additional Generation to Replace LSR Dams (2045)

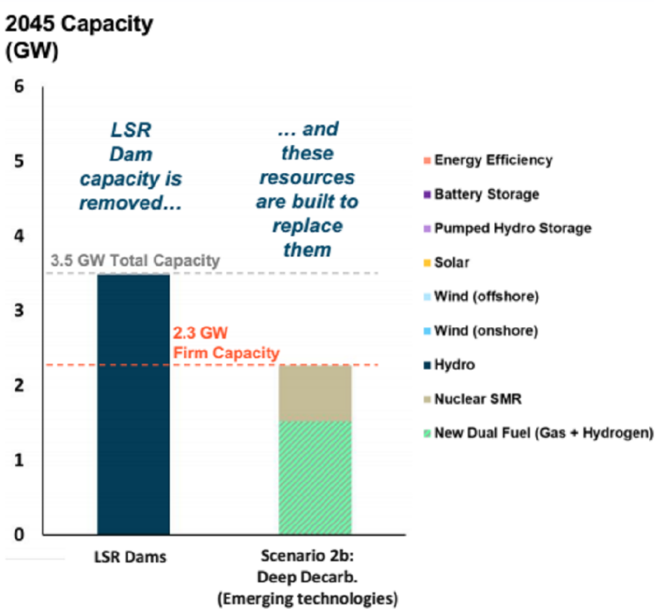


Additional Cost (2045)

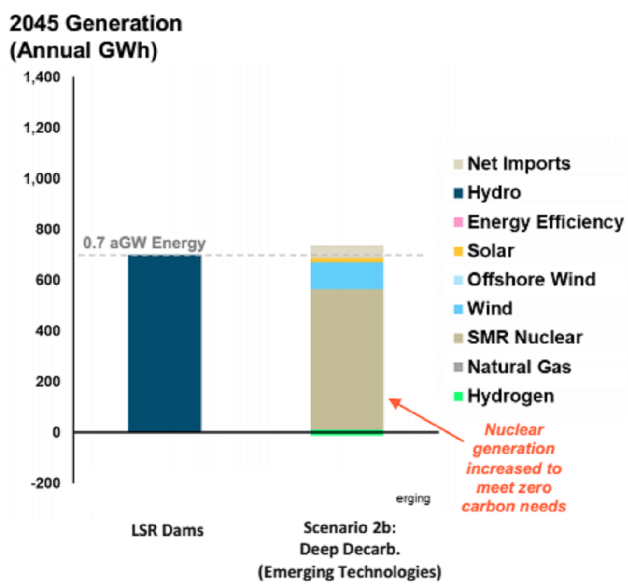


Replacing the Lower Snake River Dams
Scenario 2b: Deep Decarbonization (Emerging Technologies)

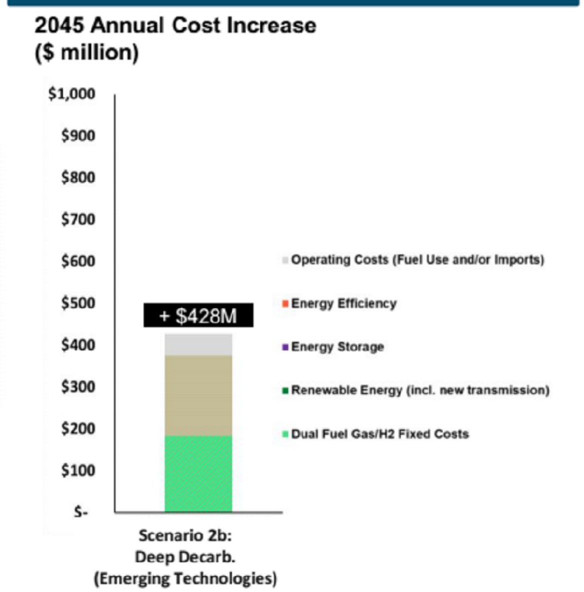
Additional Resources Built to Replace LSR Dams (2045)



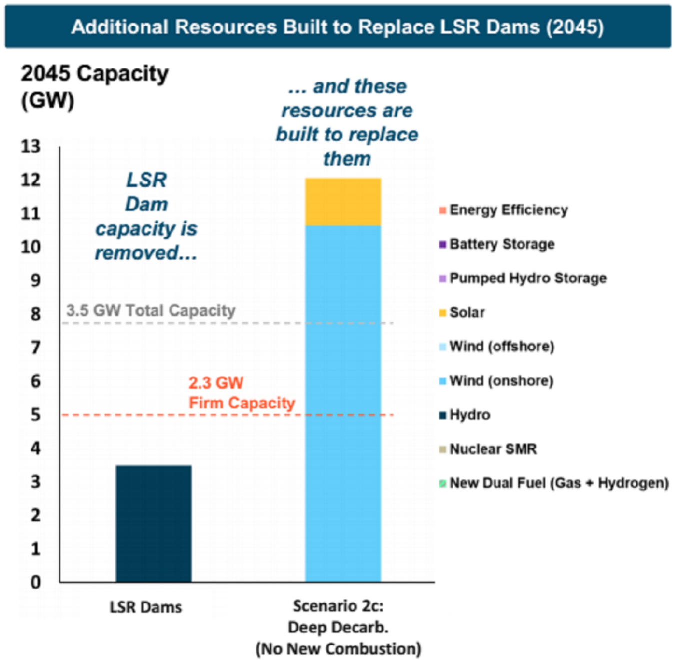
Additional Generation to Replace LSR Dams (2045)

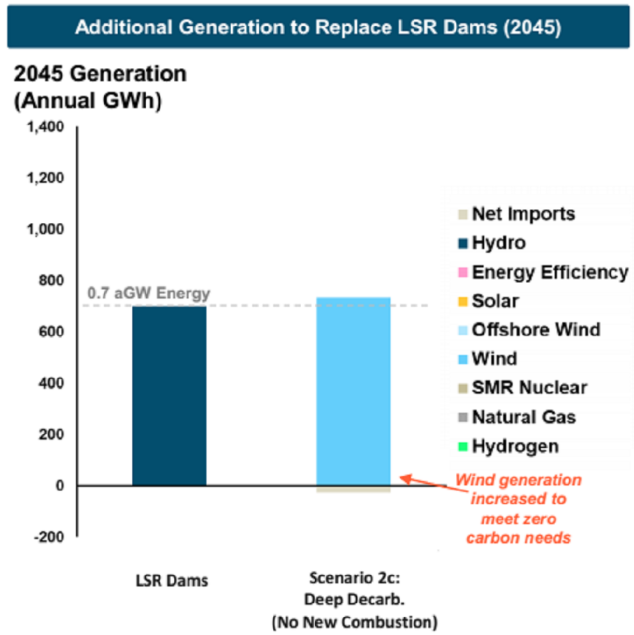


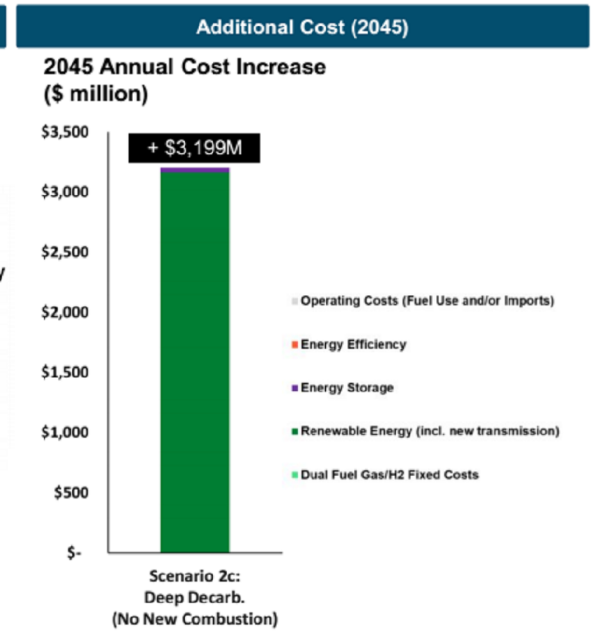
Additional Cost (2045)



Replacing the Lower Snake River Dams
Scenario 2c: Deep Decarbonization (No New Combustion)







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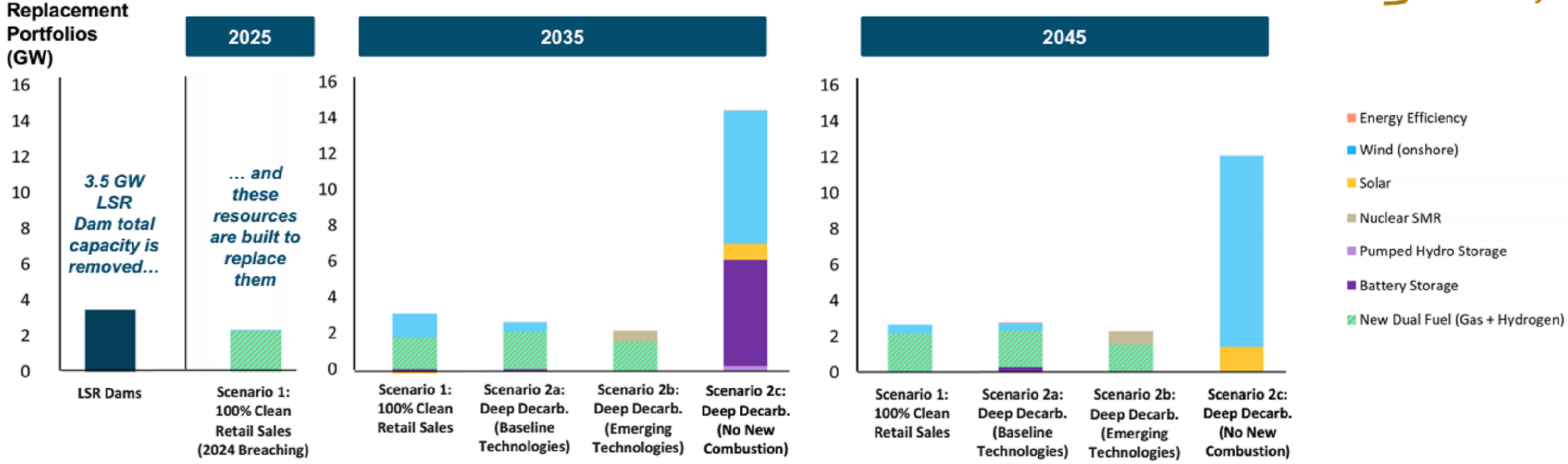
Replacing the Lower Snake River Dams Capacity Across All Scenarios

- Scenario 1 (100% Clean Retail Sales, 2032 LSR Dams breaching): shown in previous slide
- Scenario 1 (100% Clean Retail Sales, 2024 LSR Dams breaching): similar to scenario 1, but with dual fuel natural gas + hydrogen turbine replacement in 2025
- Scenario 2a (Deep Decarbonization, Baseline Technologies): shown in previous slide
- Scenario 2b (Deep Decarbonization, Emerging Technologies): small modular nuclear reactors replace LSR capacity and energy, instead of additional wind power
- Scenario 2c (Deep Decarbonization, No New Combustion): very high replacement need as wind and solar alone struggle to replace LSR dam firm capacity and zero-carbon energy output

Limited load growth, carbon emissions remain in 2045

High load growth, carbon emissions eliminated by 2045… sensitive to emerging technology availability



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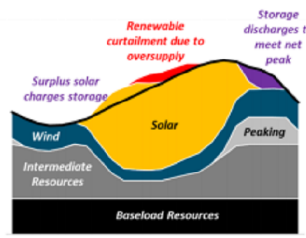
Appendix B: Additional Modeling Inputs

RESOLVE optimizes investments to meet clean energy targets reliably

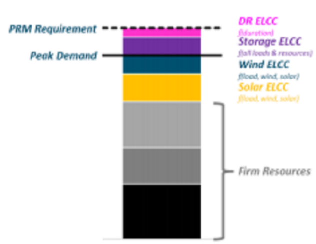
RESOLVE is an optimal capacity expansion model specifically designed to identify least-cost plans to meet reliability needs and achieve compliance with regulatory and policy requirements

- **Linear optimization model explicitly tailored to study challenges to arise at high penetrations of variable renewables and energy storage**
- **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**

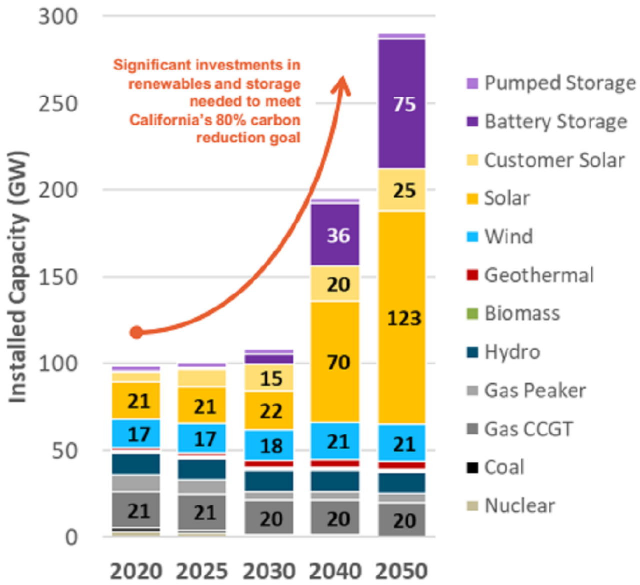
Operational module simulates hourly system operations for a sample of representative days



Reliability module ensures portfolio can meet load during extreme conditions using an ELCC approach



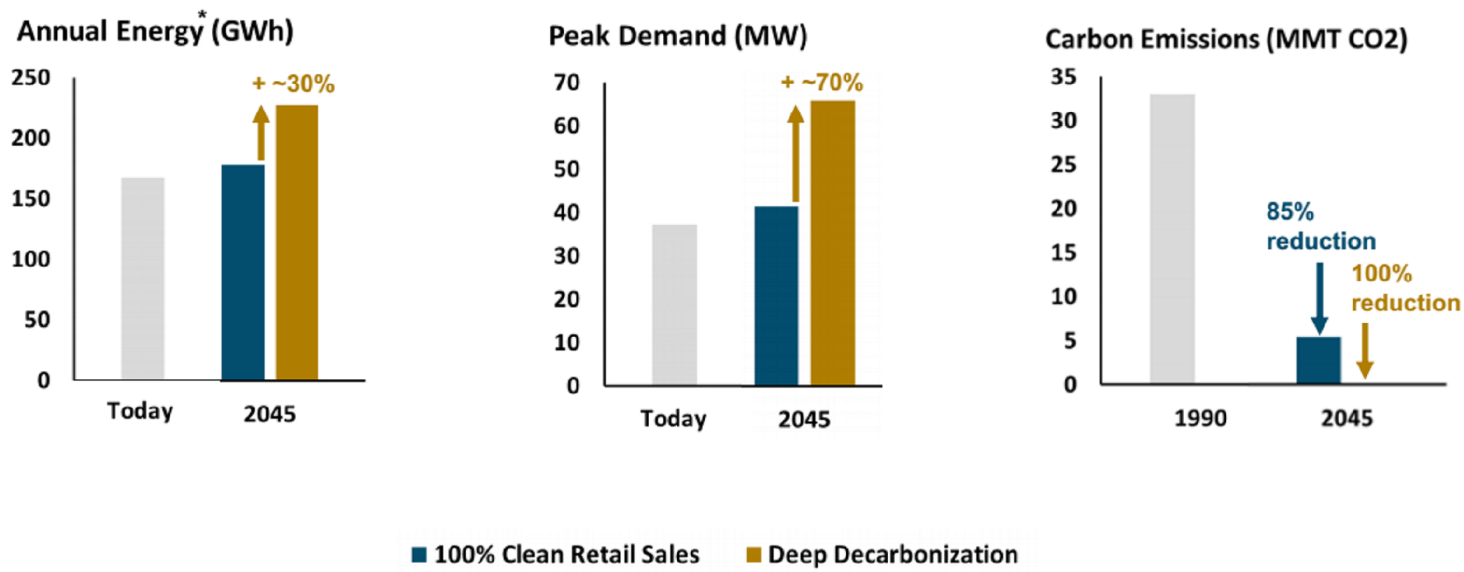
Least-cost plan cooptimizes investments and operations to meet clean energy policy targets, selecting from a diverse set of potential resources including wind, solar, storage, DSM, and natural gas



Example RESOLVE result from Long-Run Resource Adequacy under Deep Decarbonization Pathways for California (Calpine, 2019)

Load growth and carbon emissions in two clean energy scenarios modeled

Increases in Electricity Use and Declines in Carbon Emissions

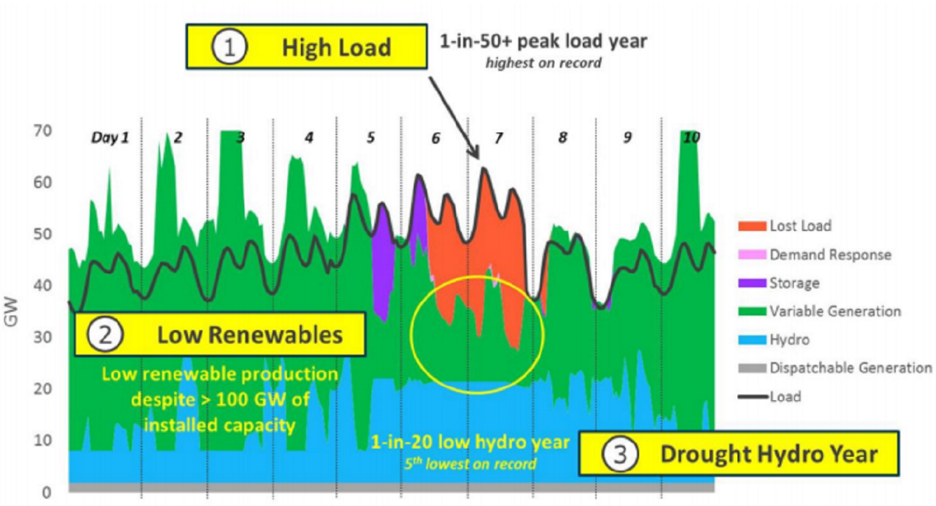


* Load based on 2021 NWPCC Power Plan, shown as retail sales (after assumed growth in customer PV and energy efficiency)

Resource Adequacy Resource Options

+ **RESOLVE resource adequacy constraint requires capacity to meet peak demand + a 15% planning reserve margin**
  - Planning reserve margin (PRM) constraint is "installed capacity" (ICAP) based for firm resources, peaking capacity for hydro, ELCC for other non-firm resources
+ **The nature of the Northwest reliability risk limits the ability of battery storage to provide reliable capacity contributions**
  - Storage and hydro show "antagonistic" interactions, which limit energy storage reliability value in "energy-limited" conditions where energy storage resources are unable to charge (with low hydro and renewable output) and run out of discharge (during extended energy shortfall events)

Key Drivers of Future Pacific Northwest Reliability Events

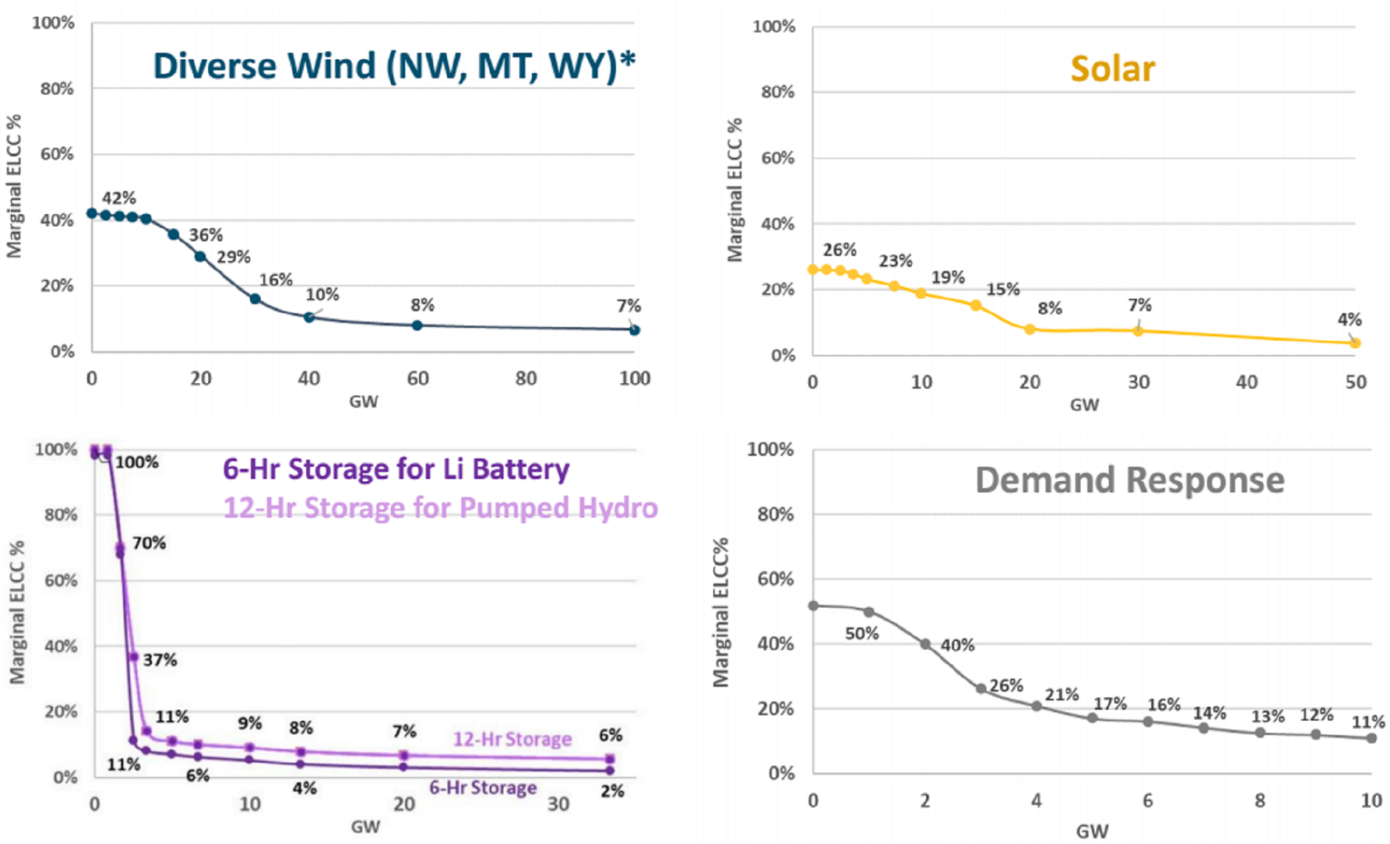


Sample week in 2050 in a 100% GHG reduction scenario, from E3, *Resource Adequacy in the Pacific Northwest*, 2019.

Resource	RA Capacity Contributions
Hydro	65%, based on sustained winter peaking capacity in critical water year conditions (per BPA/PNUCC)… WRAP method is still evolving
Battery storage	Sharply declining ELCCs*
Pumped storage	Sharply declining ELCCs*
Solar	Declining ELCCs
Wind	Declining ELCCs
Demand Response	Declining ELCCs
Energy Efficiency	Limited potential vs. cost
Small Hydro	Limited potential
Geothermal	Limited potential
Natural gas to H2 retrofits	Clean firm, but not fully commercialized
New dual fuel natural gas + H2 plants	Clean firm, but not fully commercialized
New H2 only plants	Clean firm, but not fully commercialized
Gas w/ 90-100% carbon capture + storage	Clean firm, but not fully commercialized
Nuclear Small Modular Reactors	Clean firm, but not fully commercialized

* E3 performed a sensitivity with battery ELCCs that do not decline so sharply. This sensitivity did change the LSR dam replacement resources and costs.

Incorporating Declining Capacity Contributions of Renewables, Storage, and DR



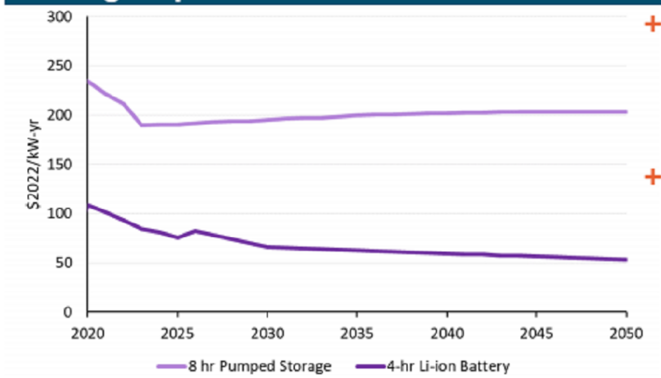
- A reliable electric system requires enough capacity to meet peak loads and contingencies
- This study incorporates information from E3's 2019 report *Resource Adequacy in the Northwest* about the effective capacity contribution of renewables, storage, and DR at various penetration levels

* The offshore wind sensitivity in this study assumed the same ELCC curve as modeled for diverse on-shore wind resources in the Resource Adequacy in the Northwest report.

ELCC = Effective Load Carrying Capability = firm contribution to system peak load

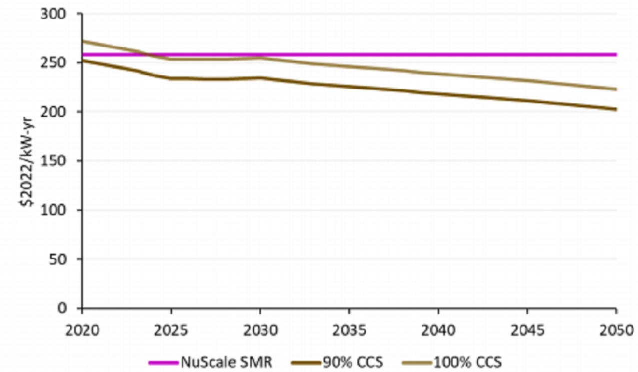
New Resource Options
All-in Fixed Costs

Storage Options



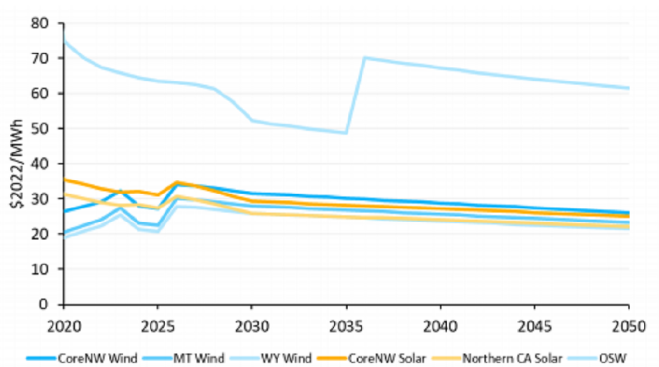
- Battery Storage costs derived from E3's inhouse and Lazard LCOS 7.0 (Oct 2021)
- Pumped storage is from Lazard's last published PHS costs (LCOS 4.0). Assumes CAPEX and FO&M are flat + financing cost trends same for battery storage.

Firm Low Carbon Options



- CCS costs derived from E3's inhouse "Emerging Tech" ProForma
- SMR costs are derived from the vendor NuScale, for an "nth of a kind" installation of the technology they are developing

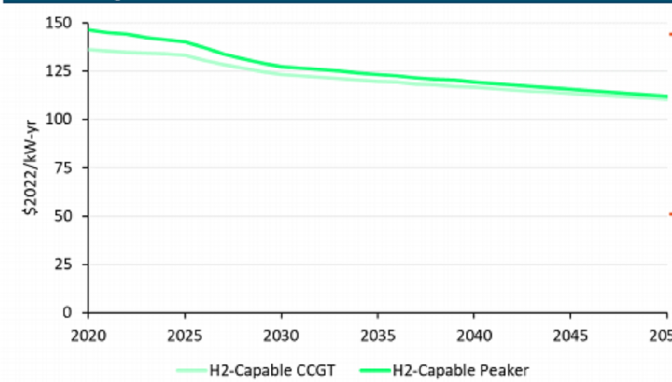
Renewable Options



Renewable costs derived from E3's in house Pro Forma which integrates NREL ATB 2021

Costs shown here do not include the cost of upgraded or new Transmission lines

Gas Options

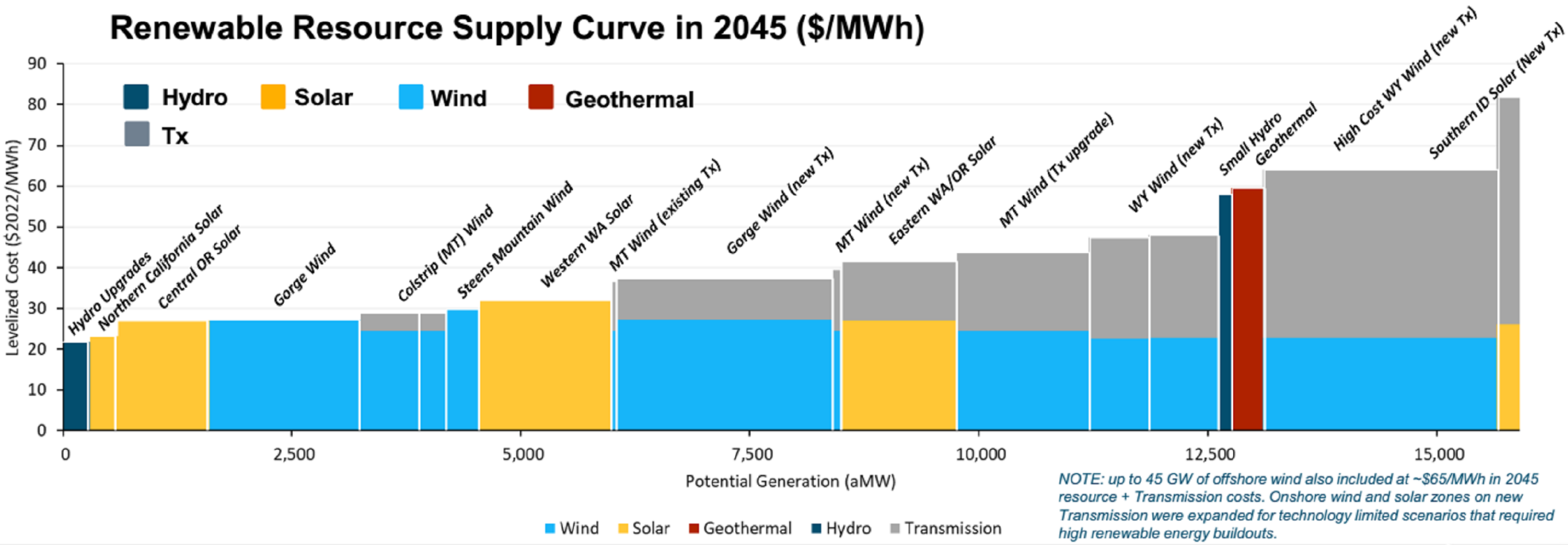


- CCGT and peaker costs are derived from E3's inhouse ProForma which integrates NREL ATB 2021
- New Hydrogen or upgrades include a ~10% additional cost that converges by 2050

NOTE: only dual fuel natural gas + H2-enabled new resources modeled, given NW policy constraints

New Resource Options
Renewables

+ **The following supply curves integrate Transmission costs that RESOLVE sees**
+ **The "no new combustion" scenario required increases in the supply of wind on new transmission (Northwest, MT+WY, and offshore) to enable a feasible solution**



NOTE: up to 45 GW of offshore wind also included at ~$65/MWh in 2045 resource + Transmission costs. Onshore wind and solar zones on new Transmission were expanded for technology limited scenarios that required high renewable energy buildouts.

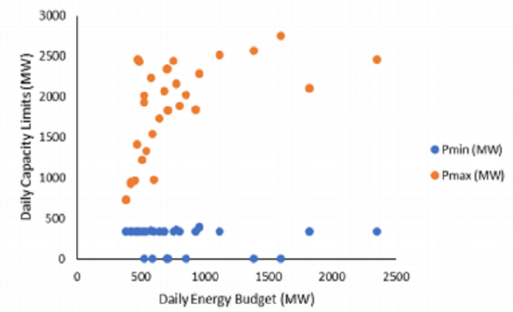
Hydro Operating Data

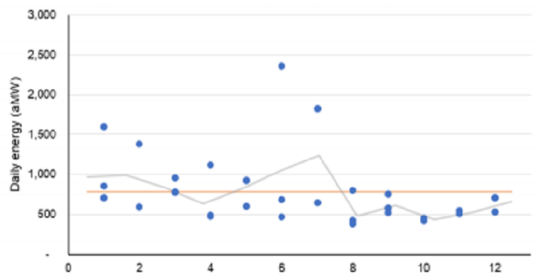
- **Key RESOLVE inputs (for each representative RESOLVE day)**
  - Max generation MW
  - Min generation MW
  - Daily MWh hydro budget
  - Ramp
- **Hydro operating data is parameterized using representative conditions for 3 low/mid/high historical years (2001, 2005, 2011)**
  - Lower Snake River and lower Columbia River dams were adjusted per BPA hydro modeling w/ latest fish spill constraints
- **Hydro firm capacity contribution is assumed to be 65% of total MW, per PNUCC methodology (based on BPA 10-hr sustaining peaking capacity)**

LSR Hydro

Ramp Rates

Hydro Resource	1-hr	2-hr	3-hr	4-hr
LSR_Hydro	36%	43%	45%	48%

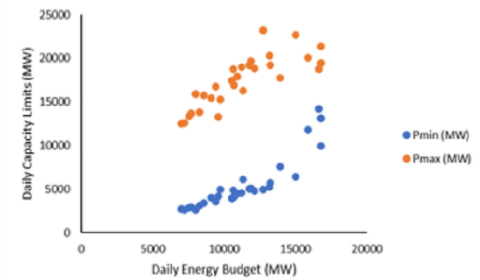


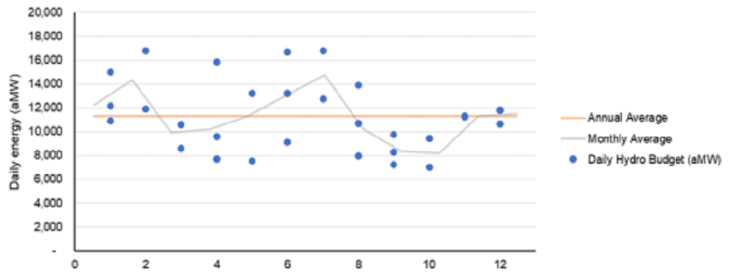


Non-LSR NW Hydro

Ramp Rates

Hydro Resource	1-hr	2-hr	3-hr	4-hr
CoreNW_Hydro	14%	23%	30%	34%





From: Zelinsky,Benjamin D (BPA) - E-4
Sent: Monday, June 6, 2022 1:17 PM
To: Koehler,Birgit G (BPA) - PG-5; James,Eve A L (BPA) - PG-5
Subject: FW: E3 results presentations

I know there are a lot of cooks in the kitchen on this so not planning to weigh in unless you'd like some help. If you do want another helping hand on any wordsmithing just let me know.

Ben

From: Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>
Sent: Monday, June 6, 2022 1:05 PM
To: Armentrout,Scott G (BPA) - E-4 <sgarmentrout@bpa.gov>; James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Hairston,John L (BPA) - A-7 <jlhairston@bpa.gov>; Cook,Joel D (BPA) - K-7 <jdcook@bpa.gov>; Cooper,Suzanne B (BPA) - P-6 <sbcooper@bpa.gov>; Leady Jr,William J (BPA) - PG-5 <wjleady@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Senters,Anne E (BPA) - LN-7 <aesenters@bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Sullivan,Leah S (BPA) - EWP-4 <lssullivan@bpa.gov>
Subject: RE: E3 results presentations

Hi Eve,

(b)(5) [redacted]

Thanks,
Jill

From: Armentrout,Scott G (BPA) - E-4 <sgarmentrout@bpa.gov>
Sent: Monday, June 6, 2022 7:10 AM
To: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>; Hairston,John L (BPA) - A-7 <jlhairston@bpa.gov>; Cook,Joel D (BPA) - K-7 <jdcook@bpa.gov>; Cooper,Suzanne B (BPA) - P-6 <sbcooper@bpa.gov>; Leady Jr,William J (BPA) - PG-5 <wjleady@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Senters,Anne E (BPA) - LN-7 <aesenters@bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Sullivan,Leah S (BPA) - EWP-4 <lssullivan@bpa.gov>
Subject: RE: E3 results presentations
Importance: High

A couple thoughts on the BPA portion of this. Suggest modification of the slides to eliminate any indication of defensiveness, etc. Make if very fact based. Example – Eliminate "No, in fact the E3 study reinforces the decision" to "There is no new information that fundamentally changes the basis for the decision". Also eliminate the "not cheap, fast or easy" language. If we are quoting some other study that said that, we should attribute it. Otherwise state it as facts, e.g. "expensive, spanning many years and complex". Anyway that is a start – but overall it is to make it straightforward but not tone based. Scott

SCOTT G ARMENTROUT
Executive Vice President, Environment, Fish & Wildlife, SES | E-4
BONNEVILLE POWER ADMINISTRATION
bpa.gov | P 503-230-3076 | C [redacted]

From: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Sent: Friday, June 3, 2022 4:06 PM
To: Hairston,John L (BPA) - A-7 <jlhairston@bpa.gov>; Cook,Joel D (BPA) - K-7 <jdcook@bpa.gov>; Cooper,Suzanne B (BPA) - P-6 <sbcooper@bpa.gov>; Leady Jr,William J (BPA) - PG-5 <wjleady@bpa.gov>; Armentrout,Scott G (BPA) - E-4 <sgarmentrout@bpa.gov>; Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Leary,Jill C (BPA) - LN-7 <jcleary@bpa.gov>; Godwin,Mary E (BPA) - LN-7 <megodwin@bpa.gov>; Senters,Anne E (BPA) - LN-7 <aesenters@bpa.gov>; Zelinsky,Benjamin D (BPA) - E-4 <bdzelinsky@bpa.gov>; Sullivan,Leah S (BPA) - EWP-4 <lssullivan@bpa.gov>
Subject: E3 results presentations

Deliberative, FOIA exempt
Hello-
Attached are the presentations sent to DOE for feedback- the E3 study results and BPA's perspective on the study results. DOE will be providing feedback by Wednesday and I believe there is coordination to schedule a time to present to CEQ.

Thanks,
Eve

From: Koehler,Birgit G (BPA) - PG-5
Sent: Monday, July 11, 2022 2:58 PM
To: Baskerville,Sonya L (BPA) - AIN-WASH
Subject: FW: urgent, more swirl, maybe release this afternoon
Attachments: E3 BPA LSR Dams_071122_embargoed version.pdf

If you have not yet sent, this has the edit from E3. Says "embargoed" in red on each page

---

From: Aaron Burdick <aaron.burdick@ethree.com>
Sent: Monday, July 11, 2022 2:56 PM
To: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>; Arne Olson <arne@ethree.com>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: [EXTERNAL] RE: urgent, more swirl, maybe release this afternoon

Sending embargoed PDF now. 2c cost range added (now $40-75B). We will make the other update (adding scenario 1B) by 4pm and resend. So, this version should not get released, but the 4pm version will be the one to release.

Aaron

From: Koehler,Birgit G (BPA) - PG-5 <bgkoehler@bpa.gov>
Sent: Monday, July 11, 2022 2:07 PM
To: Arne Olson <arne@ethree.com>; Aaron Burdick <aaron.burdick@ethree.com>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: urgent, more swirl, maybe release this afternoon

OK, here's the story:
A Salmon "Science" paper is going to a Congressional staff briefing at 6 pm EASTERN i.e. less than an hour, and DOE&BPA want the E3 study to be there too. Both will be discussed without BPA or E3 present. So we want the document info there at least.

Plan.
Keep paper as is except
P. 37 delete paragraph
In terms of costs, while this study considered the replacement costs of LSR dams from the electricity system perspective, there are other types of services that LSR dams provide that would need additional cost assessment. LSR dams are used for irrigation, recreation, navigation, and transportation. Breaching LSD dams could impact these services and therefore, should be considered alongside the electricity services replacement costs. Moreover, breaching the dams itself would be an additional cost. These factors are addressed in more detail in the report prepared by Senator Murray and Governor Inslee.[36]

Need a PDF with watermark "Embargoed until 6:00 am on July 12, 2022"
Need another copy (can follow) without the embargo

PPT, I have the latest copy that we would have presented last week, but for best version control, feel free to send me a new copy

Also need one PDF with “embargoed…” And one without

From: Koehler,Birgit G (BPA) - PG-5
Sent: Monday, July 11, 2022 1:52 PM
To: Arne Olson <arne@ethree.com>; Aaron Burdick <aaron.burdick@ethree.com>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: RE: urgent, more swirl, maybe release this afternoon

This is looking likely. Can you reply that you have received my email?

Release tonight would be an embargoed copy for DC at 6 pm Eastern time tonight.

Post public at 6 am tomorrow

From: Koehler,Birgit G (BPA) - PG-5
Sent: Monday, July 11, 2022 1:46 PM
To: Arne Olson <arne@ethree.com>; Aaron Burdick <aaron.burdick@ethree.com>
Cc: James,Eve A L (BPA) - PG-5 <eajames@bpa.gov>
Subject: urgent, more swirl, maybe release this afternoon

Hello Arne and Aaron,

I was just called onto a phone call if we can maybe release the PPT *and* report by 3 pm EASTERN time. I’ll write more as we discuss internally.

Birgit

Energy+Environmental Economics

Embargoed until 6:00 am on July 12, 2022

BPA Lower Snake River Dams Power Replacement Study

Executive Summary

July 2022

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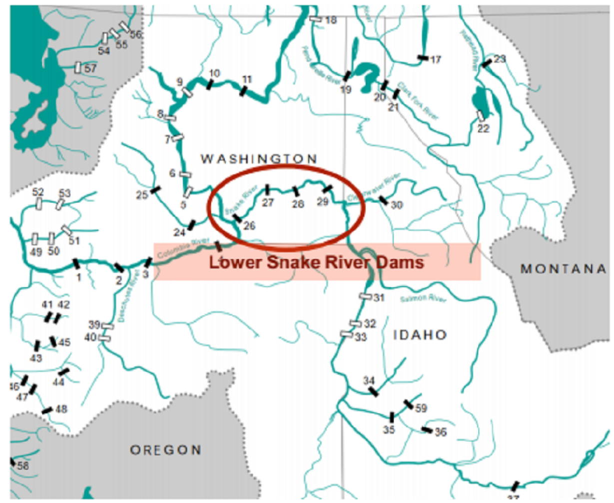
Embargoed until 6:00 am on July 12, 2022

About this study

- BPA contracted with E3 to conduct an independent analysis of the electricity system value of the four lower Snake River (LSR) dams
- E3 utilized our RESOLVE optimal capacity expansion model to identify least-cost portfolios of electricity resources needed to replace the electric energy and grid services provided by the dams through 2045
- Replacement costs are considered within the context of the Northwest region's aggressive, long-run decarbonization goals



Key Study Questions:

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

What would it take to replace the output of the four lower Snake River dams?

+ **What energy services are lost if the dams are breached?**
  - **3,483 MW of total capacity***, including approximately **2,300 MW of firm peaking** capability to avoid power shortages during extreme cold weather events
  - **~900** annual average MW of low-cost, zero-carbon energy** (enough energy to support ~450,000 households or 1.7x the City of Portland) as well as **operational flexibility** services
+ **How much would it cost to replace the power benefits of the four lower Snake River dams in E3's study with breaching in 2032?**
  - In E3's **baseline scenario**, total net present value (NPV)*** replacement costs would be **$11.8 billion**
  - In a **deep decarbonization scenario** with higher loads and zero emissions electricity by 2045, NPV costs range from **$10.7-19 billion** with at least one emerging technology
    - Reaching deep decarbonization **absent breakthroughs in not-yet-commercialized emerging technologies**, NPV costs could increase to **$40-75 billion**
+ **What are the long-term rate impacts to ~2 million public power households in 2045?**
  - Public power costs increase by **8-18% or ~$100-230 per year across most scenarios**
    - Costs increase by **34-65% or ~$450-850 per year** under deep decarbonization scenario **absent emerging technology breakthroughs**
+ **What resources are needed to replace the dams?**
  - A combination of **renewable generation** (wind), **"clean firm" resources** (such as dual fuel natural gas + hydrogen plants, advanced nuclear, or gas with carbon capture and storage), and **energy efficiency**
  - Battery storage cannot cost-effectively replace hydro capacity in the Northwest due to charging limitations during energy shortfall events
+ **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 5-7 years after congressional approval to breach the dams and possibly up to 10-20 years if additional new large-scale transmission was required. E3 assumed transmission would be built as needed for renewable additions.

Plant	Total Capacity (MW)
Lower Granite	930
Little Goose	930
Lower Monumental	930
Ice Harbor	693

Total = 3,483 MW

* Hydro traditionally operates above nameplate and closer to overload capacity (~15% above nameplate) and FERC uses these peak generation values in hydro licensing. Historical peak generation was 3,431 MW.
** E3's RESOLVE model uses 2001, 2005, and 2011 hydro years, which resulted in ~700 aMW of lower Snake River dams generation, making it a conservative estimate of the dams' GHG-free energy value
*** NPV calculated over a 50-year period following the date of breaching, using a 3% discount rate based on the approximate public power cost of capital.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Study Approach

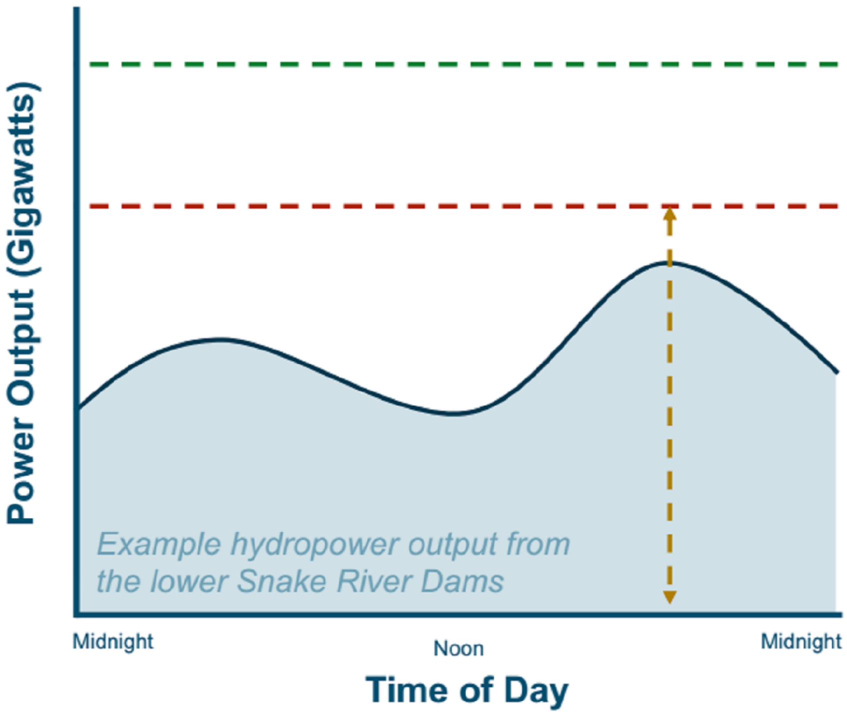
What grid services do the lower Snake River dams provide?

Little Goose

Lower Granite

Lower Monumental

Ice Harbor



Total "Capacity"
Maximum instantaneous power output the four dams
LSR Dams = 3.5 GW*

"Firm Capacity"
Sustained peaking output (+ reserves) during reliability strained conditions
(e.g. cold January during a drought year)
LSR Dams = 2.3 GW**

Annual (Carbon-free) Energy
Sum of hourly power produced across the year, subject to seasonal water availability
LSR Dams = 0.9 average GW***

Operational Flexibility
The ability to change power output to support a reliable grid, subject to water availability and operational constraints
LSR Dams provide short-term reserves + multi-hour ramping / renewable integration capabilities

E3's modeling selects the least-cost portfolio of resources to replace these services

Transmission Grid Reliability Services
Services to reliably operate the transmission grid
(e.g., voltage, frequency support, blackstart, etc.)
LSR Dams can provide, but not the focus of this study

Some of these services may be provided by modeled replacement resources, other may require additional investments

* Hydro traditionally operates above nameplate and closer to overload capacity (~15% above nameplate) and FERC uses these peak generation values in hydro licensing. Historical peak generation was 3,431 MW.
** Firm capacity assumed in this study is consistent with the ~65% Northwest hydro capacity value assumed by PNUCC (the Pacific Northwest Utilities Conference Committee).
*** Average GW means that on average across an average year the plant generated at ~0.9 GW, though its hourly output may be above or below that amount. LSR output was adjusted to reflect increased spill requirements of the EIS. However, E3's RESOLVE model uses 2001, 2005, and 2011 hydro years, which resulted in ~0.7 aMW of lower Snake River dams generation, making it a conservative estimate of the dams' GHG-free energy value.

What's the focus in this study compared to the CRSO EIS?

The study uses an optimization model to determine the least-cost replacement resources for the four lower Snake River dams subject to A) policy and B) reliability constraints

+ **Least-cost optimization: includes updated resource pricing and new emerging technologies**
+ **Policy: E3's modeling considers the effects of regional policies such as Washington's Clean Energy Transformation Act (CETA) and Oregon's 100% clean electricity standard**
  - Aggressive clean energy laws drive coal power plant retirements, price carbon emissions, and require long-term **carbon emissions reductions** by 2045
  - Study includes significant **electrification** that increases demand for electricity to support carbon-reduction in other sectors such as transportation, buildings, and industry, consistent with Washington's Energy Strategy
+ **Reliability: E3's modeling captures the need for the Northwest system to meet peak load during extreme weather and low hydro conditions (known as "resource adequacy").**
  - Captures the abilities and limits of different technologies to serve load during reliability challenging conditions
    - E.g. during extended cold-weather periods with high load, low hydropower availability, and low wind and solar production
  - Resources with high energy production costs may be selected for reliability needs but then run sparsely only during extreme conditions (e.g. natural gas + hydrogen combustion turbines)
+ **LSR operations: incorporates preferred alternative operations selected in the EIS**
  - Increases spill from the dams, lowering available annual energy and changing operational flexibility

Policy landscape: Washington, Oregon, California

+ **The study includes the impacts from clean energy policies in the Pacific states**

	RPS or Clean Energy Standard?	Coal Prohibition?	Cap-and-Trade?	New Natural Gas?	Economy-Wide Carbon Reduction?
WA	✓ Carbon neutral by 2030, 100% carbon free electricity by 2045	✓ Eliminate by 2025	✓ Cap-and-invest program established in 2021, SCC in utility planning	✓	✓ 95% GHG emission reduction below 1990 levels and achieve net zero emissions by 2050
OR	✓ 50% RPS by 2040, 100% GHG emission reduction by 2040, relative to 2010 levels	✓ Eliminate by 2030	✓ Climate Protection Plan adopted by DEQ in 2021 (power sector not included)	✕ HB 2021 bans expansion or construction of power plants that burn fossil fuels	✓ 90% GHG emission reduction from fossil fuel usage relative to 2022 baseline
CA	✓ 60% RPS by 2030, 100% clean energy by 2045	✓ Coal-fired electricity generation already phased out	✓	✕ CPUC IRP did not allow in recent procurement order	✓ 40% GHG emission reduction below 1990 levels by 2030 and 80% by 2050

Modeling approach involves a three-step process

1 ***With the lower Snake River dams*, optimize long-term resource needs and operations for the Pacific Northwest**

- Produces necessary resource additions and total system costs and emissions

2 ***Remove the lower Snake River dam generating capacity, then re-optimize* long-term resource needs and operations for the Pacific Northwest**

- Produces a second set of resource additions and total system costs and emissions
- All scenarios breach the dams in 2032, except for one scenario in 2024

3 ***Calculate additional resources and investment + operational costs* required to replace the dams**

- Calculated as the difference between steps 1 and 2 above

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Key modeling assumptions

Element	Study Approach	Impact on Dams Replacement Needs
Study Years	• 2025 through 2045*, including fuel price forecasts and declining renewable + storage costs	Considers long-term needs
Clean Energy Policy Scenarios	• Aggressive OR+WA legislation reflected, including coal retirements + carbon pricing • Two electric emissions scenarios considered: 1. **100% clean retail sales** (~85% carbon reduction**) 2. **Zero-emissions** (100% carbon reduction)	Clean energy policy requires long-term **replacement of LSR dams with GHG-free energy**
Load Growth Scenarios	• Two load scenarios: 1. **Baseline** (per NWPCC 8th Power Plan) 2. **High electrification** load growth (to support economy-wide decarbonization) • Significant quantities of energy efficiency are embedded in all scenarios	Higher load scenarios **increase the value of LSR dams energy + firm capacity**
Reliability Needs	• Modeling ensures reliability needs during extreme conditions (e.g. high loads + low hydro) • Captures ability (and limits) of renewables, battery storage, and demand response to support system reliability	Reliability needs require **replacement of LSR dams firm capacity contributions**

Technologies Modeled, including "Emerging" Technologies	• Broad range of dam replacement technology options considered:
	  • **Baseline technologies**: solar, wind, battery + pumped storage, energy efficiency, demand response, dual fuel natural gas + hydrogen combustion plants
	  • **Sensitivities** include Emerging Technologies and Limited Technologies (No New Combustion) scenarios
	• Resource costs developed by E3 using NREL 2021 ATB, Lazard Cost of Storage v.7, NuScale Power (for small modular reactor costs)
		Technology available for LSR dams replacement determines replacement cost

Distributed Energy Resource Options	• Energy efficiency, demand response, and customer solar embedded into modeling inputs • Additional energy efficiency and demand response can be selected	**Demand resource can help replace LSR dams**, though low-cost supply is limited

* 20-years of end effects are considered (2045-2065)

** A 100% clean retail sales target allows emissions for electric generation beyond that needed to serve "retail sales", i.e. losses during transmission to retail loads and exported energy

Scenarios

+ Scenario 1: 100% Clean Retail Sales

- Northwest resources produce enough clean energy to meet **100% of retail electricity sales** on an annual average basis
- Some gas generation is retained for reliability, but carbon emissions are reduced **85% below 1990 levels**
- **Business-as-usual** load growth

+ Scenario 2: Deep Decarbonization

- **Zero carbon emissions** by 2045
- **High electrification** of buildings, transportation, and industry to reduce carbon emissions in other sectors
- **Emerging technologies** become available to provide firm, carbon-free power

Emerging Technologies

Technology	S1 100% Clean	S2a Deep Decarb Baseline	S2b Deep Decarb Emerging Tech.	S2c Deep Decarb No New Combustion
Mature technologies (solar, wind, battery + pumped storage, energy efficiency, demand response)	Available	Available	Available	Available
Hydrogen (existing natural gas retrofits)	Available	Available	Available	Available
Hydrogen (new dual fuel natural gas + hydrogen)	Available	Available	Available	Not available
Nuclear (small modular reactors)	Not available	Not available	Available	Not available
Natural Gas w/ Carbon Capture and Storage	Not available	Not available	Available	Not available
Offshore Wind (floating)	Not available	Not available	Available	Available

Available
Not available

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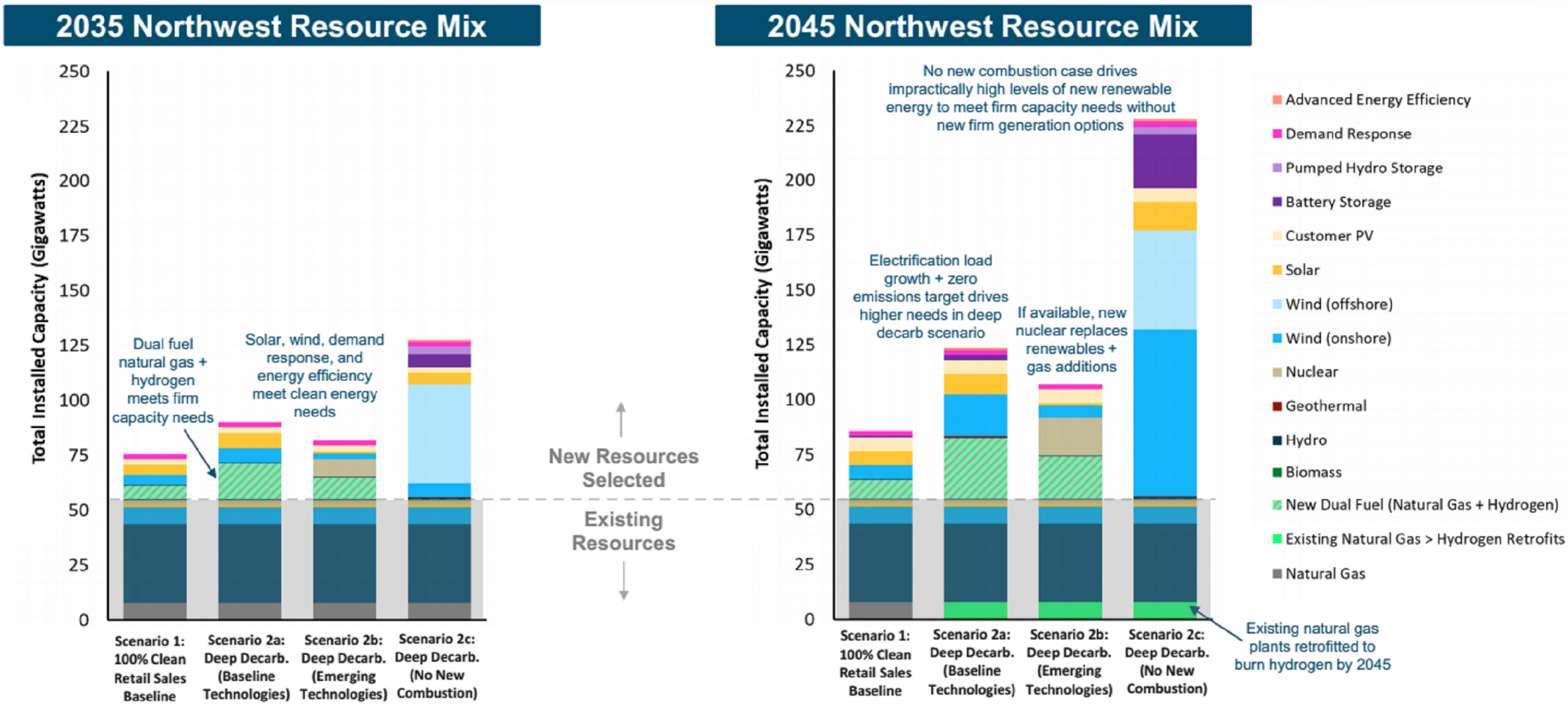
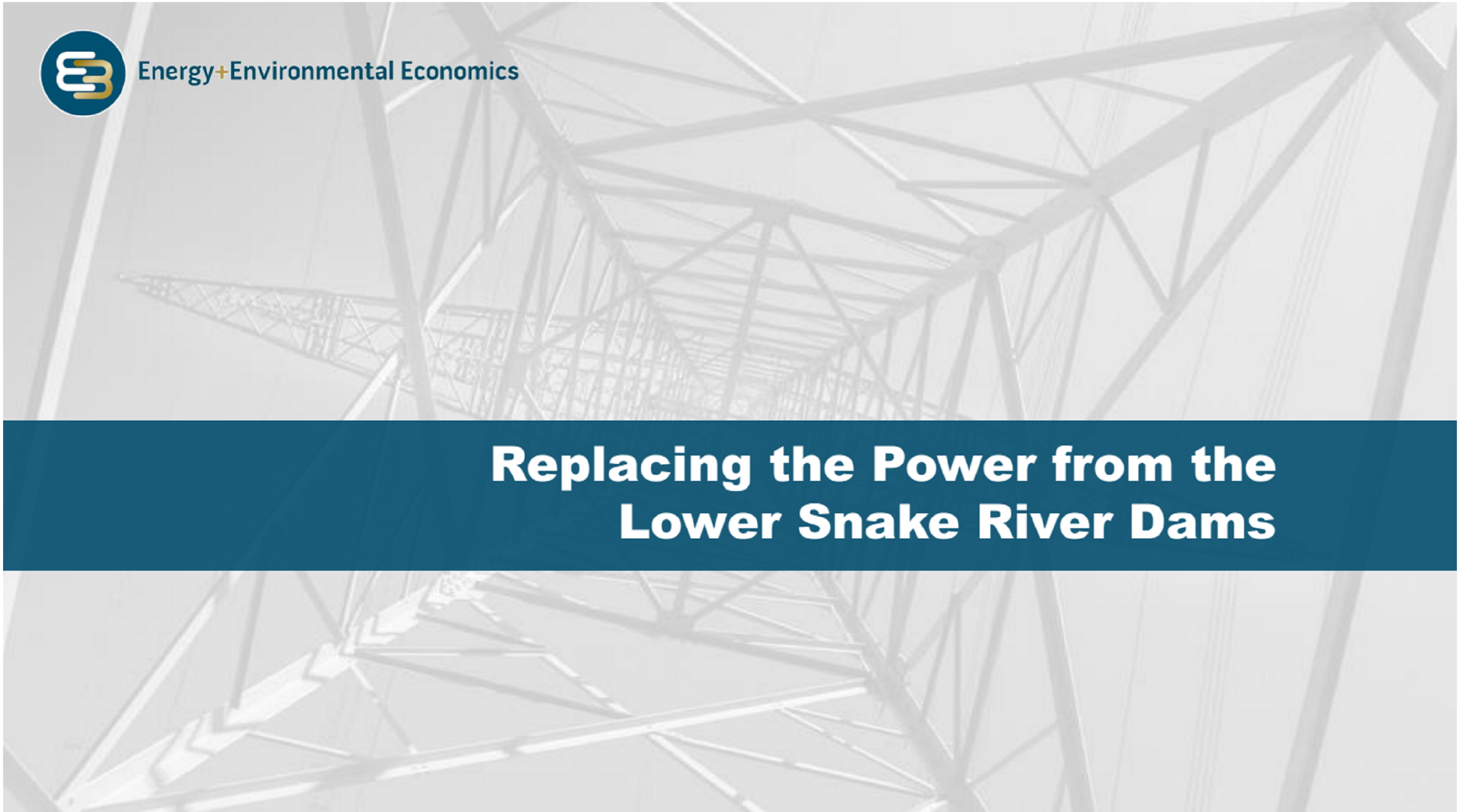
Northwest Resource Needs in Scenarios With the Lower Snake River Dams

Even without breaching the dams, all scenarios show large levels of new resource additions





Replacing the Power from the Lower Snake River Dams

Replacement resources selected to replace the lower Snake River dams

- **RESOLVE selects an optimal portfolio of replacement resources including additional advanced energy efficiency, wind, solar, green hydrogen, and/or advanced nuclear**
- **Firm 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 renewables and some of the gas plants**
- **The "no new combustion" scenario requires impractically large (~12 GW) buildout of renewable energy to replace the dams' firm capacity contributions and GHG-free energy**
  - A range of costs was developed for this scenario based on the assumed transmission needs for renewable additions

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

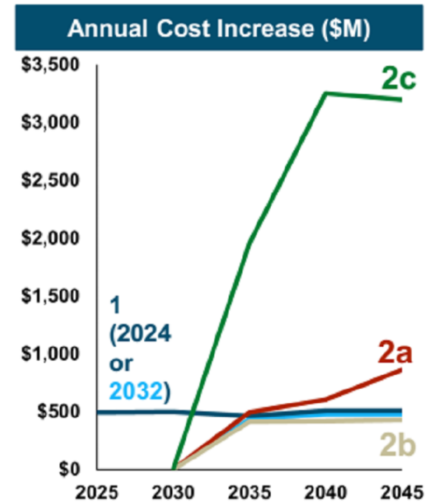
* 1 GW = 1,000 MW
** Replacing LSR dams GHG-free energy at least-cost leads RESOLVE to generate an additional 1.2 TWh of hydrogen generation during low renewable conditions (or 0.14 average GW).

Total costs for replacing the lower Snake River dams

+ Costs are expected to fall on Bonneville Power Administration's public power customers

- Costs could **increase public power retail costs** by 8-18%, or up to 34-65% absent emerging technologies
- Costs could **raise annual residential electricity bills** by up to $100-230/year, or up to $450-850/yr absent emerging technologies

	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	$11.8 billion	n/a	$434 million	$478 million	0.8 cents/kWh [+9%]
Scenario 1: 100% Clean Retail Sales (2024 dam breaching)	$12.8 billion	$495 million	$466 million	$509 million	0.8 cents/kWh [+9%]
Scenario 2a: Deep Decarb. (Baseline Technologies)	$19.0 billion	n/a	$496 million	$860 million	1.5 cents/kWh [+18%]
Scenario 2b: Deep Decarb. (Emerging Technologies)	$10.7 billion	n/a	$415 million	$428 million	0.7 cents/kWh [+8%]
Scenario 2c: Deep Decarb. *(No New Combustion)*	*$40 – 75 billion*	*n/a*	*$1,045 – 1,953 million*	*$1,711 – 3,199 million*	*2.9 – 5.5 cents/kWh [+34 – 65%]*



Deep decarbonization without emerging technologies drives impractically high costs

Cost differences driven primarily by 2045 carbon policy and availability of emerging technologies

Costs increase over time as loads grow and carbon policy becomes more stringent

- 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. NPV calculated over a 50-year period following the date of breaching, using a 3% discount rate based on the public power cost of capital.
- % 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 rate increases driven by higher loads or clean energy needs that increase regional rates as shown in the earlier 2045 incremental cost chart.
- 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).
- 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
- Lower end of range for scenario 2c assumes limited transmission build out (based on replacement resource additions' marginal ELCC instead of delivering the full nameplate capacity), annual cost plot shows only high end of range

Cost of generation for lower Snake River dams replacement resources (using common utility metric of $/MWh)

- **The lower Snake River dams provide a low-cost source of GHG-free energy and firm capacity**
- **Even in a best-case scenario, replacement power would cost several times as much as the lower Snake River dams costs**
  - This is driven by both energy replacement as well as replacement of firm capacity and operational flexibility
- **Compared to ~$13-17/MWh for the lower Snake River dams, replacement resources cost between $77-139/MWh**
  - Replacement costs rise to ~$275-500/MWh in a deep decarbonization scenario absent emerging technology

Incremental LSR Dam Replacement Resource Costs

Lower Snake River Dams All-in Generation Costs (2022 $/MWh)
$13/MWh w/o LSRCP*
$17/MWh w/ LSRCP*

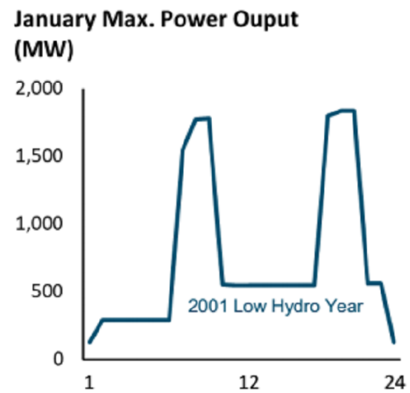
Scenario	2045 Costs to replace LSR Generation** (real 2022 $/MWh)
S1: 100% Clean Retail Sales	$77/MWh
S1b: 100% Clean Retail Sales (2024 dam breaching)	$82/MWh
S2a: Deep Decarb	$139/MWh
S2b: Deep Decarb, w/ Emerging Tech	$69/MWh
S2c: Deep Decarb, Limited Tech (no new combustion)	$277 – 517/MWh

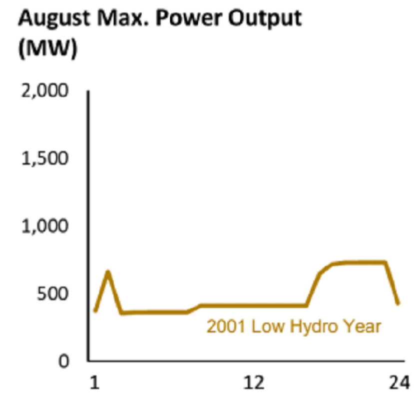
* BPA directly funds the annual operations and maintenance of the Lower Snake River Compensation Plan (LSRCP) fish hatcheries and satellite facilities. Congress authorized the LSRCP as part of the Water Resources Development Act of 1976 (90 Stat.2917) to offset fish and wildlife losses caused by construction and operation of the four lower Snake River projects.

** Replacement $/MWh costs are calculated as CoreNW revenue requirement increase with LSR dams breached divided by the annual MWh of the LSR dams assumed in E3's modeling (~700 aMW). These costs includes replacement of the LSR dam energy, capacity, and reserve provision. A significant portion of the costs is capacity costs to replace the dams' RA capacity contributions.

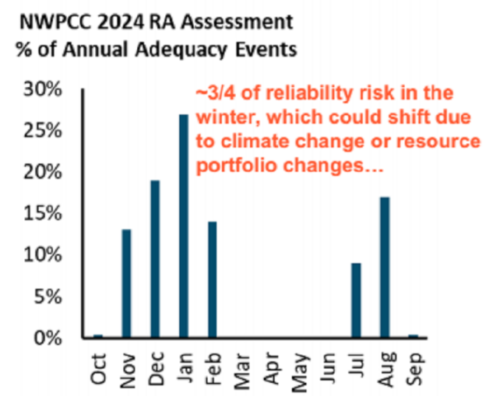
Firm capacity value of the lower Snake River dams

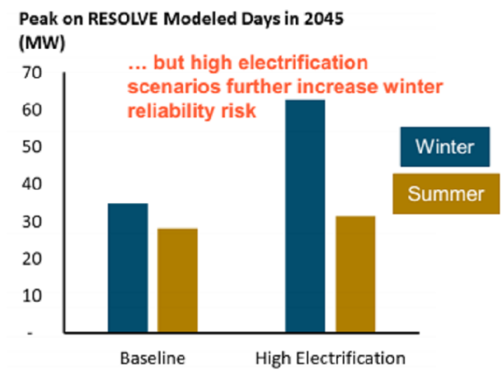
+ **The firm capacity value is a significant driver of replacements costs**
+ **PNUCC 2021 estimate of NW hydro sustained peaking capacity was used for the lower Snake River dams' firm capacity value (65% or 2.3 GW)**
+ **E3 also analyzed modeled hourly LSR dam output during the 2001 low hydro year (using BPA data post EIS spill requirements)**
  - Suggests a winter firm capacity value of ~56-60%
+ **E3 predicts a continued concentration of risk in the winter in deep decarbonization scenarios with high space heating electrification**
  - However, in a system with higher summer reliability risk, the LSR firm capacity value would be lower
  - E3 estimates the impact of a lower firm capacity value for S1 and S2a scenarios to be:
    - 1.5 GW firm capacity value (43%) → ~9-20% lower NPV replacement cost
    - 1.0 GW firm capacity value (29%) → ~14-33% lower NPV replacement cost





Assuming the Northwest remains winter reliability challenged, LSR Dams could have contributed ~56-60% of total capacity or 1.9-2.1 GW* in the 2001 low hydro year





* Includes 100-250 MW reserve provision on top of maximum power output

Key conclusions

1. **Replacing the four lower Snake River dams comes at a substantial cost, even assuming emerging technologies are available**
   - Require 2,300 – 2,700 MW of replacement resources
   - An annual cost of $415 million – $860 million by 2045*
   - Total net present value replacement cost of $10.7 – 19.0 billion based on 3% discounting over a 50-year time horizon following the date of breaching
   - Increase in costs for public power customers of $100 – 230 per household per year (an 8 – 18% increase) by 2045
2. **The biggest cost drivers for replacement resources are the need to replace the lost firm capacity and the need to replace the lost zero-carbon energy**
3. **Replacement resources become more costly over time due to increasingly stringent clean energy standards and electrification-driven load growth**
4. **Emerging technologies such as hydrogen, advanced nuclear, and carbon capture can limit the cost of replacement resources to meet a zero emissions electric system, but the pace of their commercialization is highly uncertain**
   - Replacing the dams in deep decarbonization scenarios without any emerging technologies requires impractical levels of renewable additions at a very high cost ($40-75 billion NPV cost)

* Replacement resource costs are calculated assuming project financing per E3's pro forma calculator, rather than assuming upfront congressional appropriation

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Thank you

Questions, please contact:

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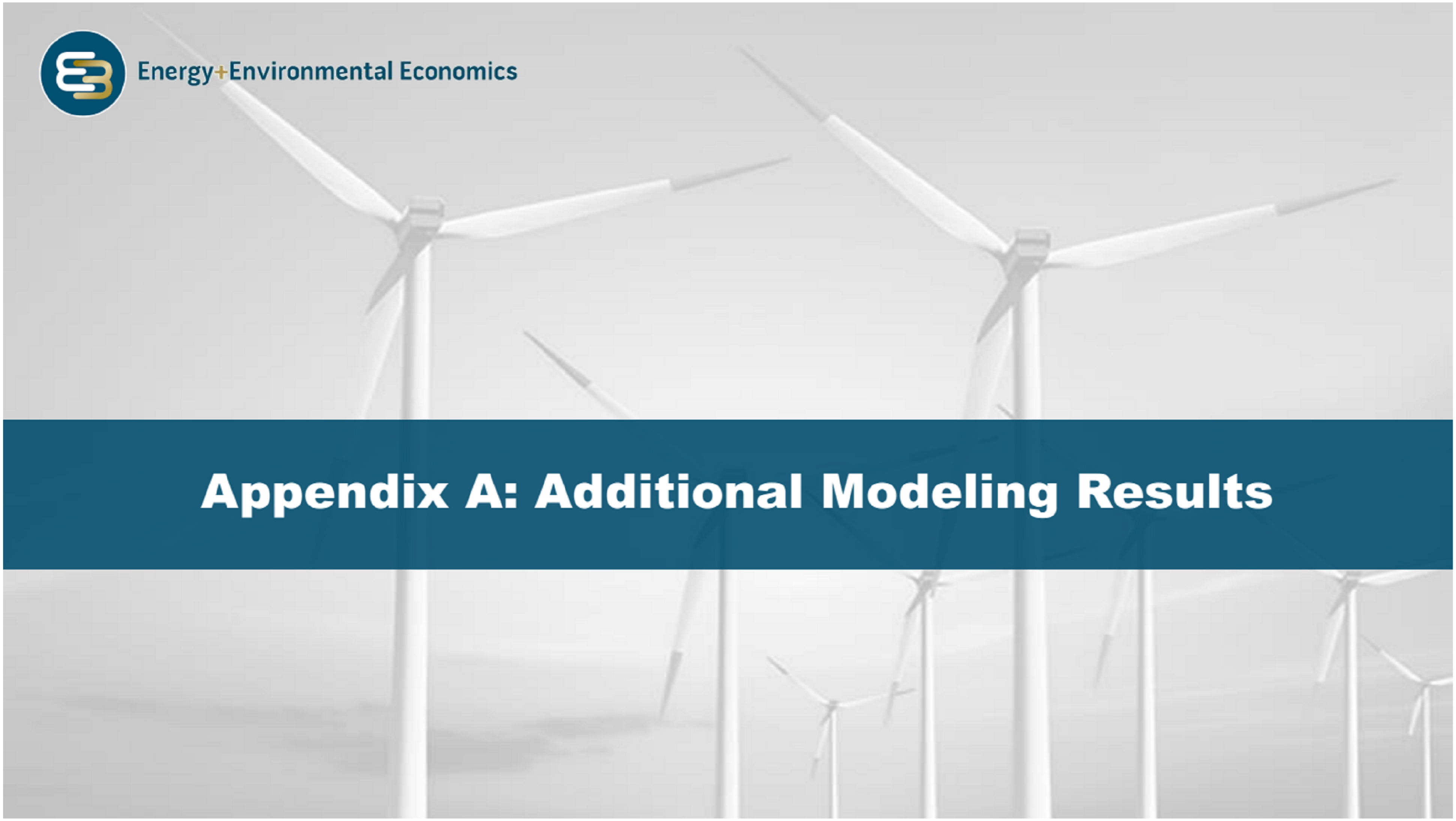

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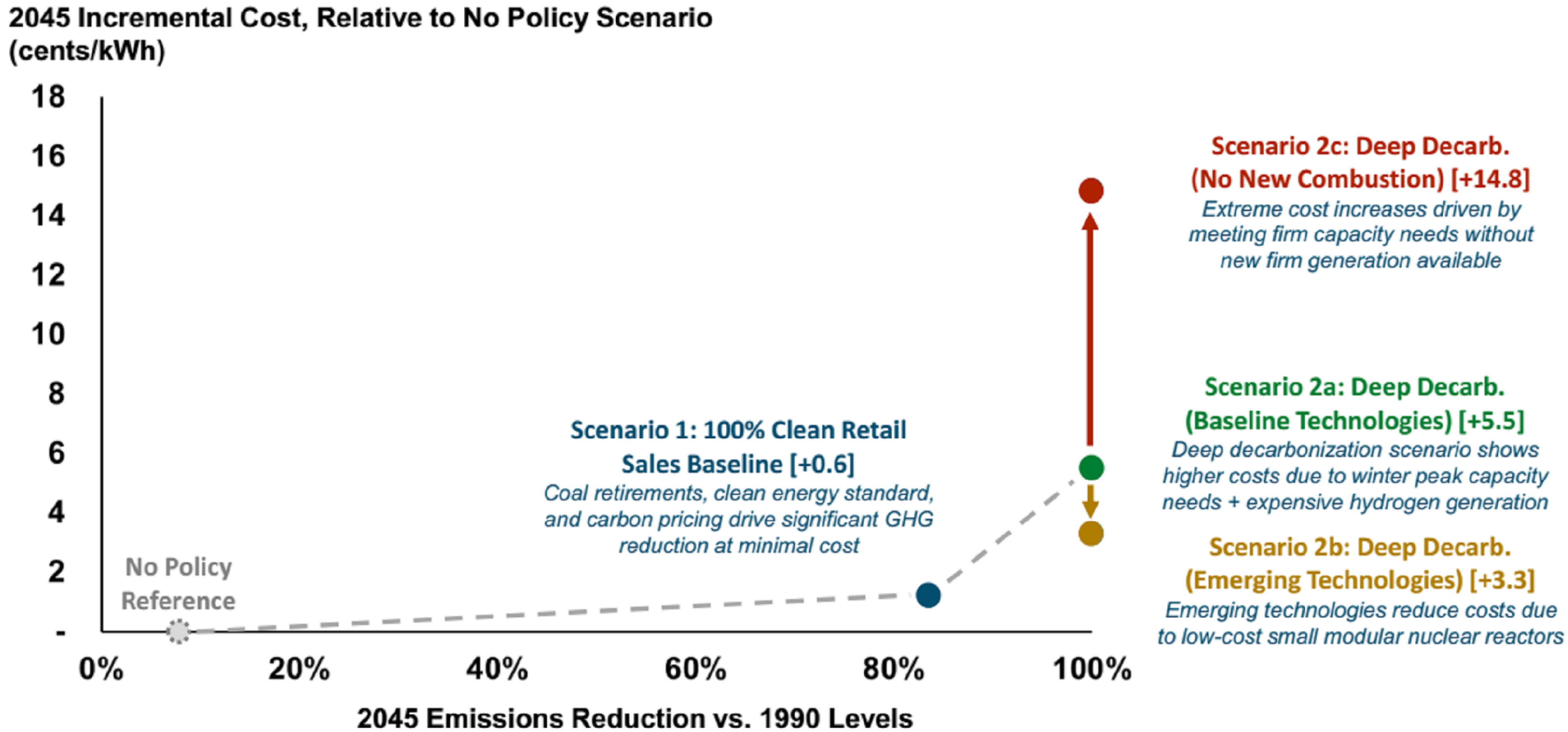
Appendix A: Additional Modeling Results

Significant carbon reductions are possible, but the cost of reaching zero emissions depends on technologies available

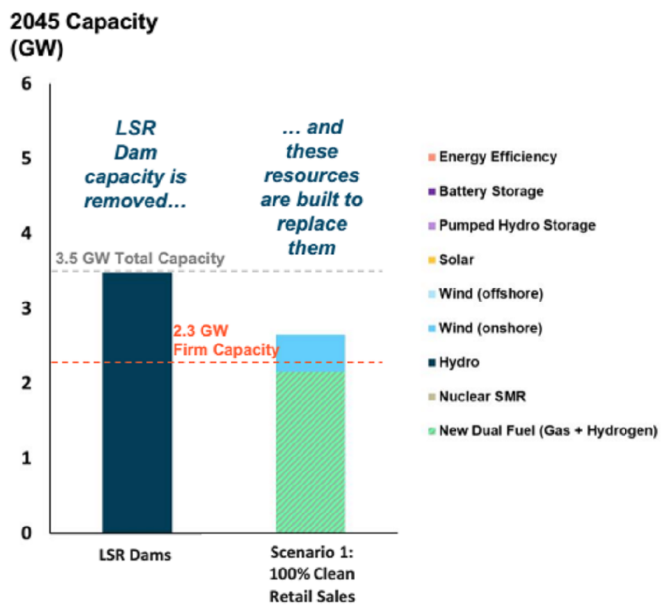


NOTES:
- 2020 average retail rates for OR and WA were 8-9 cents/kWh; 1990 electric emissions were ~33 MMT
- High electrification scenarios would avoid natural gas infrastructure costs, which would offset some of the electric peaking infrastructure cost increase

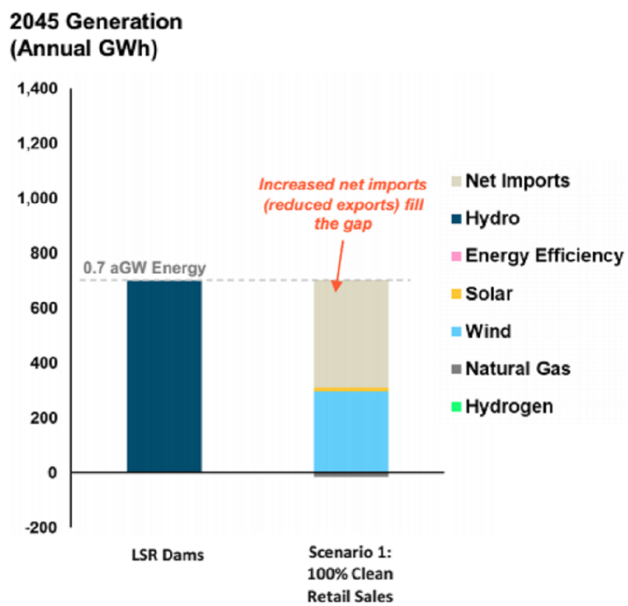
Replacing the Lower Snake River Dams Scenario 1: 100% Clean Retail Sales

- Capacity replaced with 2.2 GW of dual fuel natural gas + hydrogen turbines and 0.5 GW wind
- Wind and imports provide the most energy replacement, but gas plant is needed for meeting extreme weather peak load events to avoid power shortages
- 2045 GHG emissions increase ~11% as not all LSR generation needs to be replaced to still meet 100% clean retail sales target

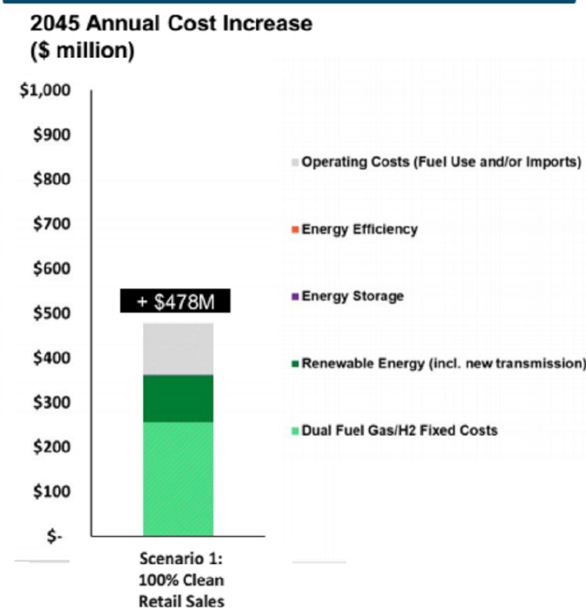
Additional Resources Built to Replace LSR Dams (2045)



Additional Generation to Replace LSR Dams (2045)



Additional Cost (2045)

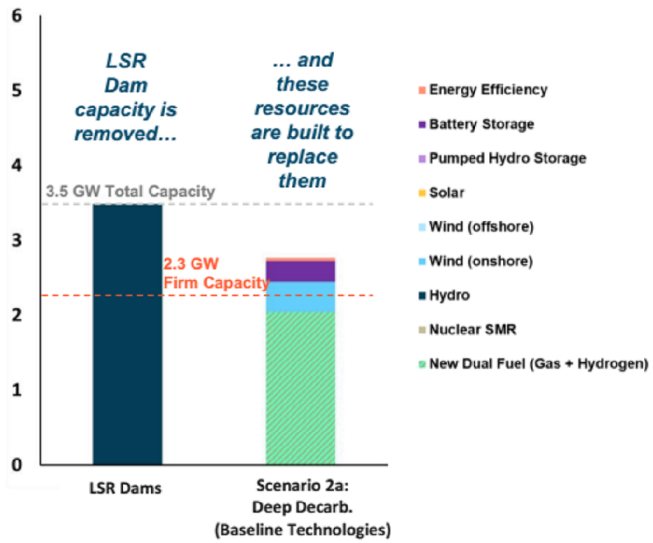


Replacing the Lower Snake River Dams
Scenario 2a: Deep Decarbonization (Baseline Technologies)

- Scenario includes electric load increases for transportation and other sectors
- In 2045, hydrogen generation is a key replacement resource and is assumed to be available, though not commercially available today
- This scenario would cost $860 million dollars per year in 2045, driven by high hydrogen fuel costs (~$40/MMbtu)

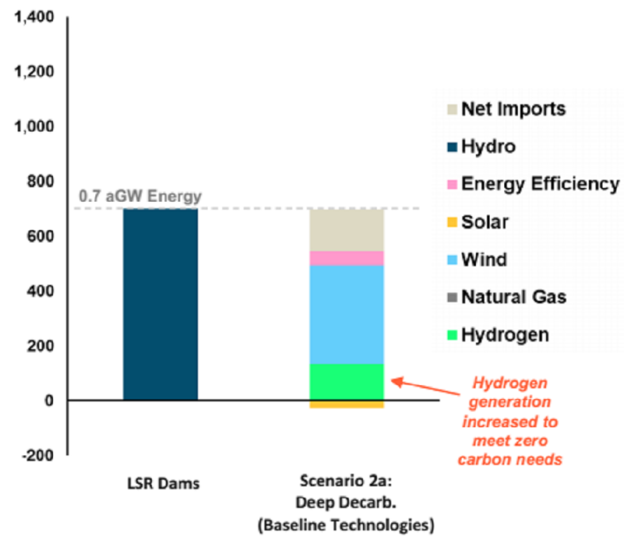
Additional Resources Built to Replace LSR Dams (2045)

2045 Capacity (GW)



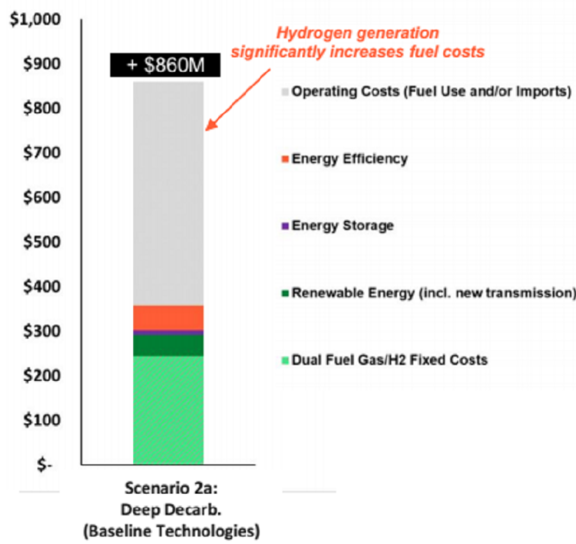
Additional Generation to Replace LSR Dams (2045)

2045 Generation (Annual GWh)



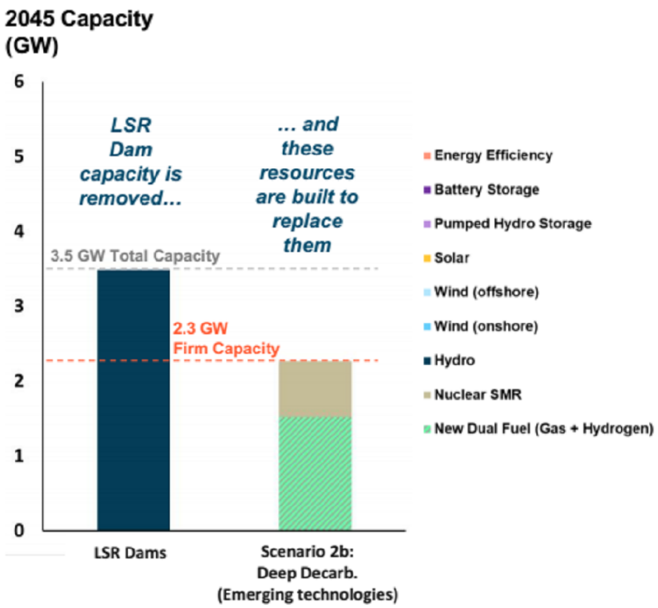
Additional Cost (2045)

2045 Annual Cost Increase ($ million)

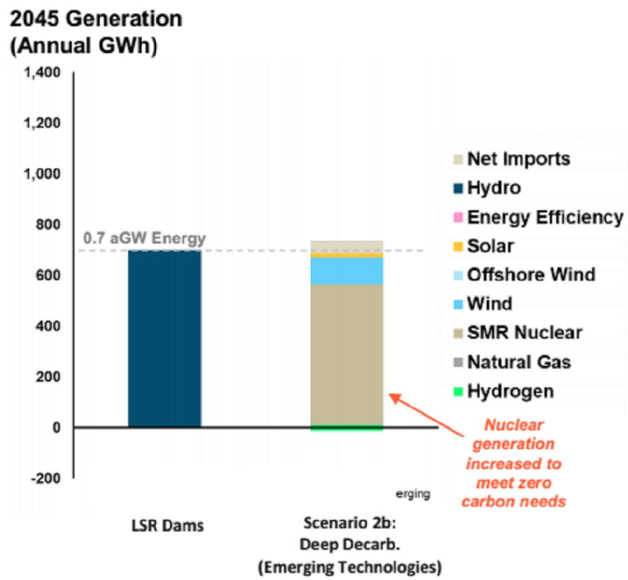


Replacing the Lower Snake River Dams
Scenario 2b: Deep Decarbonization (Emerging Technologies)

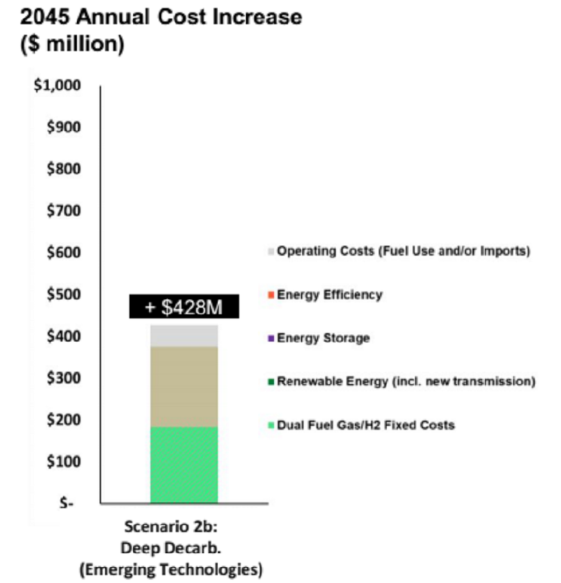
Additional Resources Built to Replace LSR Dams (2045)



Additional Generation to Replace LSR Dams (2045)

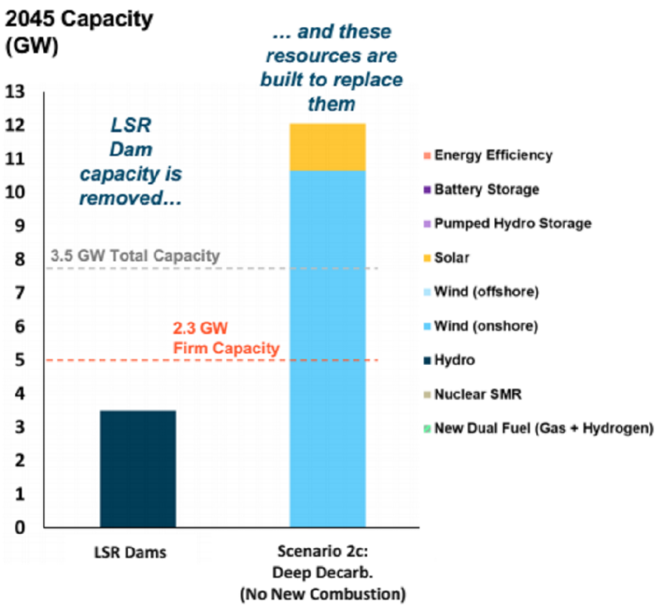


Additional Cost (2045)

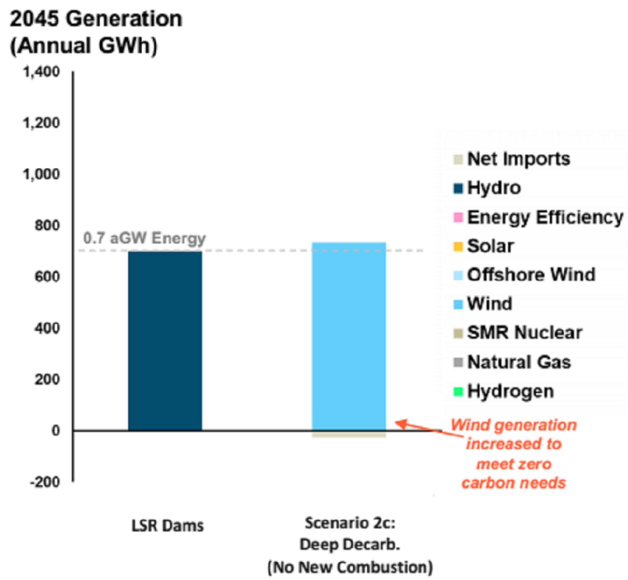


Replacing the Lower Snake River Dams
Scenario 2c: Deep Decarbonization (No New Combustion)

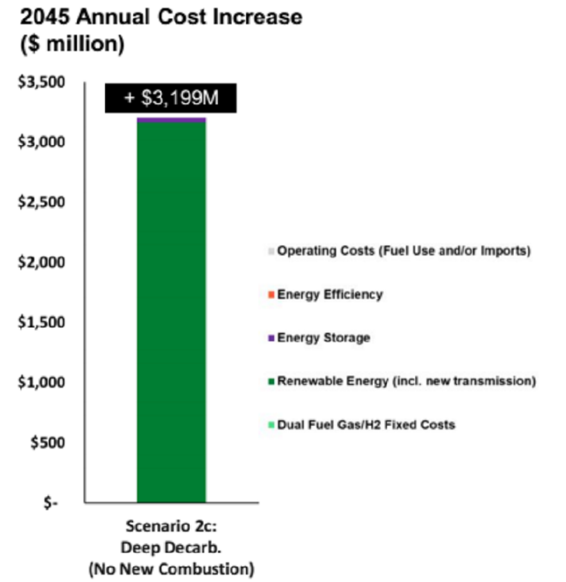
Additional Resources Built to Replace LSR Dams (2045)



Additional Generation to Replace LSR Dams (2045)



Additional Cost (2045)



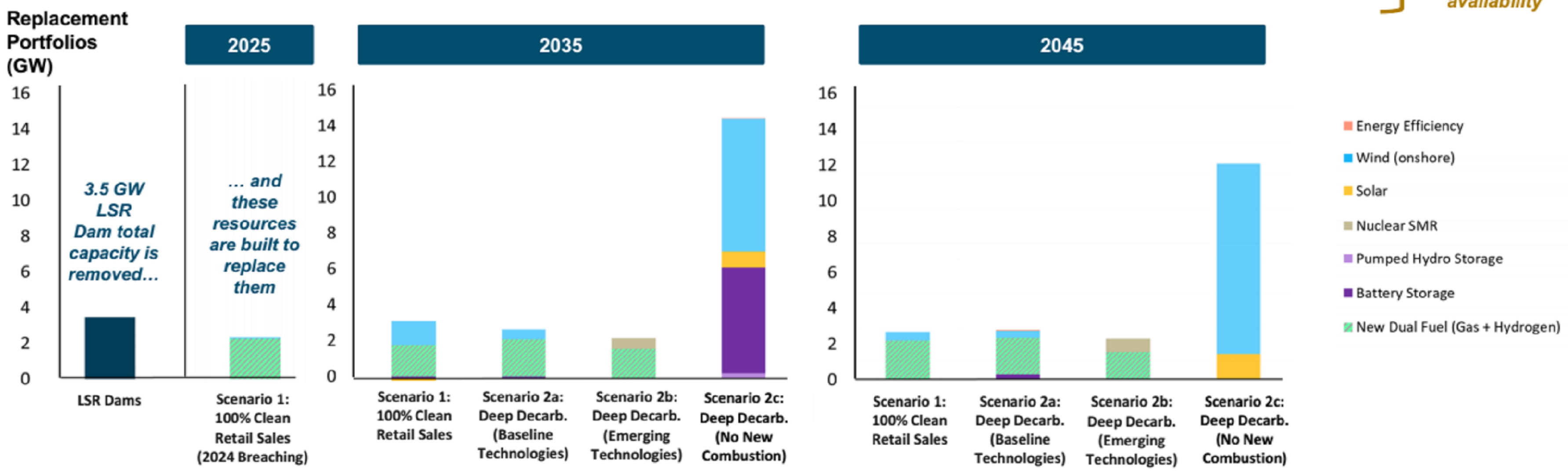
- A range of costs was developed for this scenario based on the assumed transmission needs for renewable additions
- High end assumes 100% of nameplate, low end assumes 25% of nameplate (approx. marginal ELCC of renewable additions)

Replacing the Lower Snake River Dams Capacity Across All Scenarios

- Scenario 1 (100% Clean Retail Sales, 2032 LSR Dams breaching): shown in previous slide
- **Scenario 1 (100% Clean Retail Sales, 2024 LSR Dams breaching): similar to scenario 1, but with dual fuel natural gas + hydrogen turbine replacement in 2025**
- Scenario 2a (Deep Decarbonization, Baseline Technologies): shown in previous slide
- **Scenario 2b (Deep Decarbonization, Emerging Technologies): small modular nuclear reactors replace LSR capacity and energy, instead of additional wind power**
- **Scenario 2c (Deep Decarbonization, No New Combustion): very high replacement need as wind and solar alone struggle to replace LSR dam firm capacity and zero-carbon energy output**

Limited load growth, carbon emissions remain in 2045

High load growth, carbon emissions eliminated by 2045… sensitive to emerging technology availability



Energy+Environmental Economics

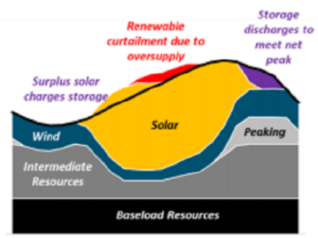
Appendix B: Additional Modeling Inputs

RESOLVE optimizes investments to meet clean energy targets reliably

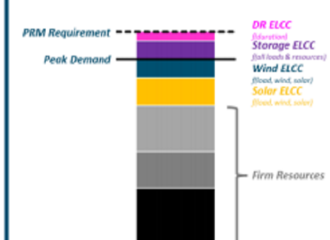
RESOLVE is an optimal capacity expansion model specifically designed to identify least-cost plans to meet reliability needs and achieve compliance with regulatory and policy requirements

+ **Linear optimization model explicitly tailored to study challenges to arise at high penetrations of variable renewables and energy storage**
+ **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**

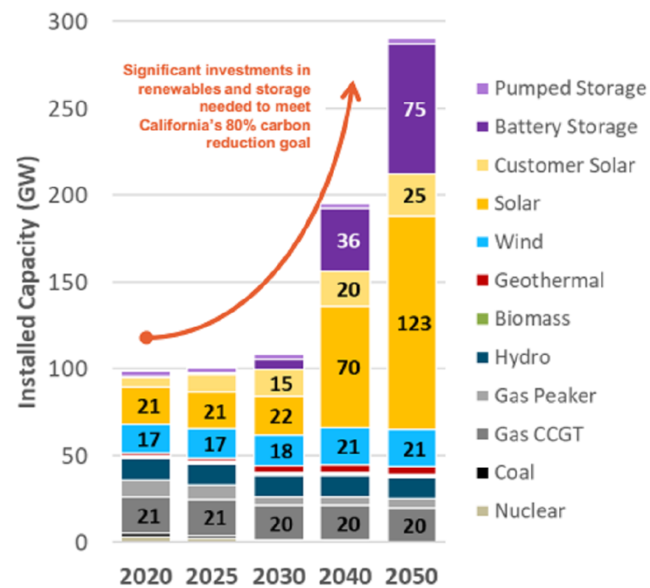
Operational module simulates hourly system operations for a sample of representative days



Reliability module ensures portfolio can meet load during extreme conditions using an ELCC approach

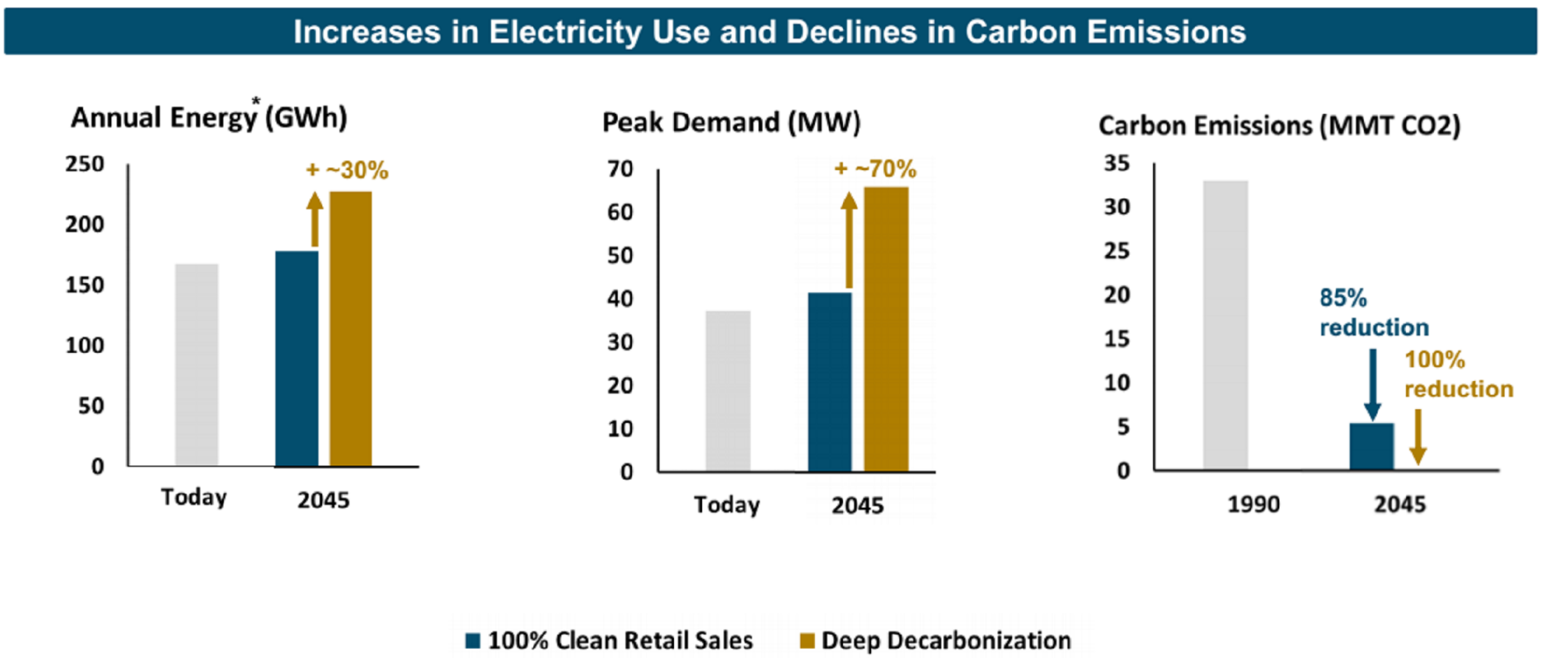


Least-cost plan cooptimizes investments and operations to meet clean energy policy targets, selecting from a diverse set of potential resources including wind, solar, storage, DSM, and natural gas



Example RESOLVE result from Long-Run Resource Adequacy under Deep Decarbonization Pathways for California (Calpine, 2019)

Load growth and carbon emissions in two clean energy scenarios modeled

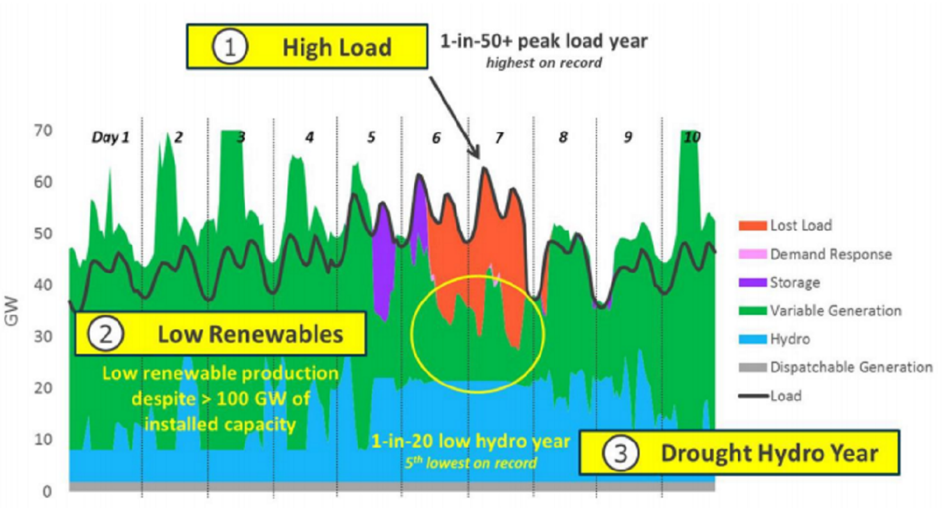


* Load based on 2021 NWPCC Power Plan, shown as retail sales (after assumed growth in customer PV and energy efficiency)

Resource Adequacy Resource Options

- **RESOLVE resource adequacy constraint requires capacity to meet peak demand + a 15% planning reserve margin**
  - Planning reserve margin (PRM) constraint is "installed capacity" (ICAP) based for firm resources, peaking capacity for hydro, ELCC for other non-firm resources
- **The nature of the Northwest reliability risk limits the ability of battery storage to provide reliable capacity contributions**
  - Storage and hydro show "antagonistic" interactions, which limit energy storage reliability value in "energy-limited" conditions where energy storage resources are unable to charge (with low hydro and renewable output) and run out of discharge (during extended energy shortfall events)

Key Drivers of Future Pacific Northwest Reliability Events

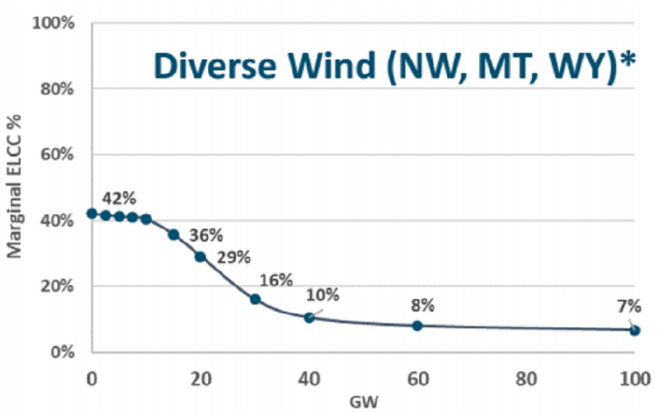


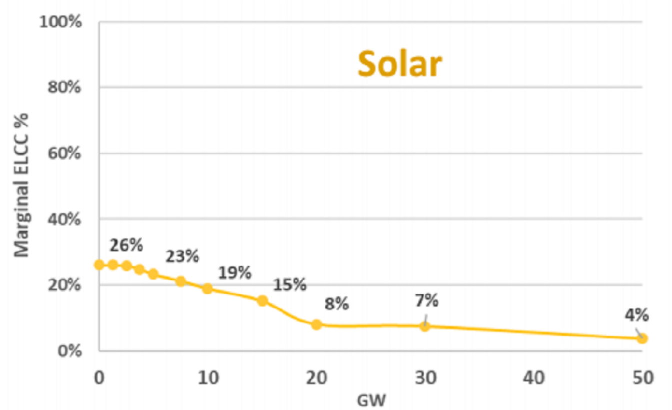
Sample week in 2050 in a 100% GHG reduction scenario, from E3, *Resource Adequacy in the Pacific Northwest*, 2019.

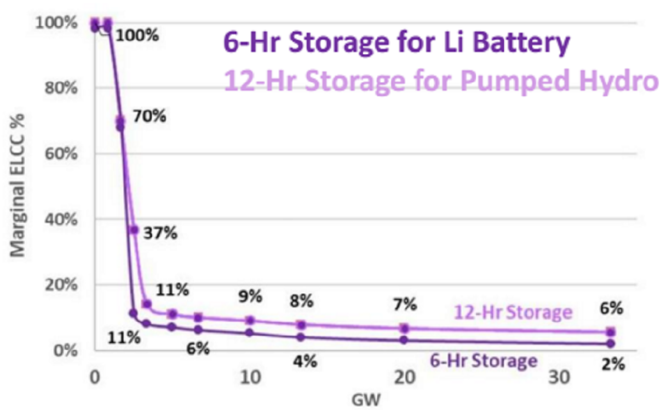
Resource	RA Capacity Contributions
Hydro	65%, based on sustained winter peaking capacity in critical water year conditions (per BPA/PNUCC)… WRAP method is still evolving
Battery storage	Sharply declining ELCCs*
Pumped storage	Sharply declining ELCCs*
Solar	Declining ELCCs
Wind	Declining ELCCs
Demand Response	Declining ELCCs
Energy Efficiency	Limited potential vs. cost
Small Hydro	Limited potential
Geothermal	Limited potential
Natural gas to H2 retrofits	Clean firm, but not fully commercialized
New dual fuel natural gas + H2 plants	Clean firm, but not fully commercialized
New H2 only plants	Clean firm, but not fully commercialized
Gas w/ 90-100% carbon capture + storage	Clean firm, but not fully commercialized
Nuclear Small Modular Reactors	Clean firm, but not fully commercialized

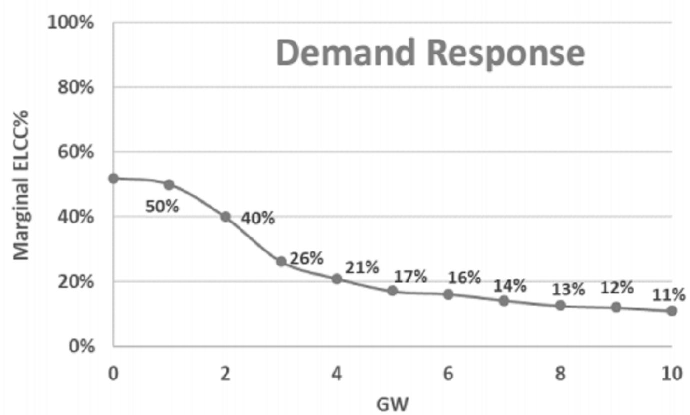
* E3 performed a sensitivity with battery ELCCs that do not decline so sharply. This sensitivity did change the LSR dam replacement resources and costs.

Incorporating Declining Capacity Contributions of Renewables, Storage, and DR









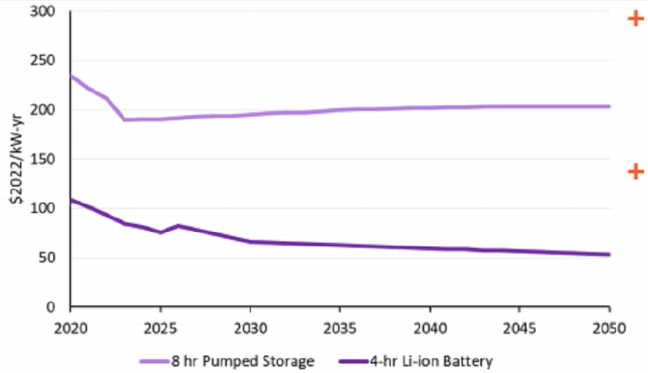
- **+ A reliable electric system requires enough capacity to meet peak loads and contingencies**
- **+ This study incorporates information from E3's 2019 report *Resource Adequacy in the Northwest* about the effective capacity contribution of renewables, storage, and DR at various penetration levels**

* The offshore wind sensitivity in this study assumed the same ELCC curve as modeled for diverse on-shore wind resources in the Resource Adequacy in the Northwest report.

ELCC = Effective Load Carrying Capability = firm contribution to system peak load

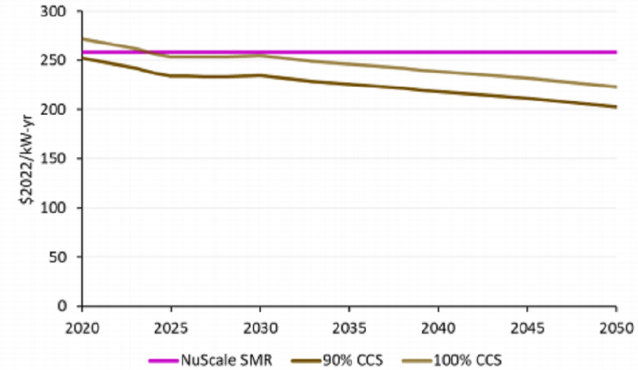
New Resource Options
All-in Fixed Costs

Storage Options



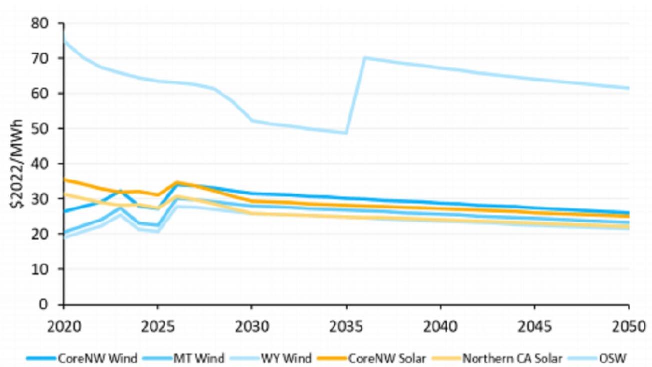
- **Battery Storage costs derived from E3's inhouse and Lazard LCOS 7.0 (Oct 2021)**
- **Pumped storage is from Lazard's last published PHS costs (LCOS 4.0). Assumes CAPEX and FO&M are flat + financing cost trends same for battery storage.**

Firm Low Carbon Options



- **CCS costs derived from E3's inhouse "Emerging Tech" ProForma**
- **SMR costs are derived from the vendor NuScale, for an "nth of a kind" installation of the technology they are developing**

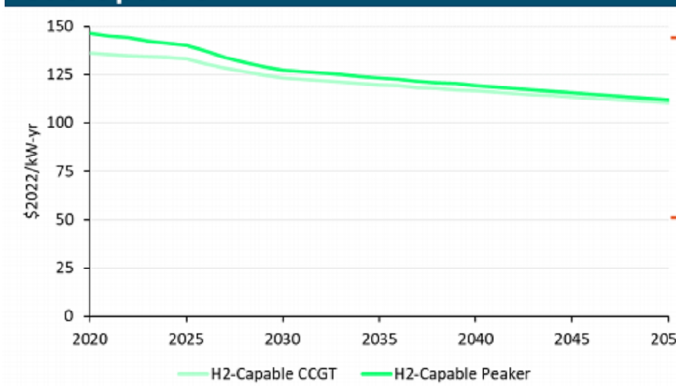
Renewable Options



Renewable costs derived from E3's in house Pro Forma which integrates NREL ATB 2021

Costs shown here do not include the cost of upgraded or new Transmission lines

Gas Options



- **CCGT and peaker costs are derived from E3's inhouse ProForma which integrates NREL ATB 2021**
- **New Hydrogen or upgrades include a ~10% additional cost that converges by 2050**

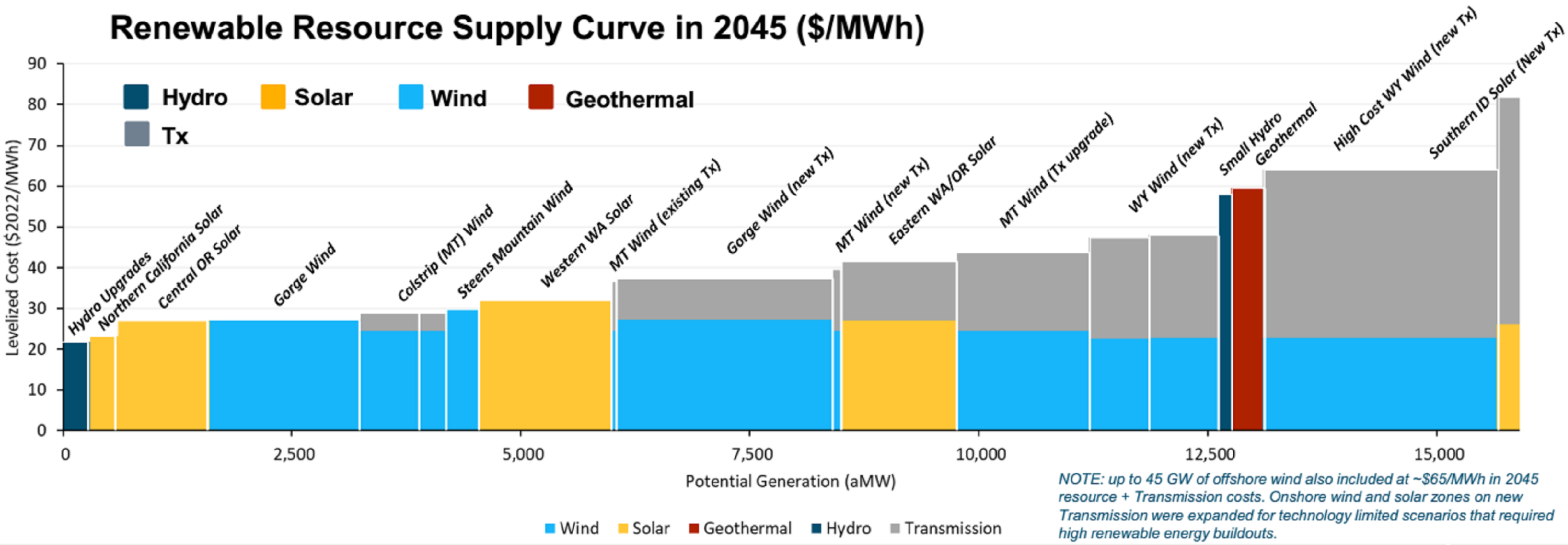
NOTE: only dual fuel natural gas + H2-enabled new resources modeled, given NW policy constraints

Embargoed until 6:00 am on July 12, 2022

New Resource Options
Renewables

+ The following supply curves integrate Transmission costs that RESOLVE sees
+ The "no new combustion" scenario required increases in the supply of wind on new transmission (Northwest, MT+WY, and offshore) to enable a feasible solution

Renewable Resource Supply Curve in 2045 ($/MWh)



NOTE: up to 45 GW of offshore wind also included at ~$65/MWh in 2045 resource + Transmission costs. Onshore wind and solar zones on new Transmission were expanded for technology limited scenarios that required high renewable energy buildouts.

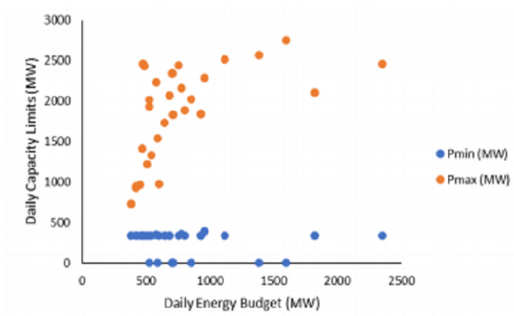
Hydro Operating Data

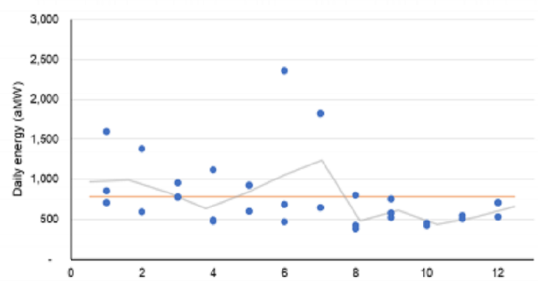
- Key RESOLVE inputs (for each representative RESOLVE day)
  - Max generation MW
  - Min generation MW
  - Daily MWh hydro budget
  - Ramp
- Hydro operating data is parameterized using representative conditions for 3 low/mid/high historical years (2001, 2005, 2011)
  - Lower Snake River and lower Columbia River dams were adjusted per BPA hydro modeling w/ latest fish spill constraints
- Hydro firm capacity contribution is assumed to be 65% of total MW, per PNUCC methodology (based on BPA 10-hr sustaining peaking capacity)

LSR Hydro

Ramp Rates

Hydro Resource	1-hr	2-hr	3-hr	4-hr
LSR_Hydro	36%	43%	45%	48%

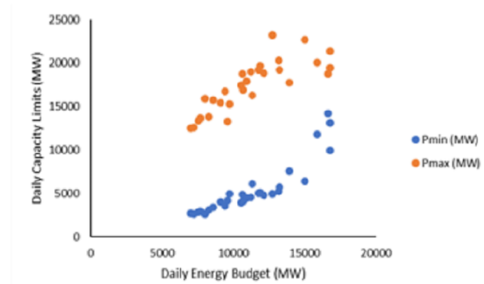


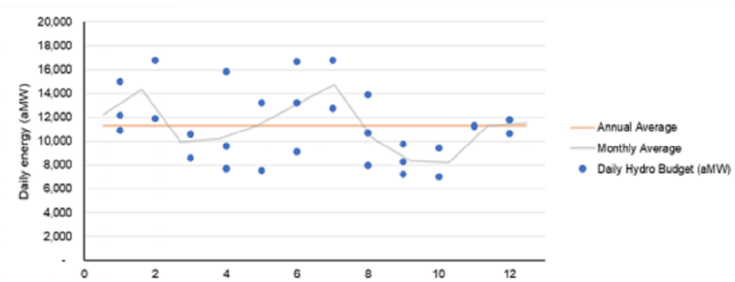


Non-LSR NW Hydro

Ramp Rates

Hydro Resource	1-hr	2-hr	3-hr	4-hr
CoreNW_Hydro	14%	23%	30%	34%





From: Leary,Jill C (BPA) - LN-7
Sent: Wednesday, April 27, 2022 4:36 PM
To: James,Eve A L (BPA) - PG-5; Koehler,Birgit G (BPA) - PG-5
Cc: Godwin,Mary E (BPA) - LN-7
Subject: NEPA and the E3 report

Confidential and privileged attorney client communication/FOIA-exempt
Hi Eve and Birgit,

(b)(5) [redacted]

Thanks,
Jill