PUGET SOUND ENERGY

2019 Integrated Resource Plan Technical Advisory Group Meeting #2
Meydenbauer Center
Rooms 407 and 408,
1100 NE 6th Street, Bellevue, WA 98004
October 11, 2018
9 a.m. – 5:00 p.m.

Attendees

Members

- James Adcock, PSE ratepayer
- Daren Anderson, The NESCO Group
- Charlie Black, Invenergy
- Joni Bosh, NW Energy Coalition
- Rob Briggs, Vashon Climate Action Group
- Rachel Brombaugh, King County
- Carla Colamonici, Office of the Attorney General Public Counsel Unit
- Orijit Ghoshal, Invenergy
- Charlie Grist, Northwest Power and Conservation Council*
- Brian Grunkemeyer, FlexCharging
- Warren Halverson, CENSE
- Norm Hansen, Bridle Trails
- Howard Harrison, Sierra Club
- Mike Hopkins, FortisBC*
- David Howarth, National Grid Ventures
- Doug Howell, Sierra Club
- Kevin Jones, Vashon Climate Action Group
- Virginia Lohr, Citizens' Climate Lobby
- Devin McGreal, Cascade Natural Gas*
- Don Marsh, CENSE
- Nicholas Matz, City of Bellevue
- David Nightingale, WUTC
- Court Olson, Optimum Building Consultants
- Bill Pascoe, Pascoe Energy*
- Marty Saldivar, Northwest Pipeline
- Kathi Scanlan, WUTC
- Elyette Weinstein, Thurston County League of Women Voters
- Bill Westre, Union of Concerned Scientists

* Indicates remote attendance

Public

- Kimberly Danke, Thurston Climate Action Team
- Ashton Davis, Cascade Natural Gas*
- Mike Elenbaas, Black and Veatch
- Fred Hewitt, NW Energy Coalition*
- Jennifer Keller, People for Climate Action
- David Morton
- Arthur Olson
- Lynne Olson, Climate Reality
- David Perk, 350 Seattle
- Nancy Shimeall, Climate Reality and PSE ratepayer

* Indicates remote attendance

Project Team

- Samantha DeMars-Hanson, PRR
- Bill Donahue, Puget Sound Energy
- Keith Faretra, Puget Sound Energy
- Nate Hill, Puget Sound Energy
- Elizabeth Hossner, Puget Sound Energy
- Brett Houghton, PRR
- Michele Kvam, Puget Sound Energy
- Garret LaBove, Puget Sound Energy
- Lorna Luebbe, Puget Sound Energy
- Jennifer Magat, Puget Sound Energy
- Lorin Molander, Puget Sound Energy
- Irena Netik, Puget Sound Energy
- Aaron Poor, PRR
- Phillip Popoff, Puget Sound Energy
- Gurvinder Singh, Puget Sound Energy
- Jenny Thacker, PRR

Meeting Objectives

- TAG members will acknowledge the scenarios PSE is modeling in the 2019 IRP.
- TAG members provide feedback on electric and gas portfolio sensitivities.
- TAG members acknowledge how PSE will incorporate reduced carbon in portfolio sensitivities.
- TAG members provide feedback on gas utility resource alternatives.

Welcome

The meeting began at 9 a.m. Irena Netik, director of energy supply planning and analytics for Puget Sound Energy (PSE), welcomed the group to the second Integrated Resource Plan (IRP) Technical Advisory Group (TAG) meeting. The meeting began with a brief safety message from Irena about pedestrian safety as the sun is setting earlier this time of year.

Irena provided an update on the listening session. The listening session will not take place in the fall as originally reported to the group. Irena continues to work with PSE leadership to plan for the listening session. Irena thanked the attendees for their patience through this process. She will keep the group updated as details are confirmed.

Question (Virginia Lohr): What topics are acceptable to bring up at the listening session? Will speakers at the listening session be able to address issues related to the IRP?

PSE Response: PSE has received many comments during the IRP process that are not directly related to the IRP process. The listening session provides a venue for interested parties to talk about any PSE issues, including non-IRP issues.

Question (James Adcock): Did we not already have listening sessions at previous IRPAG and TAG meetings?

PSE Response: We have committed to providing an IRP comment period at every meeting. Previous 2019 IRPAG and TAG meetings included a comment period with IRP staff, which is different than the listening session just described. We have not had a listening session yet. The purpose of a listening session is to address questions outside of the IRP process.

Question (Kevin Jones): Is there an example of an item not in the IRP that could be a topic of discussion at the listening session?

PSE Response: The IRP team does not set decarbonization goals. As an example, the goal to reduce PSE's carbon footprint by 50 percent by 2040 is not an IRP goal but a company goal. In previous IRPAG and TAG meetings, stakeholders have shown a lot of interest in this goal and indicated they would like to provide feedback.

Action items from previous TAG and IRPAG meetings

Next, Michele Kvam, PSE IRP stakeholder manager, reviewed the status of action items from previous IRPAG and TAG meetings. These are in the slide deck.

PSE models various carbon impacts in their IRP and made time in the October 11 TAG meeting to discuss stakeholder feedback on their inputs for these models.

A final report on supply-side resource costs, including TAG member suggestions from the July 26 TAG meeting will be posted on the IRP web page on October 19.

TAG members asked questions about the confidentiality of the bids in the Green Direct Request For Proposal (RFP).

Question (Bill Pascoe): Would it be possible to receive a summary of bids for PSE's Green Direct Program without breaching confidentiality?
PSE Response: The evaluation of bids for the Green Direct Program is not an IRP issue; it is a resource acquisition issue. In terms of what would be summarized by Green Direct,

Comment (Bill Pascoe): It would be useful to have that information available by October 19 since it is relevant to the data in the HDR report we will be receiving that day. We want to understand the relative cost between bidders and what PSE is reporting on resource costs.

Comment (Court Olson): It is important to sort out the data.
PSE Response: PSE is working with full transparency, honesty and integrity. In a setting where we have limited resources, we have to prioritize. Bids have to be screened. For the bids that are not commercially viable, we do not do an exhaustive analysis. A bid today is not what we could buy a resource for in the future.

Agenda and meeting objectives

Brett Houghton, meeting facilitator, introduced himself as a consultant that will be providing facilitation support through the IRP process so PSE can focus on the technical content of the meetings. He reviewed the meeting objectives and agenda, including the comment period guidelines.

Brett urged the group to express their agreement for a comment or question by saying "me too" or "I agree" to help capture agreements as quickly as possible without taking up extra time in the meeting.

Next, attendees in the room and on the phone introduced themselves before moving on to the modeling overview and scenarios modeled section. Brett explained that there is a call in number for remote participants and that PSE has decided to forego a video conference option for this meeting since there were technical difficulties at the last two meetings. He advised TAG members to say their name before asking questions or making a comment so it was clear for participants on the phone.

Modeling overview and scenarios modeled

Elizabeth Hossner, consulting analyst, provided an overview of PSE modeling and the scenarios for the 2019 IRP. She reviewed the regulatory landscape in which PSE operates, including the roles of Federal Energy Regulatory Commission (FERC), North American Electric Reliability Corporation (NERC), Western Electricity Coordinating Council (WECC), and Washington Utilities and Transportation Commission (WUTC). Phillip Popoff, PSE manager of resource planning and analysis, and Gurvinder Singh, PSE senior analyst, answered questions when needed.

Next, Elizabeth reviewed the differences between scenarios and sensitivities. Scenarios reflect big, regional changes in the market. With sensitivities, PSE is only modeling its own portfolio.

Question (Mike Hopkins): In your modeling or scenarios, do you include higher or lower than expected loads?
PSE Response: Yes, we do scenarios that include lower and a higher than expected regional load. PSE also uses low, medium and high load forecast of our loads in the portfolio modeling.

Question (Bill Westre): Why did you select these three scenarios (changes in carbon dioxide prices, gas prices, and regional electric demand)? What about retirement of coal plants, new renewable energy coming online, and those kinds of things.

PSE Response: Scenarios are looking at entire region. We are modeling all state renewable portfolio standards (RPS) requirements as the minimum requirement for renewable resources. More renewable resources can be built if economic. We are modeling any planned coal retirements across the WECC. Each scenario includes all planned changes and current regulations.

Question (Doug Howell): Once you have the scenarios set, are you able to change your assumptions? What happens if you put wrong information on things like long-term contracts? Do you just keep these things wrong?

PSE Response: All announced retirements are fixed. We are constantly updating our models. If we find something that is wrong, we will fix it, but at a certain time in the process the models are locked down and updates will roll to the next IRP cycle.

Comment (Doug Howell): We need all of the assumptions that go into the scenarios and sensitivities.

PSE Response: PSE will consider adding additional information in the IRP appendices that are not already included concerning all the assumptions. Let us know what is currently lacking.

Comment (Don Marsh): Having a bit of independent review would be a good thing for PSE to do. CENSE agrees with the Sierra Club's prior comment.

Comment (James Adcock): These things should not be in the appendix; they should be in the main part of the document. We should not wait until the end of the IRP report and hope to read it in the appendix.

Comment (Elyette Weinstein): I want a list of all your assumptions.

Question (Norm Hansen): How do incidents like the recent natural gas plant explosion in British Columbia go into the IRP?

PSE Response: PSE plans for a five percent loss of load probability (LOLP). PSE believes there is a five percent chance they will not be able to provide a reliable load to a portion of their customers. In our analytical process, we model forced outages on individual units, and that is where it will be covered. It goes into the planning margin, a buffer for resource adequacy.

This is more about resource adequacy than scenarios. We can talk about this at a future TAG meeting. *[Note: Resource adequacy/effective peak capacity of intermittent resources this will be included in TAG Meeting #4, scheduled for January 9, 2019]*

Question (Don Marsh):I wonder if we should include resiliency in the conversations about least cost. If we lose that capacity we will be in trouble. How is resource diversity reflected in PSE modeling?

PSE Response: PSE addresses that in the resource adequacy modeling and this will be discussed at a future TAG meeting. That is the framework that shows the value of various types of resources. Those calculations reflect in the effective load carrying capability of a resource.

Question (Kevin Jones): Going back to pipeline consideration, does the model calculate green house gas (GHG) releases related to pipeline explosion and infrastructure failure. Does the model provide financial provisions to take into account those risks? How is financial accounting done?

PSE Response: This is the first IRP where PSE is including upstream costs of emissions. We will talk later about how these numbers were calculated. Keith Faretra, senior environmental

scientist , and Lorna Luebbe, assistance general counsel, will be here to discuss how these numbers were developed.

Comment (Charlie Black): I suggest PSE provide a flow chart of how forecasts, scenarios, and sensitivities related to each other.
PSE Response: We will look into providing a graphic to illustrate the relationship between scenarios and sensitivities, and provide a roadmap of where we are at in the IRP process and share with the TAG to facilitate understanding.

Elizabeth continued with the presentation, explaining how PSE gathers information for their scenarios. The table on slide 27 explains sources for different prices, supply and demand side resources, regional demand, carbon dioxide prices and natural gas upstream emissions. PSE plans more discussion about the demand side resources, provided by Cadmus (a technical consulting company with specialty in conservation) at a later TAG meeting. *[Note: The draft conservation resource potential results will be presented on December 6, 2018; TAG Meeting #3]*
Keith Faretra, senior environmental scientist for PSE, discussed how PSE determines upstream emissions.

Question (Joni Bosh): How do renewables affect power price? Do they go into AURORA?
PSE Response: Renewables affect power prices by providing zero-cost power. The more renewable resources are added to a system, the lower the market price. AURORA captures all of the Renewable Portfolio Standards) (RPS) across the WECC. There are a significant number of renewables being built in the region, which is depressing market prices. Assumptions are built into AURORA for costs to determine which resources get built, including wind and solar. More than just RPS, economics may cause new renewables to be built, which affects power prices, by bringing them down.

Question (Joni Bosh):With regards to CO2 price, which discount rate is PSE using?
PSE Response: PSE is using the three percent and 2.5 percent rate.

Question (Rachel Brombaugh):How have the suggestions from the supply-side resource costs TAG meeting changed the supply-side inputs?
PSE Response:Following the release of the final (electric resource costs) report, we will show initial numbers and final numbers, so you can see what changes in the IRP. The report will be shared October 19, 2018.

Question (James Adcock): How does PSE develop its own load forecasting, especially on an hourly basis?
PSE Response: We get our regional load forecast from the Power Planning Council. PSE's load forecast will be discussed at a different meeting.

Question (Don Marsh): Will PSE provide retail load forecast information?
PSE Response: We are discussing regional load forecasts. You can find more detail about how retail load forecast is calculated in Appendix E of the 2017 IRP.

Question (Norm Hansen): Bridle Trails has around 9,000 residents. We are using a lot of electricity. Can you provide capacity and peak load information to Bridle Trails about its neighborhood?

Question (Doug Howell): The WUTC gave PSE a directive to use 3 percent at $42 per ton. How are you complying with that directive?

PSE Response: The WUTC acknowledgment letter concerning PSE's 2017 IRP made a suggestion, not a directive, to include the social costs of carbon in the IRP. We have done that, as we have shown in the scenarios.

Comment (Kathi Scanlan): The letter Doug is referring to suggests PSE incorporate 2.5 and 3 percent prices.

Elizabeth returned to her slides to explain how PSE creates power prices. PSE uses a software model called AURORA. The model simulates real market conditions to forecast wholesale power market prices, long term capacity expansion, and portfolio and risk analysis. PSE started using AURORA in 1999. Today it is used internationally by utilities, power producers and regulatory agencies among others around the United States, Canada and Europe. With a system diagram on slide 31 of the presentation, Elizabeth explained how energy is moving across WECC.

The focus of the meeting then transitioned to the scenarios PSE uses in the 2019 IRP. Elizabeth clarified that PSE makes assumptions to establish a baseline. Baseline assumptions are the current legal policy as well as planned building and retirements of power plants. The scenarios PSE is using combine changing CO_2 prices, gas prices and regional electric demand.

[Note: references to the specific location of suggested sensitivities on the October 11 handout has been eliminated since this may lead to confusion with the redesigned form which incorporates TAG members' feedback. The updated form was distributed on October 19 to TAG members.]

Question (Joni Bosh): Will you model a scenario that has low demand, low gas prices and moderate to high CO_2 costs?

PSE Response: We will not be developing a specific scenario as described. PSE anticipates those conditions would be covered in a stochastic analysis.

Question (Bill Pascoe): When I look at the six scenarios on page 33, it looks like you have done a good job of including a range of CO_2 prices. I agree that is a significant unknown. I am concerned that the only high gas prices scenario has high carbon prices. I would like to see a scenario with mid demand, high gas prices and mid CO_2, to tease out how big the gas price assumption has on the results.
This comment was supported by the Sierra Club, Optimum Building Consultants and the League of Women Voters.

PSE Response: We are creating a distribution of prices from the bookends (high and low gas prices).

Question (Orijit Ghosal): How does the repealed Clean Air Rule factor in?

PSE Response: Because it is was vacated by the court, we are not modeling the Clean Air Rule. We did model the Clean Air Rule in the 2017 IRP. For 2019, we are modeling carbon prices consistent with I-1631, along with the two social cost of carbon cases, as scenarios of future potential carbon regulation. It is important to keep in mind PSE is not doing societal level planning in an IRP—we are modeling potential future regulations. That is how the Commission structured its recommendation in the 2017 IRP acknowledgement letter.

Question (Orijit Ghosal): Why are you applying prices WECC wide?

PSE Response: Applying costs WECC-wide provides prices that are more accurate to how PSE will see the market and costs to customers. Applying it to Washington only just shifts energy generation to other areas. If we apply a tax on Washington only, the economic dispatch might be different, leading to higher emissions.

PSE prepared a flowchart visualizing the 2019 IRP Scenarios on slide 34 of the slide deck.

Comment (Virginia Lohr): We want to include the social cost of carbon because it is important for the planet. Thank you for including the social cost of carbon on this slide.
This comment was supported by the Sierra Club and the League of Women Voters.

PSE presented a line graph modeling prices with different costs of carbon dioxide. These numbers came from the Technical Support Document from the United States Government Interagency Working Group on Social Cost of Greenhouse Gases.

Comment (Bill Westre): The document that provided the three numbers you are using for carbon dioxide includes a fourth value. The fourth value is a lower, probably high-impact outcome. This modeling was done by William Nordhaus, whom recently received a Nobel Prize for this work. Your high social cost of carbon is not the highest number offered in the source document.

Question (Carla Colamonici): What goes into the base as a price for carbon?
PSE Response: All scenarios include carbon dioxide prices in California, scheduled retirements of power plants and our other baseline assumptions.

Question (Kevin James): How do your scenarios include the Attorney General's office support of including climate impacts in acquisitions and Public Counsel supporting mandating that utilities include climate impact costs, as shown in their letter from September 2018.
PSE Response (Carla Colamonici, Public Counsel): The letter does not mean that we believe that social cost of carbon is the only measure. We want to see the different ways to value carbon, a range of variables.
PSE PSE Response: PSE supports the key issues in Public Council's letter; specifically, PSE supports a rulemaking or legislative actions to clarify.

Irena asked the TAG members to share what they felt was missing from the conversation about the social cost of carbon.

Comment (Bill Westre): You are using the wrong data on Slide 35.

Comment (Kevin Jones): It is inappropriate to use zero cost of carbon as an option.
PSE Response: It is important to recognize the difference between a carbon price used in economic dispatch of power plants, versus an implicit carbon cost. Some command/control regulations, like an Renewable Portfolio Standard (RPS) or Clean Energy Standard, will reduce carbon and increase costs, thus have an implicit carbon cost. Modeling a command/control regulation as a carbon price will lead to bad resource decisions. While we have been modeling potential carbon prices for over a decade, the primary carbon reducing policies are command/control: emission performance standards and RPS. Having a scenario without an explicit carbon price is important to understand the differences between carbon price regulations versus command/control regulation..

Question (James Adcock): Which social cost of carbon will be used in future builds of power plants?
Answer: PSE has never made resource planning or resource acquisition decisions on the basis of a single scenario.

Comment (Doug Howell): This is a 20-year plan. The law today should not be binding in planning for 20 years. There is nothing precluding you from implementing a minimum $42 per ton. That seems to be the direction from WUTC and stakeholders.

PSE Response: There are two kinds of important analysis for each of these scenarios. What is the least cost plan in that scenario and comparing that to the least cost plan in other scenarios? What are the different decisions that you would make? We will be reflecting those risks in that stochastic analysis.

Comment (Doug Howell): At a minimum use a three percent discount rate and a social cost of carbon at $42 per ton.

Comment (Charlie Black): There is very promising work being done around deep decarbonization. You can achieve deep decarbonization at a cost below any of these scenarios. I suggest determining how much decarbonization is possible in the PSE portfolio.

Comment (Darren Anderson): What does the carbon dioxide price need to be to make all new builds renewable or storage?
This was supported by Sierra Club, League of Women Voters, CENSE, Vashon Island Climate Action Group, Union of Concerned Scientists and Bridle Trails.
PSE Response: This could be done, but it is not a sensitivity (it is a tipping point analysis).

The presentation continued to review information about upstream carbon dioxide emissions for natural gas. PSE uses the Intergovernmental Panel on Climate Change Fourth Assessment Report (AR4) 100-year global warming potentials (GWP), as directed by the EPA and the Department of Ecology. PSE used data from Vancouver, BC as they have available data. PSE found their emission rate to be 0.009484 metric tons/MMBtu. This number was used to develop levelized costs

Comment (Doug Howell): You should use AR5 for the 20-year standard. We do not know if the information from BC is complete.
PSE Response: AR5 hasn't been adopted by government bodies. The UN, the Kyoto Protocol, the Paris Climate Accords and Washington state carbon guidelines use AR4.

Comment (Doug Howell): Gas also comes from the Rockies. PSE should include information from the Rockies in addition to BC data.
This comment was supported by Vashon Island Climate Action Group, League of Women Voters, Bridle Trails and CENSE.

Question (Kevin Jones): Measuring upstream leaks has not been accurate. Some reporting says upstream leaks are underreported. Will you vary the 100-year timeframe and amount of methane leaks? A 10 to 12 year plan might better encapsulate peak methane impacts.
PSE Response: We are not varying these numbers. This is the first time we have done this upstream emission research. It is a first start. It would be great to have numbers from the Rockies and other basins.

Question (Kevin Jones): I am disturbed you will not change this number. The idea we have to wait for mandates is concerning.
This comment was supported by CENSE, Union of Concerned Scientists, League of Women Voters, Sierra Club, Citizens' Climate Lobby and King County.
PSE Response: Scenarios take a very long time to complete, sensitivities are shorter. We can do more with sensitivities.

Comment (Doug Howell): PSE seems to undervalue the impact of methane. The basis of law is not acceptable.

Comment (Elyette Weinstein): The law does not prohibit you from doing more than the law requires. As a former lawyer, PSE should go above the limit of the law.
Vashon Island Climate Action Group and other organizations supported this comment.

Question (Rob Briggs): Emission rate is given in metric tons/mmbtu. Can you say it as a percent?
PSE Response: PSE will look into providing the total mass emissions as a percent.

Comment (Doug Howell): Emission rates are usually around nine to 10 percent. What percentage of the emissions is accounted for in its leakage?
PSE Response: About 22 percent of the total mass emissions from upstream processes will come from fugitive losses. The rate calculate fugitive losses was derived using data from the BC Provincial inventory.

We need a rational basis for the numbers we choose. We are using the science that Washington state and the UN rely on within the Paris Agreement.

Question (Rob Briggs): How much gas are you getting from BC compared to the Rockies?
PSE Response: That information is available in Puget Energy's 201710K filed with the U.S. Securities and Exchange Commission (SEC). Bill Donahue will answer this later in his presentation.

While many stakeholders requested additional science be used and recommended PSE goes above policy requirements, other groups stated they did not agree with this request.

Portfolio sensitivities

After returning from lunch, the group turned to a discussion of portfolio sensitivities. Elizabeth started out by explaining the purpose of sensitivities is to test how different resources or environmental regulations would change PSE's energy portfolio. Portfolio sensitivity must be performed within a scenario and the results compared back to the least cost portfolio for that scenario. When looking at each sensitivity, PSE examines different aspects of how the portfolio changes, such as the resource mix, the portfolio cost, and portfolio emissions.

Elizabeth presented a list of sensitivities (slides 49 and 50) and stated that PSE will consider sensitivities from the following list and will not have time to analyze all the listed sensitivities. Elizabeth stressed that each sensitivity analysis required significant time and effort to complete. TAG members were invited to comment on the presented sensitivities, add to and modify the list and help PSE prioritize which sensitivities should be evaluated.

Comment (Warren Halverson): Compliments to the project team for listening to creative suggestions about the modeling. Slides 40 and 41 in the presentation are looking at regional demand in the Pacific Northwest and the WECC and shows demand falling in the Pacific Northwest and slowing growing in the WECC. I trust that in the January 9 TAG meeting, you will provide the data and assumptions you are using for the local modeling. There is also an Eastside-specific demand forecast that was published twice in the last five years but does not appear to be available now. The WUTC and the Office of Attorney General (AG) appear to have concerns about the accuracy of the demand projections. These are important because PSE is using these to plan.
Flex Charging and Bridle Trails agree with this comment.

Question (Charlie Black): This is a question regarding PSE's existing single-cycle combustion turbines. Many are from the 1970s and 1980s. I think that over a 20 year plan, there are questions about how viable they are going to be. How are you handling these in the model?

PSE Response: With this IRP we are starting to model possible economic retirements of our plants. We are currently collecting the information to take a broader look at what that would mean. One option is that these units could be retired or replaced with new resources.

Question (Brian Grunkemeyer): In the previous IRP, you had a sensitivity on electric vehicle (EV) loads. Are you going to include an EV load sensitivity in this IRP?
PSE Response: It is not currently on the list, but it could be included. We are including current use from the EV load though the load forecast. We could always include it in the base load forecast too. It makes sense to consider a sensitivity for a big vehicle load.

Elizabeth continued her presentation of sensitivities under consideration. The portfolio sensitivities are divided into three groups: Electric sensitivities (Slide 49), combined electric and natural gas sensitivities and natural gas only sensitivities (slide 50).

Elizabeth started out by talking about the sensitivities looking at the retirement of Colstrip (retire units 1 and 2 by the end of 2019; retire units 3 and 4 by the end of 2025; retire units 1-4 by the end of 2019.)

Question (Doug Howell): There are 2035 and 2030 scenarios and net zero scenarios. Which scenarios are you using? Are you using a net zero in the Clean Energy Standard? Can you clarify?
PSE Response: The Clean Energy Standard is currently open-ended. There are several scenarios that we could study. One is that all sales are met with renewables at the end of the year, offsetting the gas plant emissions. Another scenario is that all fossil fuel units are retired.

Question (Joni Bosh): Could you model Net Zero by 2030 instead of 2035?
PSE Response: Yes, we could do that.

Elizabeth reviewed sensitivities including Stakeholder-requested alternative resource costs. (Slide 49)

Comment (Doug Howell): Sunk costs for transmission should not be included.
PSE Response: Transmission costs are already reflected in our tariffs.
Comment (Doug Howell): I would like you to spell out your rationale for the data you are using and why.

Phillip turned the conversation back to sensitivities concerning the Clean Energy Standard and mentioned that representatives from Climate Solutions had asked PSE to run a sensitivity that assumed that peaker plants, instead of being retired, were run on renewable natural gas. PSE will include this sensitivity for consideration.

Question (Elyette Weinstein): What is the difference between renewable gas and natural gas?
PSE Response: That will be covered later in the presentation, by Bill Donahue, PSE Manager Natural Gas Resources.

Comment (Virginia Lohr): I like sensitivity in which peaker plants run on renewable natural gas rather than natural gas.

PSE Response: This will be added to the list of sensitivities.

Elizabeth continued describing the sensitivities on slide 49, moving to sensitivities grouped under "Demand-side resources." PSE has been using a 10-year ramp rate, after which conservation flattens out, but in this sensitivity, PSE is assuming that conservation continues beyond the initial 10 years.

Question (Bill Westre): What is the current discount rate? And the levelized cost of energy discount rate?
PSE Response: Both are 7.6 percent.

Comment (Doug Howell): I would like to see a sensitivity that includes a very aggressive pay for performance scenario over seven years for deep efficiency and what that could mean for demand-side resources. UTC has expressed their willingness to consider aggressive pay for performance and deep efficiency. Seattle City Light is one example.

PSE Response: For the potential assessment, we are looking at all of the measures and we create a supply curve. What you are talking about is a delivery mechanism, how this gets delivered to customers.

The retrofit commission measure is working with building managers in existing buildings to see how they can optimize efficiency. We can have a sensitivity where the ramp rate is adjusted so that we achieve a certain level of optimal efficiency earlier. All these measures are in our supply curve though.

We can add deep efficiency as sensitivity on our list of sensitivities to consider, and we will also investigate whether it is feasible to conduct the sensitivity.

Elizabeth introduces sensitivity concerning the social cost of carbon as a planning adder.

Question (Joni Bosh): How does this differ from the low/ medium/ high prices in the scenarios that we discussed earlier?

PSE Response: This is the legislative proposal that we worked on with the legislature last year. Use the resource mix portfolio from the social cost of carbon scenario, take that set of resource builds and put it into a different scenario.

Question (Joni Bosh): What is the price you are using for the social cost of carbon?

PSE Response: We are using the $42 per ton to start. Then we will take that into the I-1631 scenario or a no carbon price regulation scenario and see what the costs look like.

Question (Orijit Ghoshal): How are we applying the social cost of carbon to the plants? Are there any exemptions or does it apply to all carbon emitting resources?

PSE Response: We are applying the social cost of carbon to all carbon emitting plants.

Question (Kathi Scanlan): Is the cost of carbon applied to plants across the WECC? Or just to plants in Washington state?

PSE Response: The cost of carbon is being applies to all carbon emitting plants in the WECC, and the upstream emissions are also being applied to all gas plants in the WECC.

Question (Joni Bosh): Is the carbon price being applied to all generation, not just to market purchases?

PSE Response: We are applying $ per ton on to all dispatch of energy generated. What we are trying to understand is how this is going to affect our market price. I-1631 is a Washington state initiative, but by taxing market purchases, it will make the price of market purchases appear to PSE as if the tax was applied to out-of-state generation.

Question (Charlie Black): Does your base assumption include the SB 100 Carbon-free by 2045 bill in California? It was signed in early September.

PSE Response: California's carbon-free by 2045 requirements were not included. We collected all of the RPS assumptions in the spring. Our base assumption is using a 50 percent RPS standard, but not the newer clean energy standard.

Question (Joni Bosh): Will you be including it at some point? Now that it is existing law?

PSE Response: For this IRP process, we don't have the time to go back to adjust all of the assumptions.

California's carbon-free by 2045 requirements will be researched for the next IRP.

Elizabeth moved to sensitivity the carbon abatement curve (slide 49).

Question (Kevin Jones): Can you explain what you mean by a carbon abatement curve?
PSE Response: In this sensitivity, we are trying to boil down the carbon policies into their implied costs. We are asking ourselves, what if we go beyond what is just cost effective. There might be a cost and an emission reduction. If we add solar power, there will be a change in emissions. We are looking at different resource alternatives and the cost per ton of those alternatives. It is really a sensitivity for each resource examined, but we are aggregating several up into one sensitivity for this discussion.

Elizabeth presented the final sensitivity on slide 49, concerning declining market reliance. Elizabeth continued to slide 50, to discuss combined electric and natural gas sensitivities.

Question (Doug Howell): I would like to ask a clarifying question. Is the PSE goal 50 percent below 2016 levels by 2040 and the sensitivity concerning 80 percent below 2005 levels by 2035 for both gas and electric?
PSE Response: Yes, those are for gas and electric combined.

Question (Elyette Weinstein): Do the sensitivities concerning 50 percent by 2040 and 80 percent below 2005 by 2035 reductions include reduction of upstream emissions?
PSE Response: I do not recall if the PSE goal includes upstream emissions. But it was our intent to follow PSE policy. For the appropriate sensitivity we could certainly use the factor from before.

Comment (Doug Howell): I suggest that at a minimum you add the following to your carbon dioxide emission reduction sensitivities:

- Three to five percent leakage rage
- 20-year global warming potential factor
- AR 5
- A better description of gas sources beyond BC

Vashon Climate Action Group and League of Women Voters agreed with this comment.

Question (Kathi Scanlin): Regarding declining market reliance, what is being done here?
PSE Response: We have a reliance on the short-term market. We have available transmission cross-Cascades to the mid-C market. Currently we rely on this being filled for reliability to about 1500 MW. This sensitivity would look at a reduction in that amount.

Comment (Bill Pascoe): We can add a sensitivity where PSE looks at repurposing existing transmission rights to move to alternative power.
PSE Response: We want to test those transmission assets with named resources behind them. In our testing, we would assume that existing transmission could be redirected to non-emitting resources. For example, if we retire our fossil fuel plants, we would simply repurpose existing transmission rights. One potentially interesting sensitivity that is not on this list would be to look at what would happen if we can't build any additional transmission. That scenario would also look at repurposing existing transmission lines.

Comment (Bill Pascoe): When Colstrip 1 and 2 retire, PSE will have 300 MW of transmission cross-Cascades from Montana. I think that we could use it for wind energy in Montana. There are lots of things we could do. But the All- Source Request for Proposal (RFP) seems to

suggest that we want to use that capacity to make additional market purchases. I think that question belongs not on the RFP but in the IRP process.

PSE Response: It sounds like we should include a sensitivity to the list that would increase market purchases as well as decrease them. *[Note: this was added to the list to be considered]*

Sierra Club agrees with this comment.

Comment (Charlie Black): By developing these sensitivities is looking at the assumptions that will drive the AURORA modeling for market prices. And that model and the assumptions you are feeding will really drive the IRP process. But what is happening in the market is that we are adding a lot of renewable, zero-marginal cost resources. AURORA looks at these clearing prices and PSE's costs for renewable resources, but never gets to the wholesale market that AURORA is modeling. So AURORA produces prices that are lower than the full cost of building resources. This created a biased, low benchmark. I suggest a scenario that reflects the full cost of generating resources that does not value them on an undervalued benchmark from AURORA.

Comment (Fred Hewitt): I agree with Charlie's basic view of this. The modeling constructs we have now are not obsolete, but they are heading that way. The price of power is based on marginal economics and the marginal costs of generation from renewables are low or zero. As the resource mix reflects less marginal gas, the costs are going to go down. This is not a good guide for resource investments. The Northwest Power and Conservation Council uses AURORA for prices in the RPM portfolio. But this points to the so-called "missing money" issue. How do you recover the cost if you are only taking into account the operating costs? No model represents all of the reality we are dealing with. But I agree that it is important to look at prices and resources across the WECC.

Comment (Rachel Brombaugh): I agree with Charlie and Fred on the limits of current modeling. I am concerned that the base case does not include all of the renewable additions out of PSE's service area, given SB100 and California Air Resource Board (CARB) in California. There are important implications for the price curve and how plants get dispatched.

PSE Response: It is important to address two kinds of analyses. First is the Aurora price forecasting, which we discussed earlier. Second is in PSE's capacity expansion model, or PSE's portfolio analysis. In PSE's portfolio modelling, we include both fixed and variable costs for all resources, separately. That is, new fixed costs are treated as fixed and variable costs are treated as variable. This is covered for PSE's portfolio modeling. What we are talking about now is different; we are going back to price forecasts for scenarios. Several years ago, Aurora used to operate as Charlie Black indicated, the fixed cost of resources were included in variable costs. Under this old modeling approach, market prices included both capacity and energy costs, so market price forecasts were higher. AURORA changed that several years ago because it is not how markets operate. Generating units will dispatch based on variable costs, or short-run marginal cost, not long-run marginal cost. Currently, if Aurora needs to add generation to an area in the WECC to meet resource adequacy criteria, and the revenue from the plant is not sufficient to cover the cost, AURORA will estimate a capacity price, which does not occur in the Northwest. AURORA is doing a good job forecasting prices that become inputs to PSE's portfolio model.

Elizabeth described the natural gas sensitivities on slide 50.

Question (Doug Howell): How is AURORA capturing the Colstrip scenario in which tens of millions of dollars are in operations but $160 million in new capital is being spent? Is there a trend line where this is continued?

PSE Response: This is captured in the portfolio model. Any fixed cost will also be in our portfolio modeling. Capital costs are not included in the market clearing prices, but our model does include that information. We know that AURORA is not perfect. It assumes normal load, normal hydro. If you are a seller, really low market prices might not be attractive to you. But in the RFP, we also look at capacity value. For example, Montana wind will have higher peak value than a solar plant. AURORA gives us the power price input and our other portfolio model includes fixed costs and variable costs.

Phillip suggested a new sensitivity to include, looking at an expansion of a voluntary renewable program, like Green Direct. This is an area where we can feel comfortable acquiring new renewable resources. This new sensitivity to be added to the list to consider. *[Note: this was added to the list to be considered]*

Comment (Jim Adcock): I suggest a new sensitivity in which both new gas plants and existing peakers have a 15-year lifespan. This would be a new sensitivity to be added to the list to consider. *[Note: this was added to the list to be considered]*

Question (Charlie Black): What about PSE units that are 30-40 years old? What about the retirement of existing units? We should be applying the same criteria to existing and new power plants. League of Women Voters and NESCO Group agree with this comment.

Comment (Fred Hewitt): I suggest a new sensitivity looking at a high vehicle load scenario. This could have two variants. In the first there would be no shaping of demand. In the second we could look at shaping demand through time of use rates or other mechanisms. These would be two new sensitivities (one no shaping load and one shaping load). *[Note: this was added to the list to be considered]*

Comment (Virginia Lohr): I agree with what Fred and Brian are saying, but we need to broaden it. We need to drive as many things as possible from fossil fuel generated energy to renewables. We can't limit it to cars, we need to think about hot water heaters, furnaces and more. PSE needs to stop giving rebates to help people convert from electric to gas heating. We need more incentives for customers to switch from gas generated power. I think this will happen much more quickly than renewable natural gas. This should be a sensitivity.

Phillip clarified that in this sensitivity, Virginia is assuming that renewables would cover the increased load and she agreed.

Comment (Fred Hewitt): This might not be a sensitivity, but the NW Energy Coalition would like PSE to consider hydro capacity contracts as a resource for the future. We see a number of potential suppliers. Portland General Electric recently got a new contract with the Bonneville Power Authority and could provide a model. Is there a place we could put hydro capacity as a generic resource into the modeling, so it is available for all the modeling runs? Our main concern is the capacity element, primarily the five to 10 year capacity need. *[Note: this was added to the list to be considered]*

Phillip commented that this could fit under the reducing market reliance sensitivity. However, Phillip cautioned that there is a difference between managing resource adequacy risk via some kind of hydro call option and managing cost risk. If PSE signs a capacity call option that is priced at an hourly market index when called, we cover resource adequacy risk without affecting financial risk at all.

Question (Rob Briggs): Where would a series of declining emission caps fit?
PSE Response: I think that would be under the combined electric and natural gas sensitivities.

Comment (Virginia Lohr): I propose a sensitivity that would reflect the recommendations of the 2017 Synapse report and would look at getting to 100 percent carbon free by 2035 with a series of decreasing caps. *[Note: this was added to the list to be considered]*
Question (Doug Howell): The last five to 10 percent of gas is where the highest price hits happen. So the price shock of getting to 100 percent carbon free will not be as bad in the near future as it will be in the farther future. How can a sensitivity be structured that would incorporate the uncertainty of the future price shock? Especially when we do not know what the market will look like in the future.
PSE Response: You are suggesting there should be a glide path and add the lower resource costs sensitivity as a joint sensitivity. Another way to deal with that is that we are going to show you the annual costs impact. By having the annual numbers, you can then apply those judgements.

Irena asked the group to consider how they will rank the scenarios. The group consensus was that PSE staff would clean up the list of sensitivities, add the ones that were suggested in the meeting, and send it out to TAG members by October 19. TAG members agreed to send back their top ten sensitivities, and the scenarios they should be applied to, by October 31. PSE will add a column to the amended list of sensitivities they are sending out that will detail how long each sensitivity is estimated to take to run.

Question (Court Olson): Going back to slide 33 and the discussion on scenarios, I see gas price as a variable, and carbon dioxide price, but there are other energy sources besides gas. I am wondering why they are not in the mix? Why isn't each renewable its own variable? That way we could see how renewables are bringing down power prices.
CENSE, League of Women Voters, Vashon Climate Action Group, Union of Concerned Scientists, WUTC and Sierra Club agree with this suggestion.
PSE Response: As we discussed earlier, the scenarios focus on factors that have the biggest impact on market price. What you are suggesting is that we change fixed costs for renewables in the Aurora price forecast. However, again as we talked about earlier, Aurora market prices are driven by variable costs, not fixed costs—which is how resources really do get dispatched. That is why we proposed consideration of lower renewable resource costs as a sensitivity, because that is where fixed costs can change the results.

Gas resource alternatives

Bill Donahue, manager of natural gas resources, kicked off the presentation for gas resource alternatives.

Question (James Adcock): (Concerning the recent regional natural gas pipeline rupture) Where did the explosion occur and how did it impact PSE?
PSE Response: Our understanding is that the pipeline rupture occurred early evening on Tuesday (October 9) in central British Columbia near Prince George between Station 2 and Sumas. There are two parallel lines that are in the same right of way, a 36 inch diameter pipe and a 30 inch pipe. The 36 inch ruptured and Enbridge pipeline (also known as Westcoast) shut off the flow in both pipes resulting in no

gas flowing from production in NE BC to Sumas. FortisBC, a large downstream utility, was able to use some gas flowing on their pipeline from Alberta (Southern Crossing). PSE and other utilities took actions to minimize natural gas consumption, such as curtailing interruptible gas customers, and reaching out to business customers to curtail their natural gas use. Unfortunately, Jackson Prairie, the gas storage project twas on scheduled major annual maintenance but the hard-working team at Jackson Prairie were able to complete their maintenance work and return the facility to service early evening October 20 (two days earlier then scheduled). All the gas pipelines, gas utilities, power plant operators and major industrial customers worked together to add supply or shed load to make up for the loss of over 800,000 Dth of Sumas supply. The efforts prevented a significant loss of pressure and the gas pipeline system remained stable in the region. By 2 p.m. (on October 11, 2018), portions of the Westcoast system were back in service and 38 percent of the normal gas volume from BC was available. Enbridge will be restoring service as soon as possible and is working with Canadian officials to do so in a safe manner. It could be several weeks or months before they are back up to 100 percent. The case of the rupture is under investigation.

Bill discussed a regional overview of the pipelines. Bill presented long term gas supply resource alternatives, including acquisition of shipper's surplus capacity and acquisition of new gas pipeline capacity. Short term supply resource alternatives include acquisition of other shippers' surplus of storage capacity, and gas supply delivered to the PSE system. For the purposes of the IRP concerning natural gas resources, long term means three years or longer and short term means three years or less.

Question (James Adcock): You have a green gas program where volunteers can sign up to offset their emissions. Can you replace some of those renewable energy credits (RECs) with renewable gas? That would give you the immediate benefit of having funds to put into the project.

PSE Response: The green gas program is currently set up as carbon offsets, carbon offsets are significantly lower in cost than renewable gas.

Question (Doug Howell): Is it a greater cost to put it in the pipeline than to burn it in a generator?

PSE Response: For example, the Northwest Pipeline has put in facilities to support renewable natural gas being injected in the pipeline system from the Roosevelt Land Fill. The landfill put the renewable gas in the pipeline for sale as a transportation fuel in California, where it has a higher value. This program is related to EPA's Renewable Fuel Standards – but that only results if they can track that fuel as its displacing diesel. This brings greater value than the market price for generated power

Comment (Elyette Weinstein): Federal government subsidizes new, small modular nuclear reactors, and they also pay the cost of design. Perhaps the DOE could subsidize renewable natural gas as well.

Comment (Rob Briggs): What about renewable hydrogen?

PSE Response: (Bill Donahue is) going to a conference soon about this and will be talking to folks about it. We are studying it now but it is not yet commercially viable in the U.S.

Next steps and action items

Michele returned to outline the next steps in terms of meeting notes. PSE will distribute meeting notes with action items outlined on October 25. November 1 is the deadline for TAG members to provide comments on the meeting notes to PSE. On November 8, PSE will post the final meeting notes on the IRP web page: www.pse.com/irp.

Michele reviewed action items that came out of this meeting, including:

- PSE will follow-up with Virginia Lohr concerning the publication dates of the notes from the previous IRPAG meeting. [*update: Michele sent Virginia an email on October 17 reporting that the IRPAG final meeting notes were published September 27. However, there was an error in the posting and that has been corrected as of October 19.]*
- PSE will look into whether they can convert the gas emission rate as a percentage.
- PSE will look into the viability of "deep retrofits" as a sensitivity. PSE will reach out to Doug Howell, Sierra Club, to help provide define details to facilitate this viability review. *[update: PSE added this to the October 19 sensitivities list and reached out to Dough Howell via email on October 22.]*
- PSE will look into providing a graphic to illustrate the relationship between the scenarios and sensitivities and share with the TAG to facilitate understanding and also to provide a time during each meeting to present process review information
- PSE will be distributing the updated sensitivity handout on October 19. PSE will add a column to the handout to characterize level of effort of PSE staff to conduct the sensitivity analysis. PSE agreed each TAG entity can vote for their top ten by October 31. Additional clarity will be provided in the email that will be sent on October 19. *[update: PSE distributed the portfolio sensitivities for consideration on October 19 to the TAG members via email.]*

IRP comment period

The comment period began with Bruce Brown, IRP comment period facilitator, reviewing the comment guidelines. Since there were less than 25 people who signed up to speak, everyone who signed up was able to speak.

Speaker 1 – Nancy Shimeall: I'm a ratepayer and I live in Redmond. I'm a member of Climate Reality Project. I want to thank you for the Power Point presentation. As a former teacher, I recognize the time and effort it takes to prepare such materials. I have a lot of feedback. We want to know what's going on. I want to let you know that we are watching you, PSE. You should use a reasonable cost of carbon that includes the highest level (fourth). I desire the highest cost of carbon and reasonable cost of carbon and zero is not reasonable.

Speaker 2 – David Perk: I have been taking notes during this meeting as an observer and I cannot imagine you have space left in your brain for comments. I would emphasize the social cost of carbon that seems to have almost taken place multiple times really does need to take place. I do not feel that a meaningful discussion of the social cost of carbon occurred. I want the real social cost of carbon to be recognized in this IRP and I want to see policy people from PSE at these meetings. PSE should consider a global standard of carbon, and maybe break off the costs in different ways, such as methane and nitrous oxide. There is a global cost of carbon that has recently been formulated. I know recognize that is has likely been formulated too recently but it's something for you to look at as you choose other ones that are more established. I would think of that as a way of raising the baseline for the one you do choose.

Speaker 3 – David Morton: The IRP says that in estimating the "lowest reasonable cost mix of resources," it "must consider the cost of risks associated with environmental effects including

emissions of carbon dioxide." While it appears that PSE has performed a detailed analysis of its carbon dioxide emissions, a thorough analysis of the amount of PSE's methane emissions is lacking. By its very gaseous nature, methane is hard to contain, and it easily, invisibly, colorlessly and odorlessly escapes into the atmosphere. It's not likely that scrupulous measures are taken to prevent, detect and repair all methane leaks starting from the underground natural gas deposits, through the refineries and pipelines, all the way to PSE's intended destinations. A June 2018, study published in the journal Science reports that the U.S. natural gas industry is leaking way more methane than previously thought. Also, in calculating long-term load forecasts, PSE makes use of something called "normal weather." Do we even know what "normal weather" means anymore? Our climate is undergoing wild and unpredictable changes. PSE knows that their current and future combustion of fossil fuels and leakage of methane to the atmosphere have been contributing and will continue to contribute to dangerous global warming. PSE promotes renewable energy while at the same time planning to sell more electricity generated by burning natural gas. Through its combustion of fossil fuels and leakage of methane, PSE has helped to create a severe public nuisance in which the public suffers injury, loss or damage caused by rising seas, coastal flooding, wildfires, hurricanes, heat waves and other impacts of climate change.

Speaker 4 – Kevin Jones: I appreciate that you are creating a forum for dialogue and exchange of information. I feel a discussion on the social cost of carbon was not achieved today. There is more conversation that needs to take place and more understanding to be achieved. We know PSE is required to do something, and I feel PSE is not adequately addressing the risks and environmental risks associated with carbon. We know PSE is required to model all mandated costs, but a code clearly states that WAC 480 – 100-238-(2)(b) needs to take into account cost risks associated with environmental effects. I think that non-zero carbon costs need to be in the base analysis because this is the current law.

Speaker 5 – Kimberly Danke: Thank you for the opportunity to address you. I am here representing Thurston Climate Action Team. I wanted to be on the TAG, but I missed that opportunity due to timing. I want it to be on the record that we agree with everything the Sierra Club said today. I understand this is a technical group but I believe it is relevant to the framework of the IRP. PSE is required to provide the lowest reasonable cost of energy. My concern is there are two adjectives before the word energy, and reasonable continues to be left out. My request is that PSE says "lowest reasonable cost" instead of "lowest cost" and that they provide us with their definition of reasonable. Stakeholders want a discussion concerning the working definition of reasonable. That is my request, thank you.

Speaker 6 – Doug Howell: We need to get to this issue of transparency. Sierra Club has non-disclosure agreements with lots of groups so that they can turn over all the input files for modeling. If you don't turn over those input files, all of those claims of transparency are hollow. If you do not do this, your reputation of honoring transparency is on the line.

Speaker 7 – Don Marsh: At the last IRPAG meeting we got a peek at the load forecast PSE is looking for in this IRP. It went up by about a percent a year. We raised questions about whether that was reasonable. I was told we won't actually be looking at load forecasts again until January. Today it was dismissed as it was a retail forecast and doesn't have to do with that. This is a total contrast to what Seattle City Light is doing with their IRP. I have a section from their IRP that talks about their load forecast (reads from Seattle City Light IRP document). According to Seattle City Light, the most critical step in future power planning is the future of power supply needs. It's the first thing you do. It's an assessment of how much energy Seattle City Light customers are expected to consume over a period of time. Demand is decreasing over time due to changing regulation. By delaying discussion of PSE's load

forecast until January, the company is putting the cart before the horse. Let's examine PSE's methodology and agree on the forecast before discussing how we meet the need.

Speaker 8 – Jennifer Keller: I am a PSE ratepayer living in Bellevue. I'm here today because I care about forests, trees and young people. They should not have to see trees dying from heat stress. They need a transition to clean energy as soon as possible. The 2019 IRP must aim to make our group carbon free in twenty years. We must do everything we can to transition to renewables. Natural gas leaks methane and it is awful. We want clean electricity. Boeing, REI, Starbucks and a dozen other businesses are signing up for clean energy, why not us, your customers? 100% clean energy should be delivered to all of us. The IRP process should get us there as soon as possible. It's the right thing to do.

Speaker 9 – Court Olson: I am a Bellevue resident and ratepayer. Irena, you don't know me, but I have been going to these meetings for years. A big part of the problem with any human being that needs to change course is figuring out how to do that. We are not thinking far enough outside the box. This seems to be reading I keep getting from these IRP meetings. I'm involved in many groups, and they are all frustrated with PSE. It's because you are just not thinking enough outside the box. Go home, relax and think about it and see if you can find more time to make these meetings feel less rushed and have more listening going on so you don't feel frustrated like many of us are feeling.

Adjourn

At the end of the comment period, Bruce thanked speakers for their comments and for sticking to the two minutes. The meeting adjourned at 5 p.m.