PUGET SOUND ENERGY

# 2019 Integrated Resource Plan TAG Meeting #1
# Bellevue College, 3000 Landerholm Circle SE, Bellevue, WA 98007
# Paccar Atrium (Room N201)
# July 26, 2018
# 12 – 4 p.m.

## Attendees

Members

- Jim Adcock, PSE ratepayer
- Daren Anderson, The NESCO Group
- Larry Becker, Northwest Power Consulting*
- Charlie Black, Consultant for Invenergy
- Rob Briggs, Vashon Climate Action Group
- Rachel Brombaugh, King County
- Brad Cebulko, UTC*
- Nancy Esteb, Renewable Energy Coalition*
- Orijit Ghoshal, Invenergy
- Kelly Hall, Climate Solutions
- Warren Halverson, CENSE and PSE ratepayer
- Warren Halverson, CENSE
- Norm Hansen, Bridle Trails
- Howard Harrison, Sierra Club
- Mike Hopkins, FortisBC*
- Greg Hosting, Washington Energy Office*
- David Howarth, National Grid Ventures
- Doug Howell, Sierra Club
- Amanda Jahshan, Renewable Northwest
- Virginia Lohr, Citizens' Climate Lobby
- Nicholas Matz, City of Bellevue
- Tomas Morrisey, PNUCC*
- David Nightingale, UTC
- Court Olson, Optimum Building Consultants
- Bill Pascoe, Pascoe Energy*
- Marty Saldivar, Northwest Pipeline*
- Kathi Scanlan, UTC
- Deborah Reynolds, UTC*
- David Tomlinson, UniEnergy Technologies*
- Elyette Weinstein, Thurston League of Women Voters
- Bill Westre, Union of Concerned Scientists
- Amy Wheeless, NW Energy Coalition

* Indicates remote attendance

Public

- Lori Elworth
- Steve Hofer
- Carol Loughlin, Sapere Consulting
- Steve Lewis, Sapere Consulting
- David Morton, Redmond People for Climate Action
- William David Osmer, Bellevue PCA
- David Perk, 350 Seattle
- Andrea Scott-Murray
- Sue Stronk, PSE ratepayer
- Rev. Jim VanderWeele, Northlake UU Church, FACT

Project Team

- Samantha DeMars-Hanson, PRR
- Brett Houghton, PRR
- Elizabeth Hossner, Puget Sound Energy
- Michele Kvam, Puget Sound Energy
- Jennifer Magat, Puget Sound Energy
- Irena Netik, Puget Sound Energy
- Aaron Poor, PRR
- Phillip Popoff, Puget Sound Energy
- Gurvinder Singh, Puget Sound Energy
- Jamie Straus-Clark, PRR

## Meeting Objectives

- Members understand and provide feedback on the content of HDR's draft electric cost resource type report.
- Members understand the new IRP stakeholder participation process and how PSE will use stakeholder feedback.
- Members understand IRPAG input and how to use it.

## Welcome

Michele Kvam, Puget Sound Energy (PSE) Integrated Resource Plan (IRP) Stakeholder Manager, welcomed the group to the first 2019 IRP Technical Advisory Group (TAG) meeting.

## Stakeholder participation process changes

Irena Netik, PSE Director of Energy Supply Planning, reviewed the changes to the stakeholder participation process. In response to stakeholder feedback and to ensure PSE gets the feedback they need and meets regulatory requirements, PSE has updated the IRP stakeholder process to include two groups: the Technical Advisory Group (TAG) and the Integrated Resource Plan Advisory Group (IRPAG).

The TAG consists of stakeholders with specific technical skills, knowledge, and experience germane to the IRP. The IRPAG covers the breadth of stakeholder interests and concerns related to the IRP, including educating participants on the IRP process and content. The IRPAG meetings will be in the evening, based on the majority of stakeholder feedback that evening IRPAG meetings will be more inclusive and effective.

PSE hired consultants, PRR, with expertise in the stakeholder process to help facilitate these groups. Irena introduced the facilitator, Jamie Strausz-Clark of PRR, to clarify the new process for this IRP cycle and field stakeholder questions.

Jamie outlined the process to ensure communication flows between these two groups. PSE reports outcomes from the TAG meeting at the following IRPAG meeting and vice versa. PSE posts agendas, rosters, and meeting summaries from both groups on the PSE website for all to see. All stakeholders can observe the TAG meetings in person and remotely to hear the technical conversations.

Recognizing that the PSE staff responsible for the IRP are technical staff and not organizational policy makers, PSE is planning a listening session for this fall. The will be an opportunity for stakeholders and community members to share their broader interests and concerns with PSE leadership, specifically Vice Presidents. Some topics stakeholders have brought to the IRP process more suited to this broader conversation are PSE's response to climate change, improved tribal relationships, and decarbonization. The project team will share information about the listening session when it is finalized.

Jamie clarified the role of comments in the IRP stakeholder meetings, how stakeholders can communicate through email, and what is considered official public comment. PSE is committed to responding to questions to irp@pse.com that are directly related to the IRP in a timely fashion. People who submitted IRP related questions prior to a meeting are encouraged to ask questions as appropriate during the meeting and responses will be captured in the meeting notes. The timing of written responses will be communicated to the submitters and the written responses will be shared with the group email list and posted on pse.com. PSE is open to providing comment opportunities for all stakeholders, and will reach out to individuals for consent to capture the comment and may batch these comments for information management. PSE is striving to meet the level of interest and engagement in the process, and is committed to being transparent.

Irena thanked members for their support as PSE launches this new process and asked for their ongoing constructive feedback through the next year.

## Outcomes of stakeholder input from IRPAG kickoff meeting and action items

Irena reviewed outcomes of the May 30 IRPAG meeting. PSE agreed to incorporate the following elements into the IRP:

- Greater carbon reduction scenarios
- At least one scenario with no new fossil fuel generation
- At least one scenario with no new fossil fuel generation and retiring existing generation
- At least one scenarios with no Liquefied Natural Gas (LNG) facility (no gas utility)

PSE also agreed to evaluate the temperature data they currently use for reasonableness and accuracy.

Michele reviewed the status of action items from the May 30 IRPAG meeting. PSE provided a handout of the action items to TAG members. The outcomes of the action items were also posted to the PSE website prior to the meeting. The following table outlines updates to the May 30 action items.

| Action Items from 5/30 IRPAG | 7/26 Update |
|---|---|
| PSE will provide an updated charter for group to review and affirm. | PSE posted the revised drafts of both the IRPAG and TAG charters on the PSE website. |
| PSE will identify a contact person for stakeholders and public to urge improvements to PSE's their carbon reduction goals. | PSE will establish a listening session where PSE Vice Presidents hear public feedback on PSE's corporate impacts and direction |
| PSE will include carbon impact in conversations about scenarios or sensitivities at a future meeting. | PSE will include carbon impact in future conversations about scenarios and sensitivities at a future meeting. When meeting dates are confirmed, PSE will share them with individuals on the IRP stakeholder list.<br><br>PSE agreed to include a zero-carbon scenario in the 2019 IRP. |
| PSE will invite every sovereign tribe in their service region to future meetings. | PSE sent letters to 31 federally-recognized tribes and the Duwamish tribe providing an overview of the IRP and inviting them to participate. PSE sent a total of 53 letters to the Tribal Economic Development divisional managers and directors and Tribal chairs. |
| PSE will reach out to an individual stakeholder concerning her experience with PSE gas service. | PSE has made repeated efforts to reach out to this individual but has been unsuccessful. This is a reminder to all to record email addresses clearly on sign-in sheets and please to include a phone number. |
| PSE will share the work plan they submit to the Commission on July 13. | PSE posted the submitted work plan to the IRP web page and provided copies at the TAG meeting. |

Michele provided ways to provide feedback and an example of useful feedback to the HDR report. Feedback is due on or before August 2. Michele reminded attendees that the draft report was provided for TAG review on July 17.

## HDR presentation: draft electric resource costs

Elizabeth Hossner, PSE Consulting Energy Resource Planning and Analysis Analyst, provided background about the role of the draft electric resource cost report in the IRP analysis and introduced Scott Leigh, HDR Project Development Engineer. HDR developed the inputs, or supply-side costs, for the PSE modeling.

TAG members had the following questions:

Q: **Does PSE use levelized costs in its cost comparisons with different energy sources?**
A: PSE does not use levelized costs in the core IRP analysis.

Levelized costs are average costs, not marginal costs. The IRP seeks to minimize marginal costs, based on how adding a resource affects total portfolio costs. Total portfolio costs includes fixed and variable costs of new resources and variable costs of existing resources. Average levelized costs are not what customers will experience in rates. Specifically, levelized costs do not reflect how resource additions would affect the amount of electricity PSE must purchase from or sell to the wholesale market.

Phillip provided a simplified example to illustrate the difference. Assume PSE could purchase one of two renewable resources. The first has a levelized cost of $35/MWh, the second a levelized cost of $40/MWh. Minimizing levelized cost would mean PSE should purchase the first resource. However, assume the first one only generates electricity during April, when market prices are $20/MWh, whereas the second only generates electricity during August when market prices are $50/MWh. By offsetting wholesale purchases in April, the first resource would be a net *cost* of $15/MWh ($35/MWh-$20/MWh). The second will be a net benefit of $10/MWh ($40/MWh - $50/MWh). This example illustrates that using only levelized costs could lead to a higher-cost decision, because levelized costs do not reflect the impact to PSE customers. Levelized costs are good for high level comparisons of like resources.

All the information presented in the tables are needed for PSE's portfolio modeling. This information is in the packets distributed to TAG members for the meeting.

Q: **Why do resource costs considerations only include self-built processes and not power purchasing agreements? In those, the levelized cost of energy would be important**
A: IRP modeling is useful for determining resource technologies, not ownership structure. Each type of resource could have dozens of different power purchasing agreement (PPA) structures—too many to effectively manage in an IRP analysis. Additional information on PPA structures is more appropriately examined in the context of actual opportunities, based on what is actually offered by suppliers in the RFP process.

Q: (by phone/remote input) **When the utility receives bids in response to its Request for Proposal (RFP), will PSE incorporate the information from the bids into the IRP resource costs? Does it depend on when the bids are received and when PSE can make it public?**
A: Responses to the RFP are a snap shot of what the market looks like right now and for the next few months. They are not indicative of future market conditions. There may be short-term surpluses or deficits for certain types of generation and for certain components that can significantly affect pricing during any short-term period. It is not reasonable to assume pricing would be indicative of generation costs for the next 20 years, either.

This is similar to natural gas market prices, which have the single biggest impact on wholesale prices. PSE would not assume market natural gas prices in August of 2018 will be effective for the next 20-years.

The IRP conclusions will be informed by what PSE learns through the RFP process and responses, but those costs will not be modeled for the IRP filing.

Scott began his presentation with background information on HDR's work nationally and in the Northwest and HDR's experience supporting IRPs. PSE contracted with HDR to create representative characteristics for different energy sources PSE would input into the IRP modeling. As an example of how HDR created representative characteristics, Scott talked about the characteristics of F-Class combustion turbines, which PSE uses to supply energy. Bigger turbines—specifically G-Class or H-Class turbines—operate more efficiently but cost more to operate. PSE gave HDR similar efficiency and costs parameters for its other energy resources research. Scott explained the specific considerations HDR included to ensure the numbers were applicable to Washington State. HDR tailored factors such as climate in the area, ambient conditions, elevation, and available interconnections for the region PSE serves. Scott echoed the importance of staying up to date on market changes.

TAG members had the following questions:

Q: **How does HDR handle data ranges from nationwide resource costs?**
A: HDR designs their numbers using the nationwide data.

Q: **What are three other IRPs you have worked on?**
A: Portland General, Northwest Energy, Alliant Energy

Q: **Can you blend confidential PSE RFP information with other analysis and share it publicly without breaking confidentiality?**
A: No. And PSE needs to lock in their numbers for the 2019 IRP before they will have the data from RFP responses. HDR is looking at more recent numbers from around the country so they should be relevant.

Q: (*by phone/remote input*): **Why do the resource cost considerations only include self-build projects and not PPAs? The Levelized Cost of Energy (LCOE) numbers are relevant for energy purchases.**
A: Not necessarily and the PSE needs to lock in the numbers early in the process. HDR is looking at more recent numbers.

Q: (*by phone/remote input*): **Where is Scott Leigh of HDR located and where are the main authors of the Generic Resource Costs for IRP located?**
A: Scott Leigh is based out of the Ann Arbor Michigan office of HDR. Other HDR staff who worked on the report are based out of the same office.

## HDR presentation: thermal resources

Scott explained HDR's methodology for determining thermal resources. For their performance basis, HDR used models from National Renewable Energy Laboratory and talked with specific manufacturers, currently operating plants, to gather region-specific data. HDR estimates auxiliary loads to get net performance of each source.

Scott reviewed the cost basis in HDR's methodology, including how HDR allocated for electrical interconnection costs, construction costs, and fuel supply. He went on to explain how HDR allocated owners' costs, including maintenance, fixed and variable costs for different energy sources. HDR studied single and dual fuel thermal resources with simple cycle reciprocating internal combustion engines.

TAG members had the following questions:

Q: **Why did PSE choose to use a frame simple cycle combustion turbine (CT) instead of an arrow derivative combustion turbine? Did HDR also consider aeroderivative CTs? If not, why not?**

A: Arrow derivative combustion turbines are not an attractive choice in the market due to their higher capital costs. HDR analyzed the alternatives selected by PSE.

Q: **What protections exist for King County resident taxpayers? How did these discussions affect dollars per kilowatt ($/kW) rates (what ratepayers see)?**

A: Resource acquisition decisions are not made in the IRP process. The specific acquisition of those resources is beyond the scope of the IRP.

The Washington State Utilities and Transportation Commission (WUTC) scrutinizes all resource acquisitions to ensure such resources meet the Commission's prudence standards, before allowing PSE to recover the cost of resource acquisition in rates. Thus, WUTC protects King County's residents. But that process occurs outside the IRP process.

In PSE's portfolio analysis, we model resource costs in the same level of detail that will go into rates--$/kW is just one of several details. The portfolio model incorporates a full revenue requirement model. This model reflects all the financial accounting details that will go into translating fixed capital costs, fixed operation and maintenance costs, variable operating costs, and wholesale market interactions from costs to rates, based on the WUTC's ratemaking methodologies. The IRP process will split resource needs between conservation and supply-side resources.

Q: (*phone/remote input*): **Concerning thermal resource costs, did HDR assume full load conditions? In reality, many of these resources operate at partial load conditions, which results in worse heat rates and higher emissions. How does HDR (or PSE) account for those conditions?**

A: HDR provided PSE with the heat rate at full load and partial load (mmBtu/kwh), they also provided the emissions in units of lbs/mmbtu of $CO_2$ emissions. When the plant dispatches at full load or partial load, the change in emissions is captured. PSE's portfolio modeling reflects that thermal plants have an operating range, and reflects costs throughout that operating range, when forecasting the economic dispatch of thermal plants.

TAG members had the following comments:

- PSE's orientation affects how PSE evaluates the data. In other words, because PSE has not committed to sourcing all of its energy from renewable sources, it is interpreting the data to favor non-renewable sources, making them appear more cost-effective than renewable sources of energy.
- Multiple members of the TAG emphasized that seeking a zero-carbon IRP option is important to the members of their organizations.

- Some TAG member organizations asked PSE to prioritize building a carbon-free grid and want PSE to present how that would change the numbers in the IRP. Some members asked PSE to internalize carbon costs at this state of the IRP process.

TAG members had the following questions:

Q: **Are gas transportation costs included in this analysis?**
A: Yes, gas transportation costs are included from the point of interconnection. This will be discussed at the natural gas resources TAG meeting.

Q: **How will PSE incorporate leakage emissions into this research?**
A: PSE will be incorporating upstream emissions into the analysis for both the electric and gas IRPs. The impacts on these emissions on total greenhouse gas output will be included as a cost of consuming natural gas in scenarios where we assume regulations are imposed that allow PSE to recover the cost of doing so.

Q: **Can thermal resources operate on hydrogen fuel?**
A: Some of them could. In HDR's experience, some of the fuel could be a hydrogen blend for thermal generation, but the technology is not yet commercially available in the United States.

Q: **Do these thermal resources operate less efficiently at partial load conditions?**
A: HDR provides the highest heat rate. At lower loads, there are higher emissions. HDR expects a capacity factor of four percent for combustion turbines and a capacity factor of 15 percent for combustion engines. This is a reasonable expectation for peaking use.

Q. **The 85 percent capacity factor for combined cycle gas generator seems high. Why did HDR use this capacity factor?**
A. This capacity factor was assumed only for the purposes of estimating non-fuel variable operations and maintenance (O&M) costs. This is true for the other thermal assets as well. Anticipated capacity factors for the dispatchable thermal resources will be determined in production cost/portfolio optimization modeling.

PSE provided HDR the initial 85 percent assumption, for the purposes of estimating non-fuel variable O&M costs. Actual dispatch will have little impact on the average non-fuel variable O&M costs. The actual forecast dispatch of combined cycle gas generators will be an output of the modeling, not an input—we just need a starting point for variable, non-fuel O&M. If the capacity factors were to drop to the five to 20 percent range, then the variable operations and maintenance (VOM) costs would be higher. Otherwise, as long as the capacity factor stays in the range of a baseload plant, there is no change to the VOM.

*Q:* **Why are only F-class natural gas generators considered, given that G/H/J class machines are ordered and were also considered in the recent revision of the emissions performance standard?**
A: [*provided in writing by HDR and inserted here*] F-class natural gas combustion turbines were considered for the proxy simple and combined cycle technologies based on direction from PSE. F-class technology was considered a reasonable representation of frame combustion turbine technology (as is noted in the question, larger turbines exist and also a number of smaller turbines exist). F-class technology was also considered reasonable in the context of PSE's portfolio and potential capacity needs identified in the planning process. Even though the G/H/J class turbines have a better heatrate, they also have a larger capacity and cost more to build and operate. Given PSE's resource need, they are too large.

PSE encouraged members to share their comments about PSE's carbon policies at the upcoming listening session.

## HDR Presentation: renewable resources

HDR gathered information regarding on-shore and off-shore wind generation, solar, and biomass energy.

Some TAG members noted that the analyses of the costs for alternative fuels appeared more expensive than thermal resources due to economies of scale afforded to thermal resources. HDR and PSE agreed to adjust the analysis to examine bigger solar and wind farms, including independent power producers, and prorating those prices to reflect economies of scale savings.

The group discussed capital and maintenance costs of alternative sites, recent resource costs provided by the NWPCC in June, and gen-tie lines width and distances.

TAG members had the following comments:

- (*by phone/remote input*): Though I have not reviewed the report completely, and we are still in the middle of the presentation, this review looks to be heavily focused on fossil options. While I believe PSE, their customers, and the lowest cost resources for this region are going to be wind, solar, and energy storage.
- Sites with higher capacity factors and lower interconnection/gen tie costs are readily available in Montana.
- Roughly $1 million/mile for 115 kilovolt (kV) transmission in rural Montana seems high.
- Long gen tie for 100 Megawatt (MW) project is not a good economic option. PSE should base gen tie costs on larger project, perhaps 300 MW, and use realistic costs for rural construction (likely wood H-type structures).
- The hub height of wind turbines HDR is using is too low. HDR needs to re-assess the hub height they are using in their analysis and report.
    - HDR agreed to re-assess their hub height assumptions.
- Please provide data on the average wind speed for all wind sites, including those currently in the report and any new sites HDR or PSE consider and add.
    - HDR agreed to add this information.

TAG members had the following questions:

Q: **How were the sites in Montana selected and do those sites access the highest-quality wind?**

A: [*provided in writing by HDR and inserted here*] As discussed in HDR's report, proxy wind farm locations were selected in central Montana and southeastern Washington.

Site #1 (MT) was selected based on its proximity to the Colstrip transmission line and provides about 36 percent capacity factor.

Site #2 was identified to document that a higher capacity factor (42 percent) was achievable in Montana; however, the site was located at a considerable distance from the Colstrip transmission lines.

Note that the sites considered in Montana provide a general range of available wind capacity resource in the state and detailed wind project siting has not occurred. HDR, working with PSE, is reviewing Montana wind resource further and considering other sites where wind resource may be improved.

Q: **How did HDR calculate the slopes of maintenance costs of time for renewable energy sites? There is evidence of steeper drops in maintenance costs of renewable energy sites than HDR used in their calculations.**
A: HDR used a simple slope to produce their inputs.

Q: (*by phone/remote input*): **Is geothermal not a viable resource option and why not? How about run-of-river?**
A: Geothermal is not a viable resource option due to the cost of transportation the resource from the location of the resource to the location of PSE's load. Concerning run-of-the river hydro, PSE did not select that option based on availability, but run-of-river hydro projects that bid during the current RFP cycle will be considered.

A discussion of renewable resources not modeled can be found in the 2017 IRP, appendix D.

Q: (*by phone/remote input*) **Please explain how HDR determined the capacity factors for the two Montana sites?**
A: [*provided in writing by HDR following and inserted here*] Net capacity factors were estimated from publicly available wind resource data and account for losses up to the project busbar. Wind resource data was utilized from the National Renewables Energy Laboratories (NREL) WIND Toolkit application. The WIND Toolkit application includes historical meteorological conditions, and estimated turbine power for over 120,000 sites in the United States.

Q: (*by phone/remote input*) **What turbine technology was assumed?**
A: HDR's estimate considers larger (four MW class) wind turbine generators. With the unit being larger, and with the larger units having less market penetration, HDR is currently carrying a conservative (higher-end) cost for the wind turbine generator equipment.

Q: (*by phone/remote input*) **I see in the HDR report that wind and solar capital costs decrease over time into the future. Why does gas plant capital cost decrease over time?**
A: HDR's base assumptions utilized the NEMS data, because it is a consistent source for all resources used for modeling in the IRP. NEMS is a commonly used forecast in resource planning activities (e.g. Portland General Electric also considers NEMS trends). While natural gas plants are at a more mature stage in their product life cycle than some renewable resources, firms that build such generation continue to innovate, so technology continues to reduce costs and improve performance of these units.

Q: The **Renewable Energy Table from slide 13 shows solar having a 25 MW Winter Peak Net Output. Does this mean the capacity value of solar will no longer be assumed to be zero?**
A: The net output refers to the maximum generating capability at a given set of ambient conditions (in this case, winter) and does not articulate accredited capacity/resource adequacy contribution. PSE performs an Effective Load Carrying Capability (ELCC) analysis. Results of that analysis will be presented at a future TAG meeting, when that analysis has been completed.

## HDR Presentation: storage

HDR studied pumped hydro energy and different batteries. PSE provided the functional needs for storage systems HDR used for their study. HDR had access to data from confidential projects around the Pacific Northwest for their analysis. HDR researched lithium-ion batteries as well as vanadium flows. PSE wanted 25 megawatt capabilities and two daily cycles with two, four, and six hours of storage.

TAG members had the following questions:

Q: **Could the TAG see a $/kw rate for a four-hour battery presented as a capacity cost?**
A: [*provided in writing by HDR and inserted here*] HDR understands that the TAG wants to see battery capital costs expressed on both a $/kW and $/MWh basis. HDR will update the tables in the report to include both bases. In the interim, this is also presented in the table below. The $/kWh capital costs is the $/kW capital cost divided by the storage duration.

| Battery Energy Storage System (BESS) | Scale | Duration | Capital Costs (Note 1) | |
|---|---|---|---|---|
| | (MW) | (Hours) | ($/kW) | ($/kWh) |
| BESS - 25 MW Lithium Ion (2 Hour / 2 Cycles Daily) | 25 | 2 | $1,930 | $965 |
| BESS - 25 MW Lithium Ion (4 Hour / 2 Cycles Daily) | 25 | 4 | $3,059 | $765 |
| BESS - 25 MW Vandium Flow (4 Hour / 2 Cycles Daily) | 25 | 4 | $2,111 | $528 |
| BESS - 25 MW Vandium Flow (6 Hour / 2 Cycles Daily) | 25 | 6 | $2,758 | $460 |
| | | | | |
| Notes: | | | | |
| 1. Capital costs include EPC, owner's, and interconnection costs. | | | | |

Q: **Can PSE look into site-specific pump storage?**
A: The IRP process does not include resource acquisition but peak demand will be discussed at future IRPAG and TAG meetings. If developers would like to provide a summary of their specific pumped hydro storage project, PSE will consider including those descriptions in the IRP filing.

Q: (*by phone/remote input*): **What type of technology was assumed for Pumped-storage hydroelectricity (PSH)?**
A: Single-stage Francis pump-turbine

Q: (*by phone/remote input*): **Will the PSH performance characteristics in Table 8.3-1 of the HDR report be incorporated into the portfolio modeling?**
A: Yes, the operational details in the table will be used in PSE's modeling processes.

A TAG member had the following comment:

- The Min Pump and Min Gen values in Table 8-3-1 severely limit the ability of PSH to provide flexible capacity for ancillary services. Ternary PSH should be modeled with a flexible capacity range from Max Pump to Max Gen.

## Transmission

Elizabeth introduced transmission costs that PSE will consider in their inputs. The transmission/wheeling costs presented are an update of the cost assumptions from the 2017 IRP. Conversation included considering transmission as a resource and line losses in Montana.

Since the transmission content was not provided in advance of the meeting, Irena asked TAG members to provide comments on it by August 2.

A TAG member had the following questions:

Q: **Is the transmission cost the same whether the resource interconnects at Colstrip or Broadview?**
A: Yes, the transmission cost is the same.

Several TAG members made the following comment:

- TAG members expressed concern about PSE's need to achieve rapid closure on various assumptions, such as transmission costs. They expressed concern that TAG members would not have an opportunity to weigh in on items germane to the IRP process.

## Next steps

Jamie and Michele thanked stakeholders for their participation. Jamie asked TAG members to provide feedback on future agenda topics. Brett Houghton of PRR reviewed action items (see Appendix A). The next IRPAG meeting is on Tuesday, August 28, and the second TAG meeting is currently scheduled for Tuesday, September 25. *[Update: there will not be a September 25 TAG meeting. The next TAG meeting will be Thursday, October 11 at the Meydenbauer Center in Bellevue.]*

The meeting adjourned at 4 p.m. Project staff and presenters stayed for a public meet-and-greet until 5 p.m.

# Action Items from the 7/26 TAG Meeting

1. PSE will model zero-carbon, "big-build out" IRP to determine potential savings from economies of scale for wind and solar.

   PSE action: PSE will assume larger renewable projects, to take into consideration greater economies of scale, thus a lower $/kW cost for renewables. PSE will still use that lower $/kW for smaller resources, assuming PSE could be purchasing a portion of a larger project. The scale will be chosen to be realistic size and be mindful of step-function changes in costs; e.g., a 300 MW resource may have much greater transmission cost than a 250 MW plant.

   HDR will update their report and resource costs to take into consideration the economies of scales for renewable projects.

2. PSE will accept comments received through August 2 about the added HDR slides and the Transmission slide on which Elizabeth Hossner presented.

   PSE action: PSE will consider all comments received and share the comments with TAG stakeholders and will provide feedback on the comments. (In progress)

3. PSE offered to make the capacity factor numbers for the last couple of years available for PSE's combined cycles.
   PSE Response:

Average Annual Capacity Factor, %

| Combined Cycle | 2016 | 2017 |
|---|---|---|
| Encogen | 14 | 14 |
| Goldendale | 39 | 40 |
| Mint Farm | 39 | 32 |
| Sumas | 34 | 22 |

4. PSE will verify confidentiality of information from individual bids from the 2017 Green Direct RFP process.

   PSE Response: All bids collected by PSE through the 2017 Green Direct RFP process are confidential. Since HDR is working with PSE under a non-disclosure agreement, PSE shared the cost with HDR for comparison purposes. The Green Direct RFP provides the cost of the solar and wind power purchase agreement and does not necessarily reflect the cost of the project.

5. PSE will share information about the nomination process and qualifications for TAG membership, including ensuring consistency in the "two-per-organization" guidelines and clarifying that PSE does not need to "approve" proxies.

   PSE Response: PSE will update the charter and share it with the TAG prior to the next TAG meeting.

6. Confirm Kate Maracas, of Western Grid Group, approved for the TAG group.

   PSE Response: Irena Netik contacted Kate Maracas and welcomed her to the TAG on 8/2/18.

7. PSE to answer pre-meeting questions that were not addressed at the meeting from Brian Grunkemeyer (Sierra Club) on 7/18, from Bill Westre (Sierra Club) on 7/20 and in letter dated 6/12, Amanda Jahshan (Renewable Northwest) on 7/25, and Kelly Hall (Climate Solutions) on 7/25. (HDR and PSE)

   PSE action: The responses were provided to the above parties on 8/7 and distributed to the TAG and IRPAG sharing list on 8/8 and the product uploaded to www.pse.com/irp.

8. Consistent with the TAG charter, meeting summary notes will be distributed for TAG review and comment and notes will be finalized following stakeholder input. (In progress)

## Appendix B: Relevant and reoccurring abbreviations

| | |
|---|---|
| CT | Natural gas-fired combustion turbine, also referred to as a "peaker." |
| ELCC | Expected load carrying capacity. The peak capacity contribution of a resource relative to that of a gas-fired peaking plant. |
| EPC | Engineering, Procurement and Construction. A particular form of contracting arrangement where the contractor is responsible for all the activities from design, procurement, construction, to commissioning then hands the project to the end-user or owner. |
| HDR | The engineering firm Puget Sound Energy hired to draft the electric resource costs report for the 2019 IRP. https://www.hdrinc.com/ |
| lbs/mmbtu | Pounds per million British thermal (energy) units |
| IR | Integrated Resource Plan |
| IRPAG | Integrated Resource Plan Advisory Group |
| kV | Kilovolt |
| kWh | Million British thermal (energy) units |
| LCOE | Levelized Cost of Energy |
| MMBtu | Million British thermal (energy) units |
| MMBtu/kWh | Million British thermal units per million British thermal units |
| MW | Megawatt |
| NEMS | National Energy Modeling System. The National Energy Modeling System (NEMS) is a computer-based, energy-economy modeling system of U.S. through 2030. NEMS projects the production, imports, conversion, consumption, and prices of energy, subject to assumptions on macroeconomic and financial factors, world energy markets, resource availability and costs, behavioral and technological choice criteria, cost and performance characteristics of energy technologies, and demographics. NEMS was designed and implemented by the Energy Information Administration (EIA) of the U.S. Department of Energy (DOE). (https://www.eia.gov/outlooks/aeo/nems/overview/index.html) |
| NREL: | National Renewables Energy Laboratories |
| NWPCC | Northwest Power Planning Council |
| O&M | Operation and Maintenance |
| PPA | Purchased power agreement. A bilateral wholesale or retail power short-term or long-term contract, wherein power is sold at either a fixed or variable price and delivered to an agreed-upon point. |

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| PSH | Pump Storage Hydro. Pumped hydro facilities store energy in the form of water, which is pumped to an upper reservoir from a second reservoir at a lower elevation. During periods of high electricity demand, the stored water is released through turbines to generate power in the same manner as a conventional hydropower station. |
| PSE | Puget Sound Energy, Inc. |
| RFP | Request for Proposal |
| TAG | Technical Advisory Group |
| VOM | Variable Operation and Maintenance |
| WUTC | Washington Utilities and Transportation Commission |