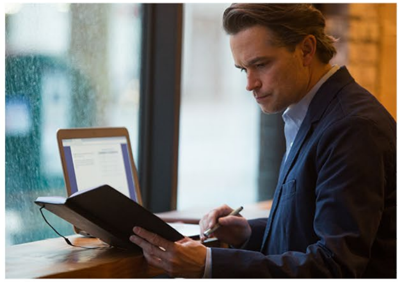
2025 Integrated Resource Plan Public Input Meeting
March 14, 2024





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Purpose Statement

- The primary focus is the customer
  - Maximum transparency
    - Assumptions
    - Constraints
  - Close the gap between planning, implementation, and execution
  - Agnostic to technology
    - Cost driver
    - Reliability driver

- Multi-state Approach
  - Specific timing for milestones in six states
  - Stakeholder feedback is critical to improving the quality of the work product
  - Milestones will be delivered based on the most restrictive state timing
  - Abide by each state’s specific policies if applicable
  - No cost shifting of state policy compliance

Agenda

SCHEDULE*	TOPIC
9:00 AM – 9:15 AM	Introduction
9:15 AM – 9:45 AM	Planning Environment Updates
9:45 AM – 11:15 AM	Input Data Development
11:15 AM – 12:00 PM	Conservation Potential Assessment Update
12:00 PM – 12:45 PM	Break
12:45 PM – 1:30 PM	Optimization Modeling Overview
1:30 PM – 2:00 PM	PLEXOS Modeling
2:00 PM – 3:00 PM	2023 IRP Update Drafting
3:00 PM – 3:15 PM	Stakeholder Feedback
3:15 PM – 3:30 PM	Summary & Next Steps

* Timing and arrangement are approximate and subject to change.

Planning Environment Updates

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Federal Ozone Transport Rule

- The Environmental Protection Agency's (EPA) final rule for cross-state air pollution for the 2015 ozone standard (the "Ozone Transport Rule" or "OTR") was published June 5, 2023, and took effect August 4, 2023.
- The final rule regulates NOx emissions for electric generating units during the ozone season (May 1 – Sept 30).
- The Tenth Circuit granted PacifiCorp's, Utah's and other industry petitioners' motion to stay EPA's final disapproval of Utah's state ozone plan on July 27, 2023, meaning the company is not subject to the federal ozone plan requirements while the stay is in place. In granting the stay, the court indicated that PacifiCorp and the other petitioners are likely to succeed on the merits. The Utah ozone case was transferred to the D.C. Circuit on February 16, 2024, for adjudication of the merits, leaving the stay in place.
- EPA published its final approval of Wyoming's state ozone plan on December 19, 2023. PacifiCorp's Wyoming thermal units are not subject to the federal ozone plan requirements.
- The U.S. Supreme Court heard oral arguments on February 21, 2024, to consider granting an emergency stay of the federal ozone plan. If the Supreme Court issues a stay of the federal plan, PacifiCorp will have additional protection during the D.C. Circuit Court's consideration of the Utah state plan disapproval, including if the stay of the state plan disapproval were lifted for some reason.

Wyoming House Bill 200

Overview:

- Required the Wyoming Public Service Commission (WPSC) to establish administrative rules requiring public utilities to develop low carbon portfolio standards utilizing carbon capture, utilization and storage (CCUS) by 2030.
- Two percent cost cap is specified in the legislation to limit customer impact.

Timeline:

- WY House Bill 200 (HB 200) was introduced in 2020 (effective July 1, 2020).
- The WPSC’s final administrative rules to implement HB 200 became effective on January 3, 2022.
- Public utilities must comply with HB 200 no later than July 1, 2030.
- PacifiCorp filed its initial application on March 31, 2022, and requested to issue a request for proposal (RFP) to retrofit Jim Bridger Units 3 and 4 and Dave Johnston Unit 4 for amine liquid solvent-based carbon capture technology. The RFP was issued in the fall of 2022.
- The WPSC approved the initial application in a written order issued on September 6, 2023, which required an RFP progress report and a revision to the RFP process by allowing proposals for additional carbon capture technologies and for other coal units.
- The Company filed the First Update to its initial application on March 31, 2023, that included an update on the RFP process.
- The Company will file its Final Plan no later than March 31, 2024, as required by WPSC’s administrative rules that will include the Company’s analysis of the proposals received.

Utah Community Renewable Program
(HB411)

Overview:

- Created an opt-out program with a goal of being 100% net renewable by 2030.
- Cities and communities elect to participate on behalf of their residents. Customers within a participating community may opt out of the program and maintain existing rates
- The legislation prohibits cost shifting to non-participating customers.

Timeline:

- April 2019 – Utah passes HB 411
- December 2019
  - 23 Utah communities pass a resolution to be 100% renewable by 2030 as required by the statute for participation. 18 of the 23 eligible communities have officially taken the next step in their participation by signing the Governance Agreement.
  - The Utah Public Service Commission adopts administrative rules to facilitate the program
- January 2022 – program design meetings begin and are currently ongoing

Oregon Clean Energy Plan (HB 2021)

Overview:

- Requires retail electricity providers to reduce GHG emission associated with electricity sold to Oregon consumers by:
- 80% below baseline emissions levels by 2030;
- 90% below baseline emissions levels by 2035; and
- 100% below baseline emissions levels by 2040

Timeline:

- July 2021 – CEP signed into law, effective September 25, 2021
- May 2023 – PacifiCorp filed first Clean Energy Plan based on 2023 IRP
- HB 2021 Requires development of CEP concurrent with each IRP
- Ongoing regulatory dockets:
    - UM 2225 – Initial guidance for utilities developing CEPs
    - UM 2273 – Investigation into HB 2021 Implementation Issues
    - LC 82 – Acknowledgement of 2023 IRP and CEP

Washington Clean Energy Transformation Act (2019)

Overview:

- Created several state decarbonization policies, including:
- Eliminating coal-fired resources from Washington rates by the end of 2025;
- Requiring greenhouse gas-neutral retail electricity in Washington by 2030;
- Requiring carbon free retail electricity in Washington by 2045.

Timeline:

- May 2019 – CETA signed into law
- December 2021 – PacifiCorp filed 2021 Clean Energy Implementation Plan (CEIP) based on 2021 IRP
- March 31, 2023 – 2023 Biennial CEIP Update filed based on Two-Year IRP Progress Report (Appendix O)
- July 1, 2023 – first CETA annual progress report filed
- CEIPs issued every four years consistent with four-year compliance periods. Biennial updates every other year following IRP update cycle. Annual progress reports filed each July.

Input Data Development

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Introduction

- PacifiCorp uses a fleet of resources and many miles of transmission lines to provide reliable service that matches its retail customer demand from moment to moment.
- Unlike almost any other product or service, electricity has to be produced ***now*** to serve demand ***now***, for each and every moment across the year.
- To keep costs down, we don't need to assume that we can meet customer demand all the time: shortfalls on no more than one day in ten years are considered acceptable for planning purposes. That does leave around 3,651 days in ten years that the system needs to be able to serve all customer demand all the time.
- **What kind of conditions do we need to consider on our system over ten years?**
  - *3,651 days out of 3,652 is 99.97%, so…basically all possible conditions.*
- **Do conditions vary over ten years?** *Yes. A lot.*
- **And "conditions" actually means lots of different load and resource data streams?** *Yes. A lot.*
- **And those load resource data streams interact or correlate with each other?** *Yes. A lot.*

What “conditions” matter?

Load	**Resources**	**Markets & System Operations**
Growth over time	Wind/solar/hydro availability	Power prices:
Heating/Cooling	Fuel supply	Forward (months ahead)
Energy efficiency	Emission limits	Day-ahead
Demand response	Forced outages	Hour-ahead
Time of use rates	Temperature derates	EIM: five and fifteen minutes
Rooftop solar	Transmission congestion/losses	Is it green? Is it clean?
Electric vehicle charging		Natural gas prices
		Ancillary Services/Operating Reserves

And these data series interact?

Load

Growth over time

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Time of use r

Rooftop solar

Electric vehicle chargi

Resources

Wind/solar/hydro availability

Markets & System Operations

Power prices:

(months ahead)

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Weather

Temperature

Wind

Sun

Precipitation

Wildfire

Transmission System

Imports/Exports

System Balancing/Reliability

Prices + Volumes --> Price elasticity

Distribution System

Distributed Resources

What are the key topics to be addressed in the 2025 IRP?

- **Resource Availability**
  - What range of conditions will we experience in a typical/”normal” year?
  - Hourly shapes for: wind, solar, energy efficiency, and demand response
- **Stochastics**
  - What range of conditions will we experience in other kinds of years?
  - Year to year variation in resource availability
- **Reserve requirements and intra-hour dispatch**
  - Reliability obligations
  - Dispatch volumes and cost impacts
- **Market prices and potential volumes**
  - Market purchase limits for reliability
  - Market sales limits due to price suppression

Hourly shapes for: wind, solar

- **Proposed analysis - develop a tool to:**
  - Access historical weather data for a user-selected latitude/longitude.
    - A dataset in use by the Wildfire Management team could provide synergies, other public options exist.
  - Use statistical techniques to report hourly wind/solar for that location.
    - Option 1: User-provided 12 month x 24 hour profile, mapped to hourly expected output based on historical weather.
    - Option 2: Location-specific results, for both expected output and weather.
- **Use tool to develop wind/solar generation profiles**
  - Proposal is to gather 20 years of history, the same timeframe underlying the load forecast.
  - The chaotic normal load forecast is based on the weather from specific days in the historical period, and the day selection evolves over time in response to climate effects.
  - "Normal" wind and solar shapes would correspond to the historical day selection embedded in the load forecast.
- **Additional considerations:**
  - Actual generation can be impacted by various types of curtailment: transmission-related, avian/environmental, market conditions. Curtailment is difficult to back out – raw weather data may be easier to use.
  - Repowering: These resources have limited actual data, as performance changes significantly after repowering.
  - Contracted, not in service: Will have 12x24 profile, but aligning with history and climate effects is complex.
  - Proxy – significant resource expansion should reflect more than the single point/profile per state in the 2023 IRP.

Hourly shapes for: Energy Efficiency/Demand Response

- Most EE/DR is reasonably represented by a 12x24:
  - Lighting, Cooking, Commercial, Industrial, etc: Subject to some variation, but not impacted significantly by weather.
  - Updated profiles are being developed for the 2025 IRP
- Cooling and heating demand drives peak requirements: loads are not the same on a peak day and on other days, and EE/DR savings varies with weather-related demand.
  - In the 2023 IRP, “normal” EE heating and cooling measure savings were distributed in proportion with the hourly heating or cooling demand in the load forecast, as provided by the load forecast team. This ties directly to the day selection in the load forecast.
  - The technique is proposed to be expanded to include DR for the 2025 IRP: Smart Thermostat programs can only provide savings to the extent the demand is there.

Stochastics in the last several IRPs

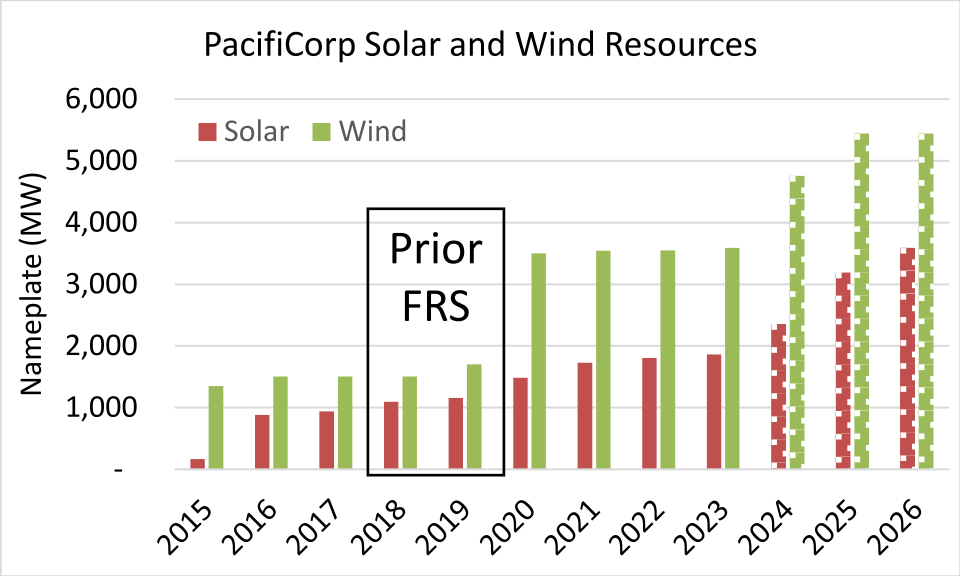
- **Thermal outages:** randomly seeded events, but typically 1 day in length.
    - Actual events range from hours to many days long
- **Load:** daily shocks, based on historical standard deviation and mean reversion statistics.
    - The hourly load forecast already reflects a range of daily load conditions, so the statistics partly duplicate variation that is already present.
- **Hydro:** weekly shocks, based on historical standard deviation and mean reversion statistics.
    - Hydro varies somewhat from one week to the next, but can vary a great deal in a wet year versus a dry year. Existing modeling understates the potential for sustained low or high hydro for months at a time. Conditions that are close to "Normal" or average can seem rare.
- **Market prices (Natural Gas, Electric) :** daily shocks, based on historical standard deviation and mean reversion statistics.
    - Actual prices are skewed: prices hitt administrative caps more often than standard deviation implies.
    - Pricing at administrative caps may also mean power is unavailable for purchase at any price.
    - Unlike load, pricing has no day-to-day variation, all weekdays in a given month are the same; however, correlation exists between high load days and high prices that is not captured in the variation already present in the load forecast
- **Wind, solar, energy efficiency, and demand response:** no stochastic variation modeled. Limited correlation to load.

Stochastics under consideration for 2025 IRP

- **Annual stochastic selection: “2005 conditions” or “2018 conditions”, for the entire year**
  - **Load, energy efficiency, and demand response**
  - **Hydro**
  - **Wind and solar**
  - **Market prices**
  - It is necessary to translate historical patterns and relationships to future periods, for example, forecasted market prices and load will still be embedded in the forecast for each future year.
  - 2005 conditions in 2025 will be different from 2005 conditions in 2035:
    - Load Growth
    - Market Price Changes
    - Climate change impacts to hydro and load
- **Thermal outages:** continue to be randomly seeded events, but with a range of day lengths.

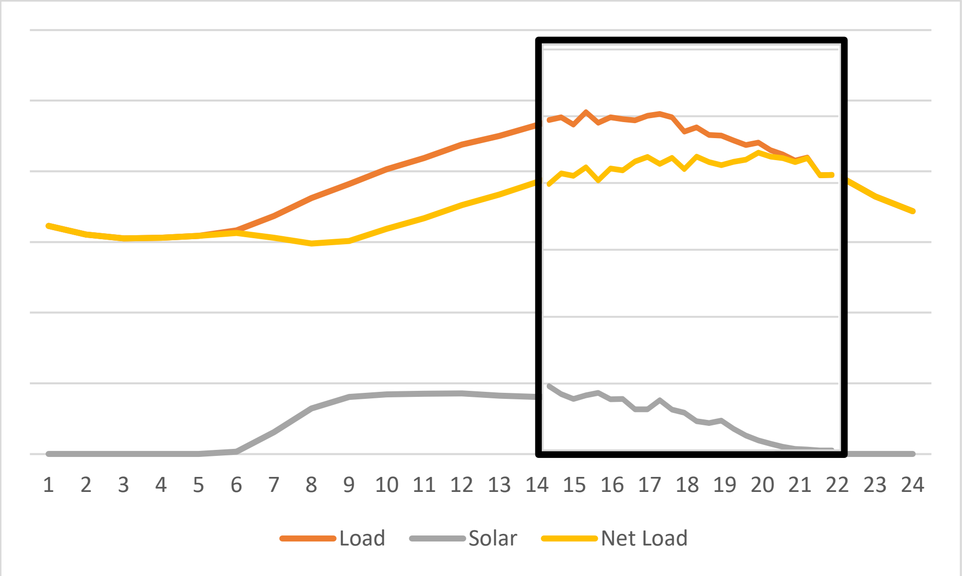
Reserve Requirements

- The last several IRP's have included a Flexible Reserve Study (FRS) (Appendix F of Volume II) which addresses a variety of aspects of reserve requirements. Contingency reserves are based on a simple formula, while frequency response reserves are deployed and restored so quickly, they have little impact on system operations.
- Regulation reserve requirements cover everything else. When load increases or resources decrease beyond a specified limit, regulation reserves must be deployed to keep the system in balance. The underlying reliability standard requires 100% compliance within 30 minutes. Managing this is complex and the last comprehensive analysis of related to the variability of wind and solar resources used data from 2018-2019.
  - As of the end of 2023, solar capacity has increased over 60%, while wind capacity has more than doubled.
  - While wind and solar are both projected to continue increasing, recent actual results are used in this analysis.
  - Regulation reserve requirements are calculated based on the difference between hour-ahead load and resource forecasts submitted in the EIM, and five-minute actual load and generation.
  - This analysis identifies how much regulation reserve might need to be deployed under different forecasted levels of load, wind, and solar.



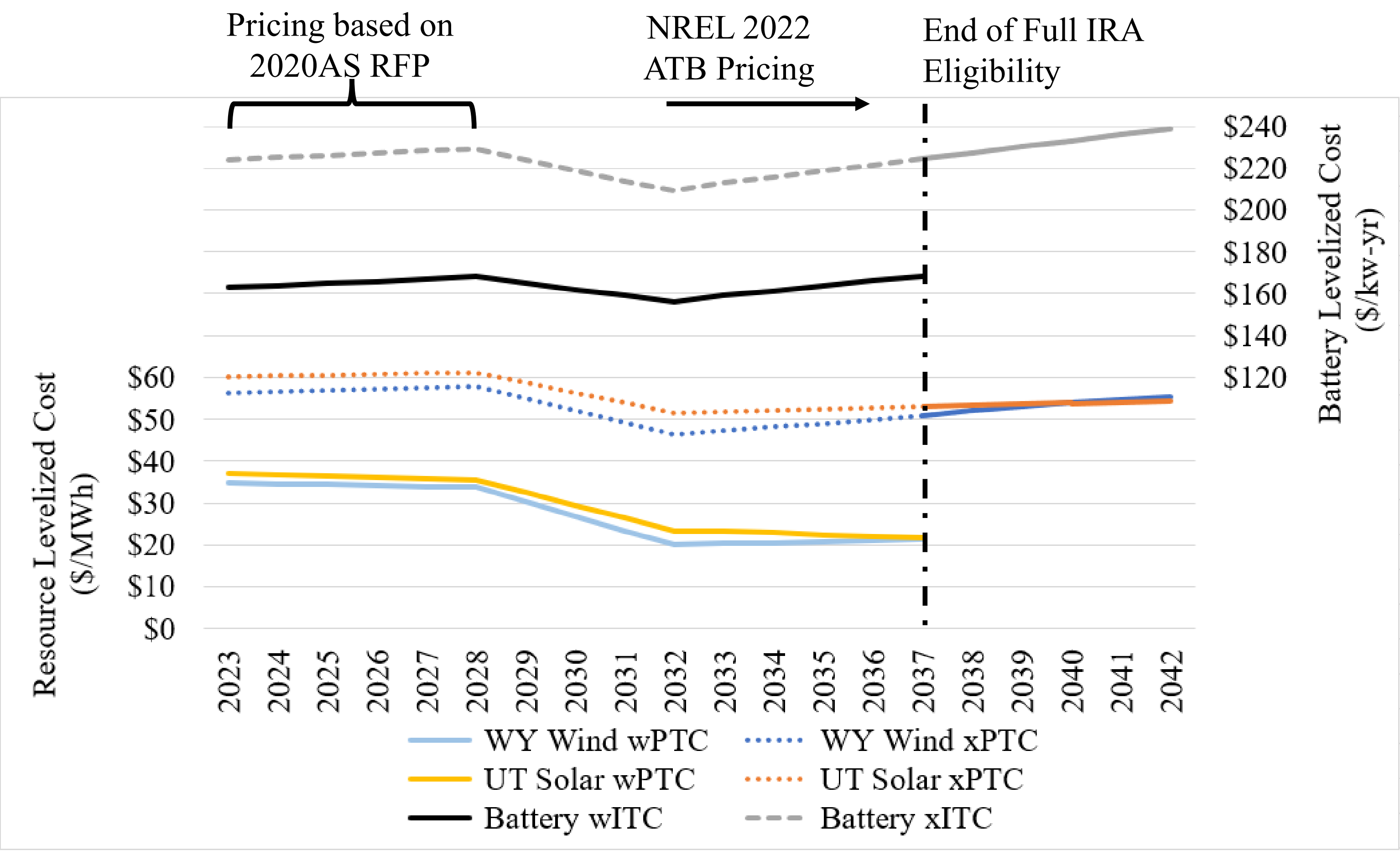
Reserve Deployment

- Reserve requirements in previous IRPs have been modeled as amounts “held available”, i.e. flexible capacity with space available that could be called upon at short notice, but it was never “deployed” by the model.
- In reality, reserves do get deployed. Keeping track of how often is more important as energy storage increases, due to storage duration limits, i.e. batteries get drained, and charge-discharge cycle counts, which impact degradation.
  - Contingency reserves: deployed a few times per week for up to an hour.
  - Frequency response: deployed a few times per month for a minute or so.
  - Regulation reserves: its complicated and involves both increases and decreases in generation.
    - Small amounts of reserves are deployed continuously
    - Moderate amounts of reserves are deployed a few times per day as the system ramps: as the sun sets, wind stops blowing, or as load comes up (summer evenings and winter both morning and evening).
    - Large amounts of reserves are deployed rarely when load or resources change unexpectedly: storm fronts, clouds, variation in customer demand.
    - Good forecasting helps limit large deployments, but all forecasts are off sometimes.



Inflation Reduction Act and Future Technology Costs

- These nominal cost curves were set in October 2022 for the 2023 IRP and are still being used in the 2023 IRP Update.
  - PTCs provide greater benefits for nearly all resource types. ITCs apply to storage, peakers, and offshore wind. Levelized impacts for 100% PTC / 30% ITC are shown.
  - IRA-eligible projects assumed to begin construction by the end of 2032, and reach commercial operation by the end of 2036 (modeled as Jan. 1, 2037).
  - Costs transition to NREL's 2022 Annual Technology Baseline (ATB) by 2032: https://atb.nrel.gov/electricity/2022/data
  - Development of cost curves for the 2025 IRP is pending release of the 2024 NREL ATB in July.



Conservation Potential Assessment - Update

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Resource Assumptions: Demand Response

Conduct research to develop a comprehensive list of DR measure/program assumptions. We utilize PacifiCorp-specific program data where available.

Event Assumptions

- Capacity Reductions
- Seasonal Availability
- Climate Zone & Curtailable Load
- Event Ramp Up (Time until Full Response)
- Event Duration
- Maximum Events per Year

DR Program Data Assumptions

- Comparable Program Assumptions (Key Sources)
- Measure Dependencies (AMI)
- Participation (including state-specific assumptions, WA CTA-2045)
- Regulatory Lead Time (years)
- Levelized Cost Methodology

Resource Options: Demand Response

- In 2023 CPA, looked at individual technologies' ability to provide different grid services, defined by time to full deployment and event duration.
- To summarize we propose to present impacts for two types of events that help to capture the differences in impacts and eligibility. In 2025, PacifiCorp is proposing to continue with these event definitions:

Fast Events: represents the impacts that could be achieved over a shorter event period (≤ 1 hour). Notification times are typically 15 minutes or less with a near-instantaneous response.

Sustained Events: represents the impacts that could be realized over a longer event period (> 1 hour). Notification could be day-ahead or day-of.

Resource Options, Continued

Program Category	Program Bundle	Mechanism / Description	Eligible for Fast Event Potential?*
Direct Load Control (Conventional)	Electric Vehicle Connected Charger Direct Load Control (DLC)	Automated, level 2 EV chargers that postpone or curtail charging during peak hours. Can potentially be used for energy storage.	✓
	HVAC DLC	DLC switch installed on customer's heating and/or cooling equipment.	✓
	Irrigation Load Control	Automated pump controllers or DLC switch installed on customer's equipment.	✓
	Pool Pump DLC	DLC switch installed on customer's equipment.	✓
	Domestic Hot Water Heater (DHW) DLC	DLC switch installed on customer's equipment.	✓
Direct Load Control (Smart / Interactive)	DLC of Smart Home	Internet-enabled control of operational cycles of white goods appliances, electronics, and lighting. Controlled by a central smart hub or smart speaker.	
	Grid Interactive Water Heater	CTA-2045 or other integrated communication port. Can also be used for energy storage.	✓
	Connected Thermostats DLC	Internet-enabled control of thermostat set points.	
Energy Storage	Battery Energy Storage DLC	Internet-enabled control of battery charging and discharging.	✓
Curtailment	Third-Party (Fast Event)	Customers enact their customized, mandatory curtailment plan. May use stand-by generation. Penalties apply for non-performance. Customers must have EMS for automated compliance.	✓
	Third-Party (Sustained Event)	Customers volunteer a specified amount of capacity during a predefined "economic event" called by the utility in return for a financial incentive.	

*All program bundles eligible for sustained events, some are eligible for fast events

Resource Hierarchy: Energy Efficiency

Similar to the 2023 CPA, a "Resource Hierarchy" for energy efficiency source data **specific to each state** has been developed.

Focus on state-specific needs and regulatory requirements, regionally applicable sources → Prioritize TRMs from neighboring states and utilities

Leverage most recent national sources → Consider reliable TRMs from other regions (Midwest/Northeast)

Priority	Washington	Idaho	Utah/Wyoming	California
Primary	RTF	RTF	RMP Ex-Ante Measure Characterizations RTF with Adjustments	California Technical Forum Electronic TRM (eTRM)
Secondary	2021 Power Plan Program-Specific Evaluations	RMP Ex-Ante Measure Characterizations Idaho Power TRM Program-Specific Evaluations	Idaho Power TRM Xcel Energy Colorado DSM Plan Program-Specific Evaluations	RTF with Adjustments 2023 CPUC P&G Study Program-Specific Evaluations
Other	California eTRM RMP| National Sources Other Regularly Updated TRMs	2021PP | California eTRM | National Sources | Other Regularly Updated TRMs	2021PP | California eTRM | National Sources | Other Regularly Updated TRMs	CMUA TRM | 2021PP National Sources | Other Regularly Updated TRMs

EE Measure List Changes

PacifiCorp and AEG have identified over 100 changes relative to the 2023 CPA EE measure lists.

There are three general categories:

Measure Additions: new technologies and measure levels for the 2025 CPA from AEG's review of priority sources and emerging technologies

- *Portable Air Conditioners (New Technology Set)*
- *Highest-Efficiency Air Purifier (12.8 CADR/W)*

Measure Reclassifications: Measure label or efficiency in alignment with latest codes and standards, industry trends, and specification changes

- *Inclusion of SEER2/HSPF2 Rating Equivalencies for Central AC and Heat Pumps*
- *ENERGY STAR Dishwasher (**6.0**) → ENERGY STAR Dishwasher (**7.0**)*
- *NEEA Tier 4 Heat Pump Water Heater (**UEF** 3.0) → NEEA Tier 4 Heat Pump Water Heater (**CCE** 3.0)*
- *Clothes Washer 2018 Standard with **IMEF** and **IWF** Ratings → Clothes Washer 2028 Standard with **EER** and **WER** Ratings*

Measure Removed/Excluded: Measure that had been determined to not be viable, obsolete, superseded by a more efficient option, or modeled under another measure

- *SEER 13 Central AC*
- *Stove - Smart Heating Elements*
- *Windows - Dynamic Glazing → Advanced New Construction Designs*

Measure List Changes

- Less changes this cycle than from 2021 → 2023. List is well maintained.
- Additions and reclassifications mainly due to:
  - New federal standards (only Final Rules included)
  - ENERGY STAR version updates (only Final or Final Draft levels included)
  - Other adjustments to match code, priority sources, and available data
- Measure Removals:
  - Many were consolidated with or covered by other measures
  - A few minor measures, including emerging measures, that were investigated previously but did not provide potential or extremely cost-prohibitive.
- Improvement: including some legacy efficiency levels (e.g., older ENERGY STAR versions) to better reflect a mixed baseline where specifications recently changed

Action Taken	Residential	Commercial	Industrial	Irrigation	Total
Additions	24	8	1	0	**33**
Reclassifications	48	10	3	0	**61**
Removal/Exclusions	10	8	6	0	**24**

Major Measures

Given expansive measure list, we recognize it may not be possible for stakeholders to review every measure and data input.

To help focus the review of measures that are likely to receive either high potential or a high level of interest (or both) in this study, AEG identifies “major measures.” Major measures are defined as:

- *Large current or expected contributions to PacifiCorp’s program portfolio (nonresidential linear lighting)*
- *Stakeholder comments and interest (heat pumps)*
- *High potential in PacifiCorp’s 2023 CPA*
- *High potential in comparable utility DSM programs and plans throughout the country*

A “major measure” flag was cretaed in the measure list to help stakeholders efficiently review draft inputs.

- ***This will be defined in the final measure list and measure database***

Measure List Review/Emerging Tech

AEG will complete a thorough review of emerging technologies, which include:

- Updating the emerging technology review conducted as part of the 2023 CPA
  - Conducted a thorough review of emerging technologies, using data from NEEA, BPA, NREL, U.S. DOE, and pilot/R&D programs throughout the nation
- Screening measures for:
  - Technical maturity (e.g., R&D, pilot, or regional implementation)
  - Applicability (e.g., small niche, one segment, one sector)
  - Data availability (e.g., manufacturer claims, independent publications, pilot data)
- Revisiting measures put on the “watch” list during the last study

PacifiCorp welcomes additional sources and/or measures not already captured on the emerging technologies measure list.

- Request to review draft measure/program lists by <u>**March 29, 2024**</u>
- Stakeholders can submit feedback or measures ideas and sources through the stakeholder feedback form

Break

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Optimization Modeling Overview

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Optimization Modeling

- Optimization modeling is a mathematical approach used to determine the optimal minimum or maximum of a complex equation
- For PacifiCorp's system, we run models which seek the lowest present value revenue requirement (PVRR) of our multistate system
- Optimization math obeys the constraints and meets the requirements it is given (e.g., reserves requirements, unit capabilities, transmission constraints, market prices, and other parameters and relationships)
- Optimization math avoids the need to examine every possible combination of options individually to determine the optimal solution
- To understand how optimization models work, it is meaningful to compare it to the alternative of "stepwise" problem solving

Stepwise Approach

- Solves a problem by executing a series of intuitive steps
- Example: If you know that you must hold reserves on your energy system, some of your steps might be:
  - Rank your generators by reserve carrying cost, low to high
  - Hold reserves on each unit, in order, until reserve requirements are met
  - Determine how much generating capacity is left after reserves
  - Rank order your units by energy production cost, low to high
  - Generate from each unit, in order, until all loads are met
  - Calculate remaining generating capability ("excess energy")
  - Sell excess energy at market:
    - … when economic; compare production cost to market prices
    - … when deliverable; keep a running total of transmission usage and market depth
- Repeat your steps for every hour (or other period) of every year, accounting for what you did in the prior hour (e.g., unit commitment or fuel use)

Optimization Modeling Approach

- Optimization modeling mathematically determines the best (optimal) solution:
  - By eliminating solutions that cannot meet requirements or obey constraints (infeasible)
  - By eliminating feasible solutions that cannot be the optimal solution
  - By assessing linear relationships to get as close to the theoretically optimal solution ("relaxed solution") as possible and;
  - Provides available output about the best solution. Possible output includes:
    - Discrete decisions (e.g., add capacity at a particular site, acquire a particular DSM package)
    - Energy production of modeled resources, usage of transmission, purchases of capacity or energy from markets

- Not all information is needed to provide a solution
  - No need for a reserve stack
  - No need to assign reserves to specific units

Simple Optimization Modeling Example: Thermal Generation

Problem: How much gas energy and how much coal energy should we generate?

Objective: Minimize system costs assuming two generating units (one gas, one coal), one transmission line, and one load area, operating for a period of one hour.

Relationships: A transmission line conveys energy to the load area.

Parameters and Constraints (in a single hour):

- Generate up to 120 MW from our gas unit
- Generate up to 150 MW from our coal unit
- Transmission capacity and load requirement are both 200 MW

Run cost:

- 1 MWh of gas-power costs $2 to generate
- 1 MWh of coal-power costs $3 to generate
- Failure to meet load costs $100/MW

Optimization Modeling Simple Example, continued

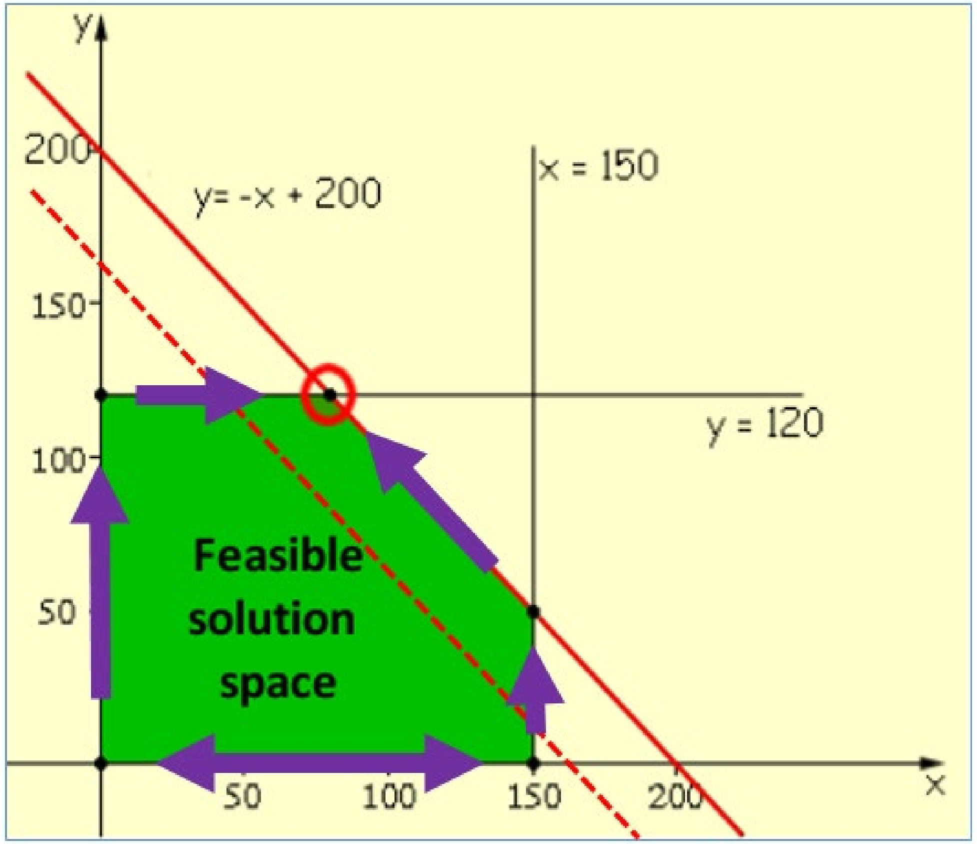
- When the model runs, modeled constraints and objectives become mathematical constraints and objectives in a complex formula, expressed as inequalities:

Linear Inequalities	Purpose
$x \leq 150$	Coal can generate up to 150 MW
$y \leq 120$	Gas can generate up to 120 MW
$x + y \leq 200$	Total generation cannot exceed transmission
$x \geq 0$	Coal generation cannot be negative
$y \geq 0$	Gas generation cannot be negative

- The model uses these inequalities to explore a “feasible solution space” – a range of possible solutions that *might* be the right answer
- In our example, we’re going to assume a $100/MW penalty for not meeting system load.

Optimization Modeling Simple Example, continued

- The graph at right illustrates how the math defines the "feasible solution space".
- The load requirement dictates that only solutions along the red line could be the best answer. (At each point on the red line, the generation total is 200 MW, avoiding the $100/MW penalty for not meeting load).
- The model "searches" for the edge of the feasible solution space, then examines other solutions along that edge to see if moving in one direction or another improves the solution (by lowering PVRR).
- The model quickly arrives at the optimal solution, found at one end (vertex) of the 200 MW load requirement.
- This vertex meets all requirements and constraints and produces the lowest PVRR. No other solution does this.



- The dotted red line would apply to a scenario where the two generators could not supply the 200 MW needed for load. The model would find an optimal solution in the same manner, minimizing the amount of penalty it must pay. If the requirement to meet load was modeled as absolute, the solution would be infeasible.

Optimization Modeling Advantages and Complexities

- You quickly approach the best (i.e., optimal) answer
  - Complexity: The best answer may not be immediately intuitive
  - However, if it isn’t intuitive, it is often an indication of a problem that must be investigated
- Multi-dimensional problem solving; detailed precision and accuracy that non-optimization approaches cannot match
  - Complexity: Determining an acceptable amount of complexity
  - Complexity: Tremendous amounts of data are required
  - Complexity: Time required to produce and analyze results
  - Complexity: Highly technical software, equipment
  - Complexity: 1-2 year training ramp-up, starting with a skilled analyst
- Optimization modeling is incredibly fast for what it does; has the *effect* of examining every modeled possibility
  - Complexity: All desired outputs may not be readily available

Plexos Modeling

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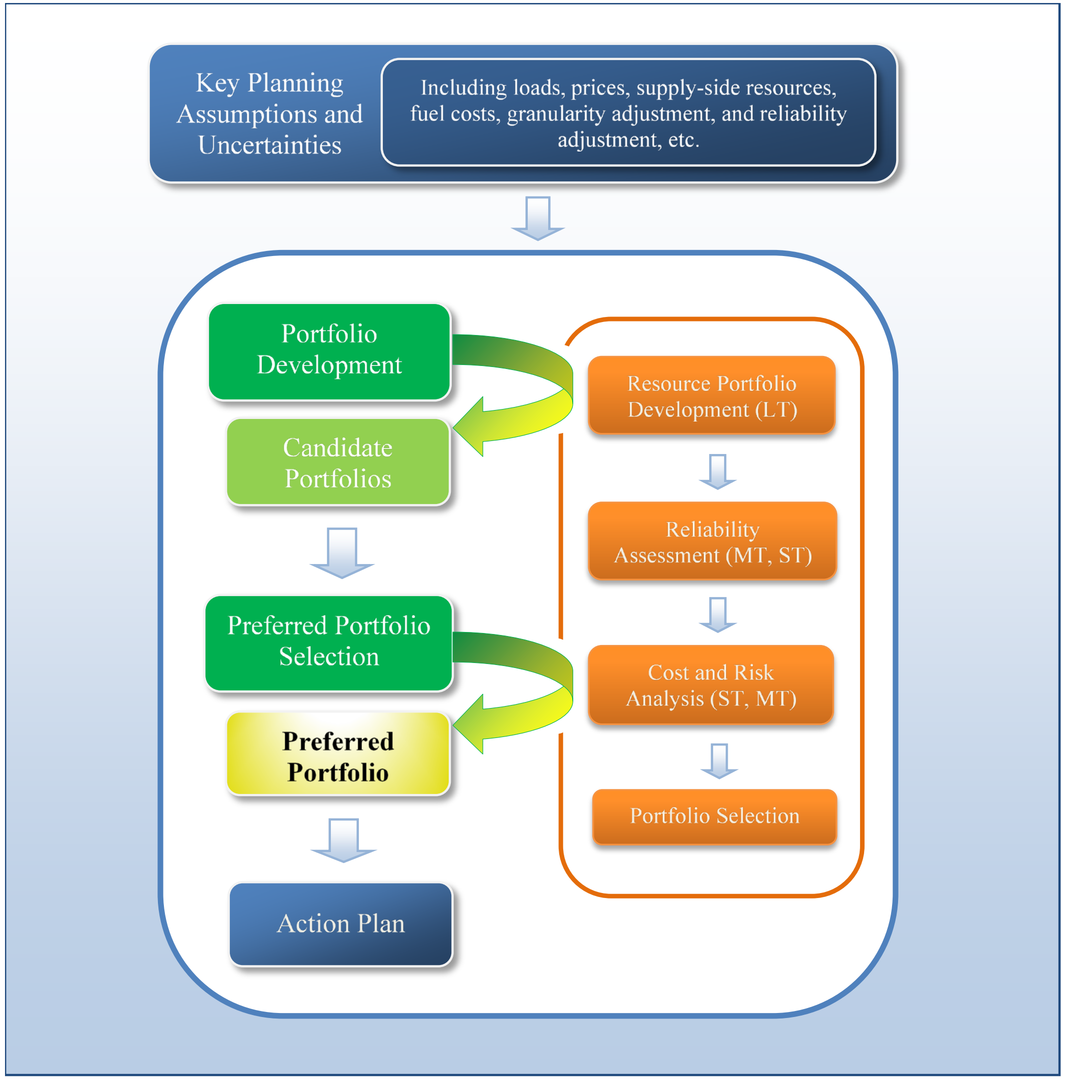
Plexos Advantages

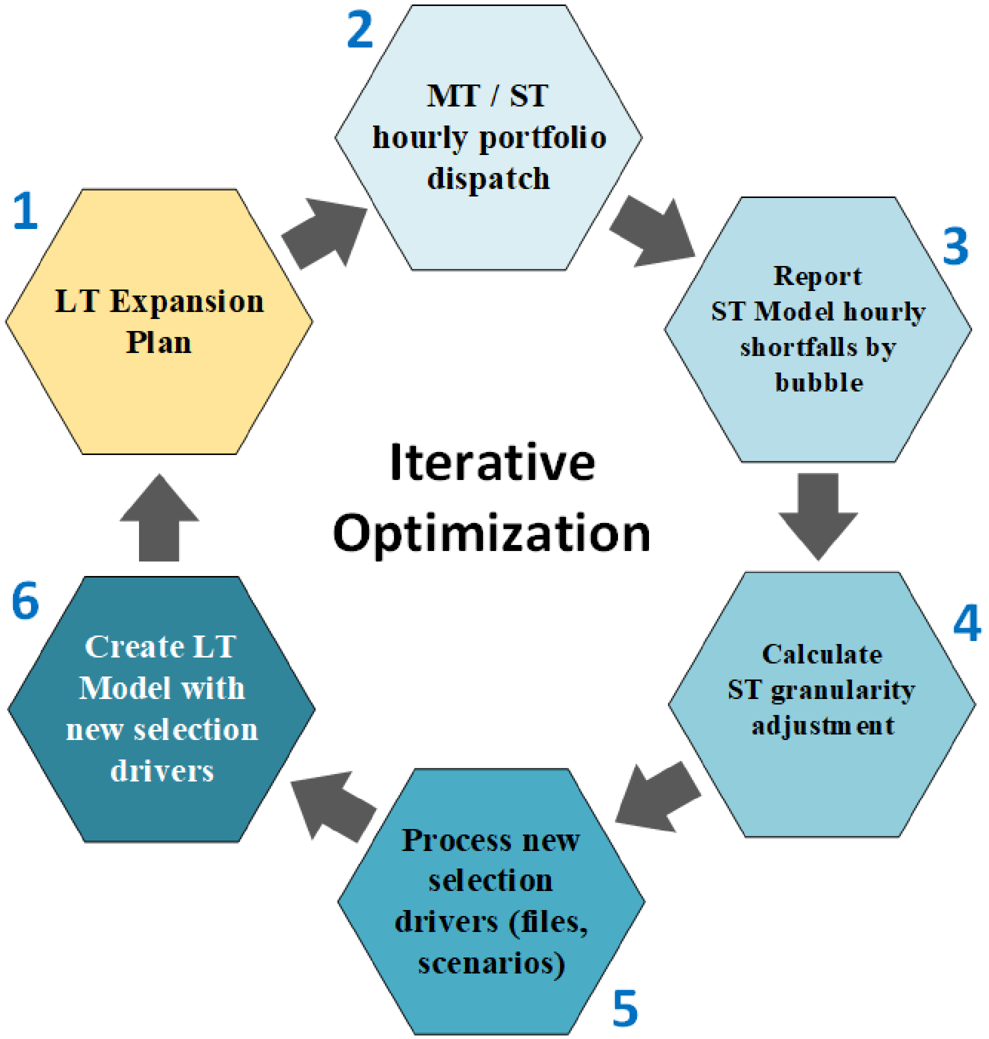
Since adopting Plexos, we have been able to:

- Model endogenous transmission
  - No complex topology additions or analytics, just math constraints
  - No need to create multiple copies of every resource (2019 IRP)
  - Multiple paths can be modeled as one option
- Introduce endogenous thermal retirement optimization
  - 2019 IRP: 78 individual retirement portfolios
  - 2021 IRP: > 260,000 retirement combinations considered in every model run
  - 2023 IRP: > 5,000,000,000,000 (5 trillion) combinations considered in every model run
  - In addition, each model run considers gas unit retirements and alternate configurations such as CCUS and gas conversions
- Granularity – significantly more control over model alignment and aggregation sampling
- Reliability – operating reserves and resource availability to meet requirements replace the planning reserve margin as the central driver for capacity expansion
  - 3 models contribute to portfolio optimization
  - Reliability measures (such as net revenue) and tools are built in

Portfolio Selection



Portfolio Development Process



What is the “Granularity Adjustment”?

For each resource and for every year of the study horizon:

IF	**Energy value of a resource’s output in LT Model**	$>$	**Energy value of a resource’s output in ST Model**	$\rightarrow$	**Increase Fixed Cost**	$\rightarrow$	**Less likely to pick resource**
IF	**Energy value of a resource’s output in LT Model**	$<$	**Energy value of a resource’s output in ST Model**	$\rightarrow$	**Decrease Fixed Cost**	$\rightarrow$	**More likely to pick resource**

Normally, it is expressed in dollars per kilowatt-year ($/kw-yr), and it can be either positive or negative.

The value in the LT Model reflects a weighted average of 7 blocks of hours in each month, or 7*12 = 84 blocks per year. The LT model balances all 20 years at the same time: 84 * 20 = 1,680 blocks and can build or retire resources.

- The blocks are designed to differentiate different types of conditions across each month:
  - Three blocks reflect the top load hour for East, West, and System (if it is different)
  - One block reflects the highest net load hours (load less wind and solar)
  - Two blocks reflect the highest wind hours and highest solar hours.
  - A final block has all other hours.
- A block can include over 100 hours, a wide range of conditions despite the groupings, the LT model only sees the average.

The value in the ST Model reflects 8760 hours per year. It solves one week at a time (168 hours), chronologically (each hour must align with the next, for battery storage and thermal unit starts and ramping), but can’t add or remove resources.

2023 IRP Update

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Portfolio Development Process

Portfolios in the 2023 IRP Update are developed using a more refined process than the 23 IRP:

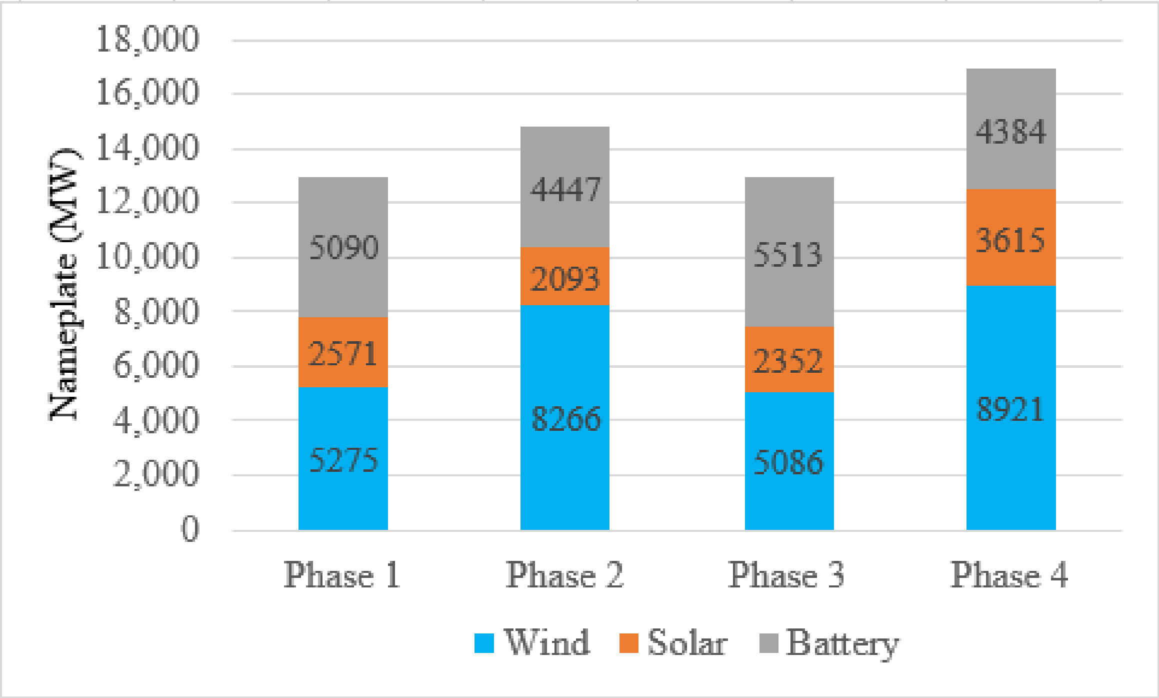
- PLEXOS outputs are the only drivers modifying LT capacity expansion portfolios
- The process is iterative, and as a result is time consuming – development of the current iterations of portfolios has taken over a month
- Automation has been enhanced to enable file processing to create results, tagged with data that checks and confirms which PLEXOS runs items are from, reducing potential for human error.
- The Granularity Adjustment reflects the marginal value of the LAST MW of a resource that is added, and in runs that are reliable, this last MW has less value than the last MW in an unreliable run
    - The $1000/MWh shortfall price during hours when a portfolio is unreliable drops drastically once sufficient resources are present.
- The Granularity Adjustment ends up “swapping” resources, overvaluing items in some runs, and undervaluing them in another. In practice, this means the iterative process builds too much of something, then in the next step does not build enough.

Refinements will continue as part of the 2025 IRP

Portfolio Development Process Continued

Below is an example of the "swapping" driven by Granularity Adjustments, based on a study with medium natural gas-medium green house gas conditions:

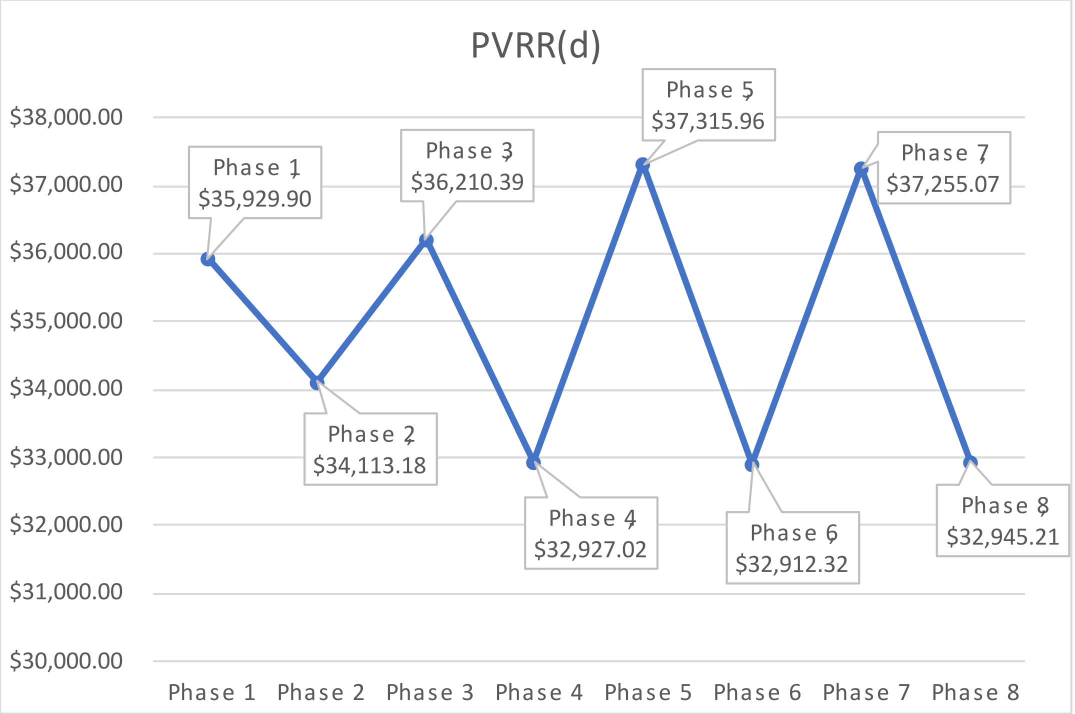
- Results from Phase 1 influenced the model to select more wind, while reducing solar and battery storage.
- In Phase 2, the larger amount of wind has a lower marginal value while lower amount of battery storage has a higher marginal value. In addition, the extra wind increases the value of battery storage (more generation available to store).
- In Phase 3 wind goes down while battery storage goes up, and solar goes up slightly as well.
- The increase in battery storage in Phase 3 provides greater value for solar, which increases along with wind in Phase 4.
- Within the totals shown, resources of each type are also moving among various locations across the Company's system.
- There is no readily identifiable "right" value for each resource type – it is influenced by locations and the presence of other resource types.



Portfolio Development Example

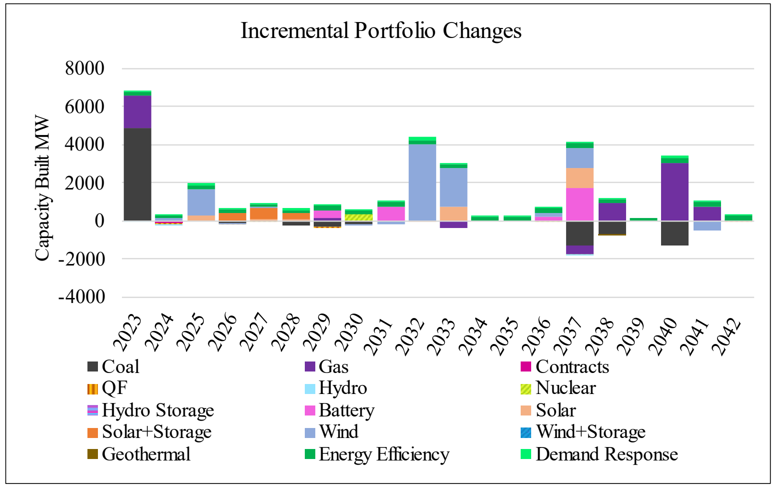
The following shows sample PVRR results of the process for an example price policy case, the Medium Gas, Medium CO2 base case – **which is still in the process of development/refinement**

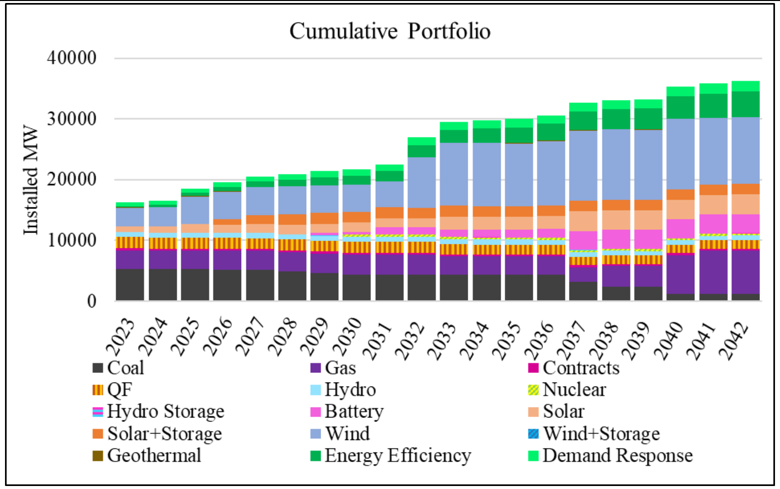
	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8
PVRR(d)	$35,929.90	$ 34,113.18	$ 36,210.39	$32,927.02	$ 37,315.96	$ 32,912.32	$37,255.07	$ 32,945.21
Rank	5	4	6	2	8	1	7	3



Phase 4 Portfolio

Summary Portfolio Capacity by Resource Type and Year, Installed MW																					
	Installed Capacity, MW																				
Resource	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**Total**
Expansion Options																					
Gas - CCCT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas - Peaking	-	-	-	-	-	-	157	-	-	-	-	-	-	-	-	950	-	3,063	750	-	4,920
NonEmitting Peaker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DSM - Energy Efficiency	165	151	211	157	171	188	213	218	245	194	218	223	237	248	285	179	179	216	229	303	4,230
DSM - Demand Response	72	38	97	93	35	113	71	5	45	201	13	41	5	24	42	20	-	148	93	1	1,157
Renewable - Wind	-	194	1,361	-	79	-	-	-	4	4,038	2,042	-	-	204	999	-	-	-	-	-	8,921
Renewable - Utility Solar	-	-	300	398	654	363	-	-	-	-	730	-	-	-	1,157	-	-	-	-	13	3,615
Renewable - Geothermal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable - Battery	-	-	-	400	565	300	415	-	758	-	-	-	-	209	1,737	-	-	-	-	-	4,384
Renewable - Battery (Long Duration)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage - CAES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage - Pumped Hydro	-	-	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	35
Nuclear	-	-	-	-	-	-	-	500	-	-	-	-	-	-	-	-	-	-	-	-	500





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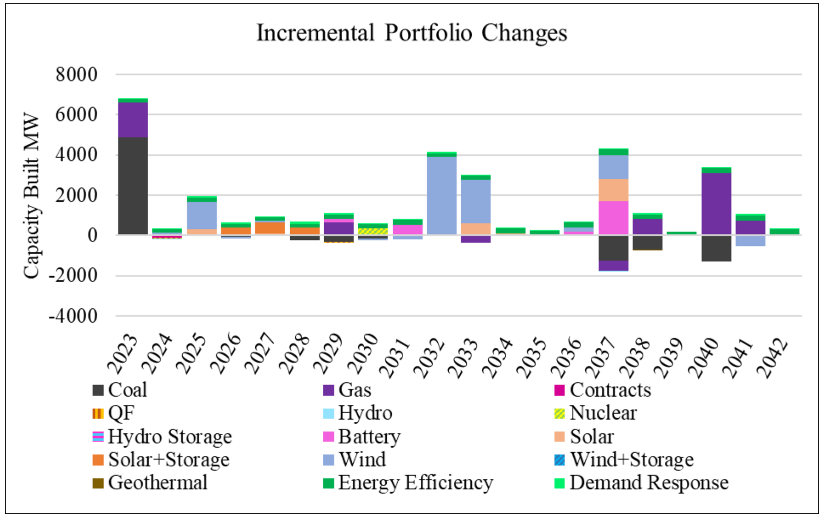
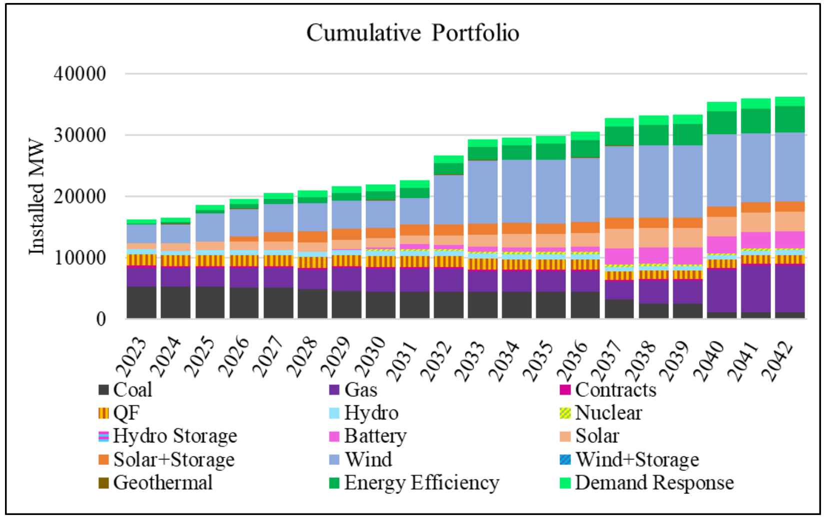
Phase 6 Portfolio

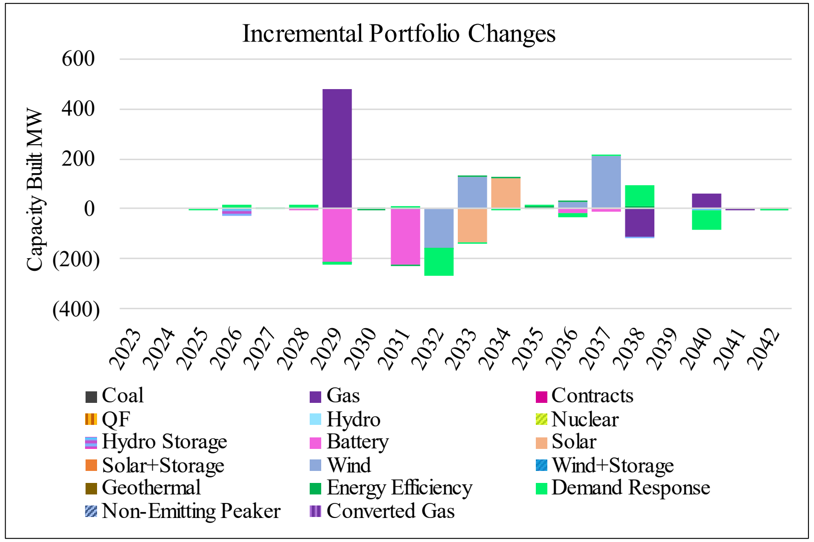
Summary Portfolio Capacity by Resource Type and Year, Installed MW																					
	Installed Capacity, MW																				
Resource	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	Total
Expansion Options																					
Gas - CCCT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas - Peaking	-	-	-	-	-	-	635	-	-	-	-	-	-	-	-	836	-	3,122	749	-	5,342
NonEmitting Peaker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DSM - Energy Efficiency	165	151	211	157	171	188	213	218	245	193	218	225	249	253	285	188	179	216	229	301	4,255
DSM - Demand Response	72	38	93	110	37	130	63	12	54	87	4	40	11	11	49	107	-	73	93	1	1,085
Renewable - Wind	-	194	1,361	-	79	-	-	-	5	3,885	2,167	-	-	228	1,202	-	-	-	-	-	9,121
Renewable - Utility Solar	-	-	300	398	654	363	-	-	-	-	599	124	-	-	1,165	-	-	-	-	14	3,617
Renewable - Geothermal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable - Battery	-	-	-	400	565	297	203	-	534	-	-	-	-	191	1,726	-	-	-	-	-	3,916
Renewable - Battery (Long Duration)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage - CAES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage - Pumped Hydro	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nuclear	-	-	-	-	-	-	-	500	-	-	-	-	-	-	-	-	-	-	-	-	500

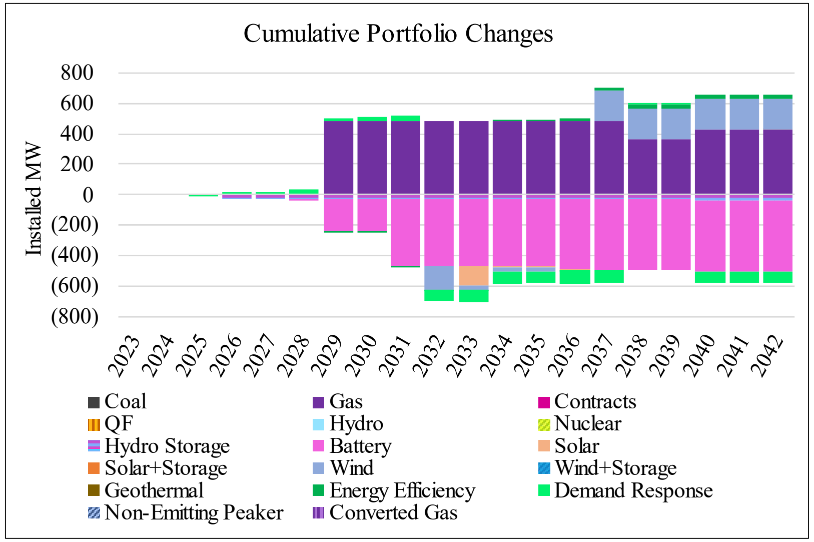




Phase 6 Portfolio less Phase 4 Portfolio

Summary Portfolio Capacity by Resource Type and Year, Installed MW																					
	Installed Capacity, MW																				
Resource	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	Total
Expansion Options																					
Gas - CCCT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gas - Peaking	-	-	-	-	-	-	478	-	-	-	-	-	-	-	-	(113)	-	60	(1)	-	424
NonEmitting Peaker	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DSM - Energy Efficiency	-	-	-	-	-	-	-	-	-	(1)	-	2	12	5	-	9	-	-	-	(2)	25
DSM - Demand Response	-	-	(4)	17	3	16	(8)	7	9	(115)	(9)	(1)	6	(13)	7	87	-	(75)	-	(1)	(74)
Renewable - Wind	-	-	-	-	-	-	-	-	2	(153)	125	-	-	25	204	-	-	-	-	-	203
Renewable - Utility Solar	-	-	-	-	-	-	-	-	-	-	(132)	124	-	-	8	-	-	-	-	1	1
Renewable - Geothermal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable - Battery	-	-	-	-	-	(3)	(212)	-	(224)	-	-	-	-	(18)	(11)	-	-	-	-	-	(468)
Renewable - Battery (Long Duration)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage - CAES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Storage - Pumped Hydro	-	-	-	(27)	-	-	-	-	-	-	-	-	-	-	-	-	-	(8)	-	-	(35)
Nuclear	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-





Existing Thermal Resource Selections

Within all eight phases of the portfolio development example:

- All coal units were selected to run through the end of life:
    - Gas conversion is currently underway for Jim Bridger 1 and 2
    - Gas conversion is selected for Naughton 1 and 2
- All existing gas is selected to run through the end of life
- In the absence of Ozone Transport Rule obligations, Selective Catalytic Reduction and Selective Non-Catalytic Reduction technology is NOT selected by the model for any coal units.

Results vary under other price-policy conditions:

- The high natural gas, high greenhouse gas scenario (HH) and social cost of greenhouse gases scenario (SCGHG) have indicated some potential for early retirements.

Oregon Compliance Study

- **Oregon compliance:**
  - **Small-scale resource (SSR) capacity standard** – at least 10% of the generation capacity used to serve Oregon customers must be renewable and no larger than 20 MW, with certain limited exceptions for biomass used for cogeneration. No cost cap exists in the law.
  - **Clean Energy Plan (CEP) compliance –** House Bill (HB) 2021 established an emission-based standard, with emission rates based on Oregon Department of Environmental Quality rules. Emissions must be 80% below the 2010-2012 Baseline in 2030, falling to 100% below the Baseline in 2040. Unspecified market purchases (not based on a specific generator) are also attributed emissions. Annual compliance cost is capped at a cumulative rate impact of six percent of annual revenue requirement.
- Oregon is allocated emissions based on its SG share of existing and converted natural gas resources, and of market purchases. Oregon has exited coal-fired resources by 2030 and is assumed not to be allocated a share of any new gas resource selections. Renewable resources only indirectly impact emissions and market purchases.
- The optimized portfolio is expected to add small-scale resources, some of which may be additional, and some of which may replace utility-scale resources. Non-emitting peaking resources can reduce the need for market purchases to help ensure CEP compliance.
- Current modeling doesn't include specified (i.e. "clean") purchases, as cost and allocation is uncertain.
- CEP compliance is based on a volume limit, not a specific cost per ton of emissions. However, optimized compliance in any given year is likely to involve a "shadow price" on emissions:
  - Dispatch "as if" there is a $25/ton emissions cost – dispatch higher cost / lower-emitting resources instead of lower cost / higher-emitting resources. Some of the resulting emissions savings cost less than $25/ton, and none will cost more. The cost of the $25/ton shadow price is not reported in the results, but the incremental cost of the dispatch changes is.
  - If emissions exceed the target, increase the shadow price, if below, use a lower shadow price.

Washington Compliance Study

Washington compliance:

- **Social Cost of Greenhouse Gases (SCGHG) price curve** is required for planning and procurement, with no cost cap or performance requirements, but is not part of customer rates.
  - This study is referred to as "Base SCGHG"
- **Clean Energy Transformation Act (CETA)** – Clean energy credit-based compliance, 100% of retail sales starting in 2030
  - From 2030-2044 up to 20% of the compliance requirement can be met with purchases of unbundled RECs.
  - Compliance is calculated over four-year periods
  - Incremental cost is capped at two percent above prior-year retail sales revenue; SCGHG is included in incremental cost calculation.
- Two separate approaches are being reviewed: one uses System Generation (SG) share for all clean resources (consistent with the existing WIJAM allocation methodology), the second uses Washington's share of Oregon, Washington, and California load (CAGW).
  - Relative to Base SCGHG case, CETA compliance requires additional resources and costs increase
  - CETA compliance under SG allocation results in very high costs – this assumes Washington only gets 8% of any new resources, but the other 92% of each new resource is still added to the portfolio. The study adds resources with large amounts of storage to enable REC generation.
  - The CAGW case allocates approximately 22% of all new renewables to Washington. This larger allocation of clean resources to Washington results in smaller total resource additions and lower incremental costs. However, some of these resources are economic for Rocky Mountain Power states, as identified in the MM Base study.
  - The final level of incremental resources requirements is calculated and adjusted after the portfolios for different states are integrated and allocations of each resource are identified. Washington gets 100% of any additions beyond the levels identified for other states.

Preferred Portfolio Integration

PLEXOS Portfolios

Systemwide

- Endogenous
- All options
- **Expected case**

Washington

- Endogenous
- All options
- **Washington specific: SCGHG, CEIP, RPS**

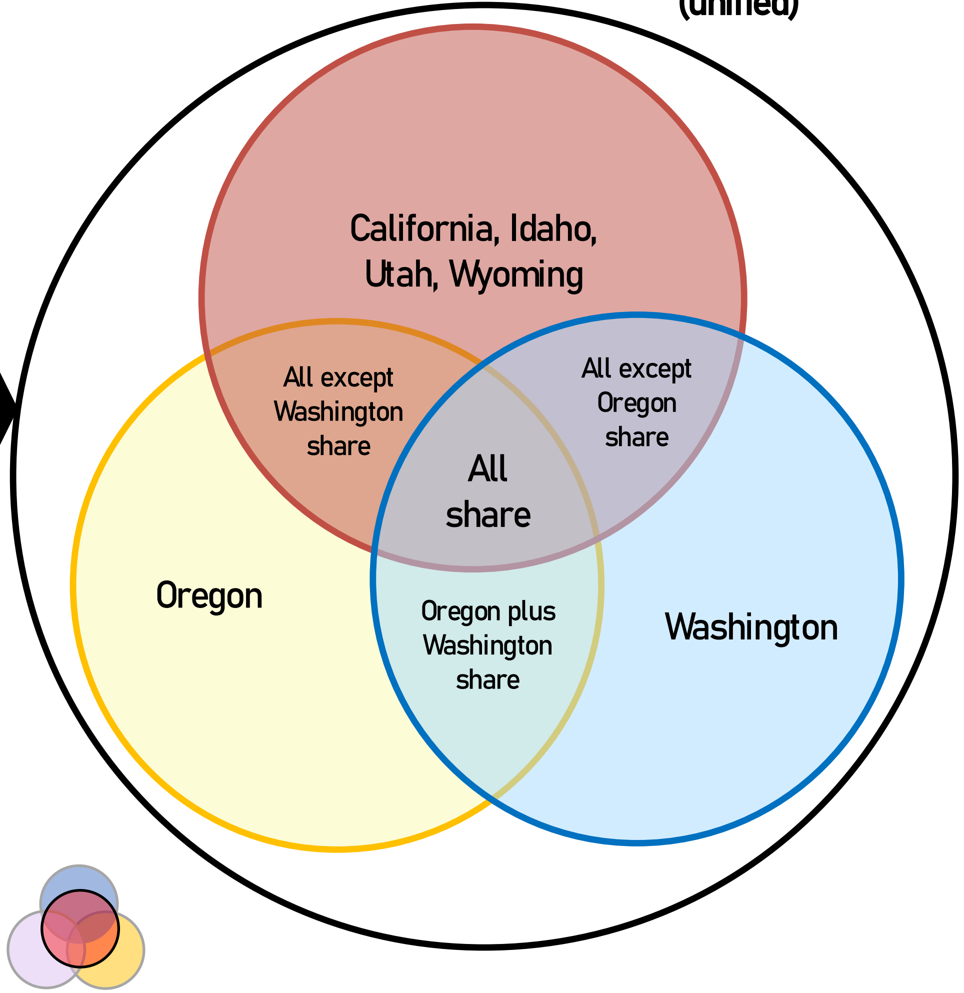
Oregon

- Endogenous
- All options
- **Oregon specific: Small-scale, CEP, RPS**

Selected Resources

- All necessary selections included in preferred portfolio
- Participation sharing based on which portfolio(s) each resource appears in

Preferred Portfolio (unified)



Oregon and Washington sharing is shown, but the process is the same for other states as needed. Showing more states is more difficult to visualize.

Stakeholder Feedback

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Feedback Form Update

- Two feedback forms submitted to date, the second of which is new from Western Resource Advocates.
- Feedback forms and responses can be located at:
  IRP Stakeholder Feedback (pacificpower.net)
- Depending on the type and complexity of the feedback, 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
  - Generally, written responses are provided with the feedback form and posted online at the link above

Next Steps

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2025 IRP Public Input Meeting Schedule

2025 IRP Upcoming Meeting Dates and Milestones *Calendar Year 2024*[1,2]
Thursday, May 2, 2024 – General Public Input Meeting 3
Wed-Thurs June 26-27, 2024 – General Public Input Meeting 4
Wed-Thurs August 14-15, 2024 – General Public Input Meeting 5
Wed-Thurs September 25-26, 2024 – General Public Input Meeting 6
➢ September timeframe – Assumptions are locked down for November and December model runs
Wed-Thurs November 6-7, 2024 – General Public Input Meeting 7
Wed-Thurs December 18-19, 2024 – General Public Input Meeting 8
Calendar Year 2025
➢ January 1, 2025 - Distribution of the 2025 Draft IRP
Wed-Thurs January 22-23, 2025 – General Public Input Meeting 9
Wed-Thurs February 26-27, 2025 – General Public Input Meeting 10
➢ March 31, 2025 – Filing of the 2025 IRP

1. *Washington law accelerates the IRP draft and final filing by 3 months. Alignment for Washington has been achieved through approved parts of a waiver request. The CEIP schedule remains out-of-sync.*
2. *The Public Input Meeting schedule has been reviewed to reasonably avoid conflicts with State Commission schedules and known events affecting stakeholders.*

Additional Information

- 2025 IRP Upcoming Public Input Meetings:
  - May 2, 2024 (Thursday)
- Public Input Meeting and Workshop Presentation and Materials:
  - Public Input Process (pacificorp.com)
- 2025 IRP Feedback Forms:
  - IRP Stakeholder Feedback (pacificpower.net)
- IRP Email / Distribution List Contact Information:
  - IRP@PacifiCorp.com
- IRP Support and Studies:
  - IRP Support & Studies (pacificorp.com)