



2019 Integrated Resource Plan (IRP) Public Input Meeting March 21, 2019



Agenda



- 9:00am-11:30am pacific – Coal Study Modeling Improvements and Updates
- 11:30am-12:15pm pacific – Lunch Break
- 12:15pm-1:30pm pacific – Modeling Next Steps
- 1:30pm-1:50pm pacific – Stakeholder Feedback Form Recap
- 1:50pm-2:00pm pacific – Wrap-Up/Next Steps



Coal Study Modeling Improvements and Updates





Progress Update

- As previously discussed, the coal unit analysis will inform PacifiCorp's long-term resource decisions, but does not on its own determine how long specific coal units will stay in service.
 - Early retirement cases must meet reliability requirements—preliminary studies reviewed at the December 3-4 public-input meeting showed that early retirement cases failed to meet system reliability requirements.
 - Once reliability requirements are met, additional analysis will further consider Regional Haze compliance options and implementation alternatives.
- At the January 24, 2019 public-input meeting, PacifiCorp provided a status update on its ongoing efforts to address the operating-reserve shortfalls observed in preliminary results presented in December 2018. In January 2019, PacifiCorp discussed its status in developing and testing the following modeling enhancements:
 - Enabling renewable resources to hold regulation reserves.
 - Establishing a consistent monthly hydro dispatch configuration from February through May to increase reserve-carrying capability rather than shaping generation to load.
 - Allowing front-office transactions up to firm transmission rights during spring and fall (up to 2,227 MW instead of 1,425 MW, which continues to be applied in other months).
 - PacifiCorp has developed the necessary tools to incorporate these enhancements discussed in January into its modeling process.

Progress Update (Continued)



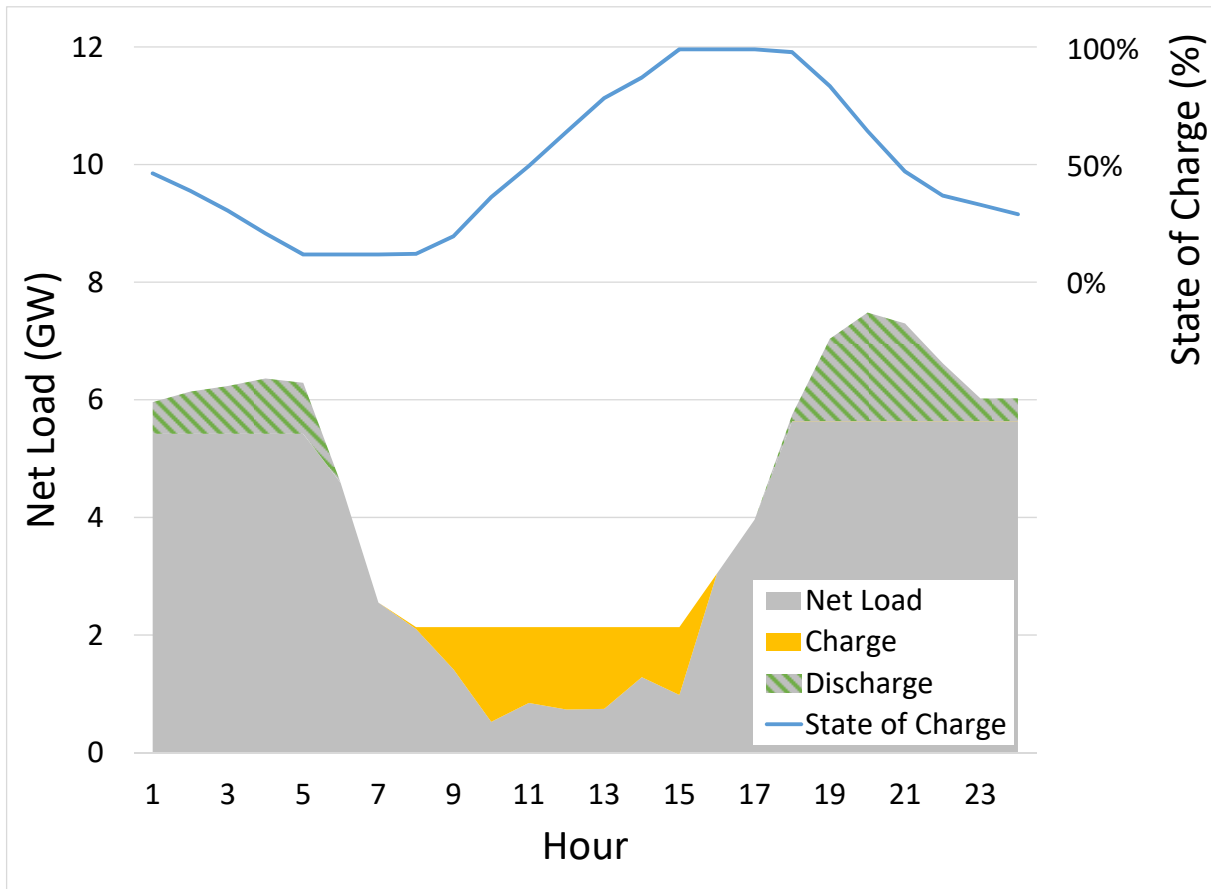
- PacifiCorp has continued to evaluate hourly reliability results in its testing, and based on this review, has identified additional modeling enhancements that improve its use of new and existing resources to mitigate capacity shortfalls:
 - Planning and Risk model (PaR) settings for the Lewis River Hydro project.
 - Improved optimization of new battery storage resources.
- PacifiCorp has also made progress in evaluating potential drivers behind differences in reserve deficiencies among different resource portfolios, where present-value costs were relatively minor in the System Optimizer (SO) model, but disproportionately impactful when analyzed in stochastic PaR studies.
 - Testing has confirmed that changes to the SO model inputs can be implemented to help mitigate this type of finding.
- Based on the ongoing testing and development of tools to implement these modeling enhancements, PacifiCorp now has a path forward to provide updated analyses of stacked coal-retirement cases to reflect potential incremental costs to remedy the capacity shortfalls originally identified in the December 2018 presentation materials.

Optimization of Energy-Limited Resources



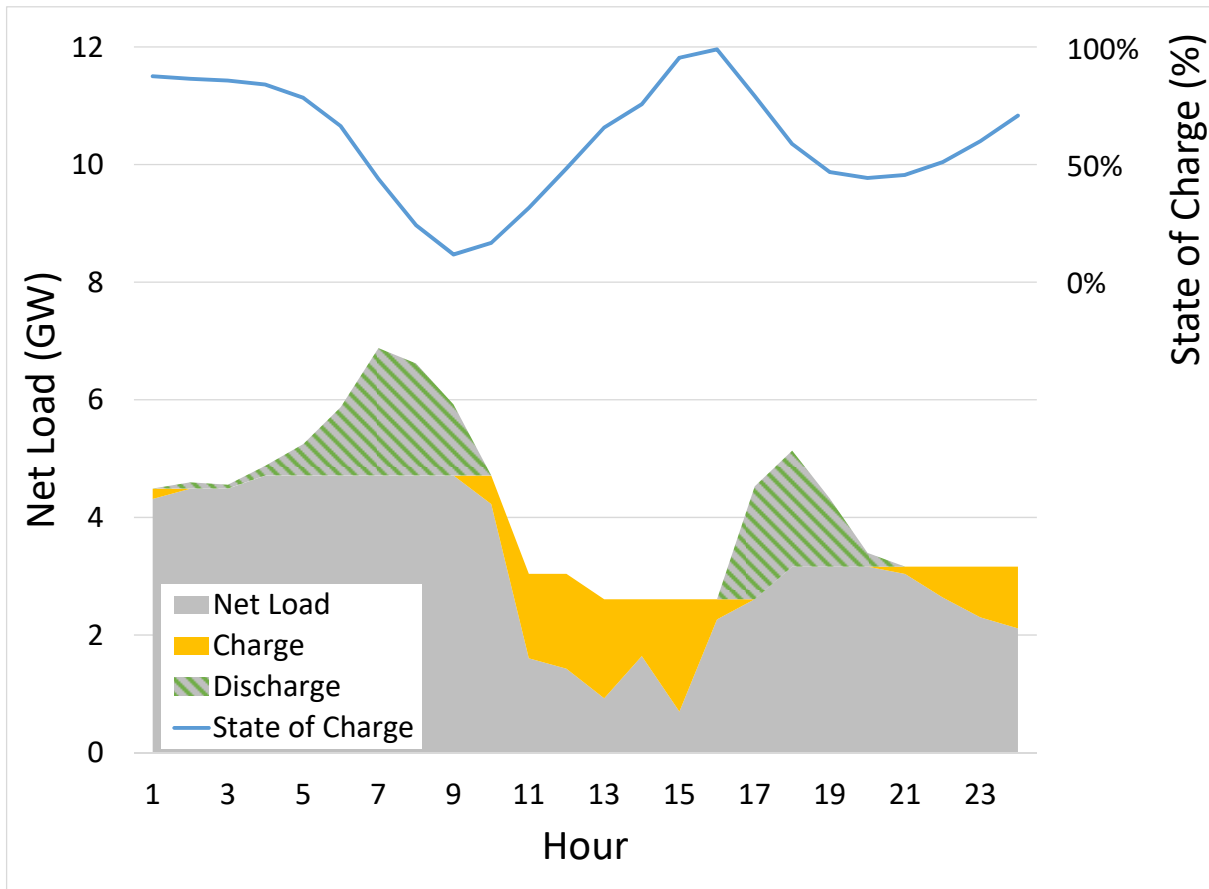
- Lewis River Hydro:
 - The original and standard model configuration led PaR to use the Lewis River Hydro project to shave peak load using available energy over a sample week for a given month—any remaining capacity was then available for use as operating reserves.
 - PacifiCorp has tested and implemented a modeling enhancement that allows PaR to shave peak load, using available energy of a sample week for a given month, net of wind, solar, battery storage (per below), and energy efficiency resources—any remaining capacity, but no less than 10 percent of the Lewis River Hydro project, is available for use as operating reserves.
- Battery resources:
 - PacifiCorp initially attempted to mimic the model settings used to enhance PaR’s use of the Lewis River Hydro project to improve its use of battery-storage resources (dispatch, charging, and reserve resources).
 - However, unlike the Lewis River Hydro project, battery-storage resources do not have an established volume of energy to use over a sample week in a given month.
 - Significant time and effort was spent to test PaR model settings for battery-storage resources, but considering the complexity of PacifiCorp’s system, the PaR optimization continued to have difficulty optimizing the dispatch for these types of resources.
 - PacifiCorp has tested and implemented an approach to produce an optimized peak-shave/valley-fill profile for these resources outside of PaR that is based on load net of wind, solar, and energy efficiency resources in any given portfolio—fixed hourly dispatch, charging, and operating reserves are entered as inputs to PaR.

Peak-Shave/Valley-Fill Energy Storage



- Sample summer day, 2038
- 2,400 MW energy storage capacity
- Dispatch calculated using constrained linear optimization
- Minimum 30 minutes of discharge held in battery to provide reserves
- Minimum storage in hour-ending 5
- Maximum storage in hour-ending 15

Peak-Shave/Valley-Fill Energy Storage



- Sample winter day, 2038
- 2,400 MW energy storage capacity
- Minimum 30 minutes of discharge held in battery to provide reserves
- Morning and evening discharge and fill
- Minimum storage in hour-ending 9
- Maximum storage in hour-ending 16

Portfolio Differences and Reserve Deficiencies

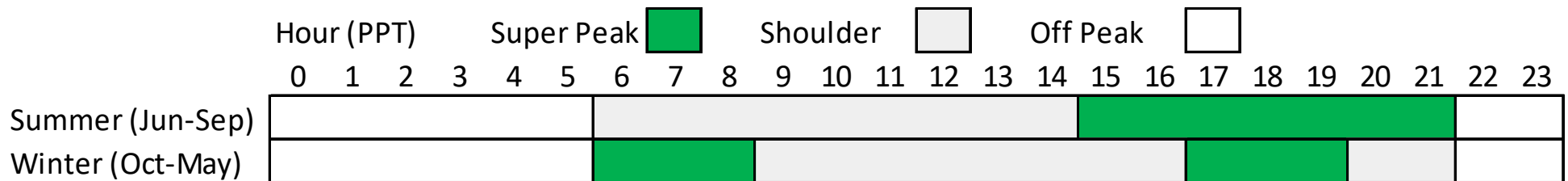


- At the January 2019 public-input meeting, PacifiCorp discussed that differences between portfolios in some cases were contributing to differences in reserve deficiencies (primarily 2038).
- These portfolio differences were causing disproportionate impacts on present-value portfolio costs in PaR relative to the SO model.
- Subsequent testing has confirmed that differences in the granularity between the two models can contribute to alternative resource selections and that these resource selections are influencing these seemingly incongruent results.
- When cost-driver adjustments based on the differences in hourly granularity between the SO model and PaR are applied to resource cost inputs used in the SO model, differences to resource portfolio results for seemingly similar cases are more stable and the cost disparity driven by reserve deficiencies are mitigated.



Cost-Driver Adjustment

- The SO model is configured to evaluate three defined periods per day: super-peak, shoulder, and off-peak.

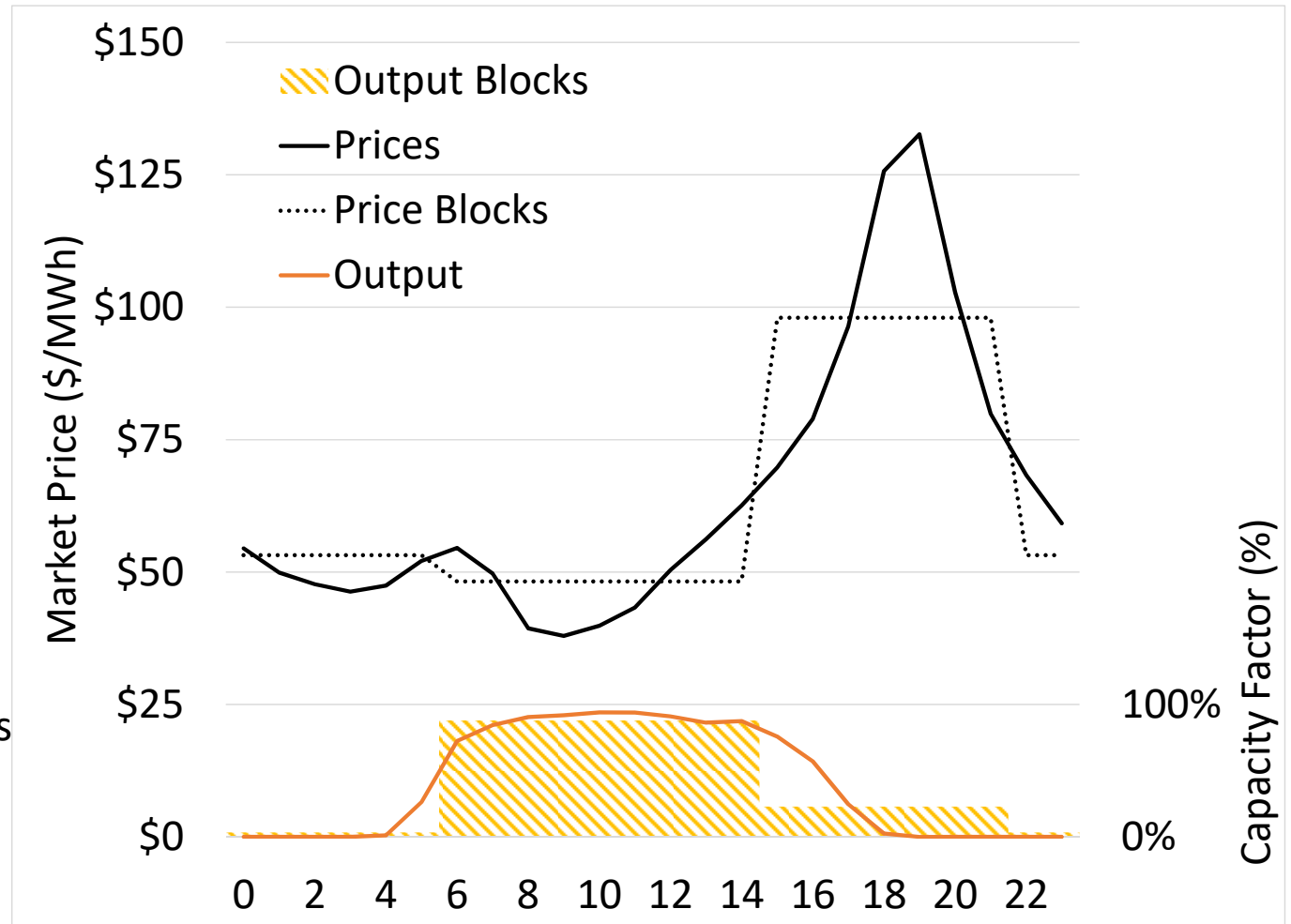


- The SO model assumes uniform/average resource availability across each block of hours within one of three time periods (super peak, shoulder, and off peak), and also uses average market prices across all hours within a given time period.
- Averaging can create a distortion of resource value when the price variation and resource within a period are positively or negatively correlated.
- An adjustment to resource costs was applied in the SO model to provide a signal to the model that accounts for variations in value it cannot see given its granularity—this is similar in concept to integration costs and the operating reserve credit.
- Because PaR is more granular, the adjustment is not applied in PaR.

Cost-Driver Adjustment (Continued)



- Solar/wind granularity cost-driver adjustment (summer 2030 solar example)
- During the highest-priced hours, solar output is zero
- But solar output does occur during the super-peak block
- The SO model sees:
block volumes times
block prices: \$57/MWh
- 24-hour volumes and
prices: \$53/MWh
- A \$4/MWh increase in
the cost of solar corrects
the SO model's
assessment of resource
value



Cost-Driver Adjustment (Continued)



- Accounting for the reduced hourly granularity in the SO model yields the average (increase)/decrease in solar and wind resource costs shown below (expressed in cost per MWh of expected output).

2019-2038, average adjustment values

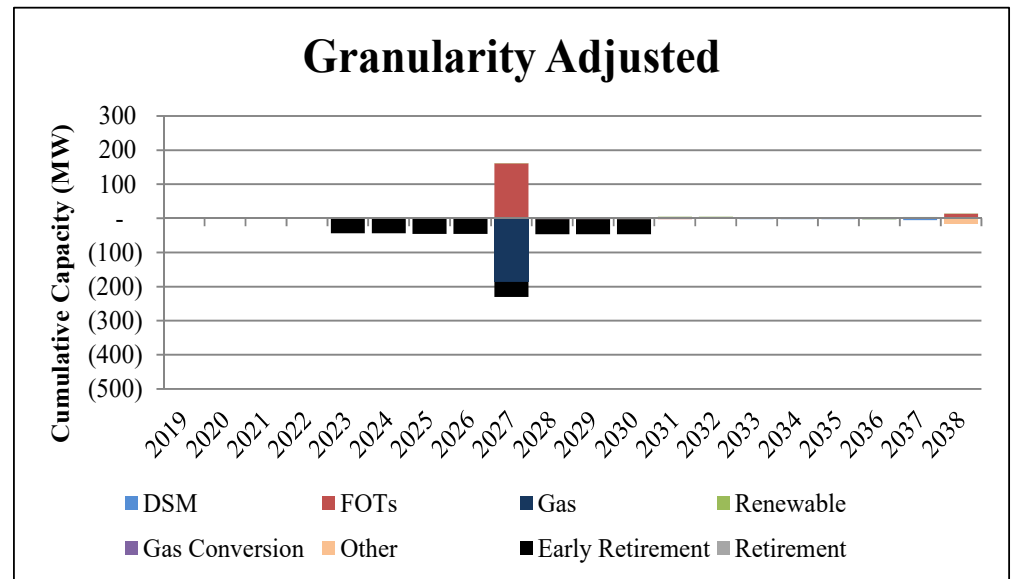
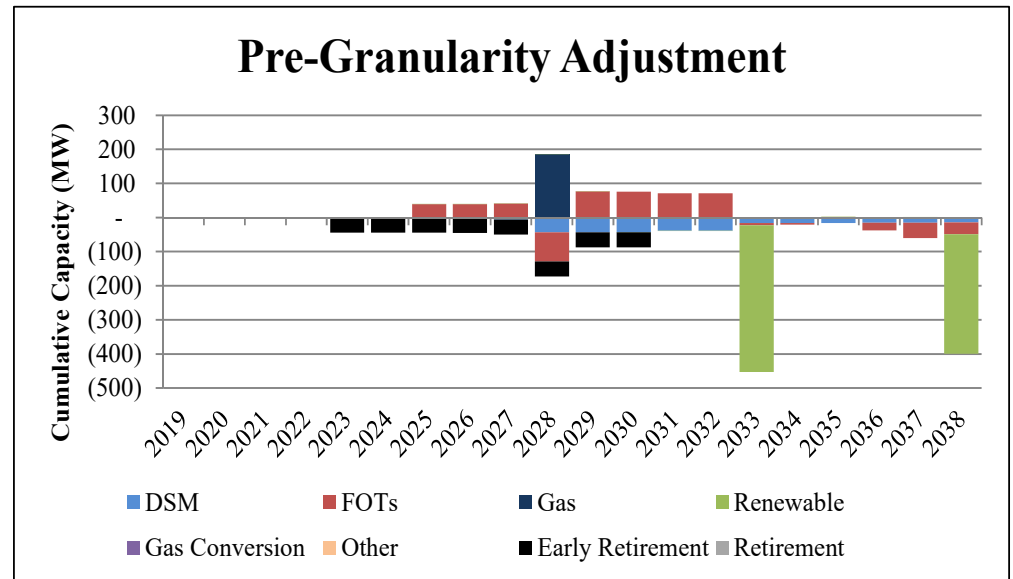
\$/MWh	Solar	Wind
OR	(7.06)	0.95
WA	(7.17)	1.05
ID	(7.28)	(0.14)
UT	(7.73)	(0.35)
WY	(7.33)	(0.90)

- Annual values are applied to proxy resources to enhance resource selection.

Implications of Cost-Driver Adjustment on SO Model Portfolio Differences



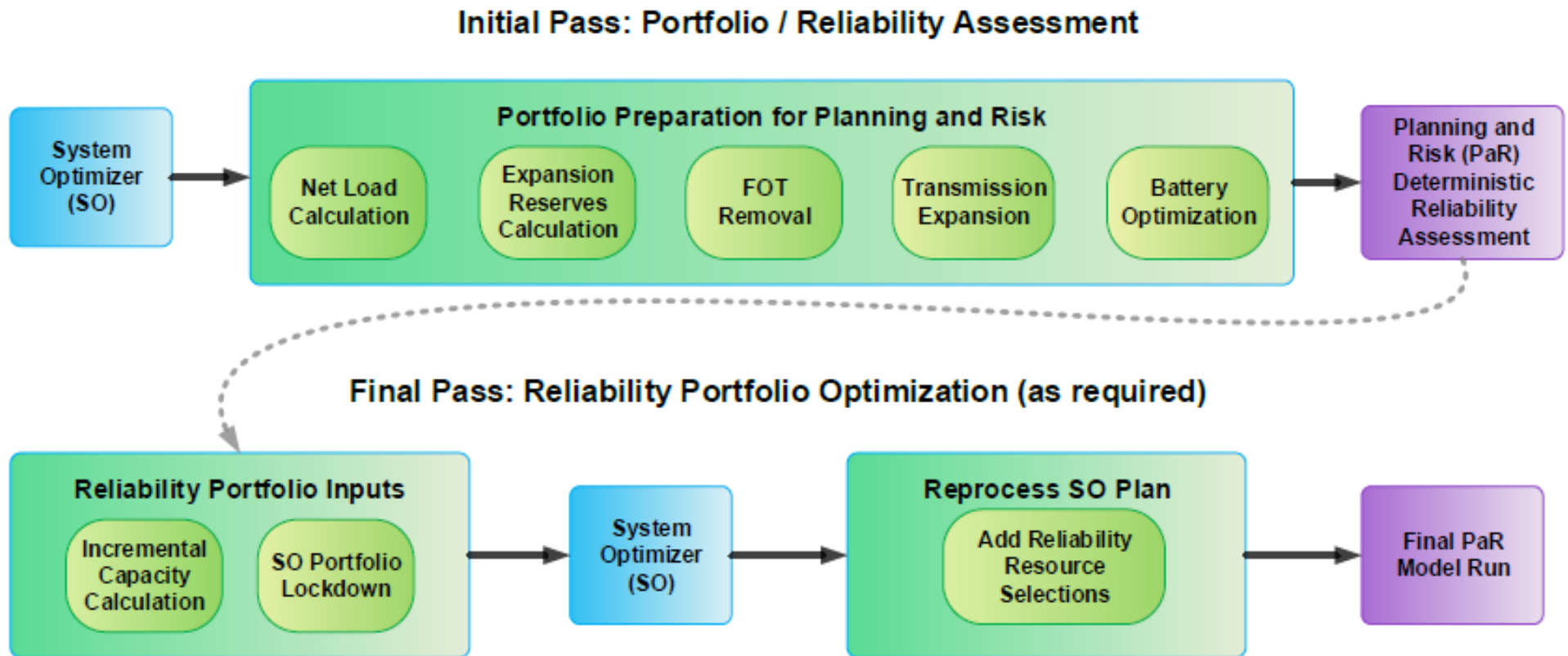
- The graphs at right show differences in the cumulative capacity of two resource portfolios (the only difference being an acceleration of an assumed Hayden 1 retirement).
- In the SO model, the difference in present-value system costs is very similar between the two cases regardless of whether the cost-driver adjustment is applied to wind and solar resource costs.
- However, in the PaR stochastic results, the case with an accelerated retirement of Hayden 1 reported deficiencies of 483 GWh, while the other case reported 247 GWh—most notable discrepancies are in 2038.
- When the cost-driver adjustment for solar and wind is applied, portfolio differences stabilize and outlier reserve deficiency costs are much less likely to drive incongruent results between the SO model and PaR.



Modeling Process to Address Reliability



- Initial pass through SO and PaR determines reliability needs.
- If required, second pass optimizes the incremental reliability portfolio and assesses final portfolio performance in PaR.

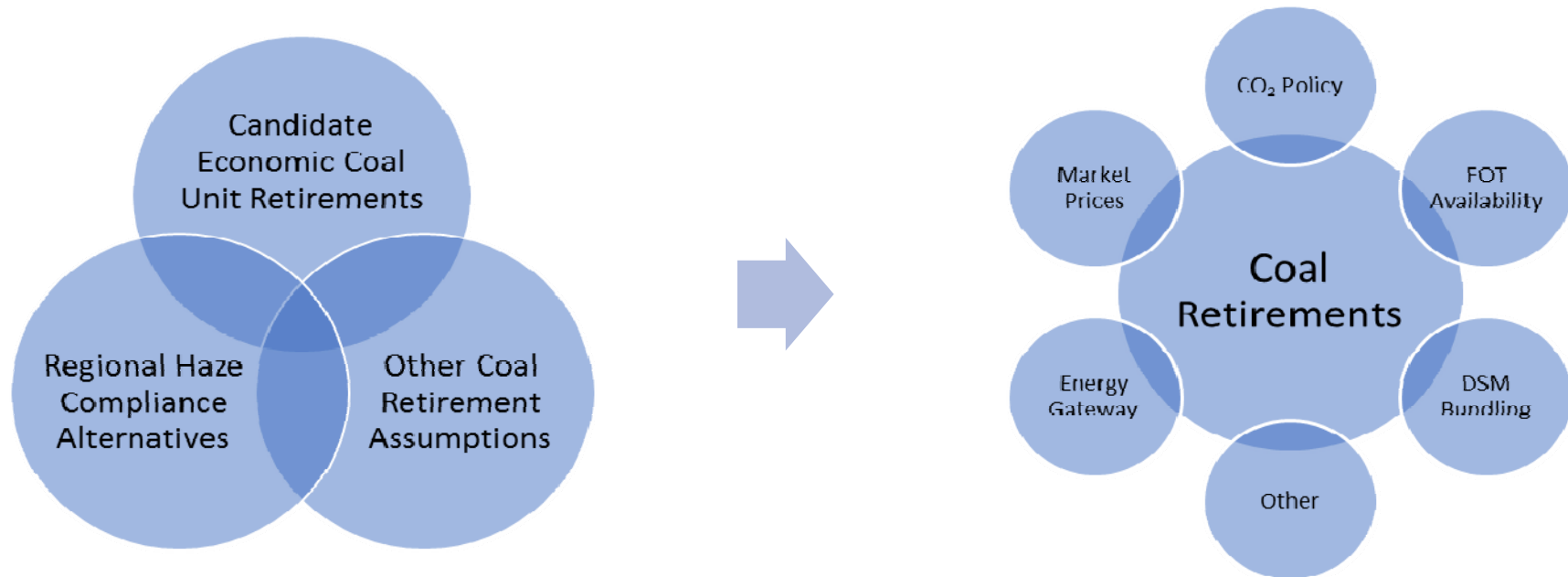




Modeling Next Steps

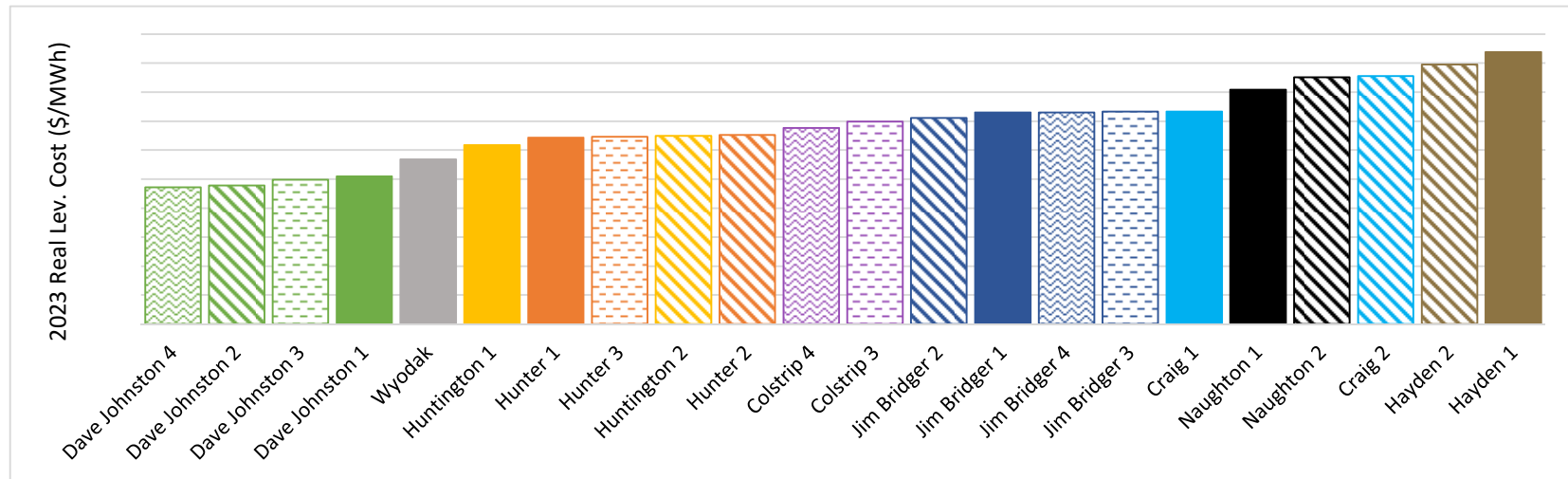


Portfolio-Development Process



- An assessment of unit-by-unit cost assumptions being used in the coal studies is generally consistent with the relative coal-unit rankings reviewed during the December 2018 public-input meeting.
- Consequently, PacifiCorp's updated coal study modeling will focus on the stacked-retirement cases initially defined in December 2018.
- Those results may trigger a need to develop additional cases (alternative combinations of units and/or timing), which can be incorporated into the 2019 IRP portfolio-development process as necessary.

Relative Forward-Looking Costs (2023-2038)



- Using model inputs for the benchmark case, real-levelized costs for each coal unit were calculated using data from the period from 2023 (the first full year after assumed retirement) through the earlier of the assumed end of life or 2038 (the last year of modeling).
 - Annual operations & maintenance
 - Forward-looking capital costs
 - Annual fuel costs
- Costs are shown on a per-MWh basis assuming an 80 percent capacity factor level—numerical values are confidential and not shown in the chart above.
- For simplicity, forward-looking capital includes are calculated as real-levelized cash rather than real-levelized revenue requirement.
- Capital does not included embedded rate base.



Stacked Study Candidate Resources

	Real Levelized Cost Rankings				
	Aggregate Rank	O&M Rank	CapEx Rank	Full Load Fuel Rank	Dec 3-4 PVRR(d) Rank
C-02 (Colstrip 3)	14	7	5	18	15
C-03 (Colstrip 4)	12	6	3	16	10
C-04 (Craig 1)	6	3	14	9	11
C-05 (Craig 2)	5	4	4	10	7
C-06 (Dave Johnston 1)	19	11	21	19	13
C-07 (Dave Johnston 2)	20	10	20	20	21
C-08 (Dave Johnston 3)	21	9	22	21	6
C-09 (Dave Johnston 4)	22	12	19	22	11
C-10 (Hayden 1)	1	1	10	1	4
C-11 (Hayden 2)	2	2	16	3	9
C-12 (Hunter 1)	11	14	12	11	19
C-13 (Hunter 2)	15	15	13	14	18
C-14 (Hunter 3)	13	18	15	12	22
C-15 (Huntington 1)	18	17	17	15	17
C-16 (Huntington 2)	16	16	18	13	14
C-17 (Jim Bridger 1)	7	20	2	6	2
C-18 (Jim Bridger 2)	9	19	1	8	5
C-19 (Jim Bridger 3)	10	21	7	7	8
C-20 (Jim Bridger 4)	8	22	11	5	20
C-21 (Naughton 1)	4	5	6	4	1
C-22 (Naughton 2)	3	8	9	2	3
C-23 (Wyodak)	17	13	8	17	16

- Real levelized cost rank analysis generally confirms prioritization of December 3-4, 2018 stacked study candidate units.
 - Naughton 1-2
 - Jim Bridger 1-2
 - Hayden 1-2
 - Craig 1-2
- Dave Johnston 3, an outlier, will continue to be included in stacked analysis at this time.
- Additional stacked candidate scenarios will be considered.

Stacked Coal Retirement Studies



Accelerated Retirements by Case

	Naughton 1	Naughton 2	Jim Bridger 1	Jim Bridger 2	Hayden 1	Hayden 2	Craig 1	Craig 2	Dave Johnston 3
C34-N1-N2	✓	✓							
C35-N1-N2-J1	✓	✓	✓						
C36-N1-J1	✓		✓						
C37-N1-J1-H1	✓		✓	✓					
C38N12-J1-H1	✓	✓	✓	✓					
C39N12J1H1C2	✓	✓	✓	✓			✓		
C40N12J12H1C2	✓	✓	✓	✓			✓		
C41-NJHCDJ3	✓	✓	✓	✓	✓	✓	✓		✓

Portfolio-Development Cases (Post Coal-Study Update)



- Additional Coal-Unit Cases
 - Naughton 3 (gas conversion alternatives)
 - Cholla 4 (retirement in 2025)
 - Jim Bridger 1 and 2 (SCR requirements)
 - Colstrip 3 and 4 (WA acknowledgement letter)
 - All coal retired by 2030
- CO₂ Prices (none, high, social cost of carbon)
- Natural Gas Prices (low, high)
- Front-office transactions (limited)
- Energy Gateway Transmission (various)
- Energy Efficiency (alternative bundling)
- Other/TBD

Transmission Cases



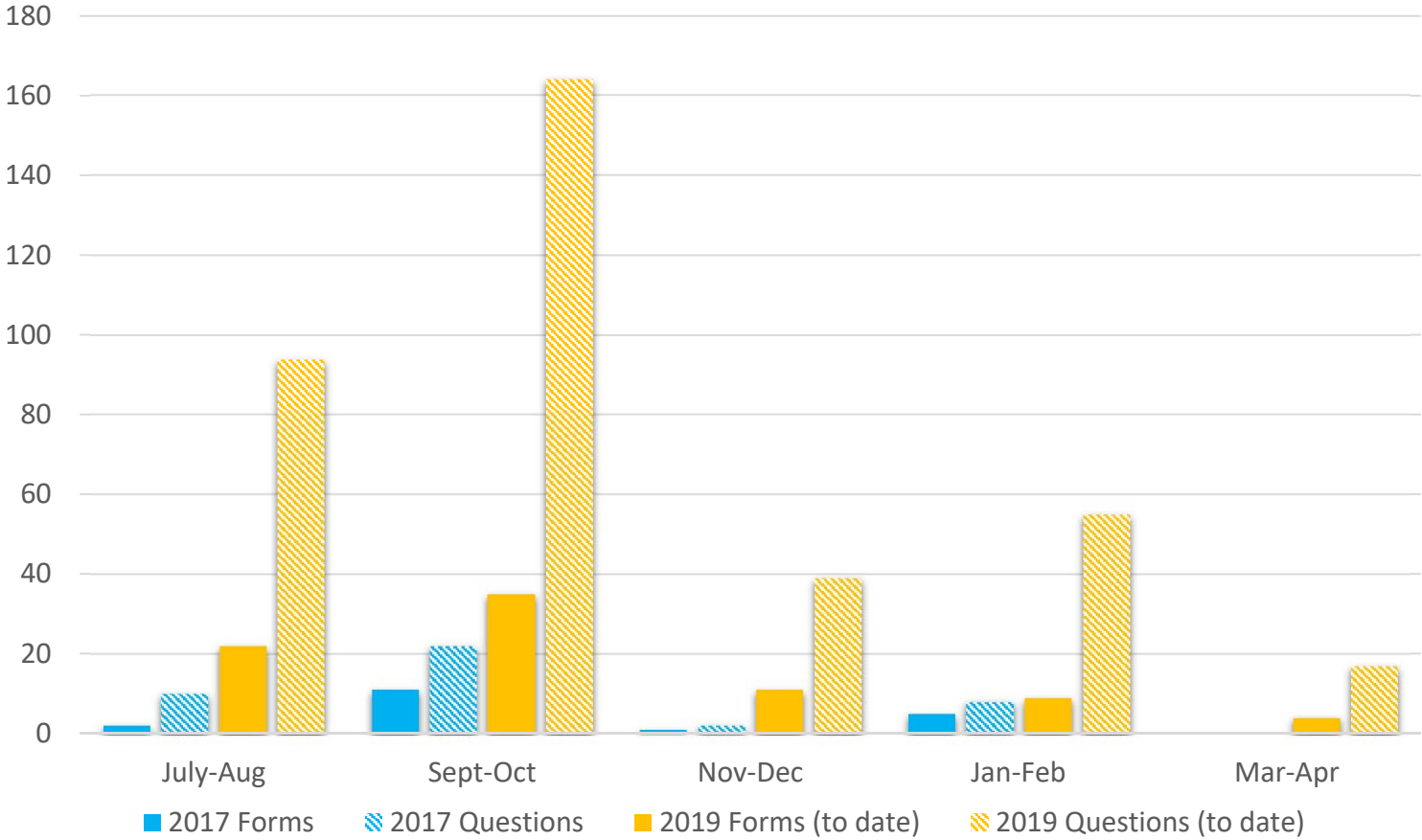
- Under PacifiCorp's Open Access Transmission Tariff (OATT), the company identifies and constructs transmission system upgrades to: (1) continue to provide existing and grant new requests for firm transmission service; and (2) grant new generation interconnection requests.
- Gateway segments are necessary transmission system upgrades to grant certain OATT service requests. For example:
 - PacifiCorp's interconnection queue has grown to approximately 37,000 MW system wide.
 - Approximately 6,500 MW of these requests are in constrained areas of WY or UT, and interconnection customers have or are expected to receive an interconnection study stating the need for Gateway segments to enable PacifiCorp to provide the requested service.
- PacifiCorp is assessing whether Gateway South may be necessary in the context of PacifiCorp's OATT requirements and significant interconnection queue backlog.
- To date, 2019 IRP studies have assumed Gateway South can be built in 2025 as a proxy for year-end 2024.
 - Review of project timelines indicate Gateway South may be able to be built by the end of 2023.
 - Portfolio development cases will allow Gateway South in 2024 as a proxy for year-end 2023, which aligns with the potential for new wind that can qualify for the 40 percent production tax credit.
- PacifiCorp will update stakeholders at the April 2019 public-input meeting on this assessment, and how it might influence the portfolio development process in the 2019 IRP.



Stakeholder Feedback Form Recap



2019 IRP vs. 2017 IRP Stakeholder Feedback Form Activity to Date



Stakeholder Feedback Forms



- 81 stakeholder feedback forms submitted to date.
- Stakeholder feedback forms and responses can be located at: www.pacificorp.com/es/irp/irpcomments.html
- Depending on the type and complexity of the stakeholder feedback received responses may be provided in a variety of ways including, but not limited to, a written response, a follow-up conversation, or incorporation into subsequent public input meeting material.
- Stakeholder feedback following the most recent public input meeting is summarized on the following slides for reference.

Summary - Recent Stakeholder Feedback Forms



Stakeholder	Date	Topic	Brief Summary (complete form available online)	Response (posted online when available)
Northwest Power & Conservation Council	Feb 21	Oregon Energy Efficiency Analysis	Requested a copy of the Oregon Energy Efficiency Analysis report discussed at the February 21, 2019 meeting.	Requested draft report was provided.
Oregon Citizens' Utility Board	Feb 22	Inflation Rate Assumption	Requested information regarding PacifiCorp's inflation rate assumption.	Response provided.
Erick Esterholdt Wyoming	Mar 8	General	Comments regarding renewable energy, reliability, Gateway South, and previous investments at Naughton Unit 3.	Target response by March 22.
Sierra Club	Mar 11	Coal Combustion Residuals	Request for information related to coal combustion residuals for specific units.	Target response by March 22.
Southwest Energy Efficiency Project & Utah Clean Energy	Mar 12	DSM Modeling Scenarios	Request for data behind tables from the September public input meeting.	Target response by March 22.
Sierra Club	Mar 15	Wyoming Original Senate File No. 159	Requested information regarding Wyoming SFO159 impact on coal studies and analysis in the 2019 IRP.	Target response by March 29.



Additional Information and Next Steps



Draft Topics for Upcoming PIMs*



April 25-26, 2019 PIM*

- Coal Studies Discussion
- Stakeholder Feedback Form Recap

May 20-21, 2019 PIM*

- Coal Studies Discussion (*if needed*)
- Regional Haze Portfolios
- Initial Portfolio Development Cases
- Stakeholder Feedback Form Recap

June-July, 2019*

- Portfolio Development Cases
- Sensitivity Studies
- Portfolio Selection Process
- Preferred Portfolio
- Action Plan
- Stakeholder Feedback Form Recap

** Topics and timing are tentative and subject to change*

Additional Information and Next Steps



- Public Input Meeting Presentation and Materials:
 - pacificorp.com/es/irp.html
- 2019 IRP Stakeholder Feedback Forms:
 - pacificorp.com/es/irp/irpcomments.html
- IRP Email / Distribution List Contact Information:
 - IRP@PacifiCorp.com
- Upcoming Public Input Meeting Dates:
 - April 25-26, 2019
 - May 20-21, 2019
 - June 20-21, 2019
 - July 18-19, 2019 (*as needed*)
 - August 1, 2019 – 2019 IRP File Date