



# 2023 Integrated Resource Plan IRP Public-Input Meeting

June 10, 2022



# Agenda



(times shown in Pacific time zone)

- 9:00 - 9:15 a.m. – Introductions
- 9:15 - 10:00 a.m. – Greenhouse Gas and Renewable Portfolio Standards
- 10:00 - 10:45 a.m. – State Policy Update
- 10:45 - 11:45 a.m. – Load Forecast Development
- 11:45 – 12:30 p.m. – Lunch Break
- 12:30 – 1:45 p.m. – Interconnection Options
- 1:45 – 2:45 p.m. – Supply-Side Resource Alternative Fuels
- 2:45 - 3:00 p.m. – 2021 IRP Acknowledgement Update
- 3:00 - 3:15 p.m. – Stakeholder Feedback
- 3:15 – 3:30 p.m. – Wrap-Up / Next Steps



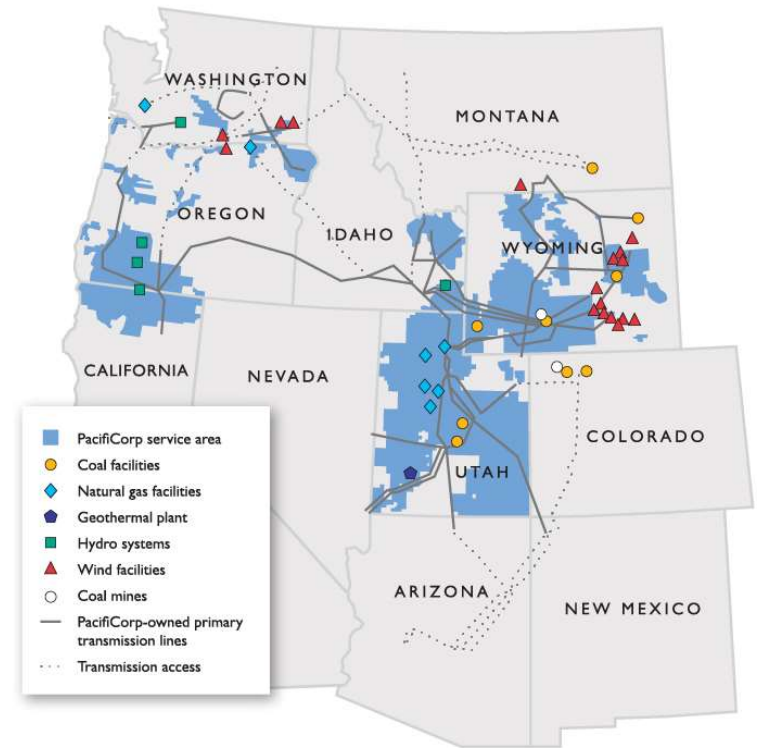
# Greenhouse Gas and Renewable Portfolio Standards



# Clean Energy Overview



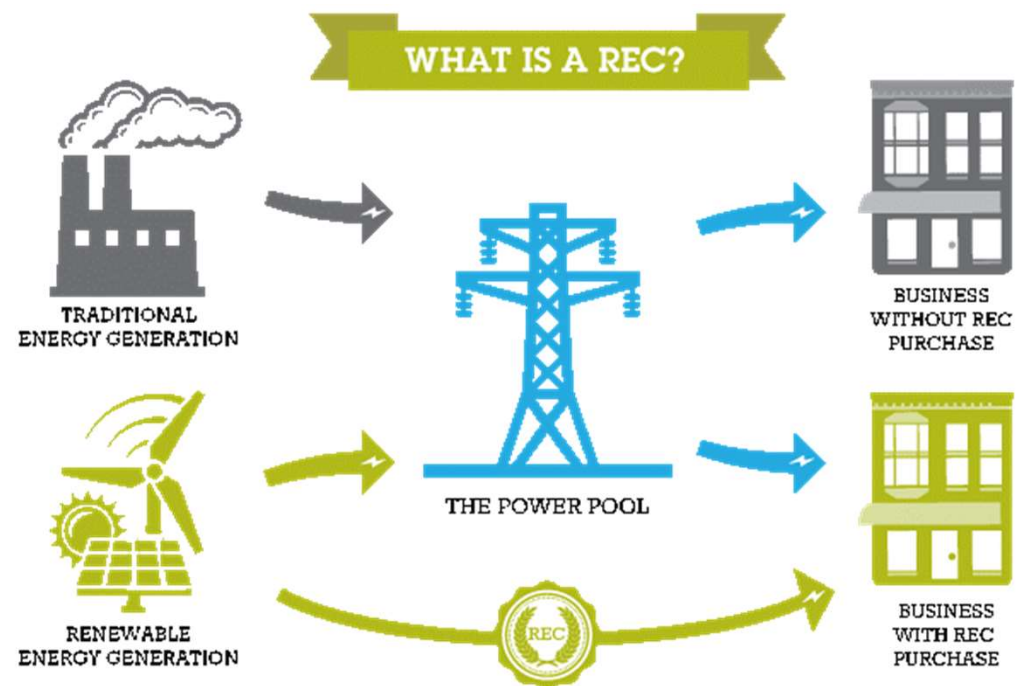
- PacifiCorp is subject to multiple clean energy laws and regulations
- Accounting principles vary widely across states and programs, but generally fall in two categories:
  - Greenhouse Gas Emissions
  - Clean Energy Production / Renewable Energy Credits (RECs)
- IRP does generate emissions data as a modeling output
- IRP does not generate REC production information or define clean energy



# Key Terms & Definitions

- **“Renewable Energy Certificate (REC)”** - 1 MWh of renewable energy generation
- RECs are tracked outside the energy grid
- RECs can be sold/transferred separately from the energy component
- For Western Electricity Coordinating Council (**WECC**), RECs are tracking in the Western Renewable Energy Generation Information System (**WREGIS**)

- **“Bundled”** - REC transferred with energy\*
- **“Unbundled”** - REC transferred without energy
- **“Brown or Null Power”** - Renewable energy without the REC



# “Renewable” Verses “Clean”

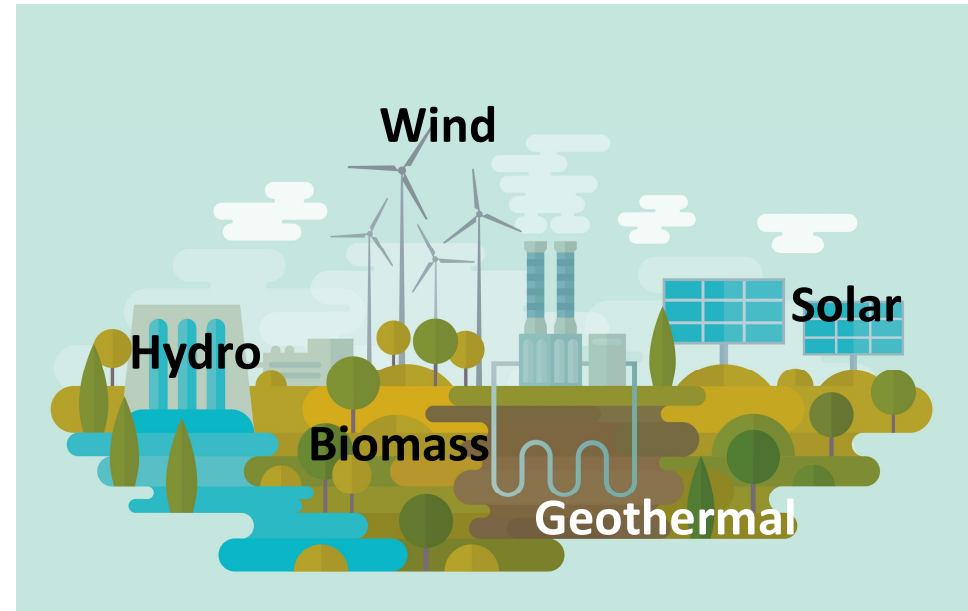


- **Renewable Energy**

- Energy from a source that is not depleted when used.
- “Renewables” are:
  - Biomass
  - Geothermal
  - Solar
  - Wind
  - Hydropower\*
- “Clean” also includes:
  - Nuclear
  - Hydrogen /Fuel Cell

- **Clean Energy**

- Energy that does not pollute the atmosphere (or environment).



*\*Depending on policy some hydropower may or may not be considered renewable*



# Greenhouse Gas Emissions



- **Global Warming Potential (GWP)** Measure of how much heat a greenhouse gas traps in the atmosphere per year, relative to carbon dioxide
- Expressed as a factor of carbon dioxide (whose GWP is standardized to 1)
- Carbon Dioxide equivalent (CO<sub>2</sub>e)

Greenhouse Gas (GHG)	Global Warming Potential (GWP)*	Atmospheric life (Years)
Carbon dioxide (CO <sub>2</sub> )	1	variable
Methane (CH <sub>4</sub> )	21	12
Nitrous Oxide (N <sub>2</sub> O)	310	121
Sulfur Hexafluoride	23,900	114

\* GWP over 100 Years

# Environmental Rules and Regulations



## Renewable Portfolio Standards (RPS) or Goals (RPG)

- Renewable targets as percent of load
- Use Renewable Energy Credits (RECs) to demonstrate compliance

- California
- Oregon
- Washington
- Utah

## Greenhouse Gas (GHG) Emissions

- Report emissions attributed to state, used to show performance under other requirements such as Cap and Trade or state targets.

- California
- Oregon
- Washington

## Power Source Disclosure (PSD)

- Annual disclosure of energy mix to customers and public.
- Based on energy allocated to customers in the state.
- Most cases requires RECs to support renewable claims.

- California
- Oregon
- Washington
- Idaho

## Cap-and-Trade

- A system for controlling carbon emissions by setting limits or **cap** on emissions production but allows further capacity by **trading** of carbon allowances. As the cap is reduced, the allowance prices increase putting market pressure on businesses to reduce emissions.

- California
- Washington



# State Specific Requirements



## California

- RPS - 33% renewables by 2020; 60% by 2030; 100% by 2045
- Reduce Emissions below 1990 levels to 40% by 2030 and 80% by 2050

## Oregon

- RPS – 27% renewables by 2025 and 50% by 2040
- Implement coal phase-out by 2030;
- Small-scale renewable capacity, 10% of total nameplate must be from resources of 20 MW or less by 2030
- Reduce emissions 80% below baseline (2010-2012 avg.) by 2030, 90% by 2035, and 100% by 2040

## Washington

- RPS – 15% by 2020
- Carbon-neutral electricity sales by 2030 (80% bundled RPS / 20% alternative compliance)
- Phase out coal by December 31, 2025

## Utah

- RPG - 20% by 2025



# State Policy Update



# Oregon House Bill 2021 (HB2021)

## Clean Energy Plan Overview



### Greenhouse Gas Targets

- Requires retail electricity providers to reduce greenhouse gas emissions associated with electricity sold to Oregon consumers to 80% below baseline emissions levels by 2030,
- 90% below baseline emissions levels by 2035, and
- 100% below baseline emissions levels by 2040.

### Clean Energy Plan

- Requires electric companies to develop clean energy plans and electricity service suppliers to report information for meeting clean energy targets
- Company anticipates first Clean Energy Plan to be filed in 2023 as an important component of its IRP
- Requires electric companies to convene a Community Benefits and Impact Advisory Group

# Oregon Clean Energy Plan Engagement Strategy



- Filed **initial** customer engagement proposal with Commission on April 21, 2022
- Provides mechanisms and processes for meaningful stakeholder engagement on utility initiatives, including the Distribution System Plan and the Clean Energy Plan
- Proposes a [hybrid stakeholder engagement model](#)
  - Relies upon existing engagement processes within IRP
  - Develops new processes – Community Input Group
- Updated Engagement Strategy to be submitted by June 21; it will continue to be refined over time
- Questions or comments on Clean Energy Plan can be emailed to [OregonCEP@PacifiCorp.com](mailto:OregonCEP@PacifiCorp.com)

# Washington Clean Energy Transformation Act (CETA) Overview



- Enacted in 2019 as Senate Bill 5116; established three primary standards:

## **2025 – No coal in Washington allocation of electricity**

Coal-fired resources cannot be included in customer rates as of December 31, 2025

## **2030 – Greenhouse Gas Neutral**

Retail sales of electricity must be GHG neutral by January 1, 2030

Multi-year compliance periods:

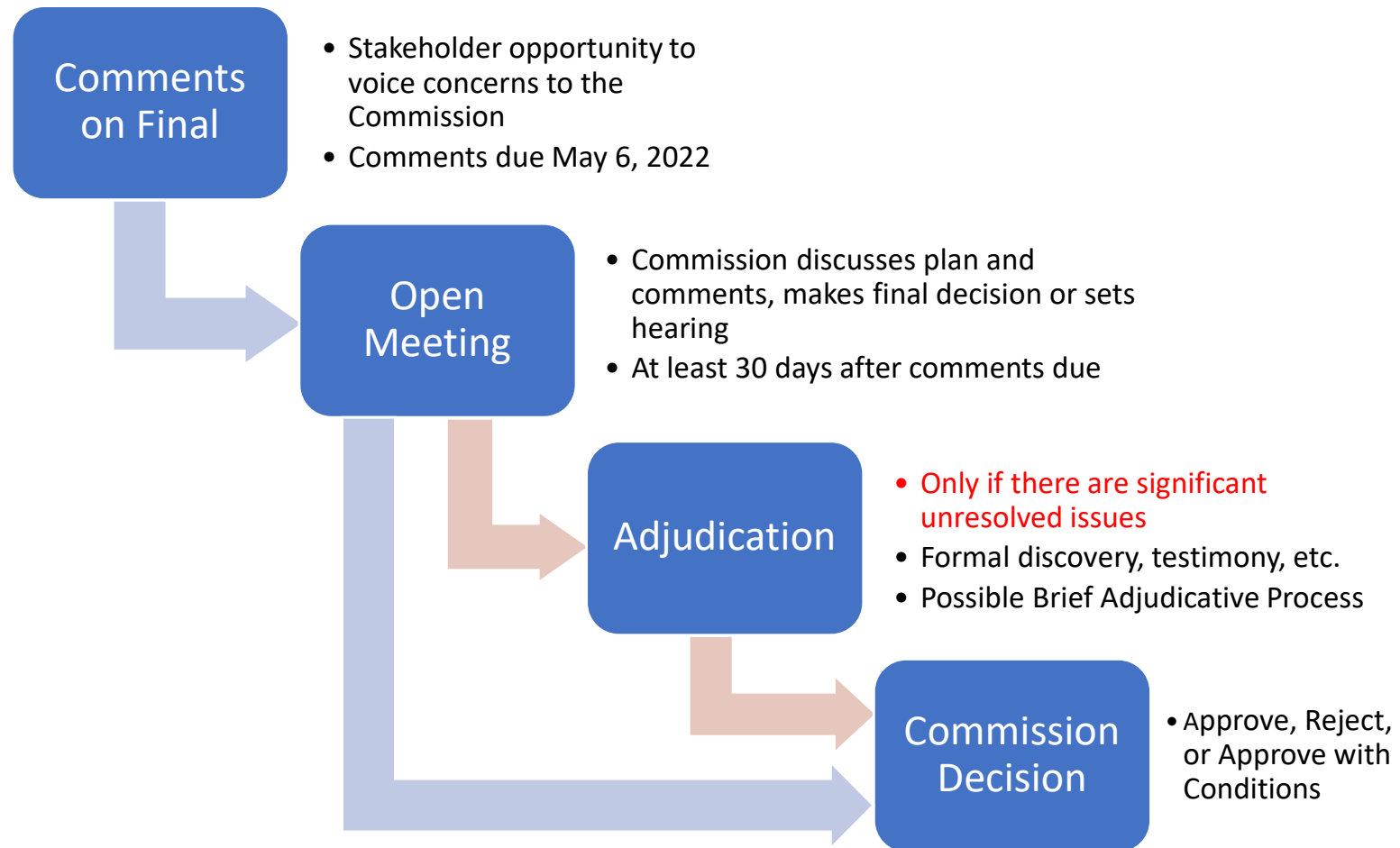
- January 1, 2030 – December 31, 2033
- January 1, 2034 – December 31, 2037
- January 1, 2038 – December 31, 2041
- January 1, 2042 – December 31, 2044

## **2045 – 100% Renewable and non-emitting**

100% of Washington retail load must be met by renewable and non-emitting resources by January 1, 2045

CETA also directs equitable distribution of energy and non-energy benefits and reduction of burden to vulnerable populations and highly impacted communities

# Washington Clean Energy Implementation Plan (CEIP) Approval Process



# Washington Clean Commitment Act



## Senate Bill 5126 - The Climate Commitment Act (2021)

- Covers all emitters in the state with emissions equal to or greater than 25,000 metric tons of carbon dioxide equivalent per year, including fuel importers and natural gas suppliers
- Electric utilities subject to CETA are allocated no-cost allowances in sufficient quantity to mitigate the cost burden of the program on Washington electricity customers in the state through 2045





# Washington Clean Commitment Act



- Established a greenhouse gas cap and trade program to be implemented by the Department of Ecology.
  - A system for controlling carbon emissions by setting limits or **cap** on emissions an organization may produce but allows further capacity by **trading** of carbon allowances. The idea is that as the cap is reduced, the allowance prices increase putting market pressure on businesses to reduce emissions.
- Requires emissions reductions below 1990 levels to 45% in 2030, 70% in 2040, 95% by 2050



Directs program revenue from allowance auction to clean transportation, natural climate resiliency, clean energy transition and assistance, and energy efficiency projects.

# Washington Clean Commitment Act



Washington Department of Ecology has three sets of rulemakings to prepare the program for administration starting January 1, 2023

Rulemaking	Adoption
Cap-and-invest program rules ( <a href="#">Chapter 173-446 WAC</a> )	Fall 2022
Criteria for emissions-intensive trade-exposed industries ( <a href="#">Chapter 173-446A WAC</a> )	June 1, 2022
Reporting emissions of greenhouse gases ( <a href="#">Chapter 173-441 WAC</a> )	February 9, 2022

- GHG obligation applies to:
  - In-state facilities (PacifiCorp Chehalis)
  - Emissions from imported electricity by first jurisdictional deliverer

# Wyoming Senate File 159 (SF 159)



- **Senate File 159 – Wyoming Coal-Fired Generation (2019)**

- Requires Rocky Mountain Power to attempt to sell certain coal-fired generation units
- Customer protection language requires the Public Service Commission to determine if accepting an offer would reduce costs/risks to customers as compared to retiring the facility
- If the Public Service Commission determines that the public utility did not make a good faith effort to sell the retired coal-fired generation plant, a public utility can not include any recovery of or earnings on specific new capital costs
  - Commission finalized application filing requirements within rules that went into effect on January 26, 2021



# Wyoming Senate File 21 (SF 21)



- **Senate File 21 – Coal-Fired Electric Generation Facilities (2020)**
  - This bill amends SF 159 to allow the purchaser to sell the output directly to a Rocky Mountain Power customer with a load greater than 1 MW



# Wyoming House Bill 200 (HB200)



- **House Bill 200 – Reliable and Dispatchable Low-Carbon Energy Standards (2020)**
  - The Wyoming Public Service Commission has developed low-carbon energy portfolio standards (EPS) specifying no less than 20% percent of PacifiCorp's electricity to be generated from coal-fired generation utilizing carbon capture technology by 2030 (as a percentage of Wyoming retail sales)
    - Unless the 20% standard is not economically or technically feasible
  - In effect as of January 3, 2022
  - Only applies to generation allocated to Wyoming customers and generation units located in Wyoming
  - Cost caps specified in the legislation limited to 2% total customer impact
  - PacifiCorp has proposed a 0.5% tariff mechanism to begin recovering costs incurred to comply with the low-carbon EPS
  - Requirement to study 20%, 40%, 60% and 80% standards





# Wyoming House Bill 166 (HB166)



## **House Bill 166 – Rebuttable Presumption Against Retirement of Coal/Natural Gas-Fired Electric Generation Facilities (2021)**

- Establishes a rebuttable presumption against retirement of coal/natural gas facilities
- Commission cannot approve retirement unless utility establishes cost savings to customers, retirement will not result in insufficient amount of reliable/dispatchable capacity to serve WY customers, and will not adversely impact dispatchability or reliability of service to customers



# Wyoming House Bill 131 (HB 131)



## **House Bill 131 – Exempting Limitation of Cost Recovery for Replacement Generation (2022)**

- Exempts advanced nuclear generation from the cost recovery limitation for generation built to replace retiring coal-fired units





# Utah House Bill 411 (HB 411)



## House Bill 411, Community Renewable Energy Act (2019)

- Allows municipalities, counties, and towns that passed a renewable resolution before Dec. 31, 2019, to work with PacifiCorp to create a program to transition to net-100% renewable energy by 2030
- 18 communities passed the resolution and are currently working with PacifiCorp to design the program to submit it to the Public Service Commission for approval
- Customers within a participating community may opt-out of the program and maintain existing rates, and the legislation prohibits cost-shifting from program participants to non-participants





# Load Forecast Development



# Load Forecast Overview



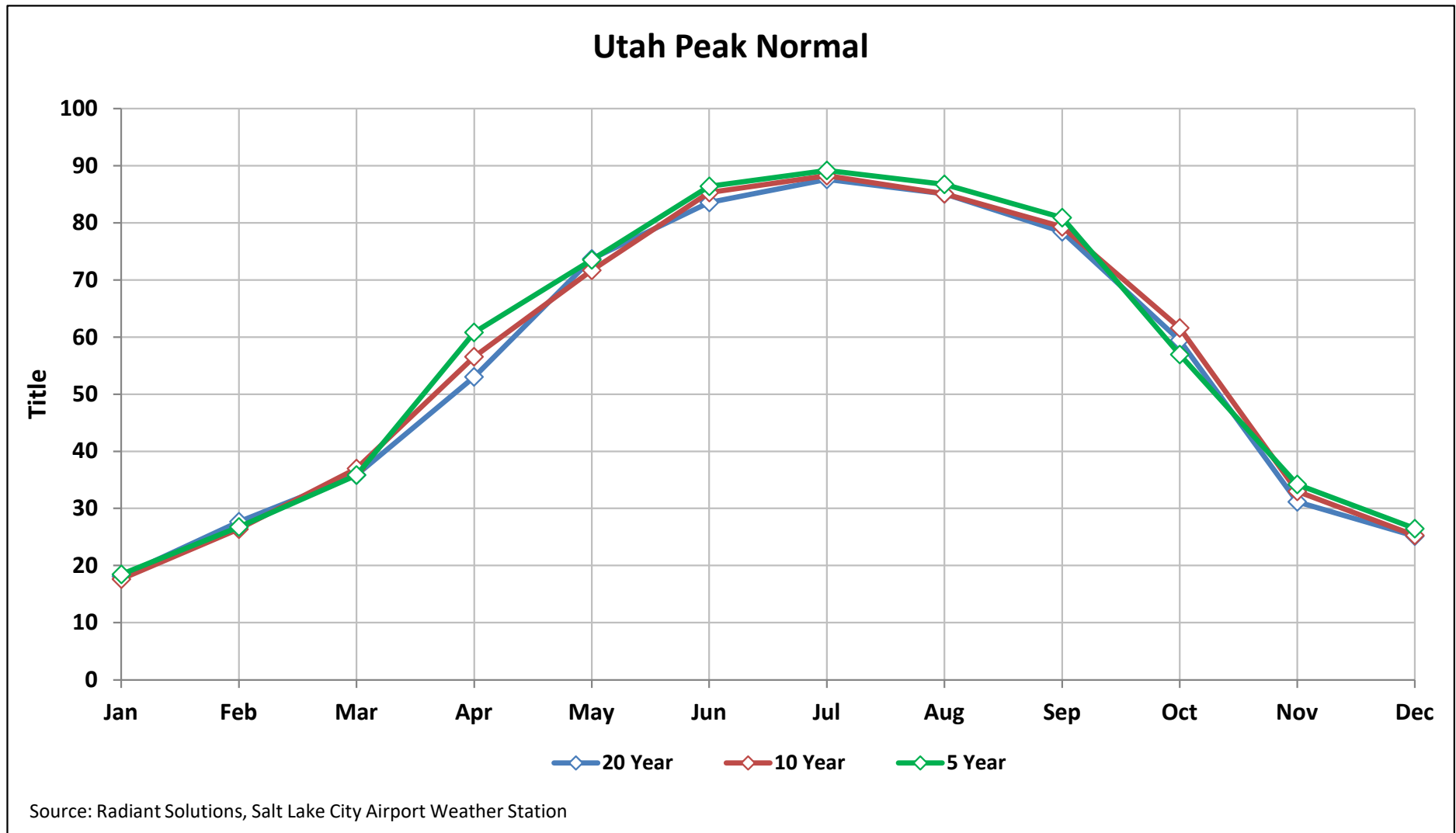
- Monthly regression models
  - Residential loads are forecast in two parts:
    - A customer model based on population or household
    - A use-per-customer model using end-use stocks and efficiency trends (Statistically Adjusted End-Use Model)
  - Commercial and Industrial models
    - Remove large customer load from historical actual load
    - Forecast remainder of the class using econometric models
    - Add large customer forecast
  - Jurisdictional peak model
    - Based on 20-year peak producing weather
- Post-model adjustments
  - Electric vehicles and building electrification
  - Private generation
  - Demand-side management
- Hourly Load forecast
  - Monthly loads from class level models
  - Historical hourly jurisdictional/state loads
  - Daily weather (historical, chaotic normal forecast weather)
  - Jurisdictional peaks from peak models

# Methodology Updates

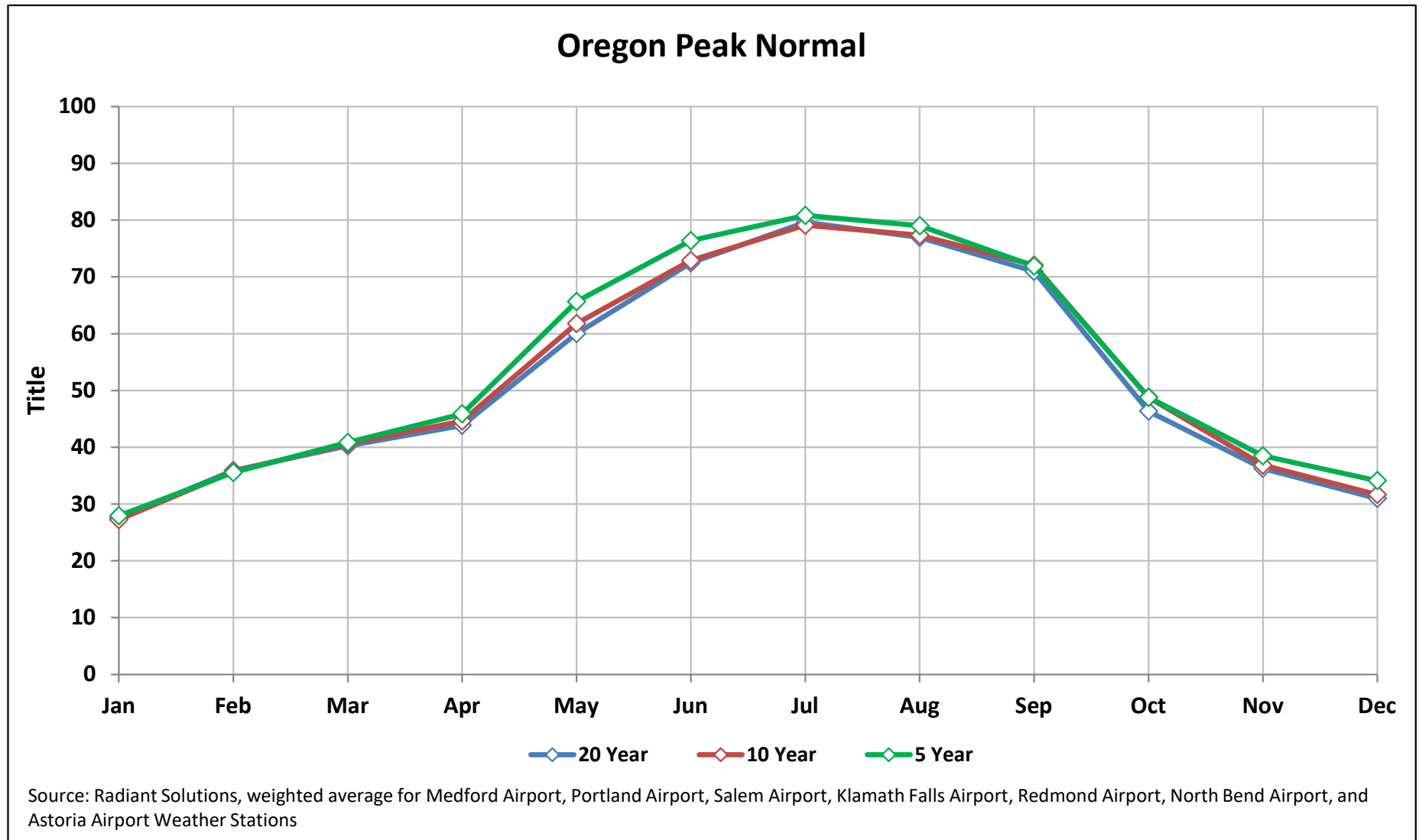


- Jurisdictional hourly methodology
  - Jurisdictional hourly load shape was previously based on 2006 through the present actual hourly load
  - PacifiCorp has updated this practice to use the most recent 5-year period to capture more recent load patterns
  - Update increases the coincident peak by approximately 25 MW
- Chaotic regular weather pattern
  - Chaotic normal weather is the daily weather pattern used to ensure the average amount of diversity/variability in observed weather is in hourly load and system coincident peak forecast
  - Since 2013, the occurrence of very large weather fronts have begun to more regularly impact both Pacific Power and Rocky Mountain Power simultaneously
  - After testing three timeframes, the 2013 to 2020 timeframe was selected for the 2023 IRP as the most representative of current weather patterns
  - Update increases coincident peak by approximately 160 MW

# Utah Peak Producing Weather



# Oregon Peak Producing Weather



# Temperature Impacts



- The Company's load forecast is based on normal weather defined by the 20 years of 2002-2021
- The peak forecast is based on average monthly historical peak-producing weather from 2002-2021
- The 2021 IRP evaluated climate change impacts on load as sensitivity, and the 2023 IRP will also consider climate change impacts
- Climate change projections were incorporated into the 2021 IRP load and peak forecast by replacing normal weather
  - The climate change scenario relied on projected temperature projections from the United States Bureau of Reclamation (Reclamation), West-Wide Climate Risk Assessments: Hydroclimate Projections Study (March 2016)
  - Reclamation has published updated temperature projections (March 2021) which are higher than temperature projections used in the 2021 IRP Climate Change scenario





# Projected Temperature Change

Reclamation Study (March 2016) - 2021 IRP		2020		2050	
		Low	High	Low	High
Kalmath River near Kalmath	California	1.4	2.4	2.6	4.4
Snake River near Heise	Idaho	1.6	3.1	3.1	5.6
Klamath River near Seiad Valley	Oregon	1.4	2.5	2.7	4.5
Green River near Greendale	Utah	1.7	3.1	3.1	5.7
Yakima River at Parker	Washington	1.5	2.6	2.7	5.0
Green River near Greendale	Wyoming	1.7	3.1	3.1	5.7
Reclamation Study (March 2021)		2020		2050	
		Low	High	Low	High
Kalmath River near Kalmath	California	1.7	2.6	3.6	5.2
Snake River near Heise	Idaho	1.6	3.0	4.1	5.9
Klamath River near Seiad Valley	Oregon	1.8	2.7	3.7	5.3
Green River near Greendale	Utah	1.8	3.3	4.2	6.3
Yakima River at Parker	Washington	1.8	2.8	3.6	5.6
Green River near Greendale	Wyoming	1.8	3.3	4.2	6.3
Temperature Change		2020		2050	
		Low	High	Low	High
Kalmath River near Kalmath	California	0.3	0.2	1.0	0.8
Snake River near Heise	Idaho	0.0	-0.1	1.0	0.3
Klamath River near Seiad Valley	Oregon	0.4	0.2	1.0	0.8
Green River near Greendale	Utah	0.1	0.2	1.1	0.6
Yakima River at Parker	Washington	0.3	0.2	0.9	0.6
Green River near Greendale	Wyoming	0.1	0.2	1.1	0.6

Reclamation Study project future decade temperature changes over the average 1990 temperatures for multiple locations. This is used to estimate average daily temperature and the associated HDDs/CDDs under a climate change future for PacifiCorp's service territory

# Load Forecast 2023 IRP Sensitivities



- 2023 IRP load forecast sensitivities:
  - 1-in-20 year (5% probability) extreme historical peak producing weather scenario
  - High and low load scenarios
    - High and low economic growth
    - 95% confidence intervals
  - High and low private generation
  - Climate Change – Will evaluate the appropriateness of adopting climate change temperatures within the base forecast



# Interconnection Options





# What is Interconnection?

- Modifications, additions, and upgrades necessary to physically and electrically connect a generating facility to the transmission system.
  - Essentially: "plugging in" while maintaining the reliability of the transmission system.
- Requirements can be impacted by:
  - Generation facility type and detailed project specifications
  - Location
  - Prior/existing generation facilities and load
  - The existing transmission system and planned or pending upgrades.
- Studies needed to identify interconnection requirements are interdependent and extensive.
- In 2020, PacifiCorp transitioned from a serial queue study process (one generator at a time) to an annual cluster study process (one study for all new requests in a given area).
- Details on signed interconnection agreements and pending requests are available at:
  - <https://www.oasis.oati.com/ppw/> (select Generation Interconnection in the sidebar)

# Interconnection Queues



- There are many queues of requests:
  - **Serial queue:** Signed agreements and near-final serial queue requests.
  - **Transition Cluster:** Remaining serial queue requests and 2020 requests.
  - **Cluster Study 1:** Spring 2021 requests.
  - **Cluster Study 2:** Spring 2022 requests.
  - **Colstrip:** Interconnection to jointly-owned Colstrip transmission assets.
  - **Surplus:** Interconnection of additional resources at the same point as an existing generator, with aggregate output not exceeding the existing limit.
  - **Provisional:** Interconnection study identifies maximum permissible output before transmission upgrades that are not yet in service.
  - **Oregon Community Solar:** projects under 3MW seeking to participate in the Oregon Community Solar program.
  - *Informational Studies:* Informational only, proposal and results are not considered part of later interconnection requests and cannot lead to an interconnection agreement.

# Queued Resources



- A variety of interconnection requests are pending:
- Serial: mostly signed LGIAs.
- Transition: some signed, some restudies/facilities studies ongoing.
- Cluster 1: studies completed Nov. 2021, most requests awaiting restudy after other projects withdrew.

Serial Queue MW		State						Grand Total
Row Labels		CA	ID	OR	UT	WY		
Biogas				1			1	
Hydro		4	1	8			13	
Natural Gas					19	0	19	
Pump Storage				416			416	
Solar				244	366	80	690	
Solar & Battery Storage				170	752	315	1,236	
Waste Heat					6	21	27	
Wind			-	-	100	196	296	
Grand Total		4	1	839	1,243	612	2,699	

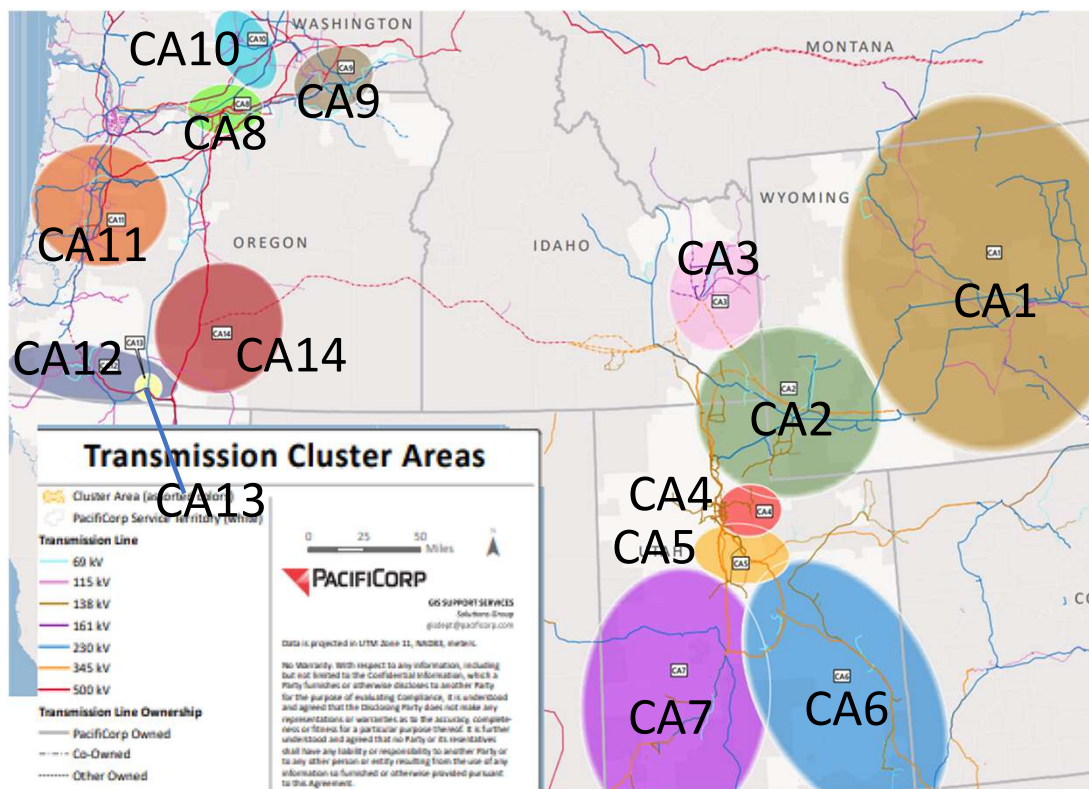
Transition Cluster MW		State						Grand Total
Row Labels		ID	OR	UT	WA	WY		
Geothermal			10	31			41	
Nuclear		600					600	
Solar			44		13		57	
Solar & Battery Storage			200	360		80	640	
Grand Total		600	254	391	13	80	1,338	

Cluster 1 MW		State						Grand Total
Row Labels		ID	OR	UT	WA	WY		
Geothermal				40			40	
Solar				200		29	229	
Solar & Battery Storage		200	1,098	2,173	450	300	4,221	
Wind				2		500	502	
Wind & Battery Storage				6			6	
Grand Total		200	1,098	2,421	450	829	4,998	

\* Excludes committed resources and 2020AS RFP Final Shortlist



# Cluster Study 1 – initial results





Cluster	Major Lines Cost (\$M)	Initial MW	Pending MW	Description
CA01	347			Shirley Basin-Anticline 500 kV, 170 miles
CA01	940	2,818	829	GWS 2: Aeolus-Clover 500 kV, 416 miles
CA01	62			Windstar-Shirley Basin 230 kV, 59 miles
CA02	162	399	-	Various Rebuilds (ERIS)
CA02	45.6			NRIS upgrades
CA03	137			Goshen-Populus 345 kV, 82 miles (ERIS)
CA03		707	200	
CA03	353			Populus-Terminal 345 kV, 137 miles (NRIS)
CA04	1.3	57	8	90th South-Oquirrh, 138 kV
CA05	42	1,948	1,298	Black Rock-Sigurd 230 kV, 64 miles
CA06	142			Clover-Emery 345 kV, 77 miles
CA06	68	1,275	775	Carbon-Spanish Fork 138 kV (rebuild), 52 miles
CA07				Sigurd-Parowan-West Cedar 345kV
CA07	274			Rebuild, 120 miles
CA07	142	1,795	340	Clover-Emery 345 kV, 77 miles (duplicate)
CA07	126			Clover-Sigurd 345 kV, 68 miles
CA08	n/a - withdrawn			
CA09	0.7			Communications Only (ER)
CA09		200	-	Walla Walla - Wine Country 230 kV, 60 miles
CA09	38			
CA10	~	450	450	
CA11	2.8	398	199	Various Rebuilds
CA12	182			Various Rebuilds (140 miles)
CA12	121	899	499	Klamath Falls - Corral 230 kV, 174 miles
CA13	none	2	2	
CA14	~	400	400	
Total		11,348	4,998	

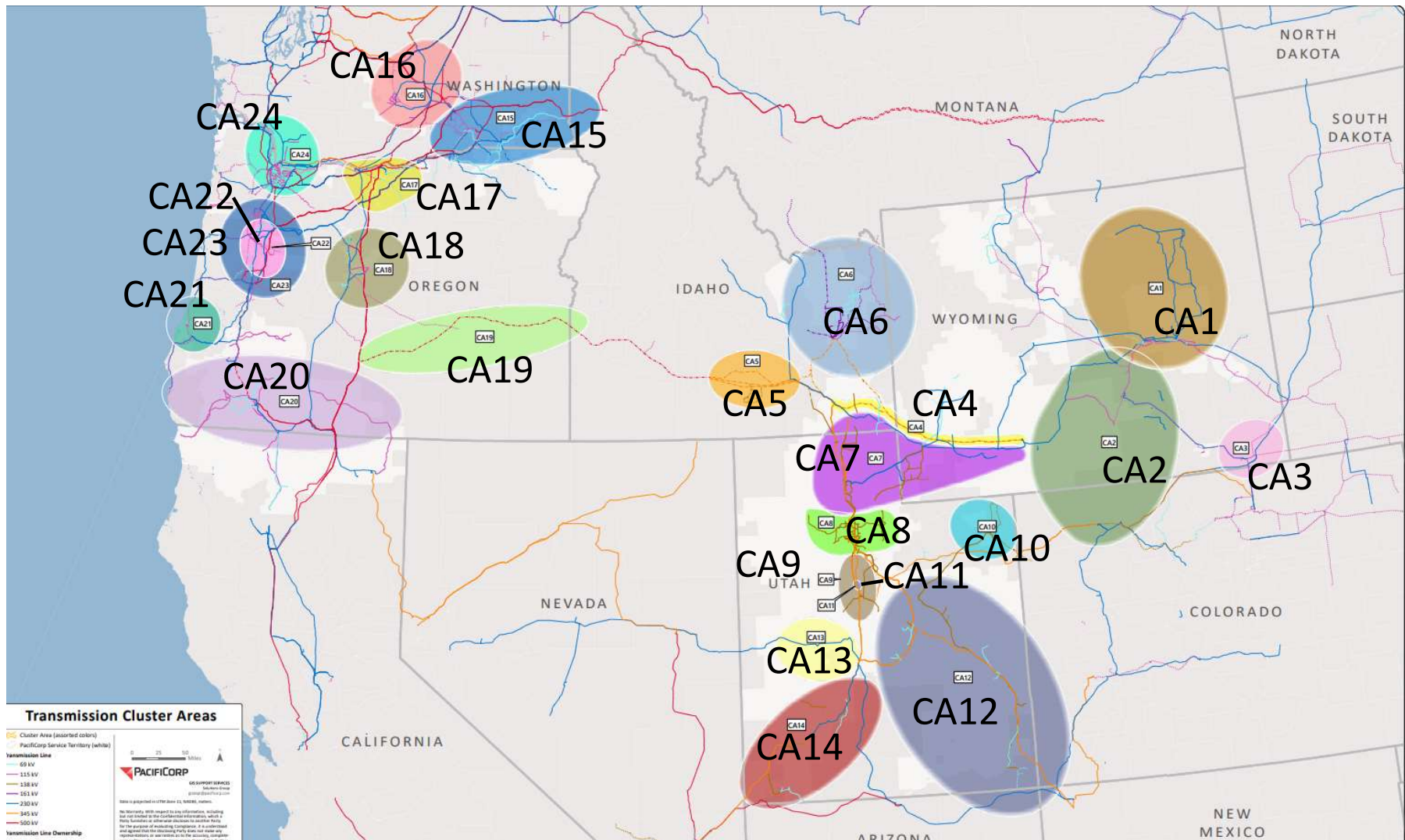


# Cluster Study 2



Cluster 2 MW		State 								
Row Labels		CO	ID	MT	OR	UT	WA	WY	Grand Total	%
Battery Storage			350		2013	3676	450	550	7039	17%
Geothermal						115			115	0%
Natural Gas								48	48	0%
Nuclear								500	500	1%
Pump Storage			1800		1000	1800	1100	1500	7200	17%
Solar			107		190	708		199	1204	3%
Solar & Battery Storage		220	2177	350	6433	7316	1343	2784	20623	50%
Wind			359		200	456		3599	4614	11%
Wind & Battery Storage							199		199	0%
<b>Grand Total</b>		<b>220</b>	<b>4793</b>	<b>350</b>	<b>9836</b>	<b>14072</b>	<b>3092</b>	<b>9179</b>	<b>41542</b>	100%
<b>%</b>		<b>1%</b>	<b>12%</b>	<b>1%</b>	<b>24%</b>	<b>34%</b>	<b>7%</b>	<b>22%</b>	<b>100%</b>	

# Cluster Study 2 – results Nov. 2022



# Existing Interconnections



- The 2021 IRP included “brownfield” interconnection capacity based on the capacity of retiring coal and certain gas resources:
- This can be applied more broadly to all resources:
  - Expiring PPAs have the potential to continue selling to the Company or may retire and free up interconnection capacity.
- PacifiCorp is considering modeling expiring non-QF PPAs as a resource option – using proxy costs and the existing resource type/technology/operating characteristics
- The OPUC directed PacifiCorp to forecast a renewal rate for QF contracts.
  - The specific renewal rate has not yet been developed, but PacifiCorp expects to apply it as a percentage to all QFs, following their current contract term.
  - For example, with a 50% renewal rate, a 10 MW QF would be reflected as a 5 MW resource following the end of the current term.
  - Unlike non-QF PPAs, QFs will not be options for the model to pick, as the Company must purchase what is offered by QFs.

# Surplus Interconnections



- Surplus interconnections add more generation to an existing interconnect:
  - This can be the same type: wind repowering resulted in higher nameplate capacity than the existing interconnection.
  - This can be a new type, creating a hybrid.
  - The total MW output at any given time cannot exceed the original interconnection capacity.
- PacifiCorp has submitted surplus interconnection requests to evaluate the addition of solar to several wind resource sites in Wyoming.



# Supply-Side Resource Alternative Fuels



# Hydrogen, Ammonia, Natural Gas, Biomass

- Fuel Use in Perspective
- Colors of Hydrogen and Ammonia
- Green Hydrogen Process
- Round Trip Efficiencies
- Advantages and Disadvantages
- Supply Side Resources



# Fuel Use In Perspective



- Average annual home heating:
  - EIA: Average U.S. Home – 49 MMBtu (2015)
  - AGA: Mountain – 58 MMBtu (2020)
  - AGA: Pacific – 37 MMBtu (2020)
- Lakeside generating facility
  - Block 1 – 3,956 MMBtu/hour = 65.9 MMBtu/minute
  - Block 2 – 4,696 MMBtu/hour = 78.3 MMBtu/minute
  - Total – 8,652 MMBtu/hour = 114.2 MMBtu/minute

[Use of energy in homes - U.S. Energy Information Administration \(EIA\)](#)  
[2022 Gas Facts Entire Document.pdf \(aga.org\)](#)

# Fuel Use In Perspective



- For Lakeside generating facility:
  - One hour of fuel use would heat one average U.S. home for 140 years
  - Forty-three minutes of fuel use would heat one average U.S. home for 100 years
  - One hour of fuel use would heat one home in the Mountain region for 118 years
  - Fifty-one minutes of fuel use would heat one home in Mountain region for 100 years
  - One hour of fuel use would heat one home in the Pacific region for 185 years
  - Thirty-three minutes of fuel use would heat one home in Pacific region for 100 years

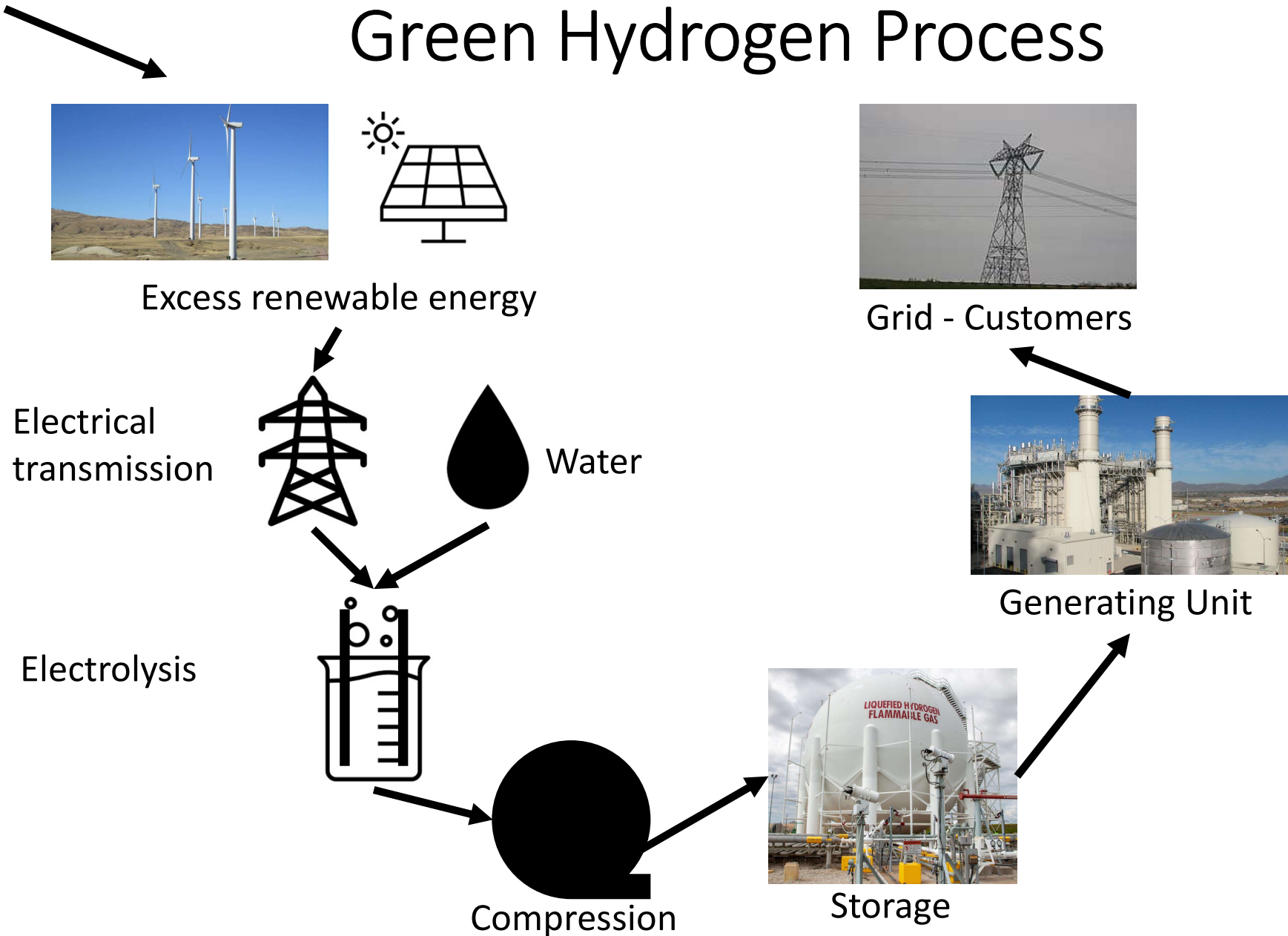
# Colors of Hydrogen



- Green Hydrogen – Hydrogen produced from a carbon-neutral source such as excess wind and solar generation
- Turquoise Hydrogen – Hydrogen produced from natural gas by a thermal process using methane pyrolysis resulting in hydrogen and solid carbon
- Blue Hydrogen – Hydrogen produced from natural gas using steam reforming process. Carbon dioxide is captured and stored
- Gray hydrogen – Hydrogen produced from coal, oil or natural gas. Carbon dioxide is released into the environment



# Green Hydrogen Process





# Round Trip Efficiency

- Green hydrogen – 18% to 46% <sup>1</sup>
- Pumped-storage hydroelectric – 70% to 80% <sup>1</sup>
- Compressed air energy storage – 42% to 67% <sup>1</sup>
- Flow batteries (less mature) – 60% to 80% <sup>1</sup>
- Lithium-Ion batteries – 80% to 93%

1 - DiChristopher, T. (24 June 2021) Hydrogen technology faces efficiency disadvantage in power storage race, S&P Global Market Intelligence. <https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/hydrogen-technology-faces-efficiency-disadvantage-in-power-storage-race-65162028>

# Fuel Characteristics



Fuel	Heating Value	Heating Value	Flame Temp	Nitrogen Content	Infrastructure
	Btu/lb	Btu/ft <sup>3</sup>	°F	% weight	
Natural Gas	22,453	1,089	~3,565	0%	Mature
Hydrogen	61,127	343	~4,000	0%	Limited to none
Ammonia	9,670	435	~3,270	83%	None
Biomass	7,000 to 9,000	N/A	Varies	0.2% to > 1%	Limited



# Green Hydrogen



- Disadvantages
  - Immature technology
  - Low volumetric energy density – large pipes & storage
  - Slightly increased NOx emissions treatment
  - Requires a supply of excess renewable energy
  - Low round-trip efficiency
- Advantages
  - Use of otherwise curtailed renewable energy
  - Long-term Storage
  - Potential storage medium for mobile applications

# Green Ammonia



- Disadvantages
  - Immature technology
  - Increase NOx emissions treatment
  - Requires a supply of excess renewable energy
  - Low round-trip efficiency
  - Hazardous chemical management (PSM / RMP)
- Advantages
  - Higher volumetric energy density than hydrogen
    - Easier to store and transport
    - Better potential for mobile applications
  - Use of otherwise curtailed renewable energy
  - Long-term Storage

# Biomass



- Disadvantages
  - Not as clean as natural gas, hydrogen or ammonia
  - High costs
  - Requires consistent supply
  - Compatibility with existing generating equipment
- Advantages
  - Use with coal can reduce some emissions
  - Reduces waste
  - Uses existing generating equipment

# Supply-Side Resources



- Included in the Supply-Side Resource table
  - Natural gas
  - 30% green hydrogen in natural gas
  - 100% green hydrogen
- Research
  - Feasibility and economics of converting coal-fueled boilers to hydrogen
  - Costs and air emissions of green hydrogen combustion at Jim Bridger
  - Flexible hydrogen load and load strategies
  - Technical, engineering and economic feasibility of converting boilers to ammonia fuel
  - Status of hydrogen in utility-scale generation



# 2021 IRP Acknowledgement Update



# 2021 IRP Acknowledgement Update



- Oregon – Acknowledged March 29, 2022
  - Order 22-178 received May 23, 2022
  - Docket LC 77
- Washington – Schedule pending
  - Docket UE-200420
- Idaho – to be issued
- Utah – Declined Acknowledgement June 2, 2022
  - Docket 21-035-09
- Wyoming – to be issued
  - Docket 20000-603-EA-21
- California – Schedule pending
  - Docket R.20-05-003



# 2021 IRP Oregon Acknowledgement Order



- Acknowledges PacifiCorp's action items regarding gas conversion of Jim Bridger Units 1 and 2.
- Acknowledges the preferred portfolio only as consistent with the no-Natrium scenario. “Due to the untested nature of and current uncertainties surrounding the Natrium project itself.” Order does not require Natrium to be included in an RFP.
- Acknowledges PacifiCorp's action item related to the Natrium advanced nuclear demonstration project which calls for the company to continue monitoring key development milestones and making regulatory filings as applicable.
- Acknowledges PacifiCorp's transmission action items.
- Acknowledges PacifiCorp's Local Reinforcement Projects.

# 2021 IRP Order Requirements



State	Reference	Description
OR	Order No. 22-178, p. 7	Require PacifiCorp to perform additional and more varied analyses regarding Jim Bridger Units 3 and 4, including a no minimum take analysis as suggested by Staff and Sierra Club and an analysis of endogenous retirement dates frequent enough to approximately match Staffs suggestion of allowing for retirement every two years.
OR	Order No. 22-178, p. 7	PacifiCorp is directed to file an updated long-term fuel plan for Jim Bridger with its 2023 IRP.
OR	Order No. 22-178, p. 10	Consider how to ensure PacifiCorp has a complete and balanced portfolio given the current posture of the Natrium project.
OR	Order No. 22-178, p. 11	In future IRPs, we expect PacifiCorp to articulate clearer justifications for its transmission projects, including how the company assessed transmission needs and alternatives comprehensively, how and why a particular project was selected in a transmission planning process, why it is reasonable for ratepayers to pay substantial costs for these particular projects, and what quantifiable (and quantified) and non-quantifiable (but valued qualitatively) benefits will come to Oregon ratepayers in particular and PacifiCorp ratepayers in general, as compared with benefits from regional projects that accrue to other regional actors not contributing to costs.
OR	Order No. 22-178, p. 12	We also expect PacifiCorp to produce the full cost information for the projects we acknowledge today in the rate cases where it seeks to place them into rate base.
OR	Order No. 22-178, p. 13	In order to connect new resources to the grid, it is critical not only that transmission be built, but that the right transmission be built; the Commission and stakeholders need to have sufficient information to verify that ratepayers are getting the benefits they are paying for at each stage of development. Going forward, we expect PacifiCorp to provide information that allows that assessment at the outset. We also expect the company to actively encourage key stakeholders like Commission Staff and consumer advocates to participate and provide a larger window into its own transmission planning processes.
OR	Order No. 22-178, p. 14	We direct PacifiCorp to forecast a likely QF contract renewal rate. Because PacifiCorp operates in a multi-state footprint, we understand this assessment to be more complicated than an Oregon-only renewal rate. However, PacifiCorp should use historical renewable rates as well as other relevant information in its possession and attempt to make its forecast as accurate as possible.
OR	Order No. 22-178, p. 14; Appx B p. 1	Develop and run a sensitivity that considers locations or online dates for large, flexible loads such as hydrogen electrolysis within the 2023 IRP. The parameters of the study would be further discussed in the 2023 IRP process. Such a sensitivity would consider optimal locations and years to include large amounts of highly flexible load, throughout the planning timeframe. We adopt this recommendation and note that there may be additional large loads, such as data centers, that fall under this recommendation too.



# 2021 IRP Order Requirements

State	Reference	Description
OR	Order No. 22-178, p. 15; Appx B p. 1	PacifiCorp to conduct a stakeholder process to determine what source the offshore wind cost data in the 2023 IRP will rely on.
OR	Order No. 22-178, p. 15; Appx B p. 1	We expect PacifiCorp to engage in the company's local transmission planning process as appropriate and to request that sufficient information to inform consideration of offshore wind in future IRPs is made available in this local transmission study cycle.
OR	Order No. 22-178, p. 16; Appx B p. 2	In places where there are inconsistencies between the WRAP and the approach the IRP takes ... we direct that the reasons for any discrepancies be explained by PacifiCorp.
OR	Order No. 22-178, p. 16	Commissioners, Staff, or the Administrative Hearings Division will lead ... a workshop to discuss increasing efficiency and demand response, including the consideration of a new, or updated, risk-reduction credit to efficiency.
OR	Order No. 22-178, p. 16; Appx B p. 2	Staff stated that it is supportive of PacifiCorp's plan to include peak time rebates in the 2023 CPA. If peak time rebates are determined to be cost-effective, PacifiCorp should further include an exploration of the potential to use a third-party vendor to implement a peak time rebate in advance of the new billing system implementation, in comparison to an approach that waits until the new billing system is implemented, as part of its 2023 IRP.
OR	Order No. 22-178, p. 16-17; Appx B p. 3	Require PacifiCorp to meet with developer intervenors, upon request, to determine a subset of the confidential data supporting the 2023 IRP that does not include commercially sensitive information that can be provided. The subset would not necessarily need to include all confidential data that is not commercially sensitive. Require PacifiCorp to seek to balance developer intervenors' need for information as IRP stakeholders with PacifiCorp's need to protect commercially sensitive information and keep the data management workload to a reasonable level.
OR	Order No. 22-178, p. 17	We direct PacifiCorp to hold at least one workshop on equity and justice issues related to the generation transition in its 2023 IRP, and we will ask members of our Staff with expertise on these issues to participate. We recognize PacifiCorp's relationship to employees and to the communities where its resources are located and encourage the company to explain how consideration of both factor into the planning processes.
OR	Order No. 22-178, p. 18; Appx B p. 1	PacifiCorp to take steps to provide complete and accurate information in the 2023 IRP that reflects accurate IRP modeling assumptions. We adopt this recommendation, though we note that we believe PacifiCorp has already been attempting to comply with this principle.
OR	Order No. 22-178, p. 18	Require PacifiCorp's 2023 IRP storage costs in the Supply Side Table to be in line with the most recent National Renewable Energy Laboratory Annual Technology Baseline report and most recent RFP Final Shortlist. Our understanding is that Staff's recommendation reflects a preference from stakeholders for publicly available sources, but that Staff also acknowledges the relevance of the market information obtainable from the most recent RFP. We thus adopt Staff's recommendation to the extent that it requires the use of publicly available data as well as proprietary sources, but with the understanding that discrepancies from the publicly available data be explained.

# 2021 IRP Order Requirements



State	Reference	Description
OR	Order No. 22-178, p. 18; Appx B p. 1	PacifiCorp to provide a map of resources in the IRP Executive Summary, which PacifiCorp agrees to do.
OR	Order No. 22-178, p. 18-19; Appx B p. 2	Require PacifiCorp to explain the reliability limitations of the LT capacity expansion model and how the IRP team selected the reliability resources of change. PacifiCorp made a strong effort at explanation in this IRP, but that the company should seek to understand questions that remain and mature its narrative discussion accordingly.
OR	Order No. 22-178, p. 19; Appx B p. 2	Require PacifiCorp to include with the 2023 IRP data discs: <ul style="list-style-type: none"> <li>a. A list of the resources that were considered as reliability resources;</li> <li>b. A list of the reliability resources that were selected in each portfolio, sensitivity, and variant;</li> <li>c. A clearly marked set of hourly reliability (ENS) data that the Company used to identify the type and size of reliability resources to add to each portfolio, sensitivity, and variant; and</li> <li>d. Any metric the Company used to select reliability resources in each portfolio, sensitivity, and variant.</li> </ul>
OR	Order No. 22-178, p. 19; Appx B p. 2	Before the 2023 IRP, include climate-change risk and adaptation as a topic of a public-input meeting to share and discuss approaches to modeling climate risk in the IRP including: proposed changes to how weather and extreme events are considered; proposed changes for the consideration of climate-related risks on supply side resources, transmission, and loads; and a discussion on how the Company proposes to include climate change impacts as part of the status quo. We adopt this recommendation and note that we appreciate PacifiCorp's thorough responses on this important issue.
OR	Order No. 22-178, p. 20; Appx B p. 2	Change PacifiCorp's Environmental, Transmission, and DSM Updates from a twice-annual report to an annual report.
OR	Order No. 22-178, Appx B p. 1	In the 2023 IRP, PacifiCorp should provide a metric calculated in its capacity expansion model that provides stakeholders with an estimate of the relative value of each coal unit to the system.
OR	Order No. 22-178, Appx B p. 1	The 2023 IRP data discs should provide graphs of the average fixed and variable costs of operating each coal unit over the planning timeframe. This should include fuel cost and run rate capital but exclude depreciation expense.
OR	Order No. 22-178, Appx B p. 1	As a part of the 2023 IRP development process, PacifiCorp should fully assess the potential for gas conversion; use of hydrogen, biofuel, or other lower-carbon fuels; or alternate coal stockpile or supply methods for Jim Bridger 3 and 4. A report should be included with the 2023 IRP.

# 2021 IRP Order Requirements



State	Reference	Description
OR	Order No. 22-178, Appx B p. 1	If technically feasible, PacifiCorp should report on the costs and emissions (CO2 and NOX) of green hydrogen combustion at the converted Bridger unit.
OR	Order No. 22-178, Appx B p. 1	The 2023 IRP should more thoroughly investigate the potential to install a new turbine designed to run on 100 percent green hydrogen at the sites of one or more retiring coal plants.
OR	Order No. 22-178, p. 15; Appx B p. 2	PacifiCorp to review its pumped hydro proposals as part of its 2023 IRP public workshop series. PacifiCorp will perform a variety of analyses regarding pumped storage hydro ... including a careful comparison with other possible pumped storage hydro projects in the 2023 IRP ... [and] sufficient information to be able to conclude that PacifiCorp has considered resources other than its own in this process.
OR	Order No. 22-178, Appx B p. 1	In the 2023 IRP, variable O&M costs should be modeled accurately as variable with generation, and not approximated as part of fixed O&M costs as they have been in the 2021 IRP.
OR	Order No. 22-178, Appx B p. 2	In future IRPs or during future RFP processes, potential RFP bidders should be given access to a 12x24 Loss of Load Probability matrix for one out of every five years in the IRP planning timeframe.



# Stakeholder Feedback





# Stakeholder Feedback Form Update



- 4 stakeholder feedback forms submitted to date
- Stakeholder feedback forms and responses can be located at:  
[pacificorp.com/energy/integrated-resource-plan/comments](https://pacificorp.com/energy/integrated-resource-plan/comments)
- Depending on the type and complexity of the stakeholder 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 form and posted online at the link mentioned above
- Stakeholder feedback following the previous public input meetings is summarized on the following slides for reference

# Summary – Recent Stakeholder Feedback Forms



Stakeholder	Date	Topic	Brief Summary*	Response*
ESS Inc.	February 25, 2022	Supply-Side Energy Storage Solutions	What changes are being made to IRP modeling to determine marginal values of long-duration flow battery storage?	The Company is considering longer duration energy storage in the 2023 IRP. PacifiCorp is commissioning a study of the cost and performance characteristics of energy storage and expects the study to include information specific to long duration flow batteries ( <i>the results of this study will be shared at a future PIM</i> ).
Renewable Northwest	March 3, 2022	Supply-Side Resource Table and Renewables Combined Study	Recommends the Company consider DC-coupled solar + storage as well as other additional battery storage durations (medium and long-duration) as part of SSR table and subsequent IRP modeling.	Proxy resource modeling in the 2023 IRP is intended to be representative of costs and operational characteristics across a range of configurations and at this time is based on AC configuration but does not preclude other constructs from participating in all-source requests for proposals.

\*Full comments and PacifiCorp's responses can be found online at <https://www.pacificorp.com/energy/integrated-resource-plan/comments.html>

# Summary – Recent Stakeholder Feedback Forms



Stakeholder	Date	Topic	Brief Summary*	Response*
Salt Lake City Corporation	05/12/2022	Supply-Side Resource Table – Long Duration Energy Storage Similar to Form Energy Iron Air Battery	Recommends PacifiCorp include a supply-side long-duration storage option with characteristics similar to the iron air battery announced by Form Energy: a 100-hour storage duration at \$20/kWh.	The Company is considering longer duration energy storage in the 2023 IRP.
Salt Lake City Corporation	05/25/2022	Price Development Update (May PIM, pg. 41 of slide deck)	Recommends PacifiCorp revises its natural gas price forecast higher in line with developments consistent with the EIA's much higher Henry Hub price forecasts relative to Henry Hub Natural Gas prices shown on slide 41 of the May 12, 2022, PIM slide deck.	The 2023 IRP price forecast has not yet been prepared. The plan is to develop a forecast in September 2022 for use in the 2023 IRP, which will incorporate then-current natural gas prices and latest long-term expectations.

\*Full comments and PacifiCorp's responses can be found online at <https://www.pacificorp.com/energy/integrated-resource-plan/comments.html>



# Wrap-Up/Additional Information



# Additional Information



- 2023 IRP Upcoming Public Input Meetings:
  - July 14-15, 2022 (Thursday-Friday)
  - August 25-26, 2022 (Thursday-Friday)
- Public Input Meeting and Workshop Presentation and Materials:
  - [pacificorp.com/energy/integrated-resource-plan/public-input-process](https://pacificorp.com/energy/integrated-resource-plan/public-input-process)
- 2023 IRP Stakeholder Feedback Forms:
  - [pacificorp.com/energy/integrated-resource-plan/comments](https://pacificorp.com/energy/integrated-resource-plan/comments)
- IRP Email / Distribution List Contact Information:
  - [IRP@PacifiCorp.com](mailto:IRP@PacifiCorp.com)
- IRP Support and Studies:
  - [pacificorp.com/energy/integrated-resource-plan/support](https://pacificorp.com/energy/integrated-resource-plan/support)