2021 IRP Webinar #5: Social Cost of Carbon

Planning Assumptions & Resource Alternatives
Electric Portfolio Model

July 21, 2020

Agenda

- Safety moment
- Social cost of carbon (SCC) in the Washington Clean Energy Transformation Act (CETA)
- SCC in the IRP models
- Upstream natural gas emissions

Safety Moment: Bike Safety

- Always wear a properly-fitted **helmet** that meets the Consumer Product Safety Commission (CPSC) standards.
- **Check your bike equipment** before heading out: check for proper fit and function, including tires, brakes, handlebars and seats.
- **Ride in the same direction as traffic**, as a vehicle on the road.
- **Obey traffic signs**, signals, and lane markings; signal all turns; and follow local laws.
- **Be predictable**; ride in a straight line and use hand signals when changing lanes or turning.
- **Stay focused**; look ahead for traffic and obstacles in your path.
- **Be visible**: wear bright colors, reflective materials and lights on your bicycle at night and in low light conditions.
- **Stay alert**: don't use electronic devices.
- **Ride safe**; riding impaired by alcohol or drugs affects your judgment and skill; it affects your safety and others on the road

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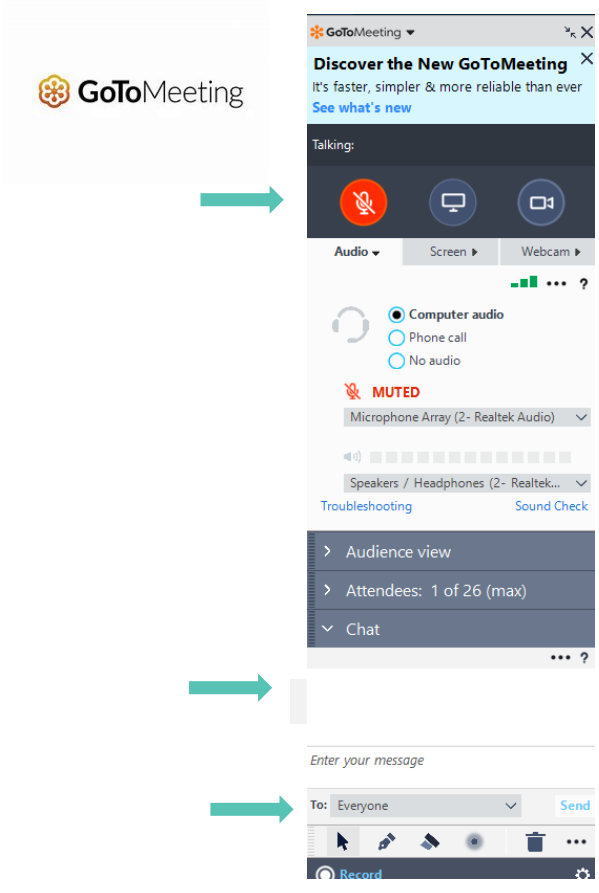
Today’s Speakers

Elizabeth Hossner
Manager Resource Planning & Analysis, PSE

Keith Faretra
Senior Resource Scientist, PSE

Penny Mabie & Alison Peters
Co-facilitators, EnviroIssues

Welcome to the webinar and thank you for participating!



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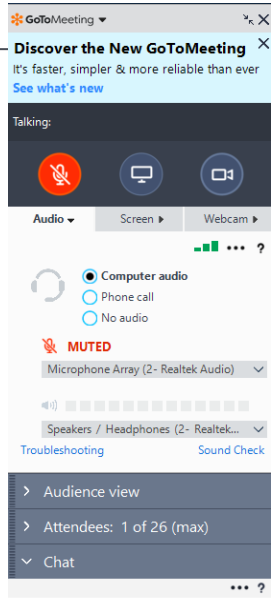
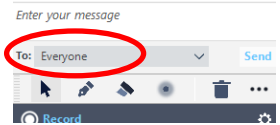
How to participate using Go2Meeting

Presentation Do's

- Mute your mic during the presentation
- You can participate in writing or verbally using the chat window
  - **In writing:** your question will be read
  - **Verbally:** type "Raise hand" and slide #, share with "Everyone"; please wait to be called on to ask your question
- Be considerate of others waiting to participate
- We will try to get to all questions



Raise hand, slide 33



Participation Objectives

- PSE will inform stakeholders of the methodology used to model the social cost of carbon in the 2021 IRP analysis
- Stakeholders to share input on possible scenarios or sensitivities around the social cost of carbon

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The Social Cost of Carbon in CETA

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SCC vs. SCGHG

- During the 2019 IRP process, many people used the terminology social cost of carbon (SCC). This term was carried over to the 2021 IRP.
- The new terminology is the social cost of greenhouse gases (SCGHG).
- SCC and SCGHG are interchangeable and refer to the same thing.
- For the purposes of this presentation, PSE will continue to use the term social cost of carbon (SCC).

The Social Cost of Carbon, According to CETA

"NEW SECTION. Sec. 15. A new section is added to chapter 80.28 RCW to read as follows:

For the purposes of this act, the cost of greenhouse gas emissions resulting from the generation of electricity, including the effect of emissions, is equal to the cost per metric ton of carbon dioxide equivalent emissions, ***using the two and one-half percent discount rate, listed in table 2, technical support document: Technical update of the social cost of carbon for regulatory impact analysis under Executive Order No. 12866****, published by the interagency working group on social cost of greenhouse gases of the United States government, August 2016. The commission must adjust the costs established in this section to reflect the effect of inflation."*

- Section 15, Page 35

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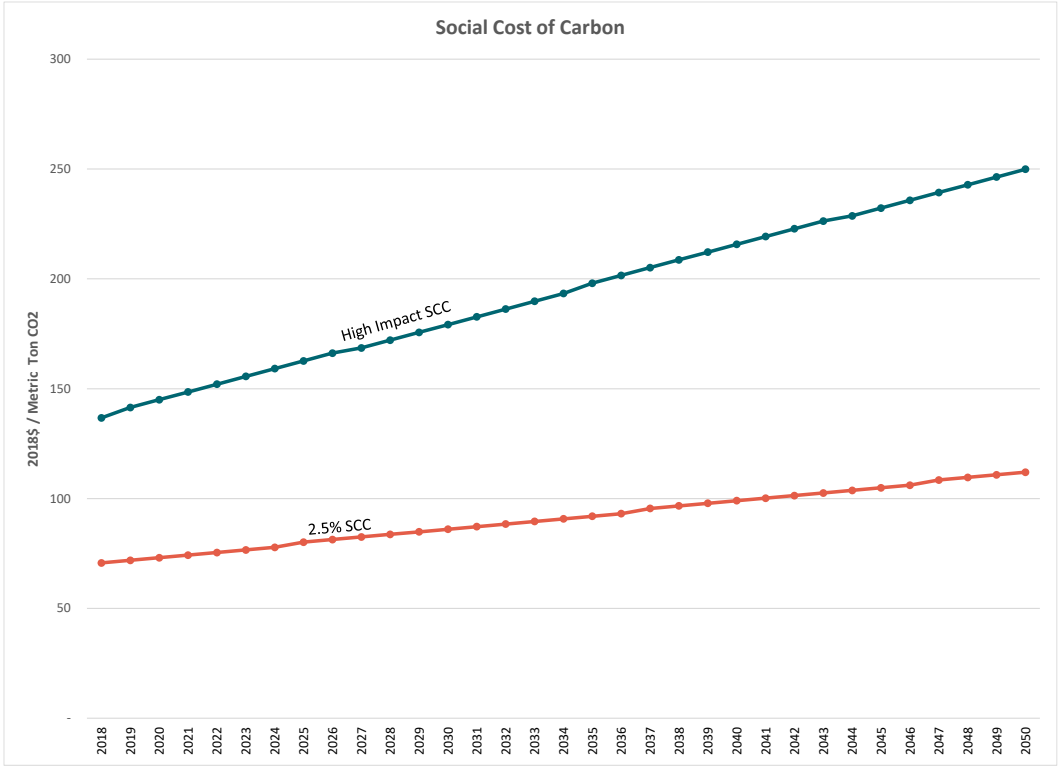
The Social Cost of Carbon, According to CETA

- CETA provides a SCC value published by an interagency working group of the federal government in August, 2016.
- For PSE, this is what must be applied as the SCC for planning decisions and final portfolio recommendations.

Year	*Social Cost of Carbon Dioxide* (in 2007 dollars per metric ton)*	*** GDP Index (2007)*	*** GDP Index (2018)*	*Adjusted Social Cost of Carbon Dioxide* (in 2018 dollars per metric ton)*
2010	50	92.498	110.382	***60***
2015	56	92.498	110.382	***67***
2020	62	92.498	110.382	***74***
2025	68	92.498	110.382	***81***
2030	73	92.498	110.382	***87***
2035	78	92.498	110.382	***93***
2040	84	92.498	110.382	***100***
2045	89	92.498	110.382	***106***
2050	95	92.498	110.382	***113***

https://www.utc.wa.gov/regulatedIndustries/utilities/Pages/SocialCostofCarbon.aspx

The Social Cost of Carbon Over Time



- The SCC rises steadily over time, tracking with inflation.
- Here, the CETA SCC is compared to a “high impact” SCC figure used in PSE sensitivity modeling.
- All figures are in 2018$/metric ton
- SCC prices available in this spreadsheet

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Using the Social Cost of Carbon, According to CETA

Where the SCC must be applied

(3)(a) An electric utility must incorporate the social cost of greenhouse gas emissions as a cost adder when:

(i) Evaluating and selecting conservation policies, programs, and targets;

(ii) Developing integrated resource plans and clean energy action plans; and

(iii) Evaluating and selecting intermediate term and long-term resource options. p. 33 E2SSB 5116.S

(b) For the purposes of this subsection (3):

(i) Gas consisting largely of methane and other hydrocarbons derived from the decomposition of organic material in landfills, wastewater treatment facilities, and anaerobic digesters must be considered a non-emitting resource; and

(ii) Qualified biomass energy must be considered a non-emitting resource.

- Section 14, Page 33

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Using the Social Cost of Carbon, According to CETA

- CETA explicitly instructs utilities to use the SCC as a cost adder when evaluating conservation and resource additions, and making the IRP or CEAP.
- PSE understands this “cost adder” to mean that the SCC is included in resource planning decisions as a part of the Fixed O&M costs of that resource.
- The SCC is not included in resource dispatch costs.
- The SCC is accounted for post-economic dispatch in order to evaluate competing resource portfolios as they would function in the real world.

The SCC in PSE Models

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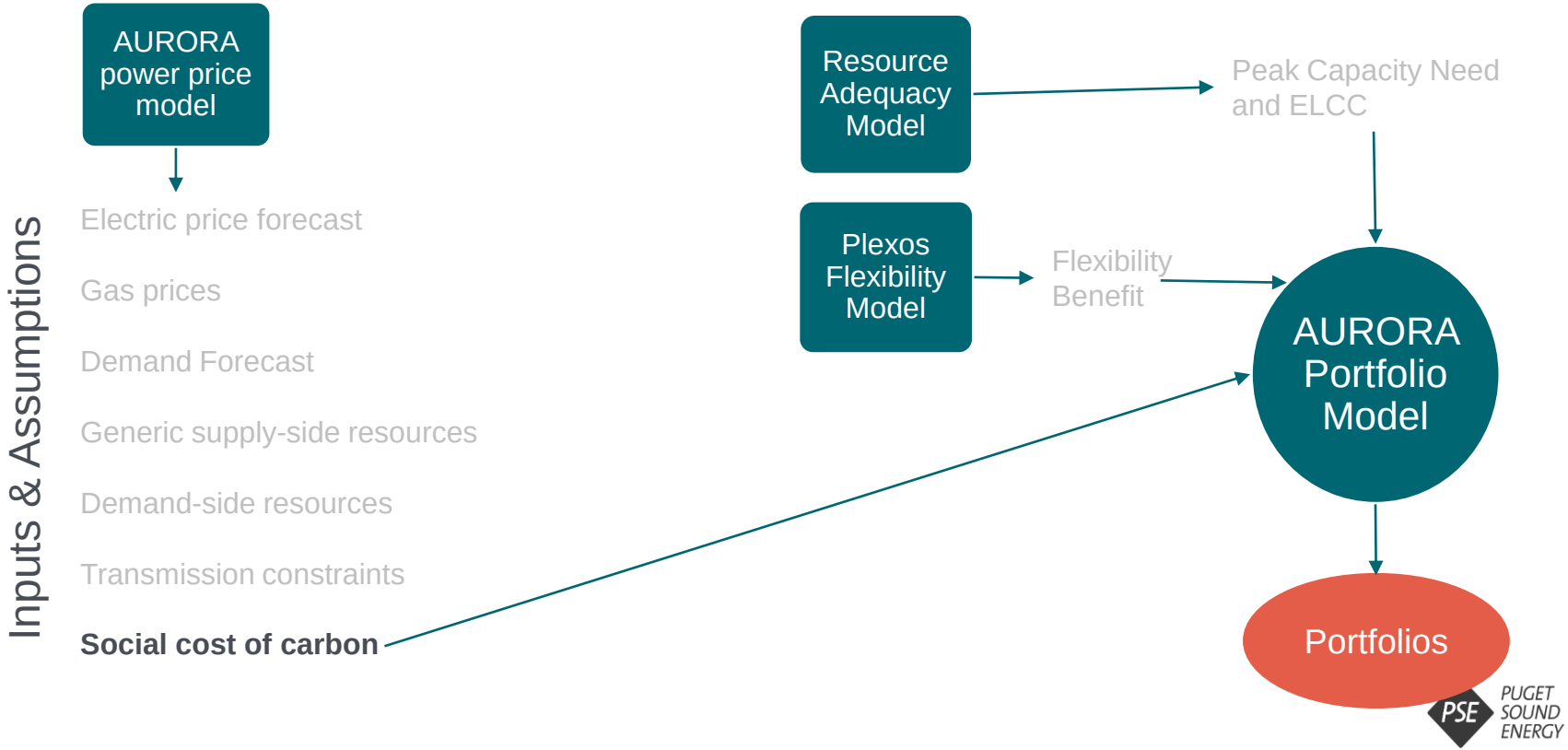
Electric IRP Models



SCC as a cost adder vs. SCC as a tax

- PSE is required by law to produce electricity at the lowest cost possible to ratepayers. The IRP process is a part of demonstrating the least-cost portfolio for PSE.

- By using the SCC as a planning adder in resource build decisions, PSE factors in the price impact of the SCC to build decisions.

- This cost adder provides an economic disincentive for building thermal plants without artificially increasing the price of electricity for ratepayers.

Applying the SCC as a cost adder

- For thermal plants:
  - Step 1: Run the dispatch of plant over its lifetime.
  - Step 2: Calculate the emission cost for each year:

    CO_2 emissions (tons) * SCC ($/ton) = emission cost ($)
  - Step 3: Add the emission cost ($) from Step 2 to fixed resource costs.
  - Step 4: Re-run the portfolio model for optimal portfolio results

- Unspecified market purchases

  SCC ($/ton) * emission rate (ton/MWh) = adder ($/MWh)

PSE is using the 0.437 metric tons CO2/MWh for unspecified market purchases from Section 7 of E2SSB 5116, paragraph 2.

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Applying the SCC as a cost adder – example using a peaker

	Tons CO2	SCC ($/ton)	Total Emission Cost ($)	$/kw-yr
2022	32,409	75	2,445,142	23.51
2023	39,897	77	3,057,055	29.39
2024	30,983	78	2,410,580	23.18
2025	13,393	80	1,073,571	10.32
2026	17,948	81	1,459,883	14.04
2027	22,998	83	1,897,758	18.25
2028	22,498	84	1,883,057	18.11
2029	26,157	85	2,220,107	21.35
2030	20,800	86	1,789,982	17.21
2031	21,508	87	1,876,205	18.04
2032	28,197	88	2,492,937	23.97
2033	28,360	90	2,540,811	24.43
2034	23,974	91	2,176,167	20.92
2035	27,195	92	2,500,563	24.04
2036	29,054	93	2,705,789	26.02
2037	29,024	95	2,771,354	26.65
2038	27,492	97	2,657,497	25.55
2039	25,237	98	2,469,328	23.74
2040	25,835	99	2,558,268	24.60
2041	26,837	100	2,689,103	25.86
2042	28,190	101	2,857,859	27.48
2043	24,806	103	2,544,081	24.46
2044	23,788	104	2,467,700	23.73
2045	22,546	105	2,365,429	22.74
2046	22,635	106	2,401,499	23.09
2047	20,501	108	2,223,375	21.38
2048	24,808	110	2,719,725	26.15
2049	22,857	111	2,532,752	24.35
2050	22,110	112	2,476,141	23.81
2051	22,321	113	2,526,028	24.29

Emissions costs added to the cost of the peaker in the portfolio model during the resource selection for the portfolio

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Note: This is an example and meant for illustrative purposes. Actual costs for 2021 IRP will be calculated later.

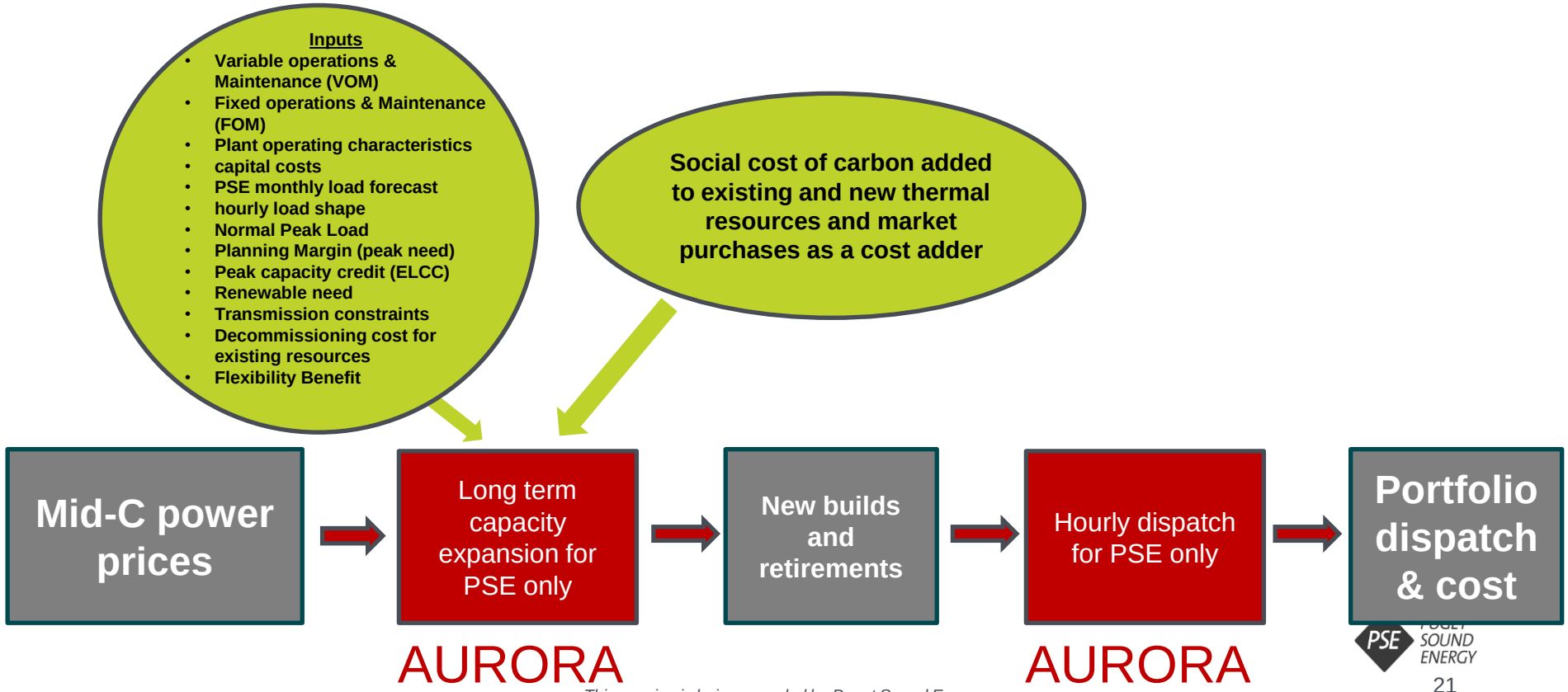
Applying the SCC as a cost adder

- How is social cost of carbon being modeled as a cost adder different than a CO_2 tax?
  - Modeling the SCC as a CO_2 tax would understate the costs and emissions associated with the plant. The model is set to optimize the dispatch of the plant including an emission price.

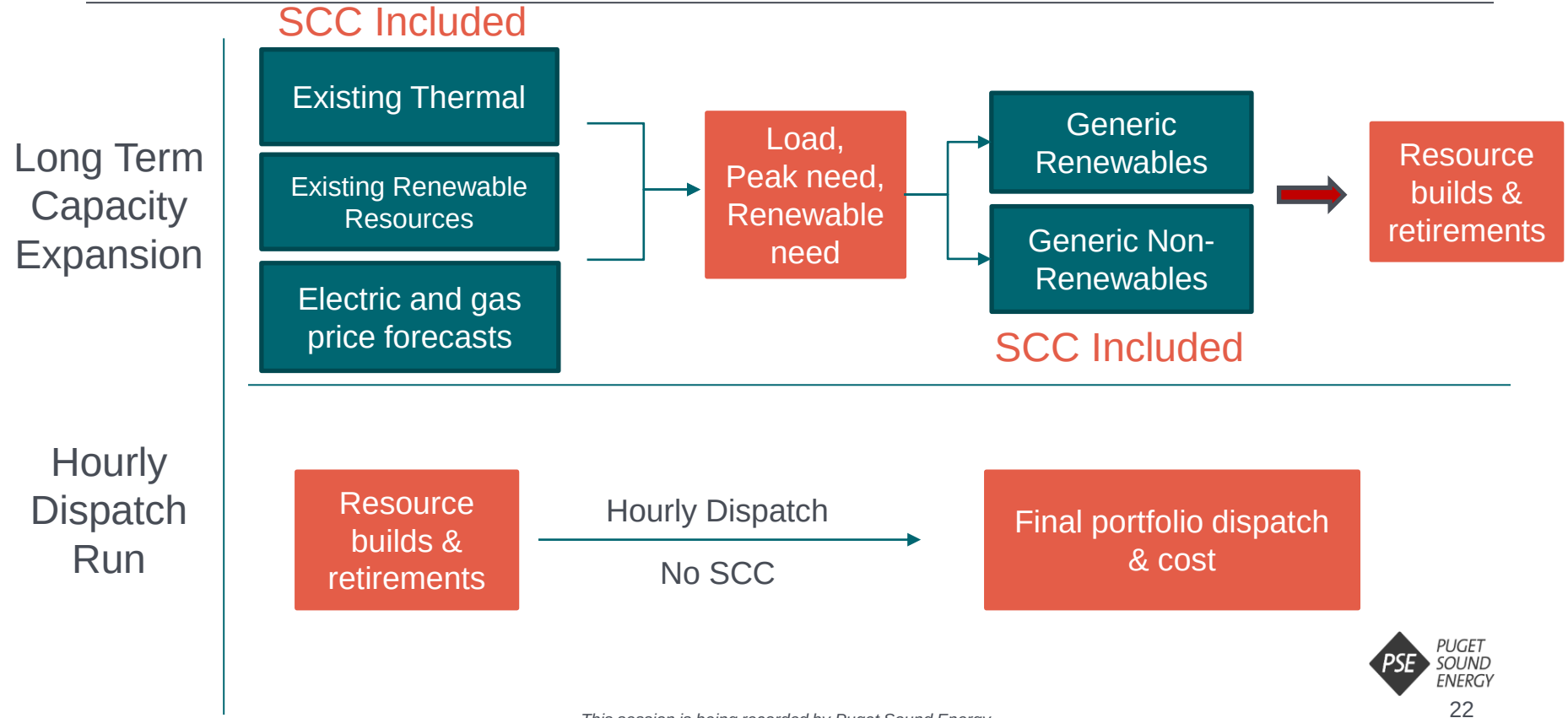
	SCC as a CO_2 tax	SCC as a cost adder
Annual capacity factor from economic dispatch	30%	70%
Annual CO2 emissions	400,000 tons	1,000,000 tons
Total cost of CO2 emissions	$32 Million	$80 Million

- The higher cost associated with the cost adder will make baseload gas plants less economic.

IRP electric portfolio model process



SCC as a cost adder in AURORA



SCC in the scenarios and portfolio sensitivities

- **PSE will apply the SCC as a post economic dispatch fixed cost adder.**

- **Portfolio sensitivity: High impact SCC**
  - Washington State passes a law or amendment that increases the SCC, or
  - Washington State rulemaking specifies that upstream emissions are to be included in SCC considerations.

- **Scenario: WECC-Wide federal CO_2 tax**
  - Across the WECC, uniform CO2 pricing is implemented as a federal tax
  - States in the WECC: WA, OR, CA, ID, MT, WY, NV, UT, CO, NM, and AZ

Conclusions from 2019 IRP process December 2019 webinar on SCC

1. Renewable resources required to comply with CETA is the key constraint driving the new portfolio resource additions.

2. With the CETA renewable requirement, the application and the value of **social cost of carbon** has little to no effect on portfolio resource additions.

Where we are looking for feedback?

- **Scenarios and sensitivities to model the SCC**
  - PSE is in the process of deciding which scenarios and sensitivities to model.
  - Scenarios and sensitivities will be discussed at the August 11 IRP webinar.

5-minute Break

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Upstream natural gas emission methodology

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Participation Objectives

- PSE will inform stakeholders of the methodology used to calculate upstream natural gas emissions

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Social cost of upstream natural gas emissions

Electric utility planning

- CETA does not include references to upstream emissions, but PSE will include upstream emissions in the 2021 IRP

Gas utility planning

- HB 1257, section 15, requires upstream emissions for conservation planning, and PSE will also apply it on the supply side resource planning for the 2021 IRP

Upstream gas emission rate data sources

Reliance on data published by the Puget Sound Clean Air Agency (PSCAA)

- PSCAA commissioned an independent lifecycle analysis for the Tacoma LNG Project
- Emissions of carbon dioxide, methane and nitrous oxide are quantified and reported on a CO_2 equivalent basis by applying the 100-year global warming potential (GWP) factors from the Intergovernmental Panel on Climate Change Fourth Assessment Report (AR4, IPCC 2007), which is currently the accepted international reporting standard and the method for the State of Washington and U.S. Environmental Protection Agency GHG reporting. The AR4 100-year GWP is the widely used default metric to weigh GHG emissions and is consistent with the goals of the the Paris Accord and the Kyoto Protocol.

- Two models considered which rely on respective national inventory data from each segment along the natural gas supply chain
  1. **GHGenius** – Canadian model used to examine all stages of natural gas pathways for life cycle assessments
     - Used for baseline sensitivity in PSCAA analysis
  2. **GREET** (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) – Argonne National Lab model, also used for life cycle assessments
     - Used for upper bound sensitivity in PSCAA analysis

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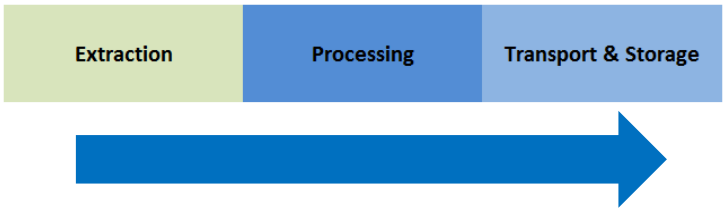
Upstream gas emission rate components from lifecycle

- Emission rate associated with extraction, processing and transport of natural gas along the supply chain
- Natural gas supply chain includes:
  1. Extraction & Production – the extraction of raw natural gas from underground formations
  2. Processing - the removal of impurities
  3. Transport & storage – the delivery of natural gas from the wellhead and processing plant to city gate transfers
  4. Fuel - energy required to move the gas (in gas driven compressors)
  5. Distribution – delivery of natural gas from the major pipeline (city gate) to the end users



GHGenius upstream emission rate

GHGenius

- Uses v4.0a (2016)
- Newer version is available (v5.0c, 2018); however, upstream emissions are lower so values in v4.0a are more conservative
- Regionally specific (by Province)
- Includes all stages of the natural gas supply chain
- Emissions data sourced from Pollutant Inventories and Reporting Division of Environment Canada
- Gas statistics sourced from Statistics Canada and the Canadian National Energy Board
- Most widely adopted protocol for Canada

GREET upstream emission rate

GREET

- Updated October 2018
- US specific
- Includes all stages of the natural gas supply chain
- Emissions data sourced from EPA GHG Inventory
- Gas statistics sourced from US Energy Information Administration
- Most widely adopted protocol for United States

Published emission rates

Natural Gas Supply Chain Upstream Life Cycle Emission Rates

Supply Chain Segment		GHGenius (Baseline Sensitivity), g/MMBtu				GREET (Upper Sensitivity), g/MMBtu			
		Carbon Dioxide	*Methane*	*Nitrous Oxide*	*Carbon Dioxide Equivalent*	*Carbon Dioxide*	*Methane*	*Nitrous Oxide*	*Carbon Dioxide Equivalent*
Natural Gas Extraction	**Extraction**	2,303.16	25.05	0.110	2,962.2	2,153.87	8.04	0.019	2,360.5
Extraction Fugitive		2.69	115.53	0.000	2,890.9	0.00	137.87	0.000	3,446.6
Natural Gas Processing	**Processing**	2,325.46	10.35	0.040	2,596.1	1,665.98	5.94	0.013	1,818.3
Processing Fugitive		1,101.04	0.00	0.000	1,101.0	702.06	6.17	0.000	856.3
Transmission - Distribution	**Transport & Storage**	1,192.80	2.29	0.009	1,252.8	1,650.74	63.04	1.385	3,639.4
Total		6,925.14	153.21	0.160	**10,803.0**	6,172.66	221.05	1.417	**12,121.1**

Source: Puget Sound Clean Air Agency, Final Supplemental Environmental Impact Statement (March 29, 2019)

Upstream Emission Rate - Sum of All Segments Expressed in CO2equivalent (CO2e)

Canadian vs. US gas in IRP models

- Electric IRP assumes all new gas from BC
  GHGenius: 10,803 g/MMBtu = 23 lbs/MMBtu
  Upstream emissions added to emission rate of NG plants
  Example:

New NG plant emission rate:	117 lbs/MMBtu
Upstream emission rate:	23 lbs/MMBtu
Total emission rate:	140 lbs/MMBtu

  Example on slide 19 for SCC calculation includes the higher emission rate with upstream emissions for total tons of CO_2

- Gas IRP assumes different rates for the US and Canadian supply hubs and then the gas model (Sendout) optimizes between the different supply hubs
  - GHGenius used for Canadian supply hubs
  - GREET used for US supply hubs

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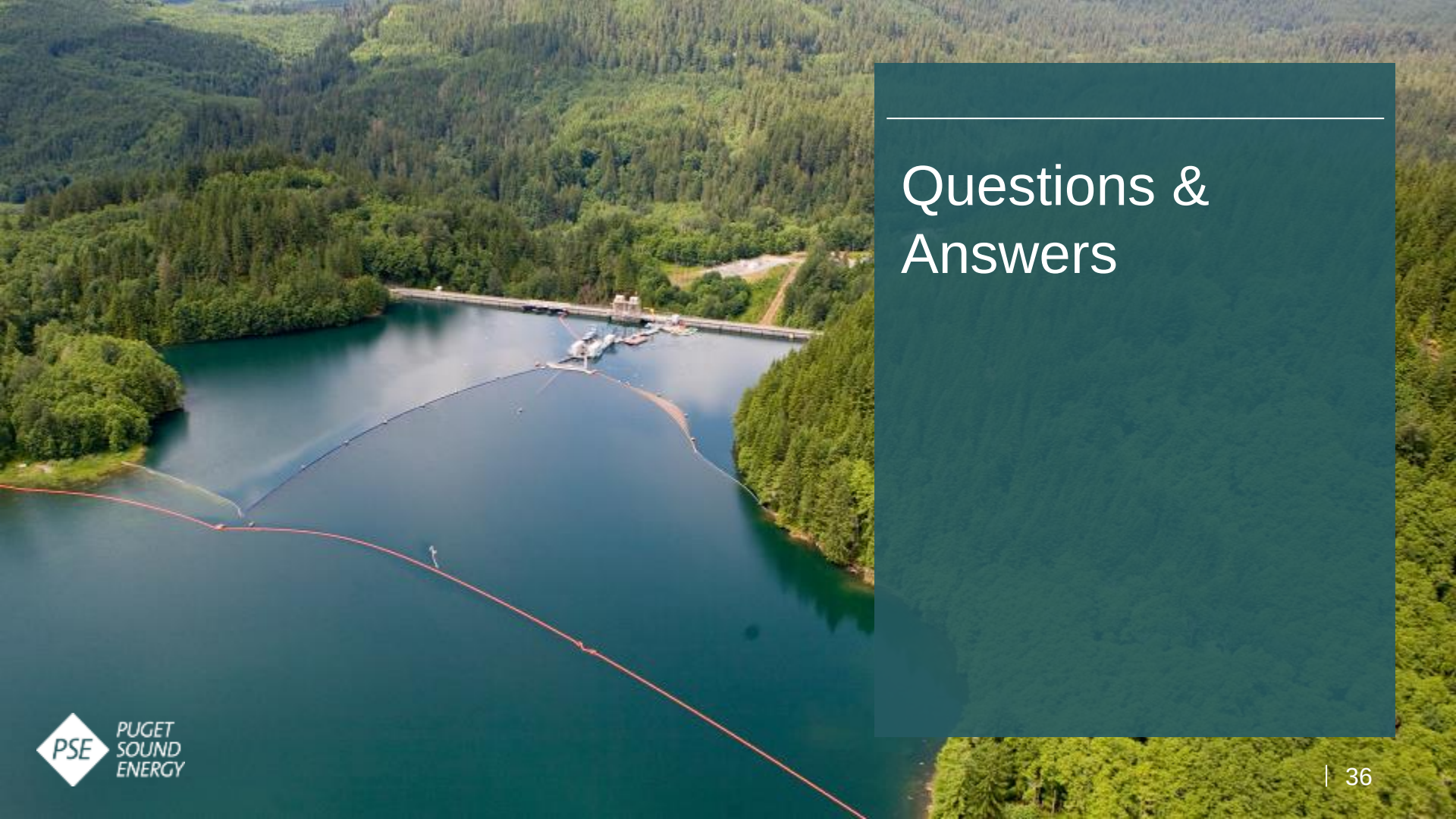

Questions & Answers

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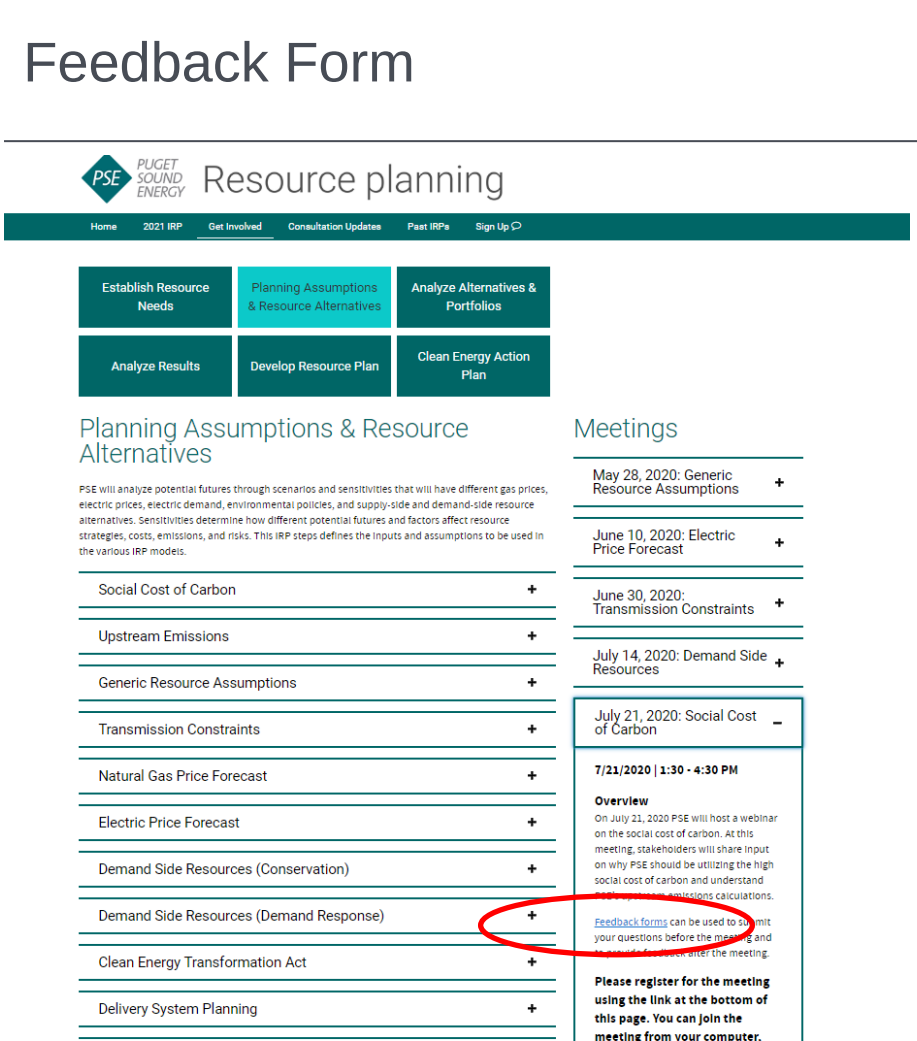
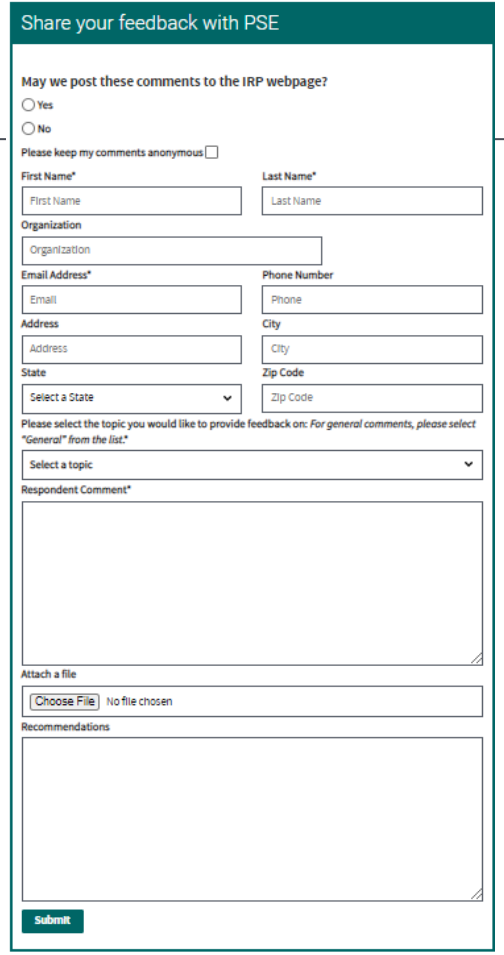
Feedback Form





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Feedback Form

- An important way to share your input
- Available on the website 24/7
- Comments, questions and data can be submitted throughout the year, but timely feedback supports the technical process
- Please submit your Feedback Form within a week of the meeting topic

Feedback Form → **Feedback Report** → **Consultation Update**

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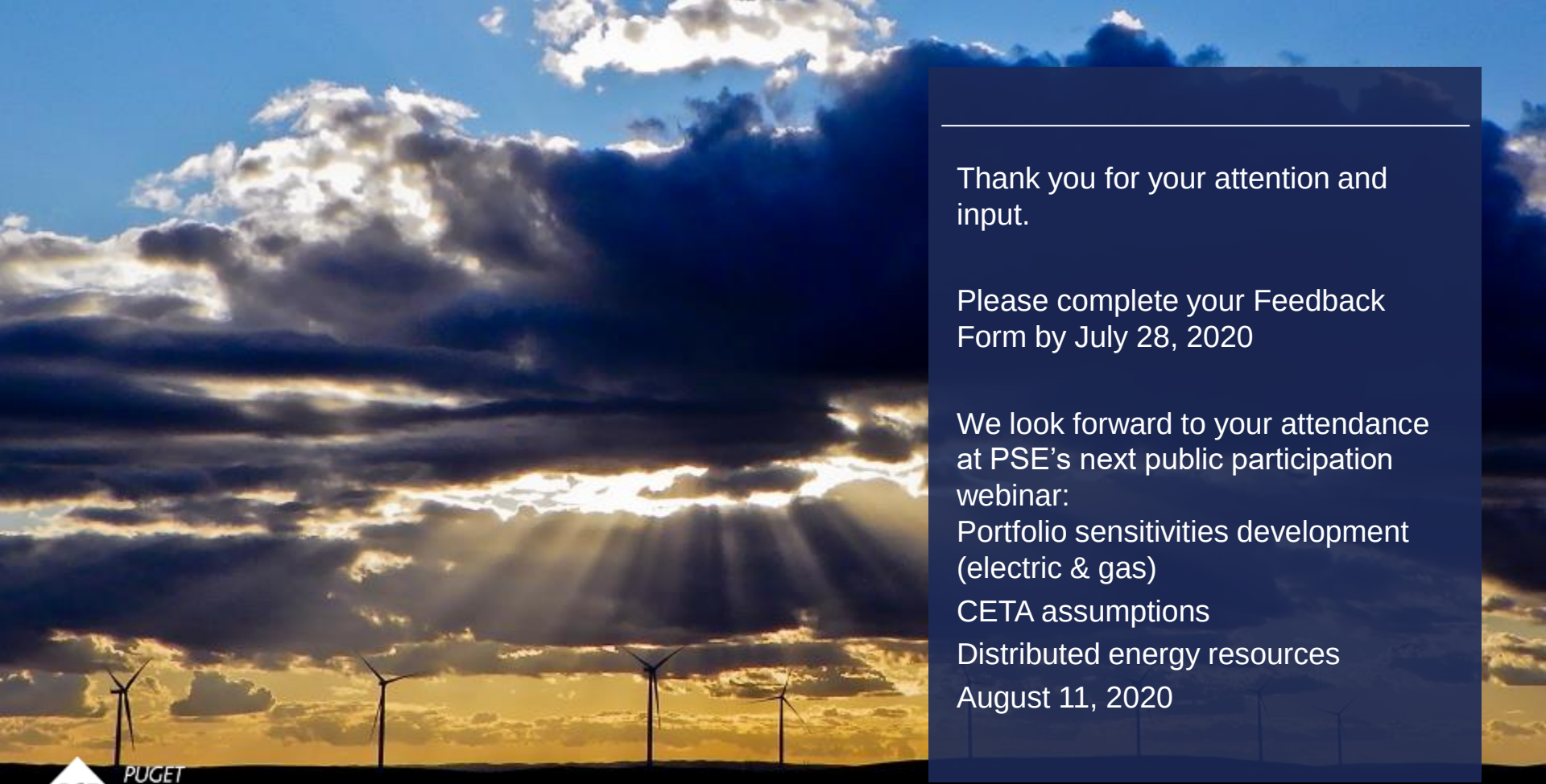
Next steps

- Submit Feedback Form to PSE by **July 28, 2020**
- A recording and the chat from today's webinar will be posted to the website **tomorrow**
- PSE will compile all the feedback in the Feedback Report and post all the questions by **August 4, 2020**
- The Consultation Update will be shared on **August 11**

Details of upcoming meetings can be found at pse.com/irp

Date	Topic
August 11, 8:30 am – 12:30 pm	Portfolio sensitivities development (electric & gas) CETA assumptions Distributed energy resources
September 1, 1:00 – 5:00 pm	Demand forecast (electric & gas) Resource adequacy Resource need: peak capacity, energy & renewable energy need
October 20, 1:30 – 4:30 pm	Portfolio sensitivities draft results Flexibility analysis
November 4, 1:00 – 4:30 pm	Clean Energy Action Plan 10-year Distribution & Transmission Plan
December 9, 1:00 – 4:30 pm	Portfolio draft results Stochastic analysis Wholesale market risk



Thank you for your attention and input.

Please complete your Feedback Form by July 28, 2020

We look forward to your attendance at PSE's next public participation webinar:
Portfolio sensitivities development (electric & gas)

CETA assumptions

Distributed energy resources

August 11, 2020

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Appendix

PSE Conversion

- In order to input the SCC into AURORA models, PSE converts the final SCC numbers into 2012$/short ton.
- To do so, the CETA GDP conversions are used to change to 2018$, and a 2.5% inflation rate is used to convert to 2012$ for the AURORA model.