Northwest Power and Conservation Council
Generating Resources Advisory Committee
October 29, 2019

Gillian Charles, NWPCC, began the meeting at 9:30 with a call for introductions and a review of the agenda.

Wind Reference Plant for the 2021 Power Plan
Mike Starrett, NWPCC

Fred Heutte, NW Energy Coalition, asked if Starrett came across any information on inter-annual variations in the range of output, particularly for the NW [Slide 8.] Mike Starrett, NWPCC, said he didn't know specifically how IPPs did their due diligence or benchmarked business as usual. Starrett added that, qualitatively, one IPP is implementing cost saving measures.

Heutte wondered how hydro variability is impacting wind and solar. Starrett said he doesn't have project-by-project grid analysis but does have a shape. Charles pointed to the project database on the Council's website, updated with annual generation through 2018, that shows project-by-project information.

Dave Nightingale, WA UTC, referenced a study from western Europe that shows asymmetrical, year-to-year variations. He noted that the study shows some years being 10% below average while the upside can be much higher. Nightingale then noted data from the Skookumchuck Wind Farm that shows a different shape than Gorge wind.

Tomàs Morrissey, PNUCC, offered data from Bonneville. Starrett asked if it adjusts for wind out of the BA. Morrissey said yes, noting that the locations of farms change as wind moves in and out of the BA which can affect capacity factors.

Nightingale asked about physical constraints that complicate transporting larger windmill parts to sites [Slide 9.] Starrett was not sure. Heutte said there are limits to physically transporting these parts, adding that the sky's the limit for offshore wind.

Garrison Marr, Snohomish PUD, asked if trend data shows that bumping up turbine height doesn't necessarily affect ROI. Starrett thought that was true as most taller windmills are being built outside the region. Starrett added that capacity factors are improving relatively for all sites because of many different enhancements. Heutte added that changes in how a fleet is positioned and managed is also improving performance.

Heutte pointed to interesting implications around shortening PPA lengths [Slide 13.] Starrett agreed.

Marr pointed to the present favorable borrowing environment but wondered about that changing over the life of the 2021 Plan [Slide 19.] Starrett agreed and explained the 5.5% cost

of debt embedded in AURORA. Starrett said there are talks about updating that number but agreed it might make more sense to use an average.

Dave LeVee, PowerCast, added that the economic cost is not necessarily the finance cost, referencing a paper he presented to the Council a few years ago.

Henry Tilghman, Tilghman Associates, asked how [Slide 23] corrects for transmission. Starrett explained the method he used for the mid-term assessment.

Heutte expressed curiosity about price trends that will be modeled. Starrett said that will have to be revisited for wind and solar technologies. Heutte reiterated that he advocates using an experience curve approach adding that it's good for the long term. He stressed the importance of thinking about the interaction between tax credits and capital costs.

Morrissey asked if there will be scenarios with greater-than-projected cost declines, similar to what staff did with solar for the Seventh Plan. Starrett did not think so. Charles added that solar costs were dropping significantly during development for the Seventh Plan, but repeating that this time is still up for debate.

Nightingale suggested getting GreenDirect data from PSE to represent western WA and OR as it is the most up-do-date [Slide 25.] Starrett said they can simulate the data too but suspected Skookumchuck will be developed sooner because of proximity to transmission. Nightingale added that the tariff is public information.

Brad Spangler, Snohomish PUD, asked if the numbers are modeled or actual. Starrett answered that they are modeled, noting that he hoped to run simulations using an NREL tool but the tool is broken with no plans to fix it.

Heutte questioned PGE's WA and MT capacity factors of 42.9 and the need for interannual data. He was glad that the Council is seriously looking at MT wind but cautioned that how the model treats it versus other wind/other renewables will be important. Charles stated that Judith Gap annual capacity factor went from 35% to 43% over the last eight years. Starrett added that O&M trouble might be lowering capacity factors.

Nightingale added that resource timing outside the Gorge is different. Starrett moved to [Slide 26] to show different shapes.

Heutte asked if the data on Slide 26 is Starrett's work. Starrett confirmed. Huette mourned how little data there is for MT wind.

Morrissey asked if the numbers are hourly shapes or average hourly shapes. Starrett said they are from an 8760-hourly data set.

Nightingale suggested scrapping the Gorge wind on [Slide 28] in favor of a western I-5 corridor location or perhaps combining SE WA and Gorge. He approved of the proposed configurations.

Heutte called the capacity factors for the Gorge and SE WA high along with the capital costs. He supported looking at "westside" wind. He wondered if separating the Gorge and SE WA will matter with the model's BA approach. Starrett stated that AURORA is BA by BA but the RPM is still just big zones.

Nightingale pointed to a few turbines at Pacific Beach that could give some representation on near shore wind.

Charlie Black, CJB Energy Economics, asked if the capacity factors are at the project busbar. Starrett confirmed. Black then asked if the MT projects are in the west or east of the state. Starrett said he will double check his data. Black pointed to transmission opportunities in MT and suggested not pre-judging. Starrett said that was his goal and when looking for prospects he searched for regions with substantial, high-quality resource that's close to transmission. Black said that's fine and then asked if the financial sponsorship is for development and ownership with sales through PPAs. Starrett said yes, adding the assumptions around capital costs and the adder for AFUDC also played a role.

Morrissey suggested keeping the Gorge as there's development in the queue. Starrett didn't think Gorge wind matches system needs but development will happen because of transmission.

Marr asked if capital costs reflect tax credits. Starrett answered no, saying it's the same for solar. Marr offered that he sees a bigger delta between Columbia Gorge and MT capacity factors. Starrett agreed but said his number comes from the best available data.

Marr noted that much of the Gorge wind is nearing the end of its life and wondered about differentiated overnight capital costs around re-powering. Starrett didn't know. Heutte agreed that some turbines are 15 years old but the bulk of them are from 2008 and beyond.

Heutte wondered what the eventual constraint on [Slide 29] will be, theorizing that hub height and associated sweep will play a role. Starrett said this will be good to stick with in the near term with the idea of coming back to talk about capacity factors and cost. He solicited the room for possible methods.

Spangler suggested looking at unit availability as the maintenance history may have improved which would get less than 4%.

Nightingale pointed to the BESS limit saying this chart pushes that envelope. Tilghman countered that there's no relationship between that and the capacity factor. Nightingale still wondered if these numbers could exceed what's physically possible. Tilghman noted that NERC has the GADS reports for outages.

Heutte wondered about the Losses numbers on [Slide 30.] Starrett called them a point of contention that everyone wonders about. Heutte wondered if the costs will be the same in the future. Starrett noted that BPA rates are pretty low when compared nationally.

Black said this highlights an underrecognized issue: while we move to a decarbonized system, we must expand transmission and manage costs. He thought it would be important, from a policy point of view, to look at the total cost of wind including the incremental costs of transmission as opposed to the rolling averaging of CAISO.

Tilghman moved back to [Slide 28] wondering if there will be any analysis around how much more wind can come out the Gorge given the present transmission system, adding that he doesn't see any available transmission. Starrett agreed this is a challenge and said he is arguing to limit this to the contractual encumberment and then looking at the delta.

Tilghman wondered if it is appropriate to include a transmission adder if wind is not expected to carry a capacity contribution and will displace expensive resources already on the line. Starrett said this would only be true if a developer was willing to be flexible with transmission which is impossible in the real world.

Tilghman countered that a PPA can get financing. Starrett agreed but said it doesn't make sense to pay for 24/7 transmission for a non-capacity resource. He did point to PGE's 5-year-pilot to take conditional firm product adding that conditional costs the same as point-to-point.

Tilghman agreed, but pointed to development in an organized market that is different. He added that a lot of people are looking at this problem and it's not unreasonable to begin thinking differently about this and called on the Council to lead.

Black pointed to the need to endogenize new transmission agreements for investments.

Nightingale countered that the region has firm transmission for all kinds of resources that have a capacity factor that's way less than 40%. He said advancing technologies plus renewable requirements will make it look more like a baseline.

Heutte complimented Starrett on being a champion for looking at the overall utilization of the NW grid. Heutte called the PGE filing interesting and "a real proposal on the table." He then referenced Bonneville's MRDAP analysis that looks at seasonal flow differences out of MT. Huette thought the firm transmission limitation could be relaxed for the 2021 Plan.

BREAK

Jim Woodward, WA UTC, wondered if all or portions of the region will be switching to a summer peak and if that is factored into the analysis on [Slide 32.] Starrett said this analysis just looks at shape but the load forecast looks at summer/winter peak and adjusts the value appropriately.

Black asked if there's any thought around the 2021 Plan adding sufficient quantities of new renewables that will require a significant expansion of transmission. Starrett agreed that any level of build leading to expansion is the on-the-ground reality but models will constrain resources based on their ability to deliver energy. Black cautioned that CA took a similar approach and called it unfortunate to develop a Power Plan that obscures the need for transmission and the doesn't look for economic ways to construct it. Starrett thanked him for his comment.

Offshore Wind as an Emerging Resource in the 2021 Power Plan
Mike Starrett, NWPCC

Heutte asked why capacity would decline as hub height doesn't matter for an off-shore resource [Slide 6.] Starrett explained the concept of "specific power" which leads to a higher capacity factor with a lower specific power. Heutte remained skeptical.

Nightingale felt that it was feasible to install bottom-mounted turbines 10-12 miles offshore [**Global Trend**: Floating Offshore Wind still mostly "Technical Potential".] Starrett agreed.

Someone on chat asked if there are any anticipated conflicts with the military [Slide 15.] Starrett answered no as pointing to negotiations.

Heutte voiced surprise with how fast technology is moving [Slide 16] and thought we could get to 15MW faster than in 10 years. Starrett agreed. Heutte reported seeing early work for 20MW machines for the mid-2020s.

Nightingale asked if there is any capacity value information based on locational [Slide 18.] Starrett answered no.

Heutte asked if there's any information on offshore performance during long-duration, onshore events. Starrett answered that it's not in the report but he'll look for information.

Nightingale found it unusual that the data is limited to 600 MW as offshore resource could get 1000MW plus. Starrett called the 600MW in the middle of proposed projects.

Spangler sent Starrett a link to the Navy's NW Training and Testing Area that could reveal more information.

Jason Busch, POET, spoke a bit about the state of offshore wind in OR and CA.

Heutte [Slide 20] spoke about transmission qualities around the Humboldt, CA area. He liked the idea of a DC link adding that it will be difficult and time consuming but pointed to a well-established underwater internet cable industry.

Heutte then pointed to fires shutting interties that might make a DC bypass more palatable.
LUNCH (half hour)

Proposed Reference Plant for Pumped Storage
Gillian Charles, NWPCC
Spangler stated that the generator and pump are separate elements in the quaternary configuration on [Slide 14] but do not require two separate powerhouses. Huette called the ramp rate for the quaternary configuration shocking. Charles agreed, moving to [Slide 15] to illustrate. Heutte said because of this a 400MW plant has an 800MW operating range.

Spangler said the cost estimate for the Banks Lake project on [Slide 19] should be 1.44 billion. Charles thanked him for the correction.

Tilghman stated that OR PUC staff is encouraging PGE to accelerate its procurement process, in order to consider pumped storage as a resource [Slide 21.] Charles agreed.

David Van't Hof, National Grid, noted that Swan and Goldendale are two very different sites yet the pricing for those two projects are below the rest on [Slide 23.] He said this means that costs are dictated by more than geography. Charles agreed.

Marr called pumped storage's ability to be re-optimized for different time periods a critical difference [Slide 25.] He said some projects he's seen could dispatch for 70-80 hours and not just eight. He didn't want a modeling cut off to short-change the resource's potential capacity contribution. Starrett said he will recheck but the enhanced GENESYS can dispatch up to the range and through the entirety of the range.

Heutte wondered if pumped storage could offer more than a diurnal time shift. Charles said storage modeling is a new feature so there will be back and forth between her group and the systems analysis team.

Van't Hof was fine with the eight-hour duration but wanted to confirm that storage resources will be compared in an apples-to-apples manner. Starrett characterized how staff addresses resource differences. Van't Hof discussed PGE's journey that lead to choosing batteries for short duration and pumped storage for long duration. Starrett said he was aware and talked about testing assets for a regional portfolio. Van't Hof asked how individual RPSs are accounted for in the Plan as he can see a difference in a regional approach versus an individual utility approach.

Spangler pointed to the resource's 100-year life, noting that the second half would not cost $2300/kW-year and might be $10/kW-year.

Tilghman asked how the overnight capital cost of $2300/kW-year was generated. Charles moved to [Slide 21] to illustrate how project developers and IRP information was used.

Tilghman wondered how much Charles trusted IRP numbers, saying the $2300 is above all but two of the projects on [Slide 19.]
Charles said the average of the projects, when converted to 2016 dollars, is about $2200. Tilghman liked the $2200 better, and said the IRP numbers are driving costs. He said developers probably have a better sense of their costs. Charles said these are all proposed costs and it would be good to have costs from an actual, finished project.

Heutte was not uncomfortable with the costs but agreed that IRPs use different levels of sophistication to generate numbers. He then stressed that the real value comes from the resource's operating characteristics. Heutte said a +/-10% on the capital costs will not be enough to displace the resource from the stack.

Spangler called it a good, gut check number comparable to numbers in DOE documents. He said the numbers are also comparable to completed, east coast projects.

Heutte called this a relatively conservative look but didn't think it would sway the model.

Van't Hof was also concerned about the conservative look and noted that scale matters. He said these numbers might be right for a 400MW project but a 1000MW project will have an entirely different cost structure. He urged moving the cost down. Charles noted that there's a new Power Plan generated every five years and more information may be available in the future. She said she's open to taking more feedback and making adjustments.

Tilghman said the real question is do we have the right relationship between batteries and pumped storage. He wondered if the numbers are just as conservative for stand-alone batteries.

Starrett pointed out that PacifiCorp commissioned a study that came up with similar numbers. He then said he understood the concern around storage but felt confident around the battery number because it contains more real data and less assumptions.

Van't Hof was fine with the development and construction time, adding that changes at FERC could shave the four-year development time to three or two.

Heutte said this slide shows a divergence in the "storage space." He called pumped storage a mature technology that might have some incremental improvements while batteries are going through significant changes. Heutte theorized that the capital cost of batteries will go down.

Heutte noted that batteries' significant degradation factor is not represented on the slide, adding that pumped storage doesn't have a degradation factor. Heutte then voiced skepticism around an 88% round trip efficiency for batteries.

Heutte concluded by urging staff to be careful when comparing these two resources as they are very different and fit very different roles.

Van't Hof acknowledged the Council's long-standing methodology but asserted that a comparative slide doesn't show the nuances of duration, life cycle and risk. Charles assured him that this slide is not meant to be a comparison but a reminder about last month's battery discussion.

Van't Hof stated that duration is not represented on [Slide 27] which loses a core attribute of pumped storage. Spangler added that the lithium ion line does not look correct because it only has a 15-year life.

Heutte called this a new version of what the Council does very well with EE. He stated that EE can have multiple replacements over 20 years and it's a straight forward thing to put into a model.

Starrett agreed that the battery shouldn't go out for 50 years and suggested that 20 would be reasonable, based on a new paper. He reassured the room that this slide is just to look at equivalent costs at a kW/year basis, adding that the model sees all attributes.

Van't Hof pushed back, asking if duration could be either one then why not show an eight-hour battery. Starrett said the four-hour battery reflects the fact that four-hour batteries are being built so there's a higher level of confidence. Van't Hof called that fair for the battery side, but not fair to base pumped storage pricing on eight hours. Starrett explained how [Slide 27] was developed.

LeVee suggested looking at the long-term value of resources for all investments through a lens of DR and smart grid innovations. He said this will change the value of storage. He asked that staff recognized the potential for rapid change when looking at the value of long-term, 50-year investments.

MicroFin Review
Mike Starrett, NWPCC
LeVee said he will comment after reviewing but stressed that finance cost is not the same as economic cost. Starrett thanked him for his future review and comments.

Nightingale moved back to offshore wind saying he supports keeping floating resources as emerging but thought there should be analysis for fixed-bottom resources. Starrett said he is working with POET to see if there's potential. Nightingale suggested not locating it in Southern Oregon as it doesn't match the region's load profile as well.

Charles ended the meeting at 2:30.

Attendees

Gillian Charles	NWPCC
Mike Starrett	NWPCC
Tomàs Morrissey	PNUCC
David Nightingale	WA UTC
Fred Heutte	NW Energy Coalition
Brad Spangler	Snohomish PUD
Garrison Marr	Snohomish PUD
Michael Coe	Snohomish PUD
Jason Busch	POET
Karl Weist	NWPCC
John Harrison	NWPCC
David Van't Hof	National Grid
Henry Tilghman	Tilghman Associates

Attendees via Webinar

Aaron Bush	PPC
Angela Tanghetti	CA Energy Commission
Dhruv Bhatnagar	PNNL
Bryan Neff	CA Energy Commission
Charlie Black	CJB Energy Economics
Cindy Wright	SCL
Daniel Lloyd	Absaroka Energy
Dave LeVee	PowerCast
Dan Davis	US Army Corps of Engineers
Deanna Carlson	Cowlitz PUD
Elizabeth Osborne	NWPCC
Eric Shierman	OR DOE
Frank Brown	BPA
Greg Nothstein	WA Dept of Commerce
Glen Best	Inland Power
Ian Bledsoe	Clatskanie PUD
James Carkulis	Independent
James Vanden Bos	BPA
Jim Woodward	WA UTC
Kurt Conger	N. Wasco PUD
Leann Bleakney	NWPCC
John Lyons	Avista
Jennifer Magat	PSE
Carl Mannheim	HDR Inc.

Paden Wallace	Absaroka Energy
Patrick Ashie	NWPCC
Peggy Beltrone	Independent
Phil DeVol	Idaho Power
Rebecca Smith	OR DOE
Ted Light	EES Consulting
Terry Toland	Clark PUD
C. D. Mclean	CA Energy Commission