

**Northwest Power and Conservation Council
Generating Resources Advisory Committee
September 25, 2019**

Gillian Charles, NWPCC, began the meeting at 9:00 with introductions and a review of the agenda.

**Resource Max Buildout for the 2021 Power Plan
Mike Starrett, NPWCC**

David Nightingale, WA UTC, asked about the economic impacts of displacing part of the existing portfolio to ratepayers [Slide 4.] Starrett explained that this is still a least-cost optimization but allows considering a broader range of potential futures. Replacement energy from a new build resource would need to be a lower cost alternative of running an existing plant.

Fred Heutte, NW Energy Coalition, asked how the transfer capability across bubbles on [Slide 6] is determined. Starrett said Aurora comes pre-loaded with some information and BPA provides more but stressed that this isn't a power flow model.

James Vanden Bos, BPA, confirmed that going with the 6900 MW+ bakes in assumptions around relief of commercial transmission contractual encumbrance through some policy, commercial, or procurement norm shift. [Slide 7.] Starrett answered yes, and pointed to the paradigm of traditional transmission requirements, the nature of solar energy and the need to change the procurement norms or offer transmission products that better match the needs of the grid today.

Vanden Bos said that the historical standard is to follow what's on the books over, which to him reads as following the commercial constraints. Vanden Bos said modeling this way could result in a Plan that is predicated on changing those commercial considerations. Starrett offered that BPA's own future portfolio modeling in their transmission group makes the same assumption being proposed today and said what could be built within a BA would be above the previous benchmark even without considering export capability. He then said he is proposing a scenario that looks at a build out in a transmission constrained world.

Rick Haener, Idaho Power, asked if there are any regulating reserves pushed in with the added solar resources. Starrett said the RPM does not have a view of short timescale reserves and will require some future thought.

Charlie Black, CJB Energy, asked if there were any other utilities beside PGE willing to procure renewables with conditional firm transmission [Slide 9.] Starrett called PGE ahead of the curve, noting that some utilities want a one-for-one build. Black noted that past Plans had a limited ceiling for gas based on infrastructure and asked if that will continue for the 2021 Plan. Starrett

answered that any technical potential limits would be incorporated for any resource. Black asked about assumed limits or expansion capacity on pipeline capacity. Charles said this is a topic for the December meeting.

Black asked if, considering WA new rule and Oregon IOU carbon limits, there are plans to track or set a ceiling on the construction of new, carbon-emitting resources for this Plan. Charles said all new rules and policies will be translated into the model. Starrett added that he doubts that CETA would outright restrict building a gas plant but would have to consider the economics.

Tom Haymaker, Clark PUD, countered that there are penalties, but no limitations on running units. Starrett asked about the 100% clean, no offsets portion of CETA. Haymaker said his understanding is that CETA is still a planning standard at the 100% clean level set for 2045. Black said that CETA does set clean energy requirements that could be met with penalties with teeth. Haymaker said there are penalties for 2030-44 but not 2045.

Nightingale asked if other regional planning organizations are aware of the Council's plan to set a ceiling. Starrett said this has been vetted with a few utilities and hopes that the GRAC would be another resource. Nightingale then asked if a solar summer peak is being considered in the same way as a winter peaking resource. Starrett said it would be aligned with the yearly peak load of the BA.

Heutte asked how the reference plants on [Slide 9] maps back to the bubbles. Starrett explained that in Aurora the resource profile for solar, for example, would match the area covered by the BA and that in the RPM, which only differentiates by East and West, only the smaller subset of profiles specifically tied to the chosen Reference Plants would be used.

Nightingale called this a good approach that reflects the reality of a more flexible system going forward [Slide 12.]

Solar Reference Plant for the 2021 Power Plan

Mike Starrett, NWPC

Nightingale asked if the clipping on [Slide 12] suggests that installers will undersize systems. Starrett said yes, it's the norm to undersize the inverter relative to the panels and said he will get into numbers later in the presentation.

Haymaker asked if this poses a safety issue. Starrett answered no, explaining that there's no thermal waste, the clipping is executed by de-tuning the solar panels to be less efficient through system controls.

Heutte said bi-facial solar panels is new and coming into the market quickly and he doesn't know if it will have an impact on inverter sizing [Slide 13.] Starrett offered that to the extent that bi-facial solar increases the capacity of a panel at a competitive price, over-loading inverters may continue to an even further extent.

Heutte noted that the reference plant uses 1.4 inverter load ratio (ILR) [Slide 15] while the NREL baseline is still 1.3. Starrett said that the 2019 ATB is for 2017 tech and that he will address this later in the presentation.

Nightingale asked if the black box calculation on [Slide 16] is because the majority of energy will be above or near capacity for generation. Starrett said most big costs scale with the DC sides while the inverter doesn't.

Haymaker asked for further explanation of the caveat "not in utilities' IRPs." Starrett said utilities look at price per KW AC but the solar industry quotes price per KW DC and this is a way to convert.

Heutte asked what dollar year is being used for the 2021 Plan [Slide 18.] Starrett answered 2016.

BREAK

Solar Reference Plant for the 2021 Power Plan (continued)

Mike Starrett, NWPCC

Heutte asked if project finance professionals were consulted for the numbers on [Slide 20.] Starrett answered that he did this by looking at market trends and welcomed referrals of any experts.

Haymaker asked if this only represents hardware costs. Starrett said they are overnight costs, similar to a utility's IRP cost expectation. Haymaker said he's looking at other IRP work and PGE's is at the \$1500 level. Starrett agreed that their numbers have gone up. Heutte said NW Energy Coalition thinks that the number is too high.

Heutte brought up assumptions around the shortening length of PPA projects. Starrett agreed, saying this often puts the risk on equity investors.

Heutte voiced some concern over using 1.4 as we are not yet seeing it in the region [Slide 23.]

Heutte asked how the Columbia Gorge is defined on [Slide 28] and why it's skipped. Starrett said it goes back to where load is. Heutte said BPA's generation queue puts most of the solar in the Gorge because of transmission. Starrett said he will revisit this.

Heutte agreed with one solar PV on the east side and one on the west approach [Slide 31] but then moved to [Slide 5] and suggested breaking the east side into north and south as well. Starrett said that wouldn't change the answer.

Nightingale pointed to the different economies of scale in western WA and OR [Slide 31.] Starrett said he reflected that in the overnight capital costs and then explained why he chose a 15MW plant. Heutte explained OR land use restrictions that will make it harder to build in the

Willamette Valley. Nightingale asked if rules are different in Eastern Oregon. Huette said there's limited high-value farmland there and lots of large projects in the BPA queue.

Nightingale asked if [Slide 32] tries to estimate the full cost of a residential system. Starrett said if the RPM picked an incremental amount of cost-effective rooftop solar it would be something to explore. Nightingale confirmed that the region wouldn't be buying it to put on houses. Starrett said no, it's more about the signal it reflects. Starrett said that the model choosing rooftop solar would be akin to choosing energy efficiency – it would suggest that utilities should bring that onto their system before building some other, more expensive resource. How they actually bring such a resource online would depend on how they currently acquire energy efficiency, for example.

Huette said [Slide 34] represents what the model will pick to build out versus what the model should incorporate as a trend. Starrett agreed.

Nightingale said he was not familiar with Energy2020 [Slide 32] but said if people are willing to pay half the cost for solar then the cost to the region would only be half of the \$2000. Starrett explained how Energy2020 works, saying the load side looks at how much people will pay out of pocket while the portfolio side reflects potential economic opportunity above and beyond what people would buy on their own. Any rooftop solar selected here would mean that it is part of the least-cost portfolio and should be acquired ahead of other more expensive options.

Nightingale noted that federal tax credits are going away and wondered if that will change the trend. Starrett said the 2020 model does consider the tax benefit and, in the future, it might be similar to any other energy efficiency product.

Haymaker noticed that there were no variable costs on [Slide 33.] Starrett said he didn't know what the fixed O&M would be but said he will come up with something. Haymaker noted that there is a lot of handholding and additional costs when you get to the single, consumer level.

Battery Storage Reference Plant for the 2021 Plan

Mike Starrett, NWPCC

Huette said [Slide 4] applies to lithium ion batteries but not flow. Starrett noted that the Tesla paper says a key to battery life is keeping the product cool.

Heutte confirmed that the Y axis on [Slide 11] is per KW year before calling the fixed costs high. Starrett agreed, saying there's an expectation of cell replacement. Heutte agreed, saying that there will be a learning effect that may bring the costs down. Starrett agreed that costs seem likely to come down but couldn't find research to support that.

Haymaker asked what is assumed for fuel price [Slide 12.] Starrett said John Ollis, NWPCC, will talk about modeling storage later adding that it's a challenge.

Heutte asked how they derived 88% for round trip efficiency. Starrett said he spoke to people who have them. Heutte then asked where the degradation factor is incorporated. Starrett said he will do some research on it.

Haymaker asked if the round-trip efficiency is at the battery terminal or line losses. Starrett answered that it's at the terminal.

LUNCH

Pumped Storage in the 2021 Power Plan

Gillian Charles, NWPCC

Dave Van't Hof, National Grid asked if the 400MW reference plant with 1200MW maximum on [Slide 3] reflects expected regional need. Charles said is available potential. Van't Hof said, after looking at the projects, it seems like the prospects are larger than 1200MW. Starrett explained how the model works and the benefits of signaling the region with incremental steps. Van't Hof understood the approach and suggested that there wasn't a need to artificially constrain the model to 1200MW.

Nate Sandvig, National Grid, suggested dropping in a pump storage scenario. John Ollis, NWPCC, said that will be addressed in the next presentation. Ollis then said the lead time for pump storage is so long that the model might option to choose it and then find after the lead time has evolved, enough has changed in the market that it was not a good investment. It could also continue to be a good investment, of course, but the idea is that the model considers lead time as part of its decision making logic.

Nightingale asked about the downside of going beyond 1200MW. Ollis said that every resource should be sized per what is expected in 20 years but being conservative shouldn't be an issue as there's a new Plan every five years. Starrett added that if the model latches on to the 1200MW they can dig in deeper.

Nightingale suggested that the narrative could mention that with coal shutting down this resource could fill the gap.

Heutte agreed that the 1200MW is arbitrarily low but said there should be constraints.

Council's Modeling Portfolio

John Ollis, NWPCC

Sandvig noted that in some studies California doesn't exist [Slide 3] even though there's projected development of 100GW. Ollis said that would be captured in Aurora which may be great for storage. Starrett said there's also a presumption about what is available to us in a time of need. Ollis said import assumptions are being discussed and suggested attending the Resource Adequacy Advisory Committee.

Sandvig asked if any Council staff participates in WIRAB Flexibility Assessment. Ollis said yes, noting they've helped with the modeling. He was confident that between Aurora and the redeveloped GENESYS they will get a good look at storage.

Van't Holt asked if model runs take individual utility IRPs into account. Charles said if a resource is under construction, they are considered existing, while sited and licensed is usually proposed but there is room for judgement.

Van't Holt brought up an earlier comment about solar being better suited to four-hour storage, saying PGE is looking at longer duration storage. Ollis said the redeveloped GENESYS has been enhanced to understand forecast error which may favor storage, but cautioned that the Council models the region, not just PGE's footprint.

Van't Holt asked about direct or indirect contribution towards policy/goals. Ollis said it's a way to stop overbuilding and curtailments among other things.

Carl Borgquist, Absaroka Energy LLC, said there are three things to think about 1. The solar impact from California is going to create ramping and arbitrage issues in the model. 2. Capacity and dispatch need to be thought of regionally using Gordon Butte, Gorge Wind and Colstrip transmission as an example and 3. The problem of replacing inertia as coal and gas plants go down.

Ollis agreed with the first two points, saying that's why he's using a portfolio model approach and explained the process.

Pumped Storage: Long-Duration Bulk Storage

Nate Sandvig, National Grid

Huette asked if there's a possibility of Swan Lake going beyond 400MW in the future. Sandvig said that's what the license is for.

Charles asked what needs to happen for a 2025 operation date [Slide 6.] Sandvig offered to send a block schedule adding that the big piece is the turbine production which takes around five years. Van't Holt added that utility agreements are the biggest constraint.

Heutte asked if the EER and E3 studies are publicly available. Sandvig answered yes. Starrett requested a link that could be posted with this presentation.

Banks Lake Pumped Storage Project

Matthew Dunlap, Kleinschmidt Group

Starrett asked about the head range on [Slide 4] wondering what the minimum generating capability is at the bottom end of the reservoir. Dunlap said the upper reservoir only has a three-foot band which doesn't impact capacity much but the tailwater does.

Heutte asked about the issues around scaling to 1000MW. Dunlap said the only issue is the amount of capital cost and instantaneous demand peak projections.

Gordon Butte Closed Loop

Carl Borgquist, Absaroka Energy LLC

Starrett asked how to interpret the equity options on the financing side [Slide 15.] Borgquist said it means we have a very capable counter party ready to take it to financing and could probably write a check for the entire project.

Methodology for quantifying the environmental costs and benefits of new resources for the 2021 Power Plan

Gillian Charles, NWPCC

Heutte asked how recent the Washington study on [Slide 13] is. Charles answered that they a little over a year old.

Charles concluded the presentation and asked for questions or comments to be sent to her [Slide 19.]

Black said she has described fastidious compliance with the 40-year-old Northwest Power Act and said it would be useful for the 2021 Plan to provide as good as possible information around greenhouse gas emissions. Charles said the Council will attempt that.

Heutte asked if Aurora or the RPM provides CO2 emissions. Starrett answered yes, adding that the proposed strategy is to apply the social cost of carbon as a post-processed damage cost to each run to get an emissions cost. Heutte said GridView provides that. Starrett said they are applying a cost multiplier to each ton of carbon, which the model provides as an outcome of each run.

John Shurts, NWPCC, addressed Black's earlier question noting that there are many environmental issues that have to be considered for the Plan but don't fit into the narrow box of environmental methodology.

Haymaker asked if and how the environmental footprint of manufacturing products is factored into the environmental impacts. Charles said they would quantify that if they could but a lot of that is goes into the qualitative narrative. She said the Seventh Power Plan had a 100-page appendix that spoke to such upstream issues.

Charles ended the meeting at 3:15.

Attendees

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|-------------------|---------------------|
| Gillian Charles | NWPCC |
| Mike Starrett | NWPCC |
| Henry Tilghman | Tilghman Associates |
| James Vanden Bos | BPA |
| Ben Fahy | BPA |
| David Nightingale | WA UTC |

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| Fred Heutte | Northwest Energy Coalition |
| Tom Haymaker | Clark Public Utilities |
| Samuel Girma | Energy Trust of Oregon |
| Nate Sandvig | National Grid |
| Dave Van't Hof | National Grid |

Attendees via Webinar

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| Baili Connors | Northwestern |
| Brenna Vaughn | NW Hydroelectric Association |
| Bryan Neff | California Energy Commission |
| Charlie Black | CJB Energy |
| Clint Gerkenmeyer | Energy Northwest |
| Adam Cornelius | Snohomish PUD |
| Gregory Cullen | Energy Northwest |
| Dave LeVee | PwerCast |
| Dan Davis | US Army Corps of Engineers |
| Deanna Carlson | Cowlitz PUD |
| Elizabeth Osborne | NWPCC |
| Frank Brown | BPA |
| Greg Nothstein | WA Energy Office |
| Rick Haener | Idaho Power |
| Jim Woodward | WA UTC |
| Jimmy Lindsay | PGE |
| Kelli Schermerhorn | Northwestern |
| Dan Lloyd | Montana |
| John Lyons | Avista |
| Jennifer Magat | Puget Sound Energy |
| Malcolm Ainspan | NRG |
| Matthew Dunlap | Kleinschmidt Group |
| Will Price | EWEB |
| Paden Wallace | Absaroka Energy |
| Patrick Oshie | NWPCC |
| Phil DeVol | Idaho Power |
| Rhett Hurless | Absaroka Energy |
| Rob Diffely | BPA |
| Robert Campbell | Northwestern |
| Samuel Birru | |
| Scott Spahr | Snohomish PUD |
| Shirley Lindstrom | NWPCC |
| Thaddeus Steerman | Energy Trust |
| Brian Dekiep | NWPCC |