Integrated Resource Planning

ROUNDTABLE 21-8

NOVEMBER 2021

PGE

MEETING LOGISTICS

Electronic version of presentation:

https://www.portlandgeneral.com/our-company/energy-strategy/resource-planning/integrated-resource-planning/irp-public-meetings

Teams Meeting

Please click the meeting link sent to your email or here:

Join Microsoft Teams Meeting

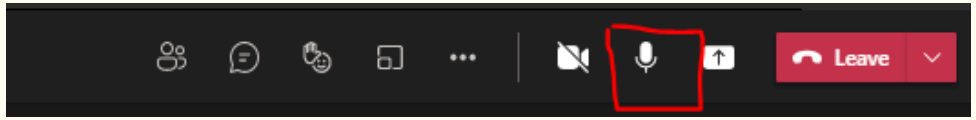
+1 971-277-2317 (dial this number into your phone for best results)

PW: 177 228 513#

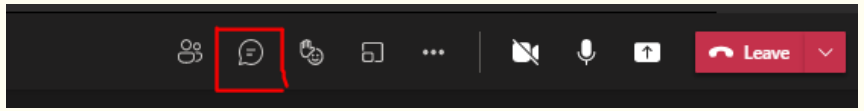
*Please use Microsoft Edge or Google Chrome with Teams as it will give you the best experience

PARTICIPATION

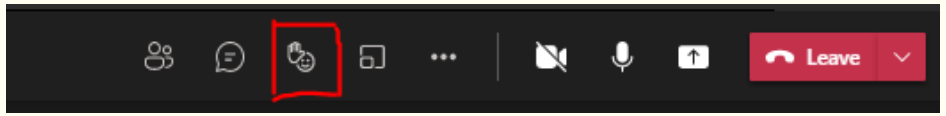
- Mute your mic while others are speaking; to unmute via phone press *6



- We will ask for comments and questions along the way
- Participate using the chat box or ask questions verbally



- Use the “raise hand” feature to signal you would like to ask your question verbally



- Wait to be called on
- Please be polite and respect all participants on the webinar
- Please stay on topic; we may interrupt or shorten questions to meet the time commitment of the meeting

AGENDA

Welcome and introductions	15 minutes
Safety moment	5 minutes
Pricing methodology	45 minutes
Supply Side options	20 minutes
Portfolio requests from participants	5 minutes

SAFETY MOMENT

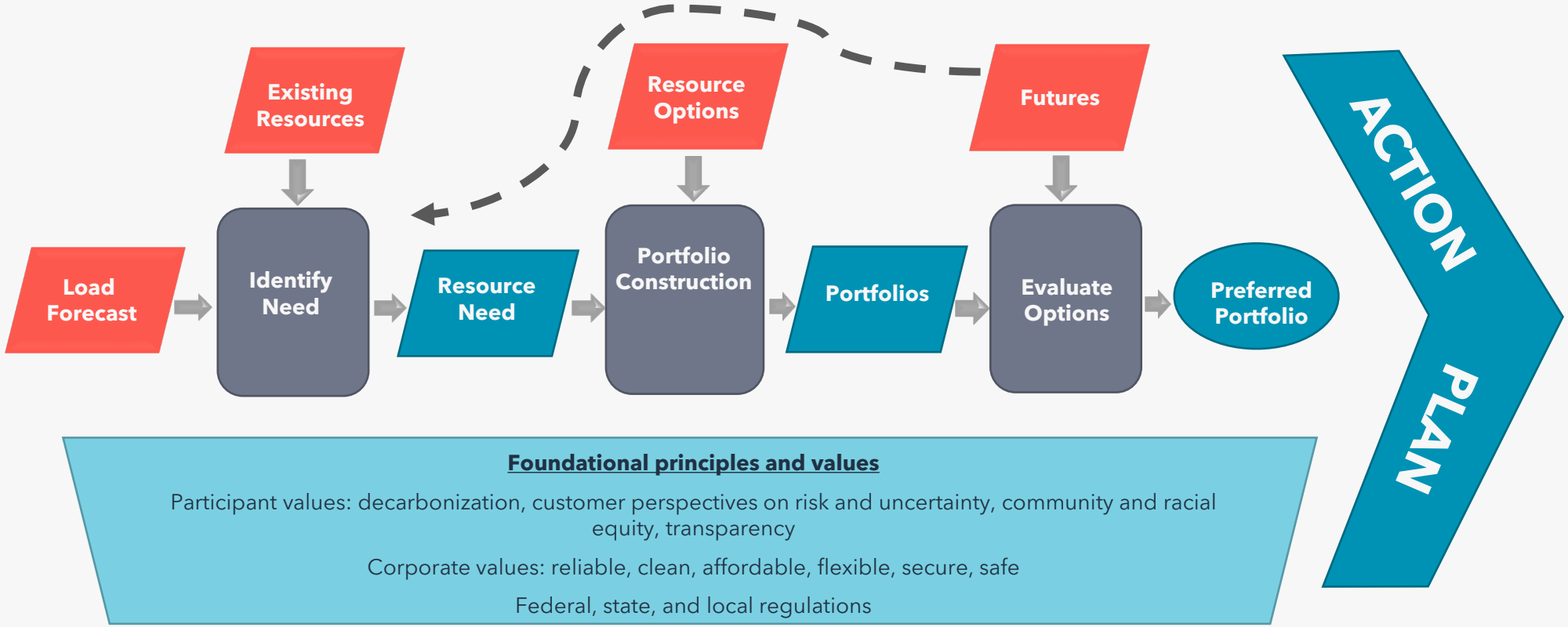
Safe Driving and Traveling

Distracted driving, speeding, and driving under the influence are the cause of most accidents each year

Tips to be a safe driver and commuter

- Plan travel before leaving your destination
- Set up navigation and/or blue tooth before leaving
- Slow down if conditions warrant it
- Use headlights, reflective clothing, and bike lights
- Be aware of wildlife, especially at dawn and dusk
- Use phones and ear buds responsibly – be aware of the risks around you

IRP ANALYSIS PROCESS



PRICING METHODOLOGY

Silvia Melchiorri, Rainbow Wong

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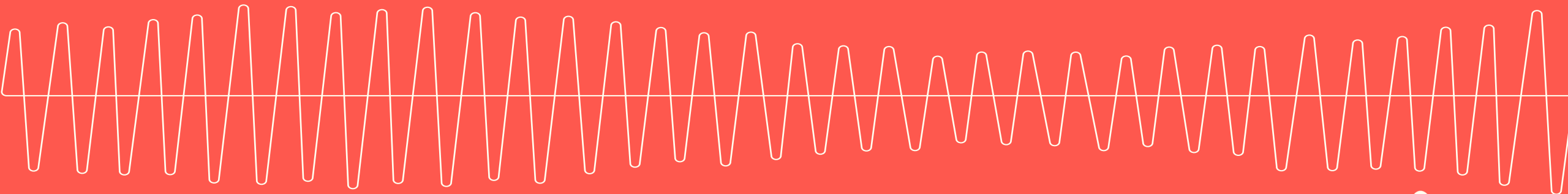


Electricity Price Forecast: Recap

Recap: PGE proposed methodology and comparison with previous IRP was presented in:

- Roundtable 21-1 in February 2021, and
- Roundtable 21-3 in May 2021

Goal: simulate long-term electricity prices for the Pacific Northwest

We use Wood Mackenzie (WM) data with Aurora software to simulate WECC-wide prices. Then we input such prices in PGE-PZM Aurora model for PGE portfolio dispatch

Today's agenda:

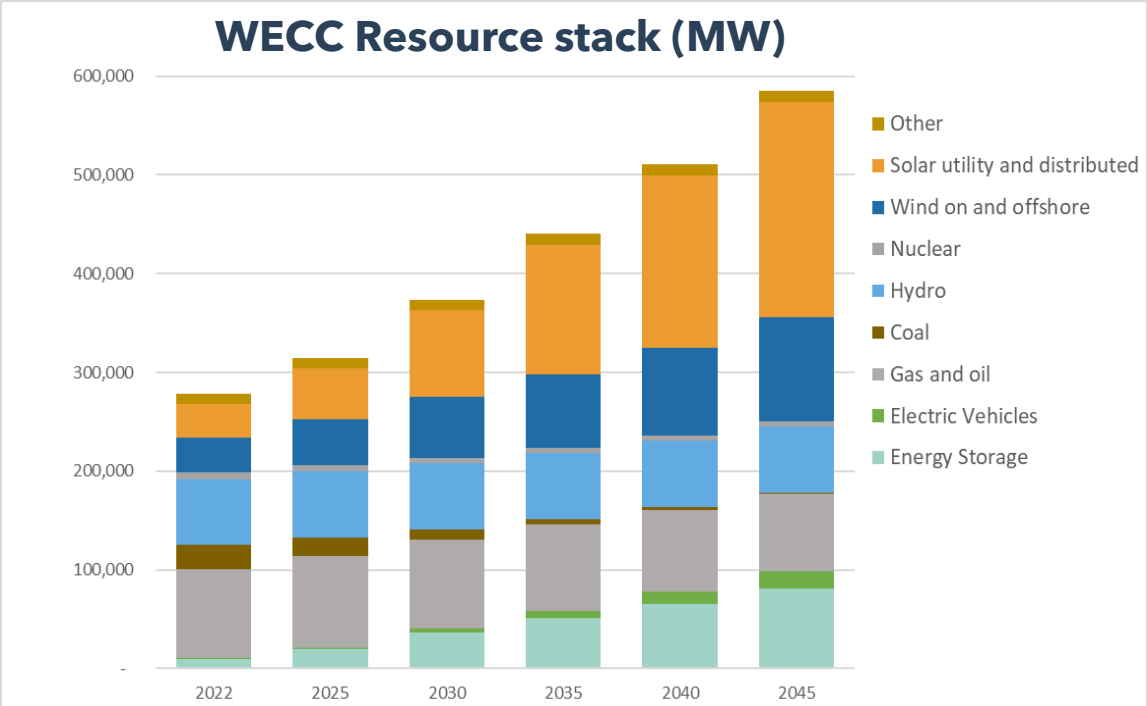
1) Confirm WECC model setup and reference future - methodology locked

2) Show the detail requested in the last RT

3) Propose list of futures to simulate for scenario analysis – still open to your suggestions

WECC Model Setup: High Renewable + Storage Build Out [Locked]

- WM 2020H2 embraces the view of future additions being mainly renewables + storage
- Graph shows the capacity installed by fuel/technology and year
- Coal plants are progressively retired
- Older, less efficient, oil and gas plants are also retired starting in the 2030s



These charts were obtained from the North America Power & Renewables Service &Tool – WECC, a product of Wood Mackenzie.

Reference Futures: Long-Term Prices

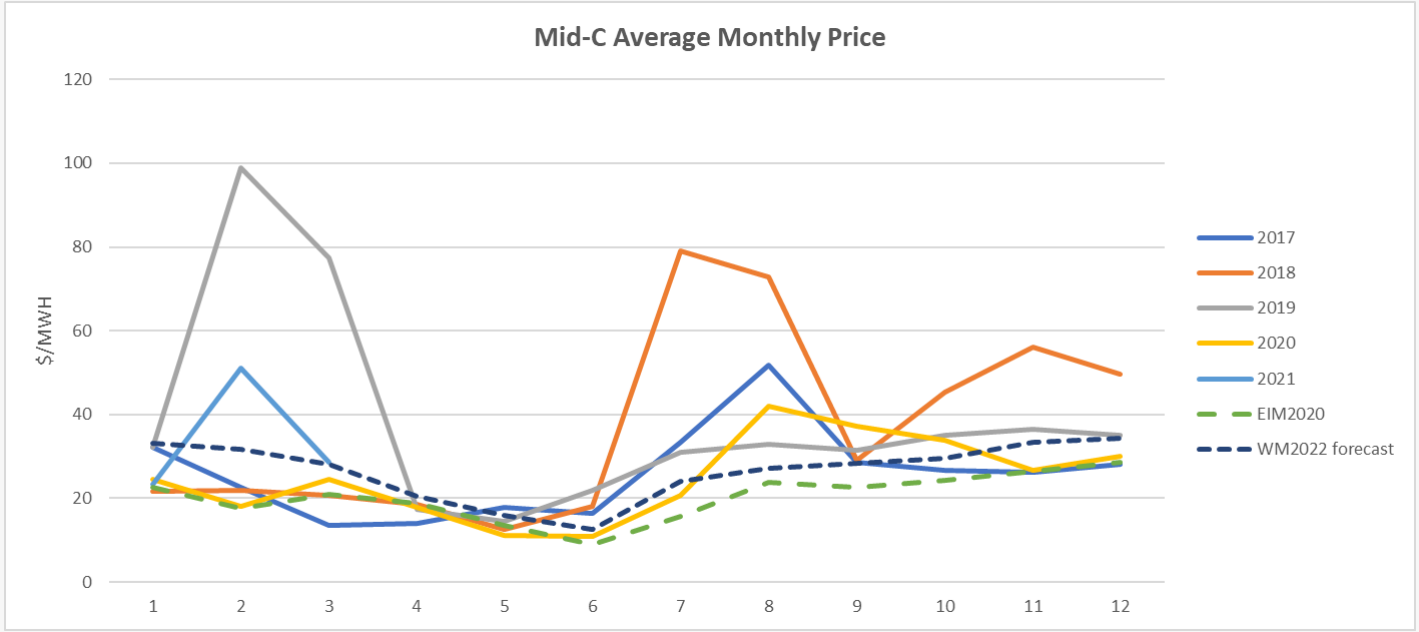
Any single future price forecast is wrong - our goal is to model a set of futures that capture a reasonable range of outcomes

RT 21-3 Questions:

- *What are the hourly fluctuations? Do prices capture abundance or scarcity?*
  - ➉ Yes, prices capture abundance and scarcity in seasonal prices. However, real world fluctuations might be underestimated. We modeled a new future to address such risk (see “List of simulated futures” slides)
- *What is the difference between IRP prices and operational prices?*
  - ➉ IRP prices are driven by "normal" assumptions, are the results of a balanced system, and benefit from good forecast of load net wind. They resemble EIM prices, representative of hour-of dispatch cost
  - ➉ Operational prices do not have any of the above and depend also on when we lock prices for future procurement

Actual vs. Simulated Prices

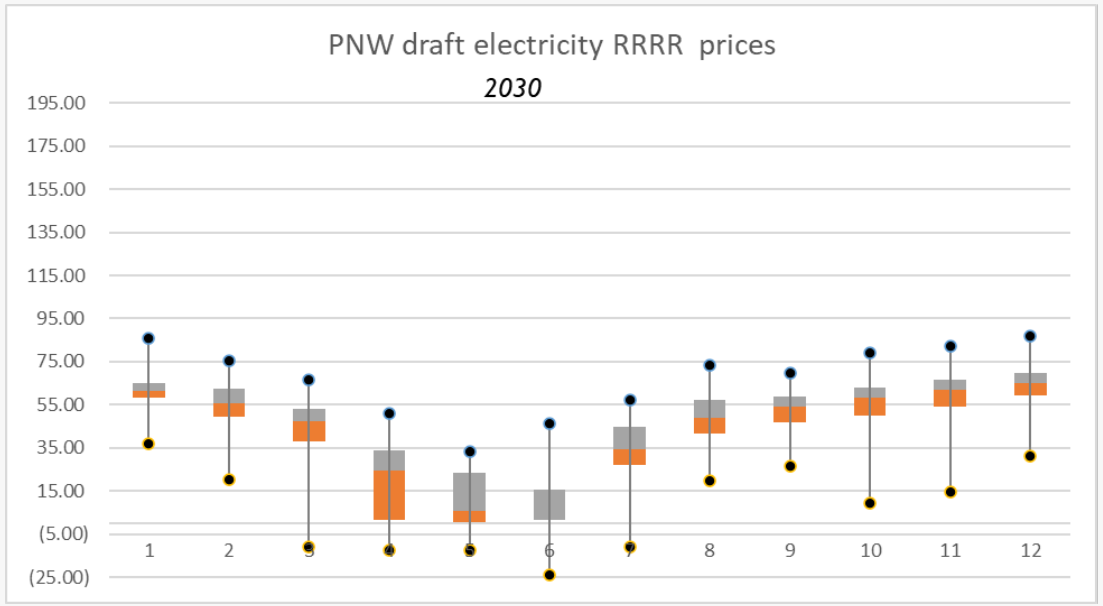
- Actual recorded transactions are plotted as solid lines
- EIM prices are the green dotted line
- Wood Mackenzie calibrated Aurora to EIM prices
- The resulting Wood Mackenzie prices are the dotted dark blue line for 2022

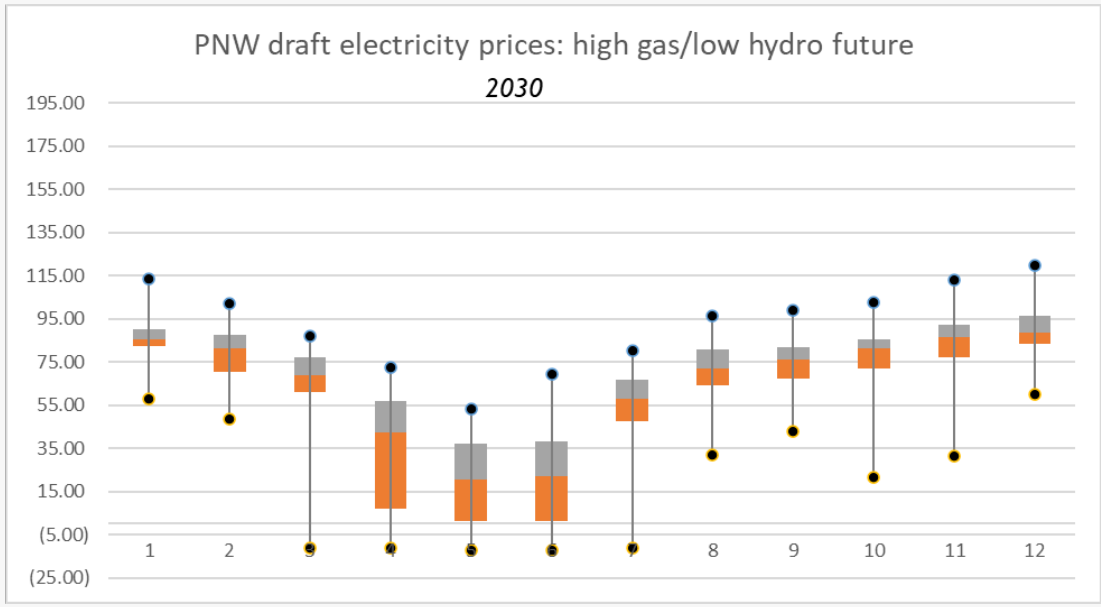


Source: ICE, on https://www.eia.gov/electricity/wholesale/#history

Price Range by Year & Month: 2030 Draft

Simulated prices: refence vs. low hydro/high gas future
Resource abundance in spring leads to a collapse in price (in both futures)
Resource scarcity is triggered in our model mostly in winter, when prices peak

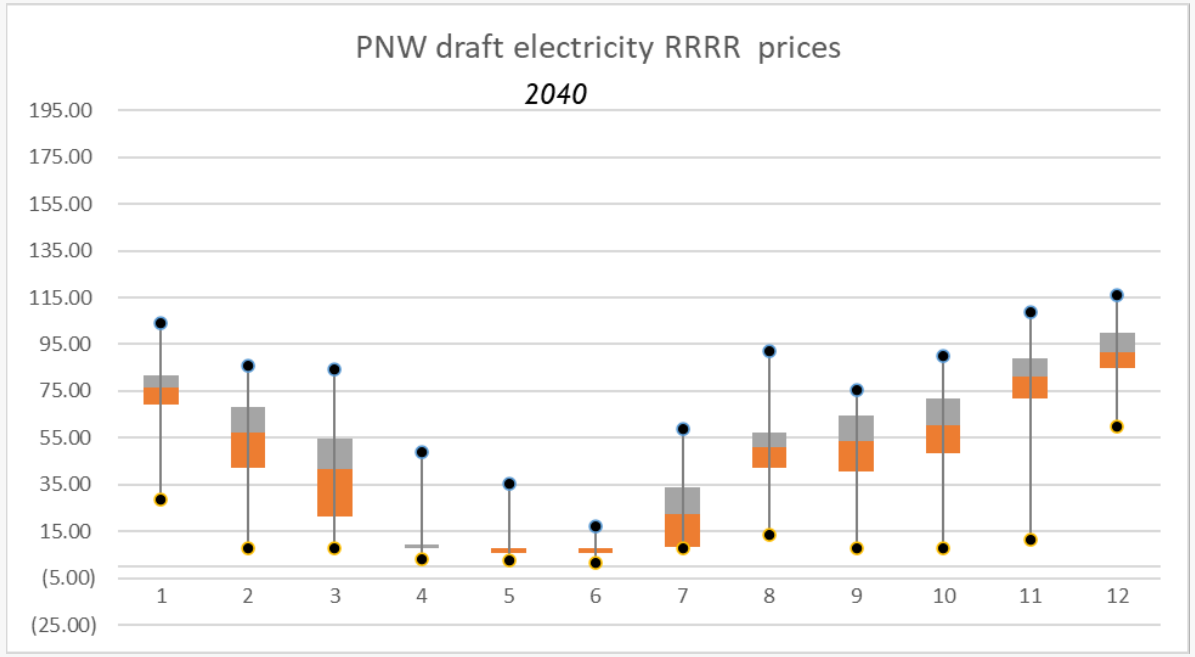


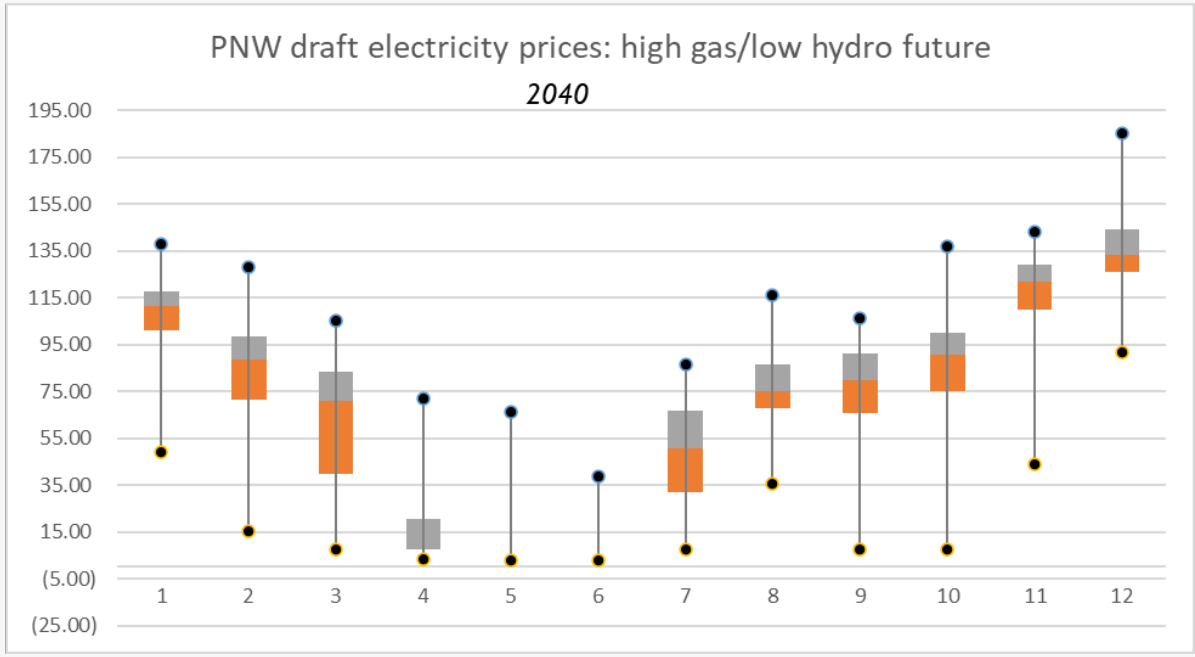


Price Range by Year & Month: 2040 Draft

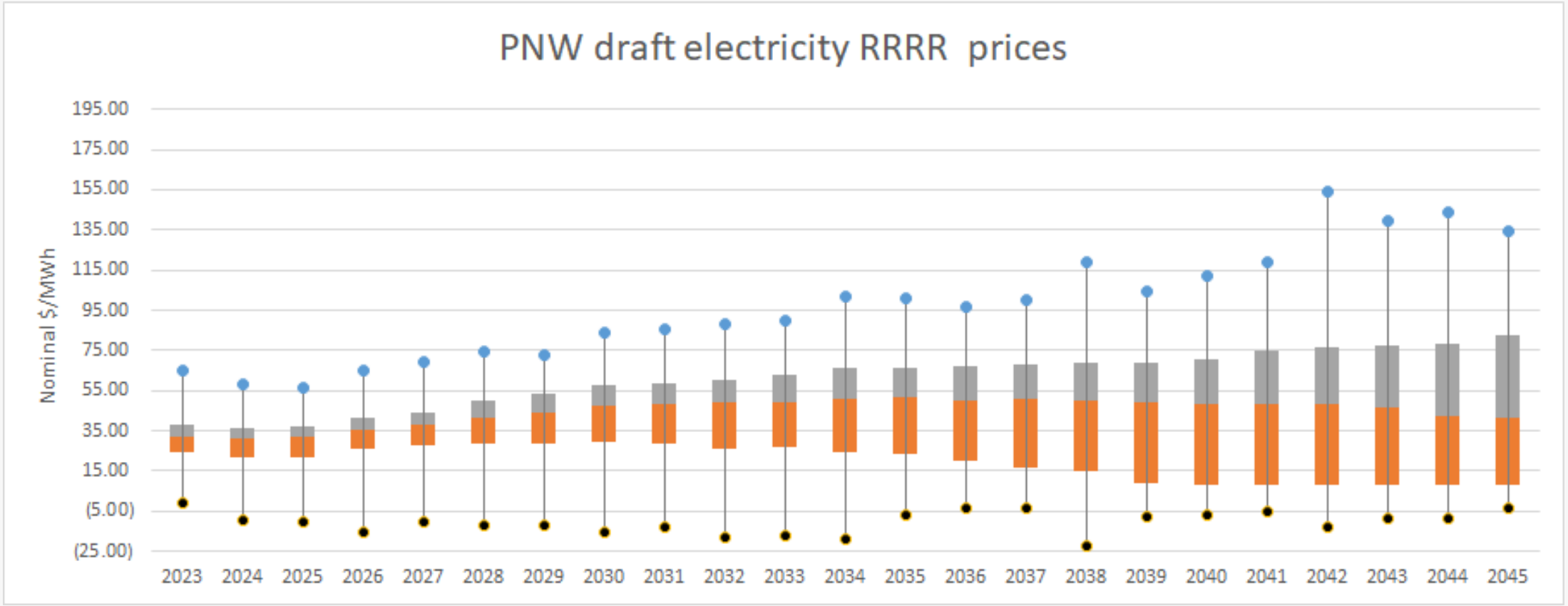
2040 simulated prices: refence vs. low hydro/high gas future

Wind/solar/storage in 2040 are expected to have less fossil fuel capacity than in 2030. This will increase price levels in 2040.



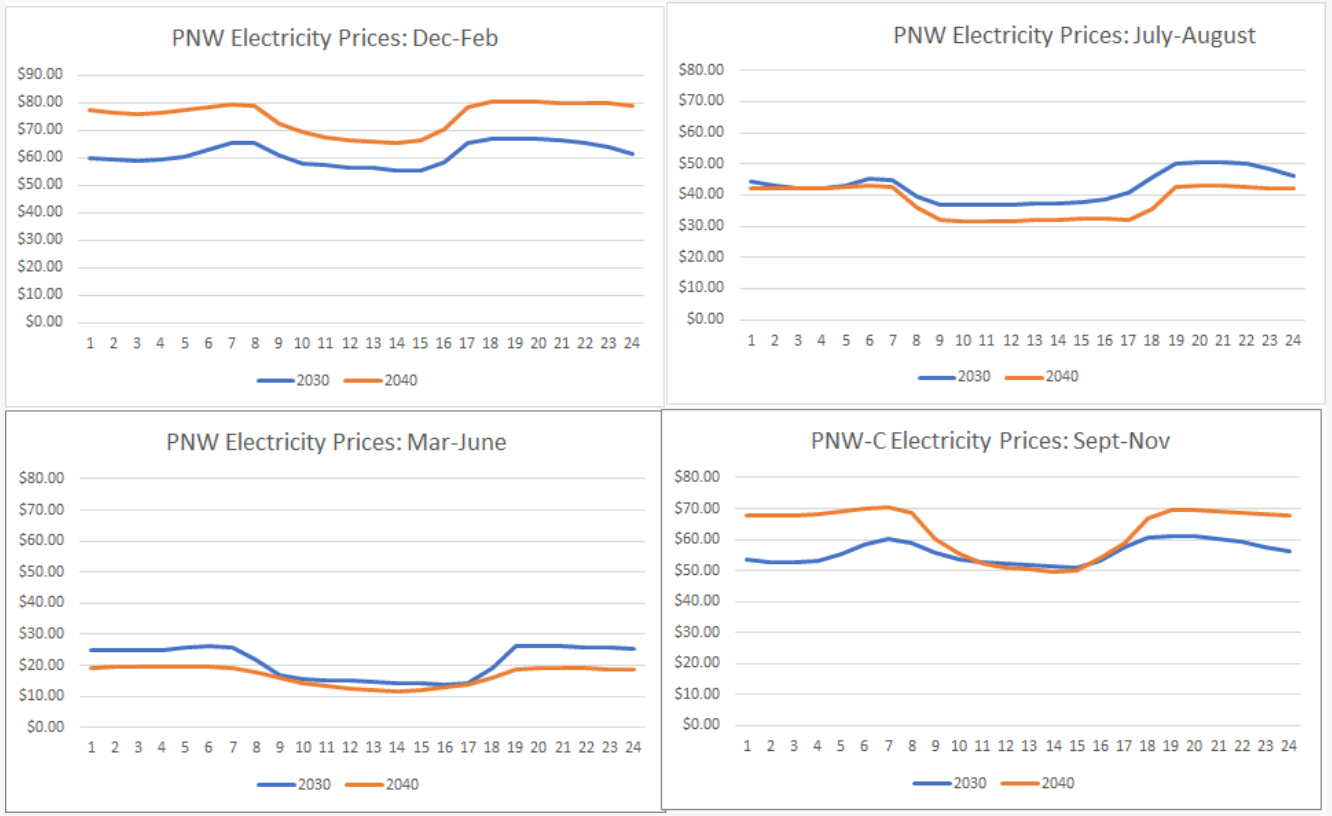


Reference Draft Prices:
Hourly Price Range: 2023-2045



Reference Draft Prices: typical day per season

- The new model surprised us with a projection of winter prices being increasingly higher than summer prices
- Wood Mackenzie's price drivers are: solar generation, wind seasonality, electric vehicles demand, load seasonality in PNW, net load becoming higher in winter in the rest of WECC



List of simulated futures: a) combo of gas/hydro/carbon

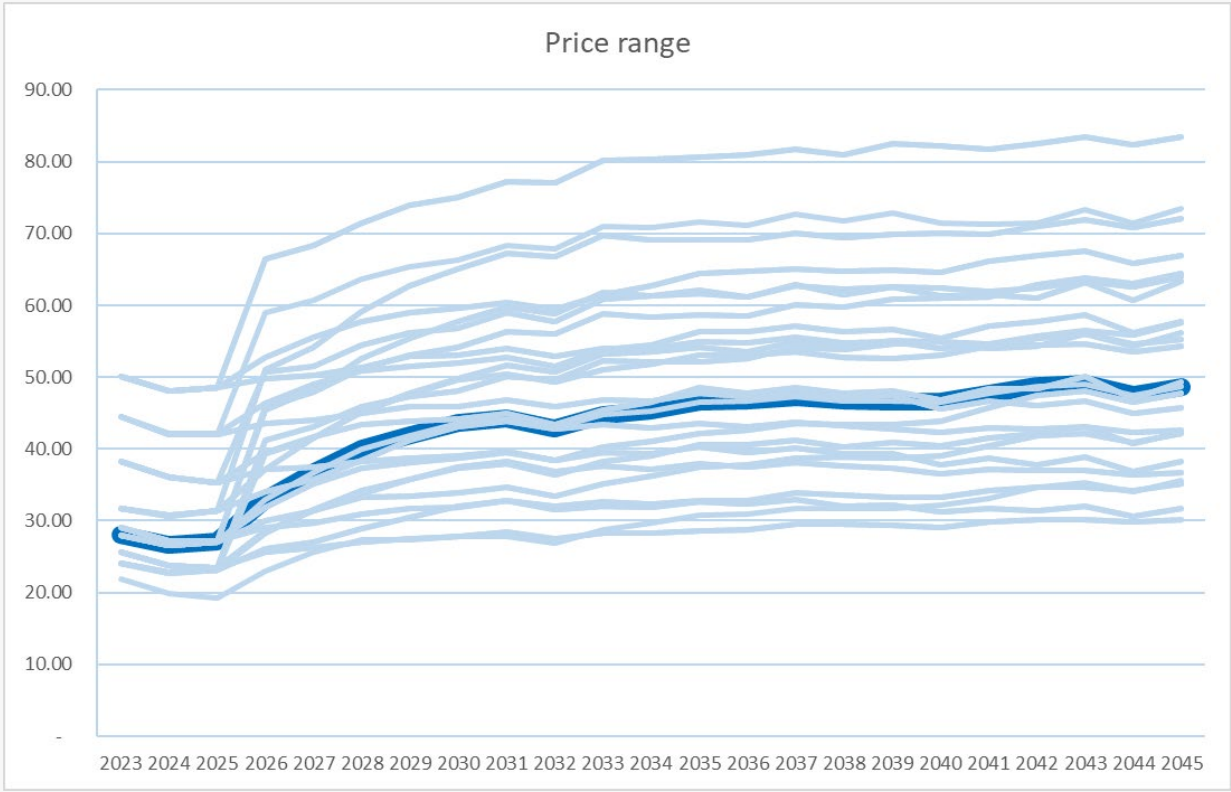
PGE continues to identify:

- gas prices,
- carbon goals/policy, and
- hydro conditions

as risk factors for which we generate electricity price futures

The combination of these variables is used to generate 27 price futures, whose annual average level is reported in the graph

This methodology is locked

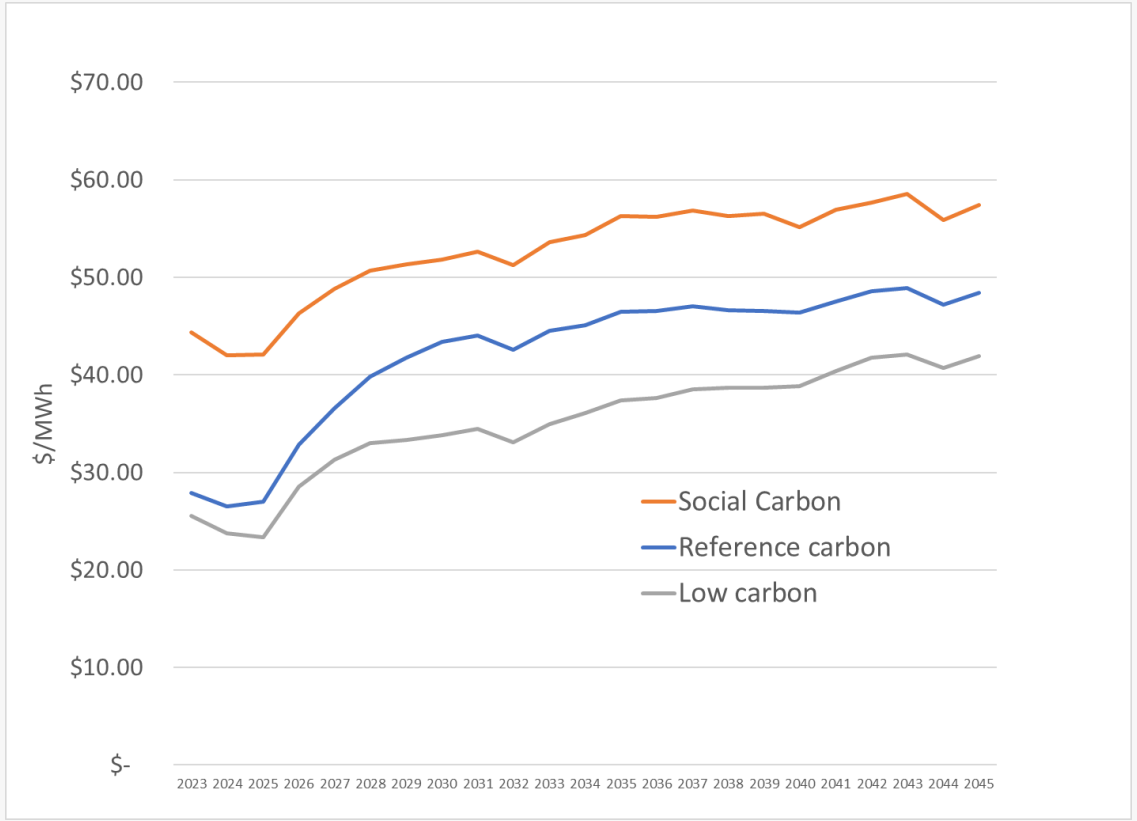


List of simulated futures: b) Impact of Carbon Adders

Since our meeting in May, we adopted the social cost of carbon as our “high" carbon case

The graph shows the impact of carbon adder cost on prices, with reference gas and hydro inputs

Draft PNW price forecasts



List of simulated futures: c) Gas prices

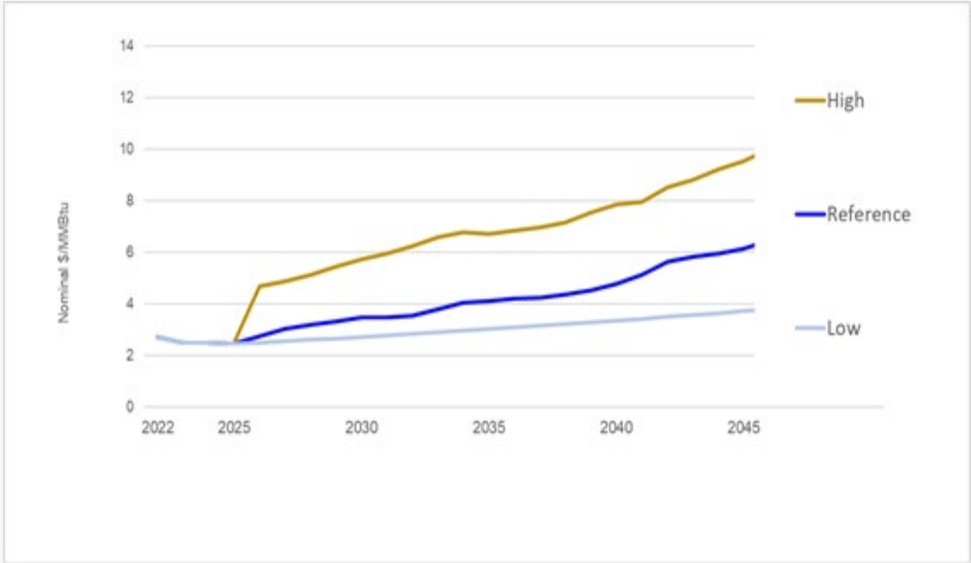
Since last meeting in May, gas prices increased world-wide

- Our trading reflected this increase
- 2021H1 forecast from Wood Mackenzie did not. It is like what was showed in RT 3-21
- If 2021H2 forecast shows a materially different trend, we'll update prices accordingly before our final simulations

For our final simulation we suggest minor methodology changes to:

- High gas: use EIA starting in 2022
- Low gas: use estimate of minimum instead of trading curve
- The plan is to lock methodology by year-end

Draft Sumas hub gas price forecasts

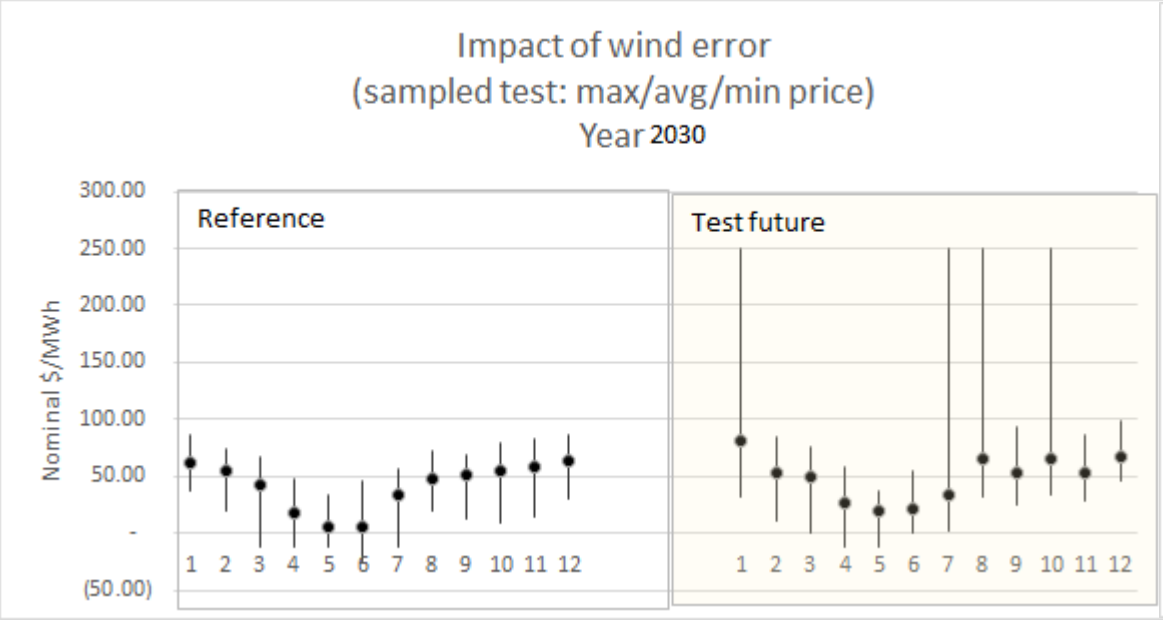


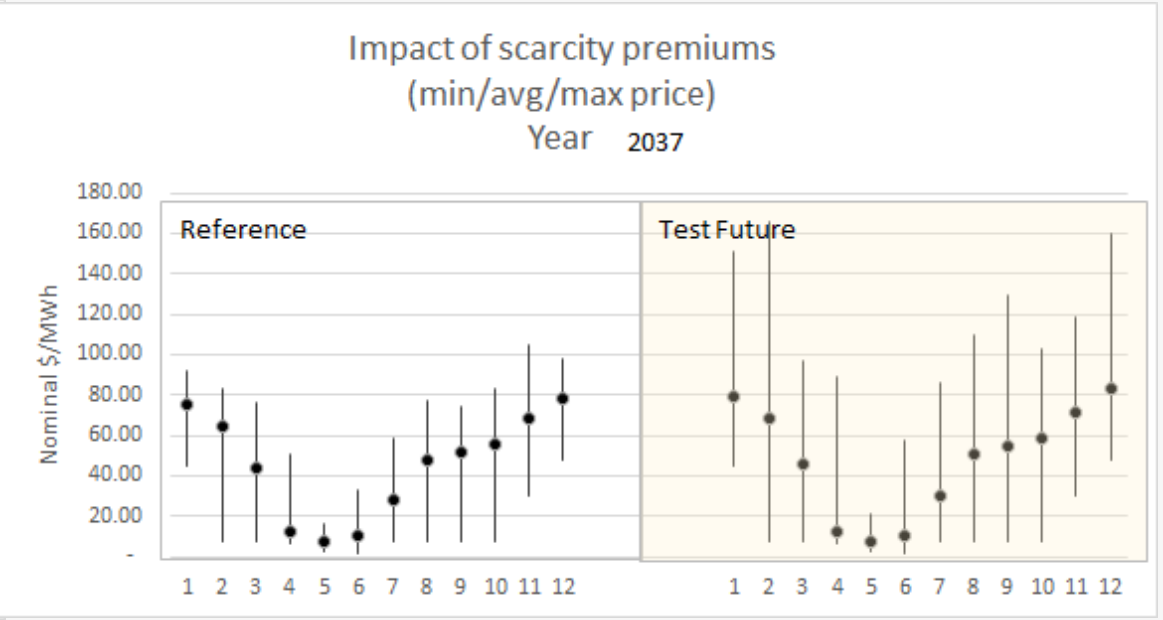
These charts were obtained from the North America Power & Renewables Service &Tool – WECC, a product of Wood Mackenzie.

List of simulated futures
d) New futures proposal

Risk driver	How we proxy it
Uncertainty	Wind availability: Aurora has perfect foresight for net load. Adding some error in hour ahead wind generation. See appendix for more information. 2 futures: reference and high cost 1. Wind error + ref gas + ref hydro + ref carbon 2. Wind error + high gas + Low hydro + ref carbon
Scarcity	1. Scarcity premiums affecting prices. No easy way of doing this. Proxied it with adding start-up costs to on-peak hours Future: Start-up cost + ref gas + ref hydro + ref carbon 2. Postpone resource additions. Not simulated. It would address the concern of aggressive additions but impact on modeled retirements of such a delay is unpredictable. Also, we typically do not model unbalanced systems 3. No wind + low hydro future Not simulated. It happens but modeling long-term ongoing combo of no wind + low hydro is catastrophic
Carbon	Modeled 1 future where no other State other than CA , BC, AB implements a carbon cap and trade

List of simulated futures:
e) Hourly view of the new proposed futures





Volatility is highly impacted by net load uncertainty while average prices are not

On-peak imposed start-up adders do modify hourly price behavior but, again, not overall averages and trends

List of simulated futures: f) comparison to 2019 IRP

2019 IRP	next IRP
Three gas futures: Ref., Low, High	Keep methodology to be locked after this RT
Three carbon price futures: Ref., Low, High	Modify high carbon to social. Keep 3 cases – locked methodology
Three hydro futures: Ref., Low (-10%), High (+10%)	Keep Locked methodology
2 WECC build-out: Ref. ; high VER	No, will not be simulated High VER is our reference
	2 VER uncertainty 1 scarcity premiums 1 carbon regulation WECC Open to proposals before locking in 1Q2022
Total of 54 futures	Total of 27+ 4 = 31

SUPPLY-SIDE OPTIONS

Robert Brown

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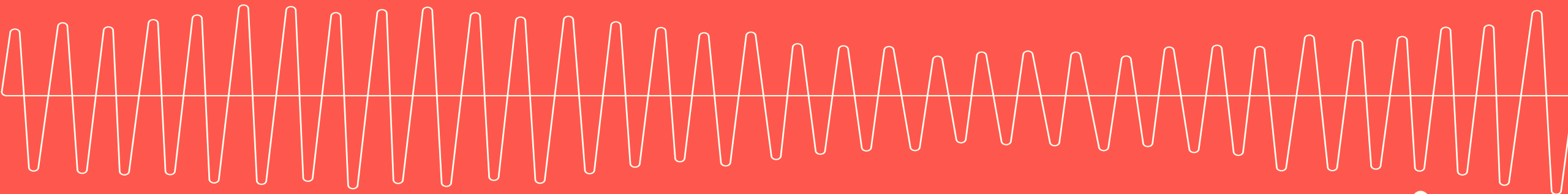


Supply-Side Options

Resource needs arise due to several factors (e.g., load growth, contract expirations, retirements, and regulatory compliance)

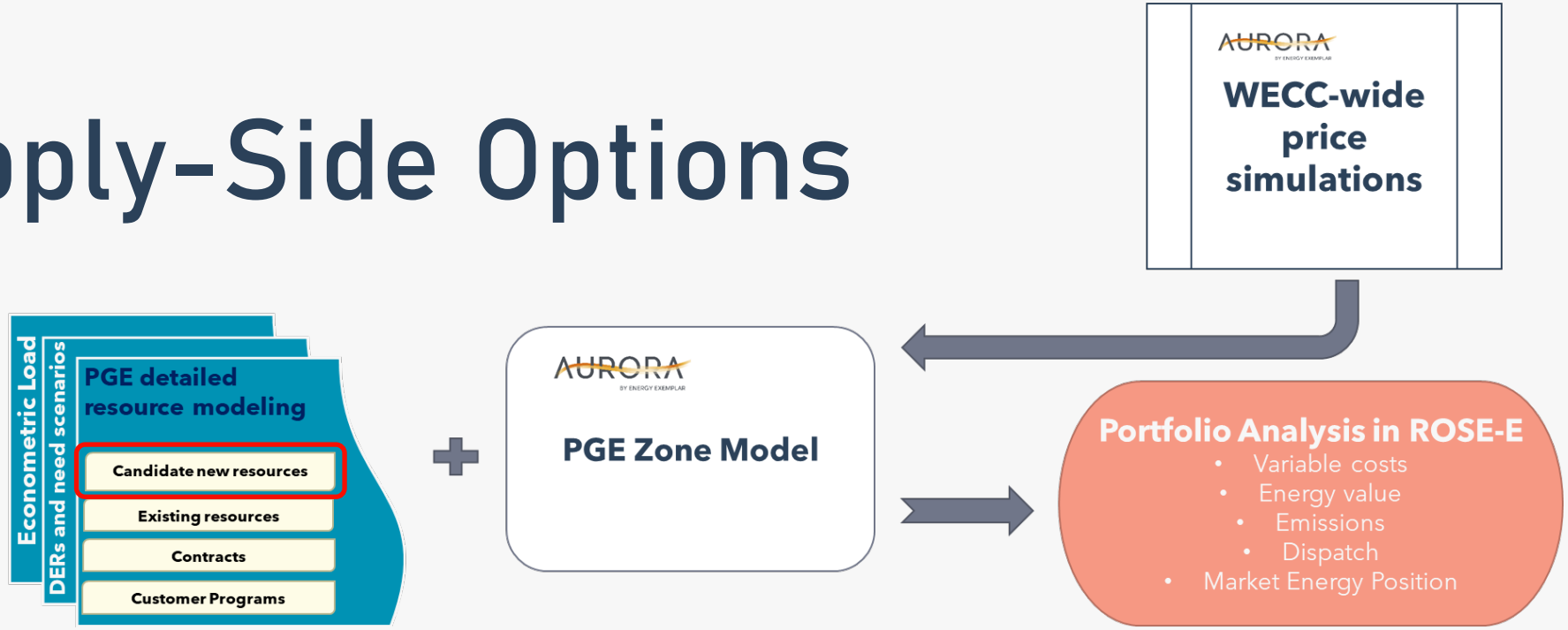
We consider a variety of resource options to meet future needs

- *Distributed Resources*
  - Typically located at or close to the customer site
  - Energy efficiency, flexible load and demand response, rooftop solar, customer storage
  - Currently estimated through our DER and flexible load study (discussed at roundtable 21-6)
- *Supply-Side Options*
  - Typically larger in size and interconnected at higher voltages to utilize T&D infrastructure

This presentation will focus on the selection of supply-side options in the next IRP

PGE provided coverage of supply-side options in Roundtable 21-1
PGE's IRP analytical process was reviewed in Roundtable 21-2
The role of technology cost uncertainty was presented in Roundtable 21-4

Supply-Side Options



Goal: use publicly-available sources of candidate new supply-side resource option cost and operating characteristics to inform portfolio analysis.

PGE provided coverage of supply-side options in Roundtable 21-1

PGE's IRP analytical process was reviewed in Roundtable 21-2

The role of technology cost uncertainty was presented in Roundtable 21-4

Supply-Side Options

Gather all **possible** generation technology

(*e.g., high-altitude wind, thorium*)

Economic Analysis:

Evaluate characteristics of resources **plausibly** found in the region

(*e.g., biomass, conventional geothermal*)

Emerging Technologies:

Highlight technologies that might have future **potential**

(*e.g., hydrokinetic, advanced geothermal*)

Portfolio Analysis:

Conduct portfolio optimization on the set of resources **most informative** to our evaluation

(*e.g., SE WA Wind, Solar + Storage*)

Only focused today on this category of potential options

Supply-Side Options for Portfolio Analysis

Wind – Onshore	Oregon Gorge, SE Washington, Montana
Wind – Offshore	Southern Oregon
Solar	Central Oregon, Oregon Gorge, Willamette Valley [1.3 ILR]
Battery Storage	Lithium Ion [2, 4, 8, 16, 24-hour]
Hybrid	Solar + Battery Storage [DC-coupled, 1.3 ILR, 4-hour, 1:2]
Pumped Storage	Pumped Storage Hydropower
Geothermal	Hydrothermal
Hydrogen	Fuel Cell, Co-fire

QUESTIONS/ DISCUSSION?

PORTFOLIO REQUESTS FROM PARTICIPANTS

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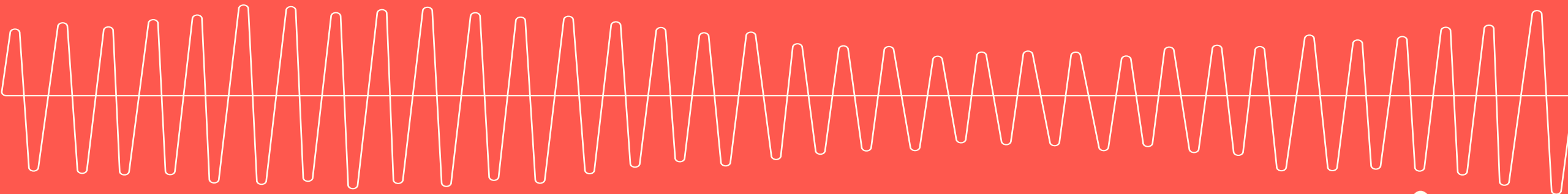

PGE

PORTFOLIO REQUESTS

- Our portfolio optimization model ROSE-E has flexibility to evaluate any specific resource/size/year combination
  - For example, we could estimate the portfolio effects of adding 235 MW of SE Washington wind in 2036 and/or 150 MW of 6-hr batteries in 2026
  - In the 2019 IRP, we used this capability to evaluate the size and timing of 16 different renewable additions MW/year combinations

- We are open to any suggestions for portfolio questions to be evaluated
  - Please contact us (email: IRP@PGN.com)

PORTFOLIO REQUESTS

List of received requests

- A portfolio with Montana Wind and Montana Pumped Storage Hydro sharing PGE's Colstrip transmission rights. The resource mix would be roughly 300 MW of wind and 100 or 150 MW of PSH sharing roughly 300 MW of transmission rights.
- 300 MW of Montana wind using PGE's repurposed Colstrip transmission.
- Portfolio #1 - 100 MW of MT pumped storage hydro sharing repurposed Colstrip transmission with 300 MW of MT wind.
- "Clean Flex Portfolio" which considers only a mix of renewables, hybrids (solar/wind paired with 2, 4 and 6-hour batteries), standalone battery storage (2, 4 and 6-hour Li-ion BESS) and pumped hydro storage (8 to 12 hours) in addition to available demand response and energy efficiency programs. No new natural gas power plants should be allowed to be built in this portfolio.

1. Maximize renewable and hybrid additions in the near-term (@025) to tap into the ITC and PTC extensions.
2. Select at least 400 MW of standalone battery storage resources by 2028 (2, 4 and 6-hour durations)
3. Select at least 250 MW of Pumped-Hydro (Swan Lake) starting 2026 or 2027.
4. No addition of new natural gas/biofueled power plants.

PORTFOLIO REQUESTS

List of received requests

- Portfolio #2 - Additional MT wind above 300 MW. The Montana Renewables Development Action Plan (2018) identified transmission upgrades on the Colstrip and BPA transmission systems that could move additional renewable resources from eastern or central Montana to Mid-C. Although these upgrades are more expensive than existing transmission, they may be cost effective given the competitive advantages of Montana wind.
- Do not consider biomass or biofuel-based power plants as "non-emitting" (although it may be renewable).
- In response to PGE's request for feedback on the types of resource portfolios we would like to see evaluated in this IRP cycle, we encourage the utility to evaluate additional portfolios that assess potentially limited availability of hydropower within PGE's resource mix. First, we urge PGE to evaluate a 100% renewable resource portfolio that excludes legacy hydropower by 2040. Second, we urge PGE to evaluate a 100% renewable resource portfolio that reduces available hydropower by 50% by 2040. Modeling these resource portfolios through ROSE-E will help PGE and stakeholders identify potential constraints and impacts from possible reductions in hydropower availability as the utility decarbonizes its resource mix. These portfolio analyses will also help PGE evaluate uncertainties that may arise during the IRP period, including the potential for increased environmental and operational constraints on the Northwest hydropower system, the possible removal of dams, and/or greater hydropower variation resulting from unpredictable climate conditions.

PORTFOLIO REQUESTS

List of received requests

- Portfolios that meet emissions reductions required by HB 2021
  - ❿ Two portfolios that meet the emissions reductions required by HB 2021
    One in which 50% of new renewables are built in the state of Oregon
    One in which there is no in-state new renewables requirement
  - ❿ One portfolio in which 75% of new renewables are built in Oregon
    75% MWh solar, 25% MWh wind
- Portfolios that meet President Biden's national proposal for 50-52% GHG reduction (from 2005 levels) by 2030 and a carbon-pollution free power sector by 2035

NEXT STEPS

A recording from today's webinar will be available in one week

Upcoming Roundtables:

December 15, 2021

THANK YOU

CONTACT US AT:
IRP@PGN.COM

Appendix – List of simulated futures
d2) New futures, modeling info

Risk driver	How we did it
Uncertainty: Wind error	This future(s) are used as proxy for load net wind uncertainty. Input different wind generation in Aurora for commitment and dispatch. Using approximately +/-15% availability delta for commitment vs. actual. Applied randomly to each day/hour of the month. All months have the same random hour ahead vs. actual delta. As preliminary tests lead to occasional severe price increases, we capped max price to $250/MWh
Scarcity: start up cost	Consulted with WM. They do add scarcity premiums on-peak to Aurora simulated prices. Overall, this post-processing does not change average monthly prices significantly. Volatility is instead increased. Used Aurora feature: Price Uplift. This feature post-processes prices by adding start up costs to simulated prices. Modeler can choose when to add them: all months, all hours, etc.
Carbon	Modeled 1 future where no other State other than CA , BC, AB implements a carbon cap and trade