Resource Adequacy Information Session

August 24, 2022

PUGET SOUND ENERGY

Safety Moment

National Back to School Month

- Drive slow in residential neighborhoods and school zones in the morning and after school hours
- Watch for children on and near the road in the morning and after school hours
- Reduce distractions inside the car and focus on your surroundings
    - Ex. Set phone to *Do not disturb*

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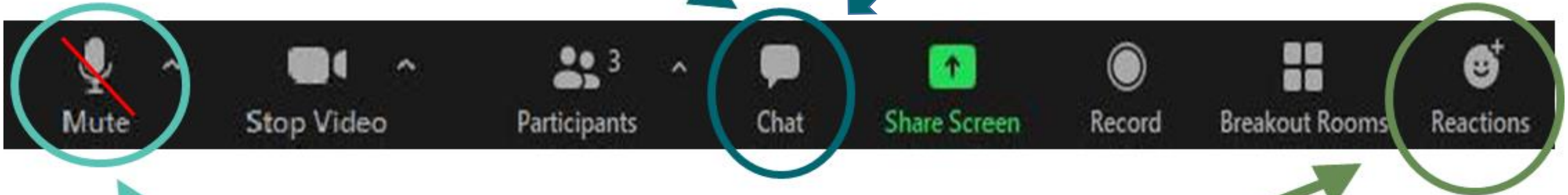
Welcome to the webinar and thank you for participating!

If you **want to type a question regarding the presentation,** insert **"Slide X followed by your question"** in the chat box!

If you **have a technical issue or a general question,** please type it in the chat box.



Please **keep yourself on mute** unless you are speaking.

If you want to **ask a question verbally,** click the 'Reaction' button and click on the **'Raise Hand'** option and we will call on you.

Facilitator Requests

- Engage constructively and courteously towards all participants
- Respect the role of the facilitator to guide the group process
- "Take space and make space"
- Avoid use of acronyms and explain the technical questions

Agenda

Time	Agenda Item	Presenter
1:00 – 1:05 p.m. (5 min)	Opening	Sophie Glass, Triangle Associates
1:05 – 1:15 p.m. (10 min)	Recap from July Demand Forecast IRP / Meeting Purpose and Context	Phillip Popoff, PSE
1:15 – 1:50 p.m. (35 min)	Western Resource Adequacy Program Overview (WRAP)	Ryan Roy, WRAP
1:50 – 2:15 p.m. (25 min)	Regional Forecast	Aliza Seelig, PNUCC
2:15 – 2:25 p.m. (10 min)	Break	All
2:25 – 3:55 p.m. (90 min)	Summary of Resource Adequacy Modeling Results	Arne Olson & Joe Hooker, E3
3:55 – 4:00 p.m. (5 min)	Break	All
4:00: - 4:25 p.m. (25 min)	PSE Resource Needs & Market Reliance	Phillip Popoff, PSE
4:25 – 4:30 p.m. (5 min)	Next Steps	Sophie Glass, Triangle Associates
4:30 p.m.	Adjourn	Sophie Glass, Triangle Associates

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Today’s Speakers

Phillip Popoff
Director, Resource Planning Analytics, PSE

Arne Olson
Senior Partner, Energy + Environmental Economics (E3)

Joe Hooker
Associate Director, Energy + Environmental Economics (E3)

Ryan Roy
Director of Technology Modeling & Analysis, Western Power Pool

Aliza Seelig
Analytics and Policy Director, PNUCC

Sophie Glass
Co-facilitator, Triangle Associates

Recap from July Demand Forecast IRP

Phillip Popoff
Director, Resource Planning Analytics, PSE

How input from July meeting is shaping our work

Themes heard at July 12th Meeting (Demand Forecast)	What we did with it
Interest and concerns about the demand side resources in the IRP process. Some stakeholders expressed frustration that those elements were not included in the presentation.	PSE will consider how to improve the Integrated Resource Plan (IRP) process and the timing for presenting information to IRP stakeholders.
How does PSE incorporate compliance with the Climate Commitment Act within the Load Forecast? Given the state of gas and methane, is there some interaction with the load forecast?	PSE will analyze this after the portfolio analysis.
Stakeholders would like to provide input on conservation planning programs before they are implemented.	PSE develops these programs as part of the Biennial Conservation Plan that is filed with the UTC.
It is unclear if PSE is capturing heating trends for appliance use.	PSE will address this in the Conservation Potential Assessment (CPA).
Distribute the feedback document to participants by email instead of asking stakeholders to locate it on the IRP website.	PSE will update the location of the feedback form on the IRP website to make it more visible and link the feedback form in IRP emails.
Climate change: - Appreciation for including climate change and peak summer forecasts in load forecast. - Caution against lowering peak load expectation in the winter due to the possibility of wide swings in the wintertime due to climate change. - Weather variability takes out temperature swings and slides that show weather as variable are not weather-normalized.	PSE is working to improve climate change analysis. Load forecast reflects trends in normal peaks and resource adequacy will reflect variability.

Feedback and responses from July 12 meeting are addressed in the Feedback Report.

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PSE's Resource Adequacy Evolution

2021 All-Source Request For Proposal

- Aug of 2021, PSE hosted a workshop to discuss ELCC assumptions
  - PSE had an independent review of our resource adequacy model by E3
- Sept of 2021, E3 presented their findings to stakeholders
- Oct of 2021 PSE posted E3 ELCCs report along with PSEs action plan

2023 Electric Progress Report

- March of 2022, Resource adequacy modeling outsourced to E3 due to a key retirement
- E3 addressed made the updates PSE committed to making in Oct of 2021 to their RECAP model, results will be reviewed during the meeting today

Links to the above information can be found on the PSE IRP website here PSE | Get involved.

Western Resource Adequacy Program

WRAP Presentation for PSE
August 24, 2022

Ryan Roy, Director of Technology, Modeling, and Analytics
Western Power Pool

Presentation Topics

- » WRAP Overview
- » Preliminary Metrics
- » Timeline and Status

WRAP
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WRAP OVERVIEW

Phase 3A Participants

Arizona Public Service
Avangrid
Avista
Black Hills
Basin Electric
Bonneville Power Administration
Calpine
Chelan PUD
Clatskanie PUD
Douglas PUD
Eugene Water & Electric Board
Grant PUD
Idaho Power
NorthWestern Energy
NV Energy
PacifiCorp
Portland General Electric
Powerex
Puget Sound Energy
Salt River Project
Seattle City Light
Shell
Snohomish PUD
Tacoma Power
The Energy Authority
Turlock Irrigation District

WRAP
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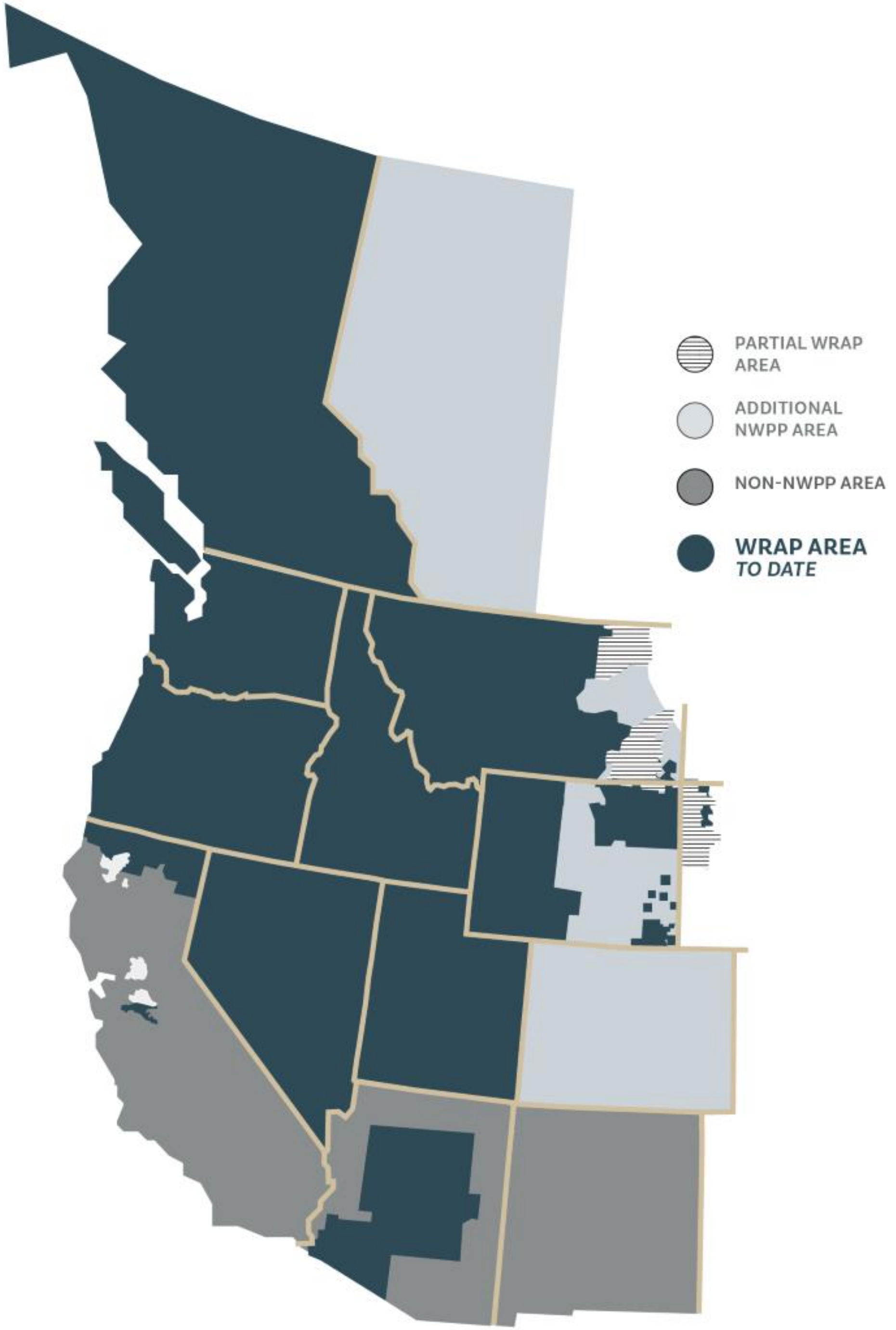


- **Industry-driven initiative** for regional approach to help ensure resource adequacy in light of changing resource composition and increased resource uncertainty
  - Estimated peak winter load of 65,122 MW and summer load of 66,768 MW
- **Participation is voluntary**, with mandatory requirements once joined
- Implemented through **bilateral transactions under existing frameworks**

Solving a Problem

- What WRAP does:
  - Implements a **binding forward showing** framework that requires entities to demonstrate they have secured their share of the regional capacity need for the upcoming season
  - Implements a **binding operational program** that obligates members with calculated surplus to assist participants with a calculated deficit on the hours of highest need
  - Leverages the binding nature of the operational program, together with modeled supply and load diversity, to **safely lower the requirements** in the forward showing and help **inform resource selection** for the region, **driving investment savings** for members and their end use customers

WRAP
POWERED BY WPP

PROGRAM DESIGN OVERVIEW

FORWARD SHOWING PROGRAM

» Establishes a **regional reliability metric** (1 event-day in 10 years LOLE)

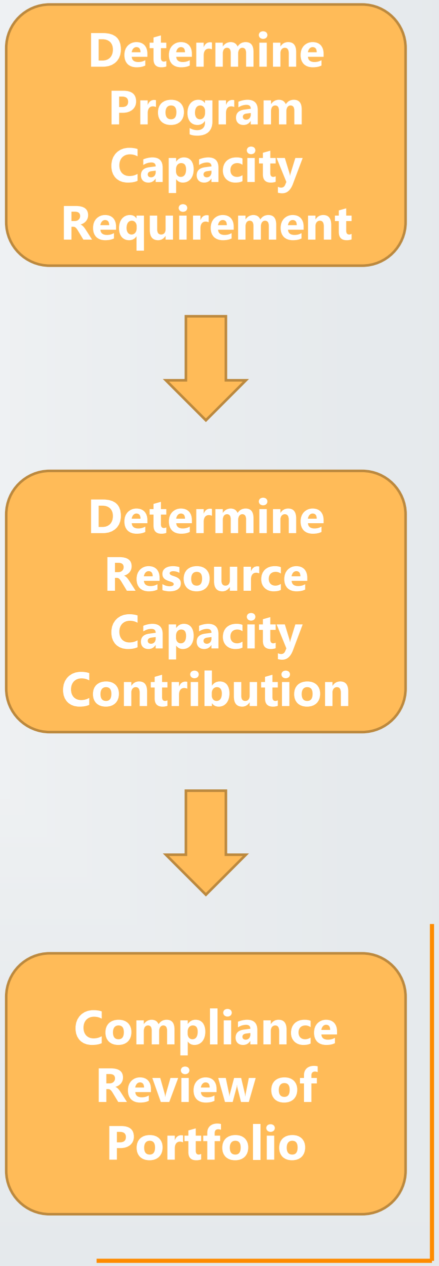
» Utilizes thoughtful modeling and analytics to:

- » Determine historical summer and winter **capacity critical hours** (CCHs) data sets for the region
- » Determine each resource type's **qualifying capacity contribution** (QCC) to the regional capacity needs
- » Determine a planning reserve margin (PRM) which is applied to peak load forecast based on P50 metric

» Showing requirement includes **deliverability** component

- » Firm or conditional firm transmission to meet 75% of P50 + PRM (paired with robust exception framework)

» Participant compliance obligation (7 months in advance of binding season) = **physically firm resources to meet P50 + PRM**



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Program Design Overview

Operations Program

- Evaluates participants operational situation relative to Forward Showing assumptions (for load, outages, VER performance)
- Obligates participants with calculated surplus to assist participants with a calculated deficit on the hours of highest need
- Deficiency forecast on day before Operating Day (Preschedule Day) establishes Holdback Requirement for surplus participants
- Surplus Participant that fails to provide assigned Energy Deployment must pay Energy Delivery Failure Charge

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Preliminary Metrics

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Phase 3A WRAP Metrics

» Metrics provided are based on modeling completed with data from current (Phase 3A) participants

» Metrics are only representative if:

  – The WRAP exists (is FERC approved), has participants, and can share load and resource diversity amongst participants as anticipated

  – Current participants move forward with WRAP in December 2022

  – Participants are subject to binding obligations to share diversity

» Until we reach this status, each participant will continue to make assessments of their own circumstances to determine how to interpret these modeling results, what reserve margins to keep, etc.

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Phase 3A Planning Reserve Margins

- WRAP footprint was modeled in two main subregions:
  - Northwest (NW)
  - Desert Southwest / East (DSW/E)

	Winter 2023-2024					Summer 2024			
	Nov	Dec	Jan	Feb	Mar	Jun	Jul	Aug	Sep
NW	21.6%	17.7%	19.0%	19.9%	26.0%	16.5%	10.4%	10.3%	17.9%
DSW / E	20.1%	16.8%	16.9%	21.5%	21.9%	17.8%	12.1%	12.8%	20.3%

Qualifying Capacity Contributions

Resource Type	Accreditation Methodology
Wind and Solar Resources	Effective Load-Carrying Capability (ELCC) analysis
Run-of-River Hydro	Average monthly output on capacity critical hours (CCHs)
Storage Hydro	WPP-developed hydro model that considers the past 10 years generation, potential energy storage, and current operational constraints.
Thermal	Unforced capacity (UCAP) method.
Short Term Storage	ELCC analysis (recent update - to be completed next model run)
Hybrid Resource	"Sum of parts" method where energy storage resource will use ELCC and generator will use appropriate method as outlined above
Customer Side Resources	Can either register as a load modifier or as a capacity resource

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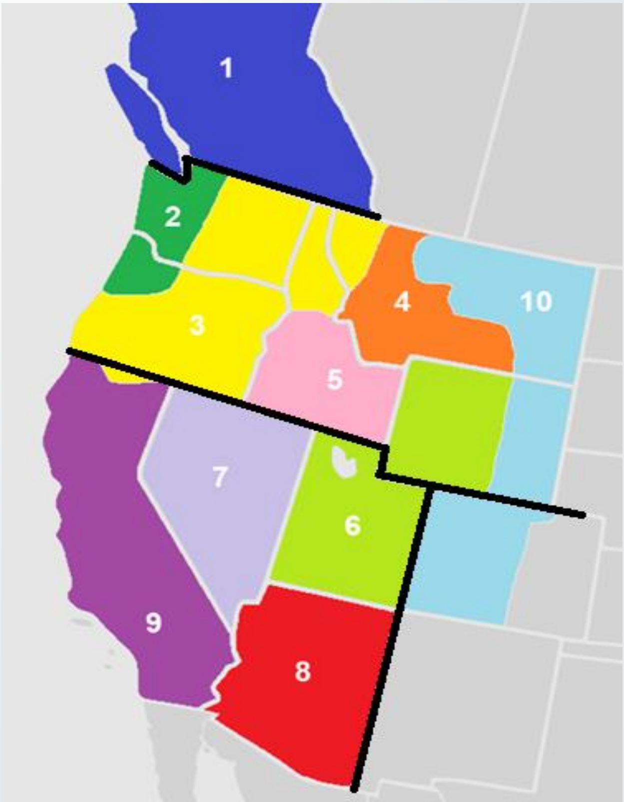
3A Hydro Average QCCs

	Nameplate	Winter 2023-2024					Summer 2024			
		Nov	Dec	Jan	Feb	Mar	Jun	Jul	Aug	Sep
Storage (data from Phase 2B)	46,467	81%	83%	84%	83%	82%	77%	77%	77%	78%
Run of River (summer peaking)	2,815	19%	18%	14%	13%	15%	71%	71%	63%	63%
Run of River (winter peaking)	1,408	31%	34%	35%	37%	35%	30%	26%	21%	20%

Solar ELCC Zones

WRAP footprint split in two zones for solar resource ELCC modeling

- Zone 1 – North
  - Washington, Oregon, Idaho, Montana, Wyoming
- Zone 2 – South
  - California, Nevada, Utah, Arizona



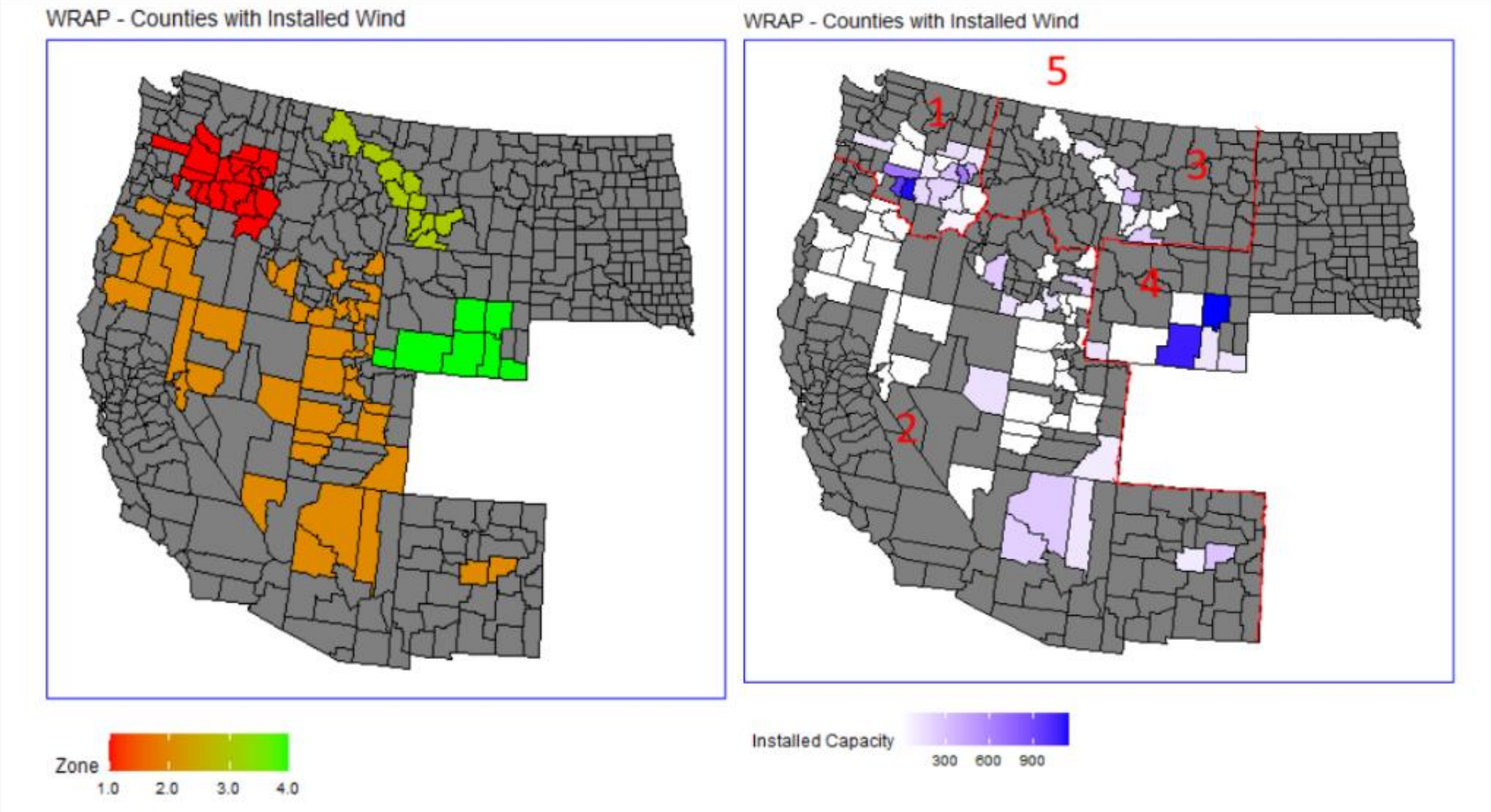
WRAP 3A Solar ELCC

- Allocation of ELCC within each zone based on average monthly output on CCHs
  - Anticipated to capture the time zone and geographic (East/West) diversity of resources

		Winter 2023-2024					Summer 2024			
	Nameplate	Nov	Dec	Jan	Feb	Mar	Jun	Jul	Aug	Sep
Zone 1 (North)	2,138 MW	2%	3%	3%	4%	5%	23%	30%	24%	13%
Zone 2 (South)	9,024 MW	3%	5%	7%	7%	5%	16%	24%	23%	11%

WRAP POWERED BY WPP

ELCC Wind Zones



WRAP 3A Wind ELCC

	Nameplate	Winter 2023-2024					Summer 2024			
		Nov	Dec	Jan	Feb	Mar	Jun	Jul	Aug	Sep
Zone 1 (WA+)	5,734	10%	9%	8%	11%	13%	19%	22%	18%	13%
Zone 2	2,400	32%	30%	28%	32%	34%	18%	18%	16%	16%
Zone 3 (MT)	1,378	30%	29%	28%	23%	25%	13%	12%	13%	14%
Zone 4 (WY)	2,429	36%	32%	30%	27%	31%	15%	16%	14%	14%
Zone 5 (BC)	747	29%	28%	23%	24%	22%	18%	17%	21%	22%

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$$Resource\ ELCC = Monthly\ ELCC\ MW\ * \left(\frac{Resource\ average\ hourly\ net\ power\ output\ on\ CCHs}{Zone\ total\ average\ hourly\ net\ power\ output\ on\ CCHs}\right)$$

For both wind and solar, analysis of historical average hourly net power output will utilize the following data:

- 3 years of data, if available
  - No less than 3 years will be utilized - if 3 years of data is not available, resource will receive (class ELCC %) x (nameplate) *
- Allocation of zonal ELCC to individual resource may be adjusted as actual production data is accumulated

*exception for new / repowered resources

Timeline and Status

Transition Timeline

Non-Binding Forward Showing

Winter 22-23, Summer 23, Winter 23-24, Summer 24, Winter 24-25

Transition Seasons (Ops and FS)

Summer 25, Winter 25-26, Summer 26, Winter 26-27, Summer 27, Winter 27-28

Non-Binding Operations Program

Summer 23 (trial – will include testing scenarios), Winter 23-24, Summer 24, Winter 24-25

Binding Program Without Transition Provisions

Summer 28 and all seasons following

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Current Phase Activities

Oct 2021

PO collected data from participants

Design refinement and public webinars

Design refinements led into tariff drafting

Participant review of tariff in Spring

PO running LOLE/ELCC models – *draft results to participants*

We are here

Draft tariff out for public review and webinar

Showing for Winter 2022-2023 Non-Binding season

Aiming to file with FERC in late August

Showing for Summer 2023 Non-Binding season

Asking for sign ups in late 2022 for transition to Binding program

Asking for FERC order prior to sign-up window

Dec 2022

1/23 Requested effective date for WRAP implementation

PO = Program Operator
LOLE = Loss of Load Expectation
ELCC = Expected Load Carrying Capacity

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Thank You

Ryan.Roy@westernpowerpool.org

For general inquiries or to be added to our mailing list:
wrap@westernpowerpool.org

PNUCC

2022 Northwest Regional Forecast

PUGET SOUND ENERGY IRP PUBLIC MEETING

AUGUST 24, 2022

Northwest Regional Forecast
A regional adequacy barometer

- Since 1946 public and private utilities have come together at the Pacific Northwest Utilities Conference Committee (PNUCC) to assess regional power supply
- For 70 years, adding up NW utilities' firm requirements & resources (sum-of-utilities integrated resource plans)
- Tracking trends using consistent assumptions
    - ✓ Annual energy
    - ✓ winter & summer peak 1-hour

The region

It’s all utilities

- Avista
- Benton PUD
- Bonneville Power
- Central Lincoln PUD
- Chelan PUD
- Clark Public Utilities
- Clatskanie PUD
- Cowlitz PUD
- Douglas PUD
- Emerald PUD
- EWEB
- Flathead Electric Coop.
- Franklin PUD
- Grant PUD
- Grays Harbor PUD
- Idaho Power
- Mason PUD #3
- NorthWestern Energy
- Pacific Power
- Pend Oreille County PUD
- PNGC Power
- Portland General Electric
- Puget Sound Energy
- Seattle City Light
- Snohomish PUD
- Springfield Utility Board
- Tacoma Power

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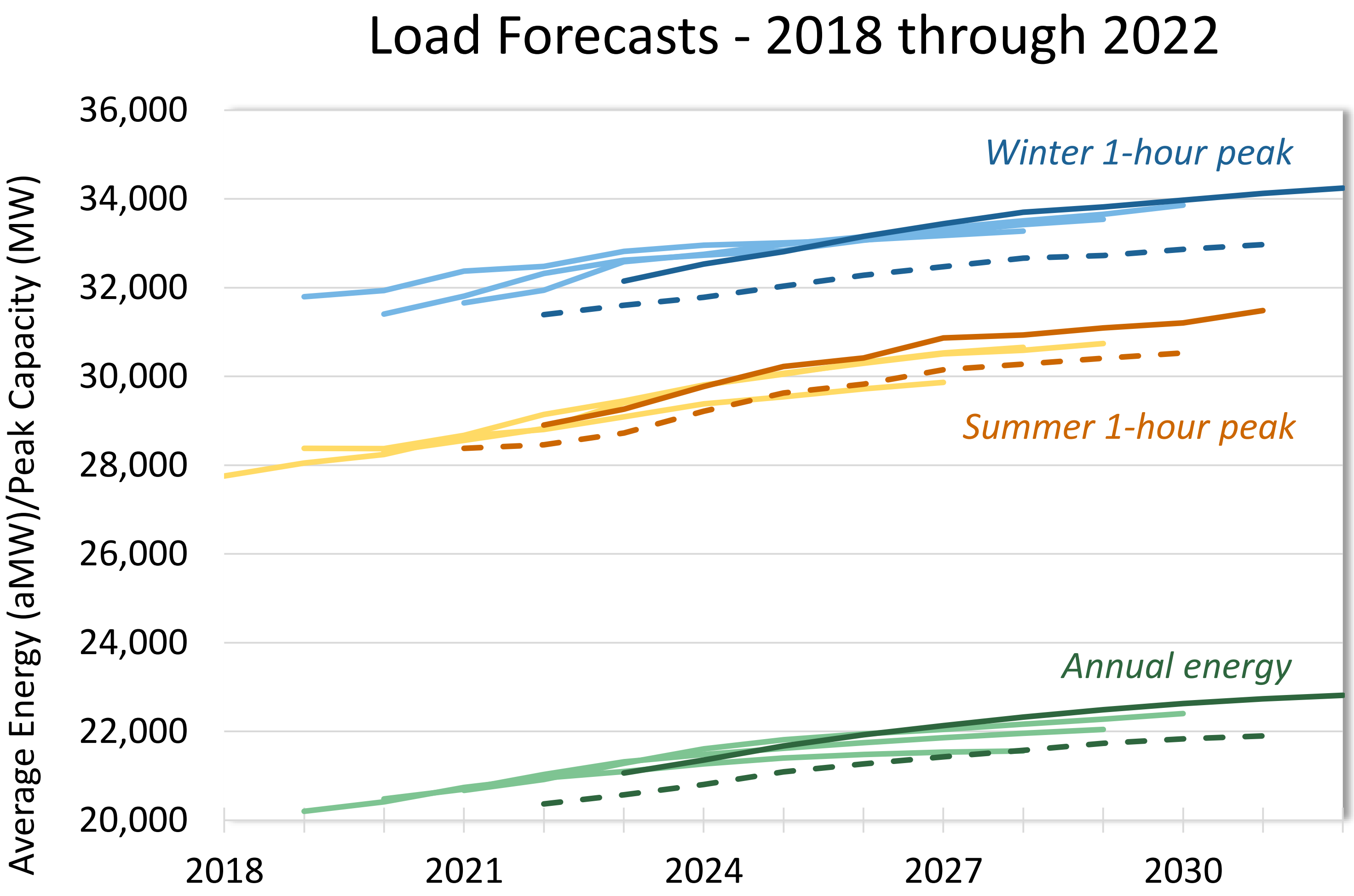
Sum-of-utilities requirements & resources

Requirements	1-in-2 loads after energy efficiency 16% planning margin for peak Long-term export contracts
Demand side management	Utilities’ savings forecasts
Generating resources	Utility-owned only Utilities’ expected operation
Hydropower	Low water conditions (8% for peak)

Load forecast comparison



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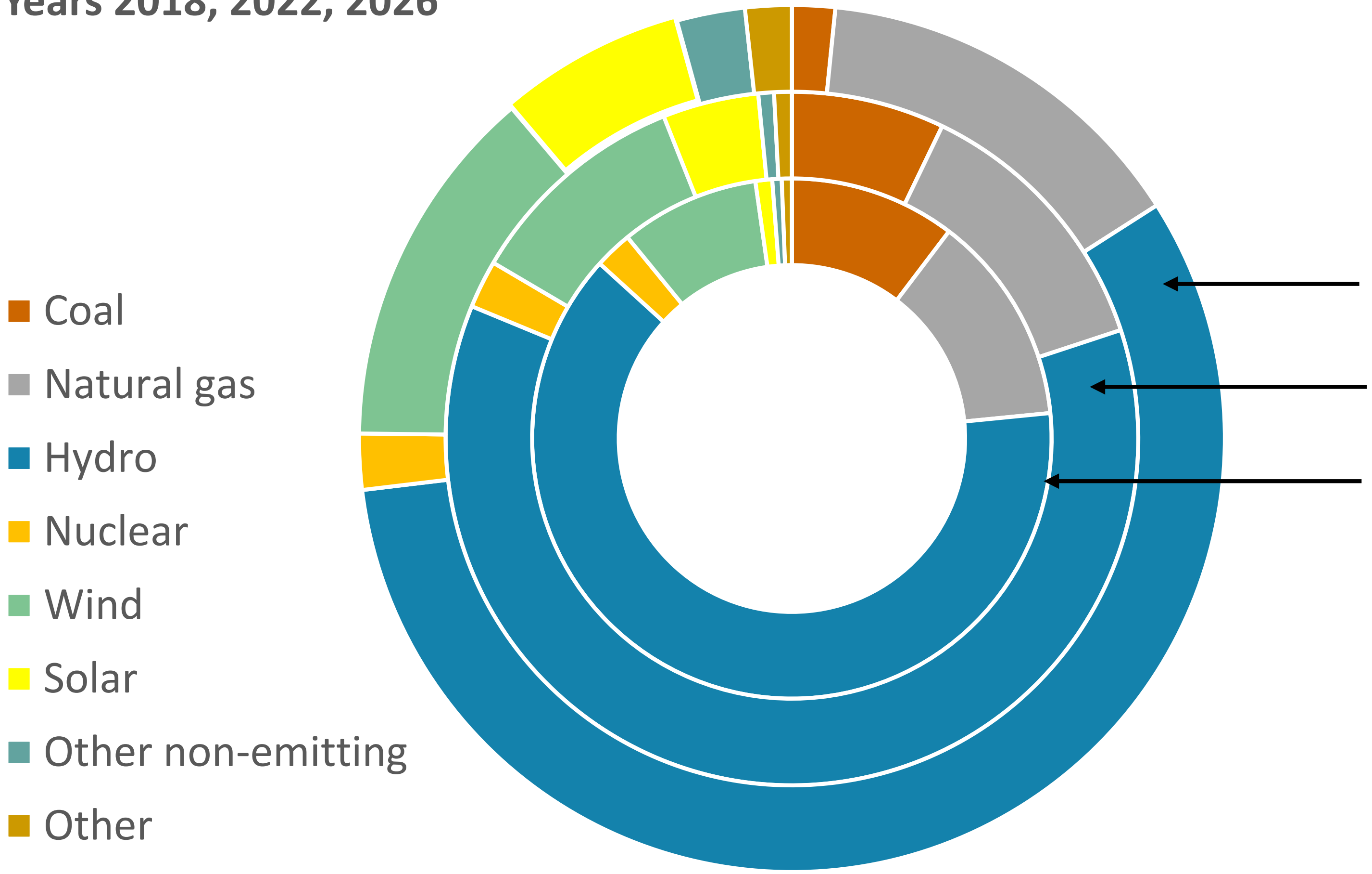
Generating resources evolving

Northwest Utilities Generating Resources

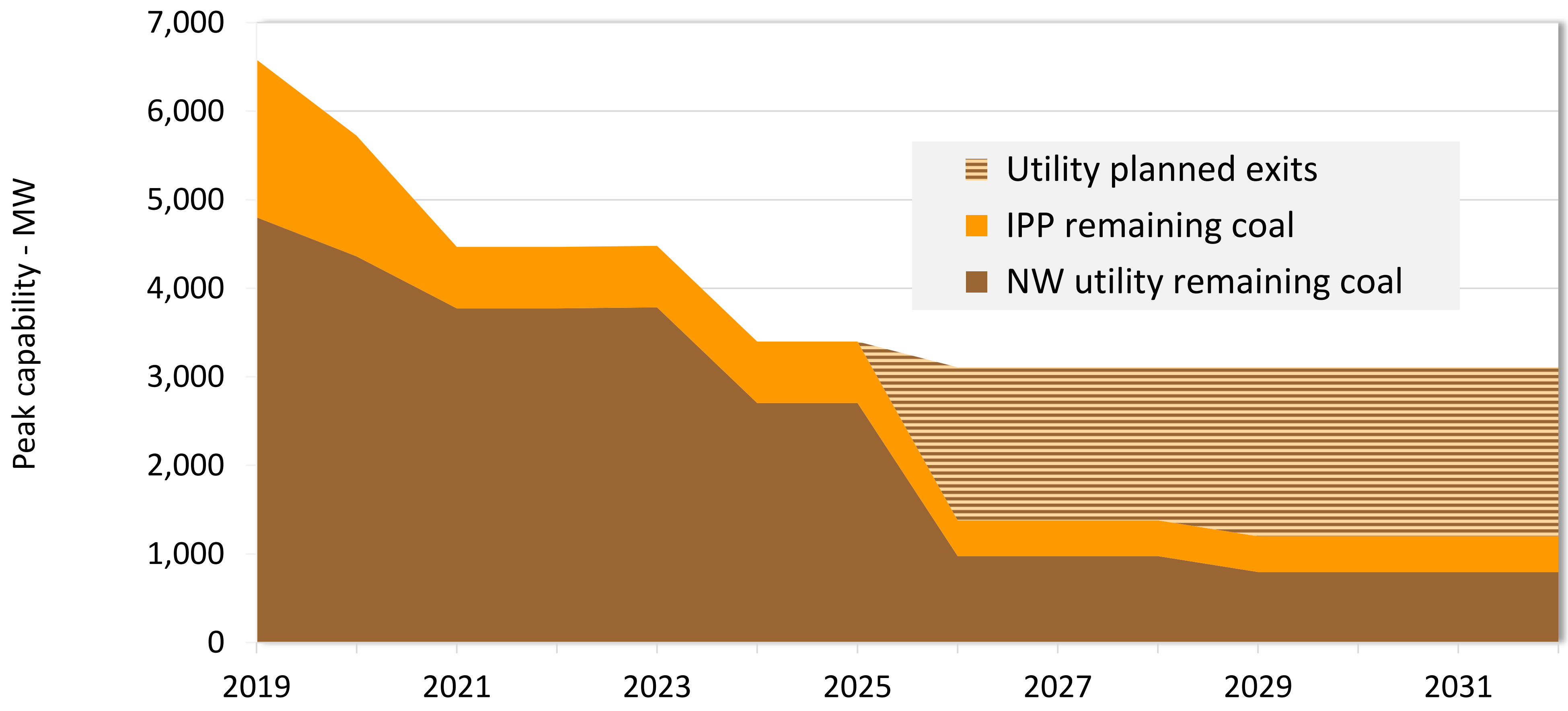
Years 2018, 2022, 2026



Nameplate Installed

2026	59,200 MW
2022	55,100 MW
2018	52,500 MW

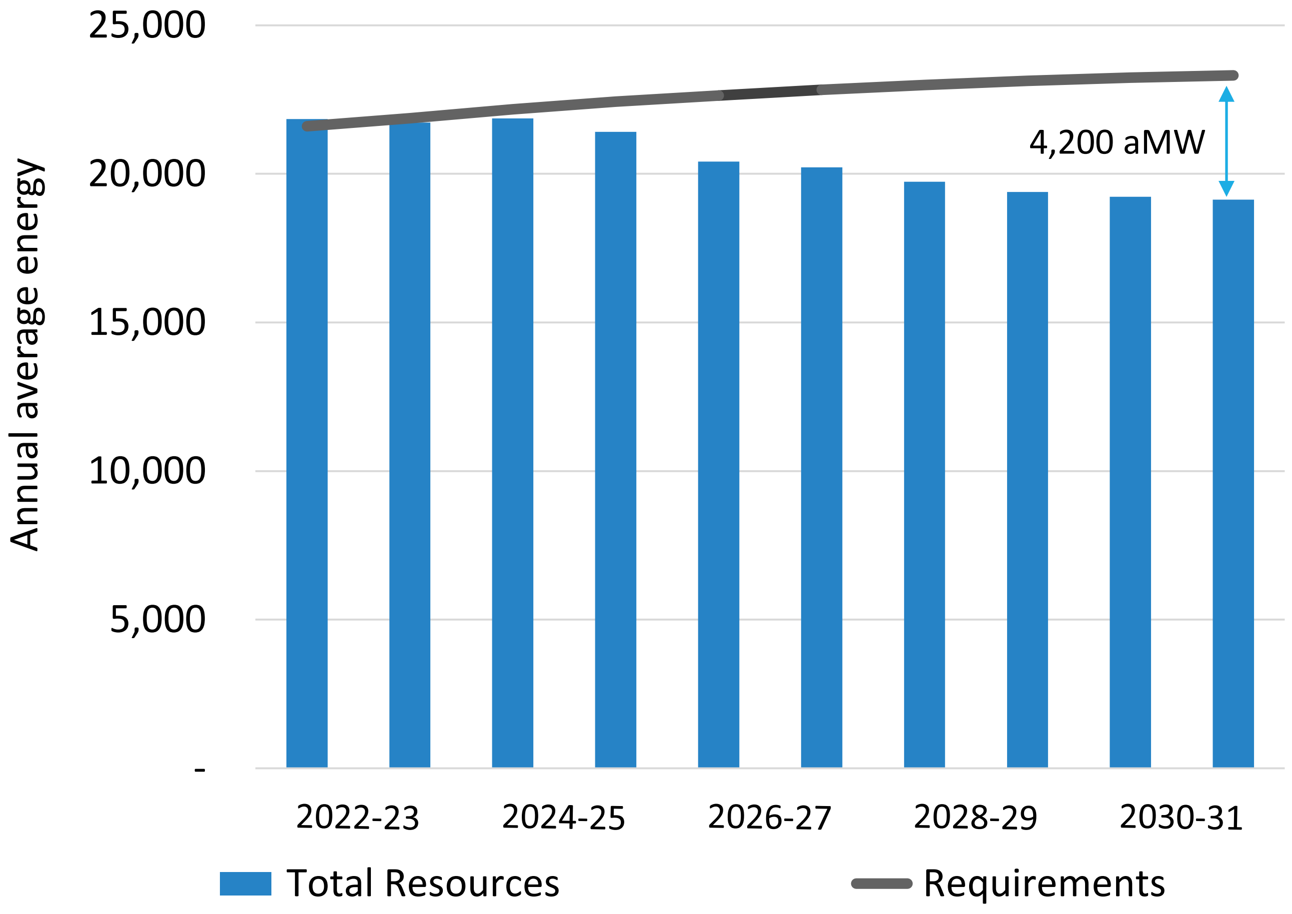
Coal plant availability is declining



Energy need on the horizon

- Jim Bridger 1 & 2 offline in 2024 for conversion to natural gas
- Planned energy efficiency programs are part of load
- Demand response included in resources

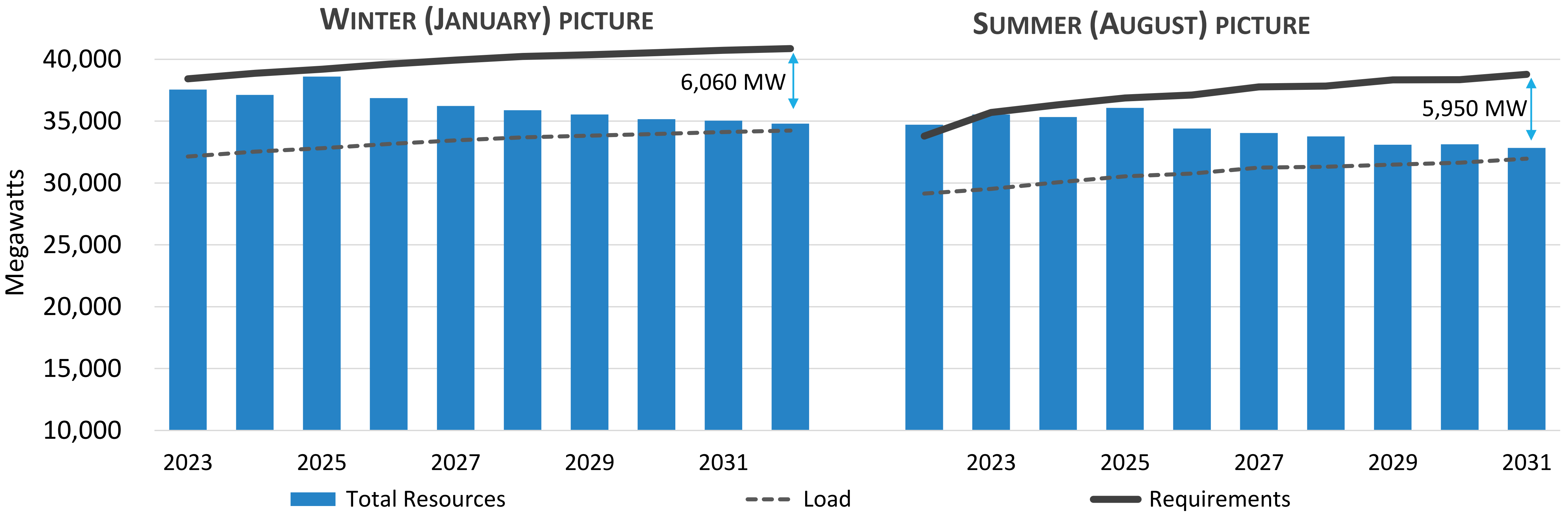
Northwest Energy Load & Resources Picture



	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Surplus/ (Deficit)	240	(150)	(311)	(1,015)	(2,220)	(2,601)	(3,259)	(3,735)	(4,007)	(4,187)

PNUCC

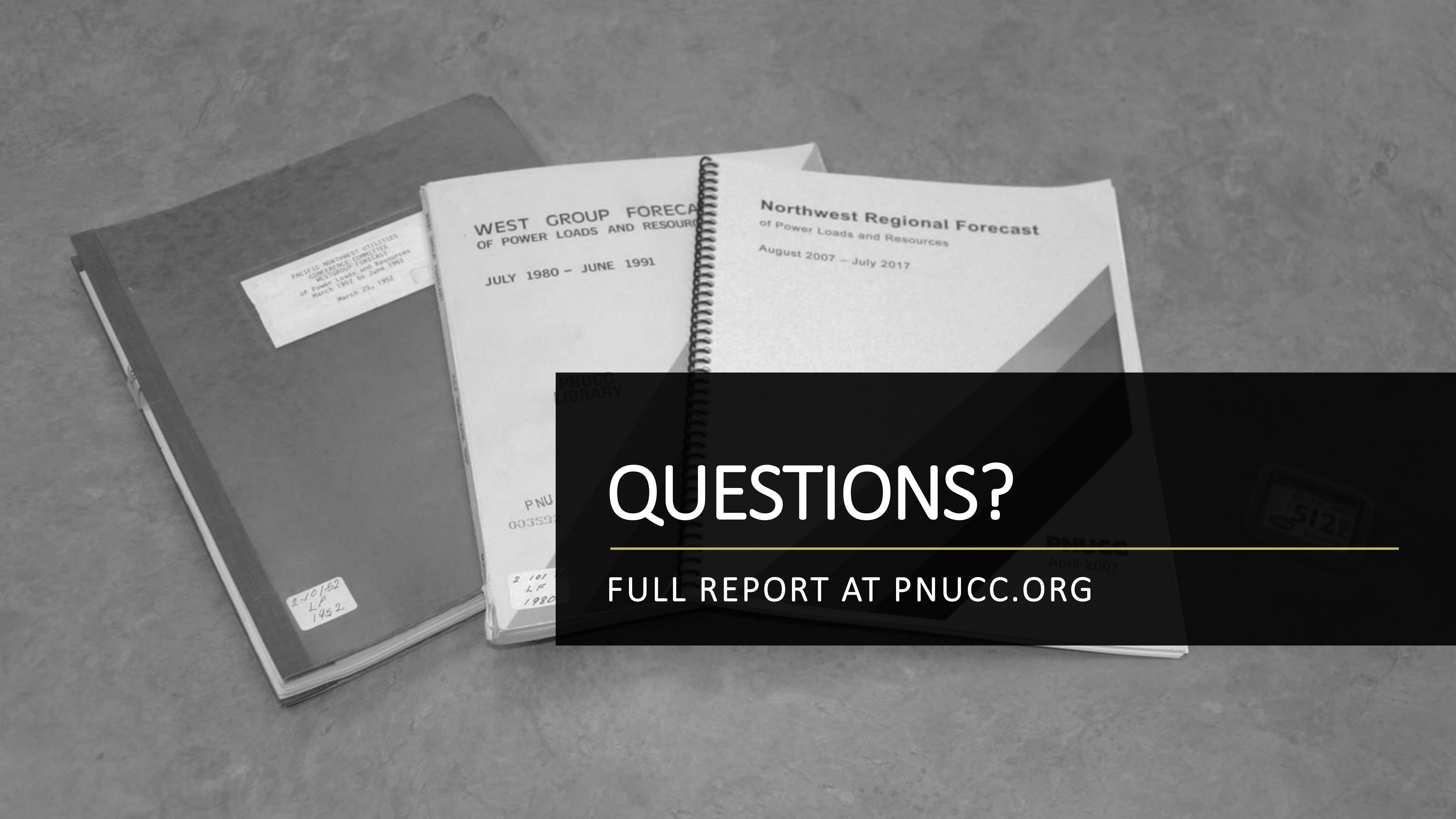
Peak load needs continue to grow



Surplus/ (Deficit)

2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
(869)	(1,745)	(599)	(2,733)	(3,711)	(4,349)	(4,833)	(5,382)	(5,679)	(6,058)

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
922	(165)	(981)	(803)	(2,720)	(3,727)	(4,064)	(5,242)	(5,215)	(5,945)



QUESTIONS?

FULL REPORT AT PNUCC.ORG

Break

Please return in 5 minutes

*Monet Wind" by Eric Jensen of Roslyn, WA

Puget Sound Energy Resource Adequacy

Stakeholder presentation

August 2022

Arne Olson, Senior Partner
Joe Hooker, Associate Director
Charlie Gulian, Consultant
Ruoshui Li, Associate

Energy+Environmental Economics

Agenda

+ Background on resource adequacy
+ Changes in the 2023 IRP
+ Results
+ Q&A

Energy + Environmental Economics (E3)

Technical and Strategic Consulting for the Clean Energy Transition

~90 consultants across 4 offices with expertise in energy economics, policy, modeling


San Francisco


New York


Boston


Calgary

250+ projects per year across diverse topic areas

Recent Projects

- Resource Adequacy in the Desert Southwest - E3 conducted a study to examine reliability in the Southwest and identify best practices for resource adequacy that will provide a durable foundation for utilities' planning efforts to preserve reliability in the region
- Lower Snake River Dams Power Replacement Study – E3 evaluated options for replacing power from the Lower Snake River dams across a wide range of scenarios. E3 developed alternative resource portfolios and estimated costs across these scenarios
- NorthWestern Energy Capacity Contribution Accreditation – E3 supported NWE's 2019 Resource Procurement Plan by calculating ELCCs to use for capacity accreditation

E3's experience performing resource adequacy analysis

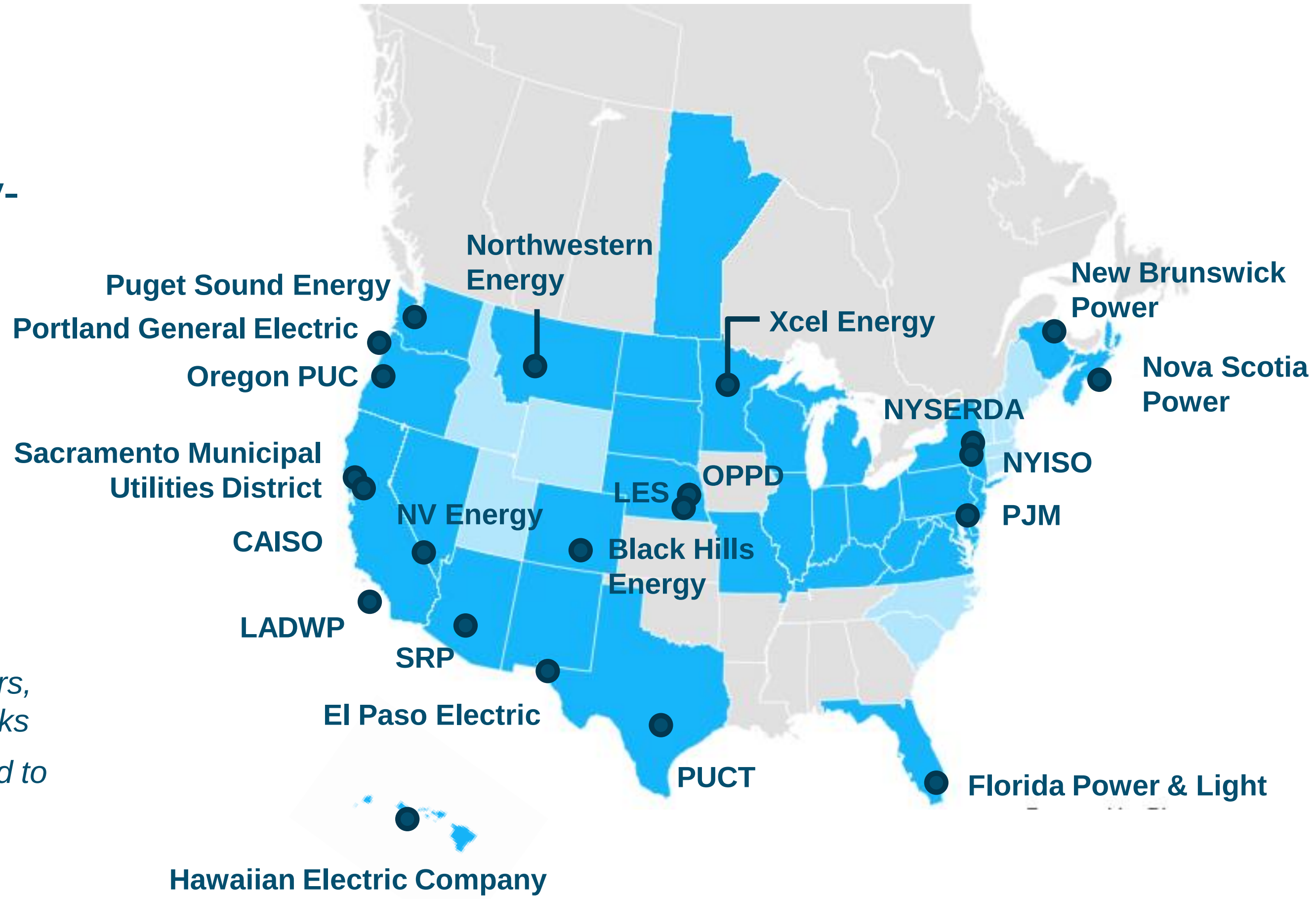
E3 has developed RECAP, a proprietary model for performing loss of load analysis

- Simulation model for assessing resource availability over **hundreds of simulation years**
- **Time-sequential dispatch** for capturing energy-limited resource dynamics for hydro, energy storage, and demand response

States where E3 has provided direct support to utilities, market operators, and/or state agencies to perform RA modeling or develop RA frameworks

Areas where E3 has worked with other clients to examine issues related to resource adequacy

E3 has worked directly with utilities across North America to study resource adequacy needs



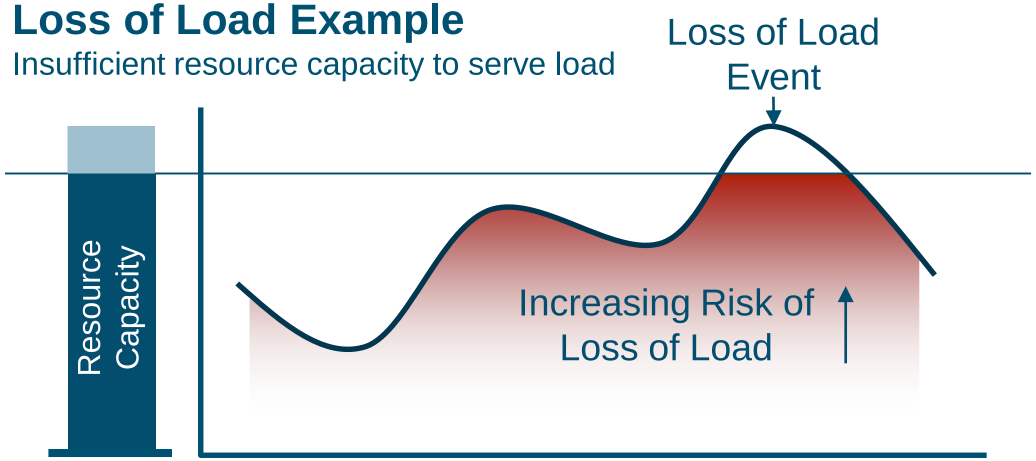
Background on Resource Adequacy

Energy+Environmental Economics

What is resource adequacy?

+ **<u>Resource adequacy</u> is a measure of the ability of a portfolio of generation resources to meet load across a wide range of system conditions, accounting for supply & demand variability**
+ **No system is planned to achieve a perfect level of adequacy**
  - The most common standard used throughout North America is a “one-day-in-ten-year” standard
  - PSE uses a 5% LOLP standard

Loss of Load Example
Insufficient resource capacity to serve load

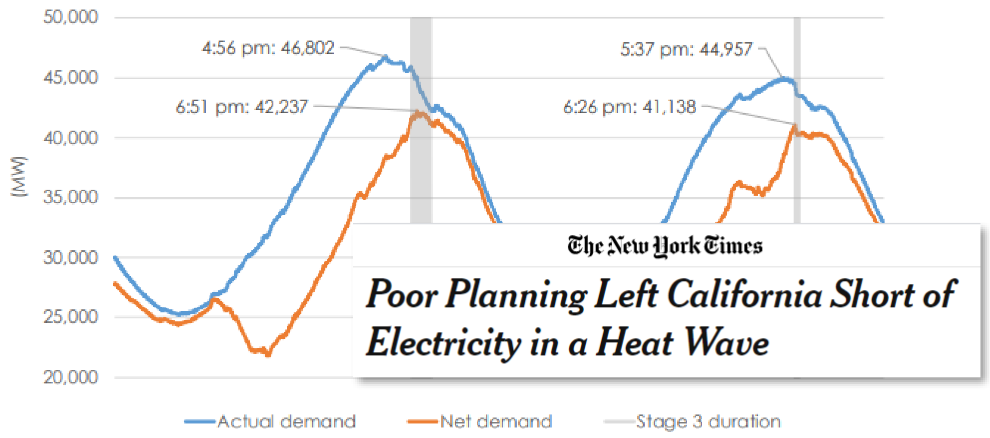


<u>NERC Definition of Resource Adequacy:</u>
“The ability of supply-side and demand-side resources to meet the aggregate electrical demand (including losses)”

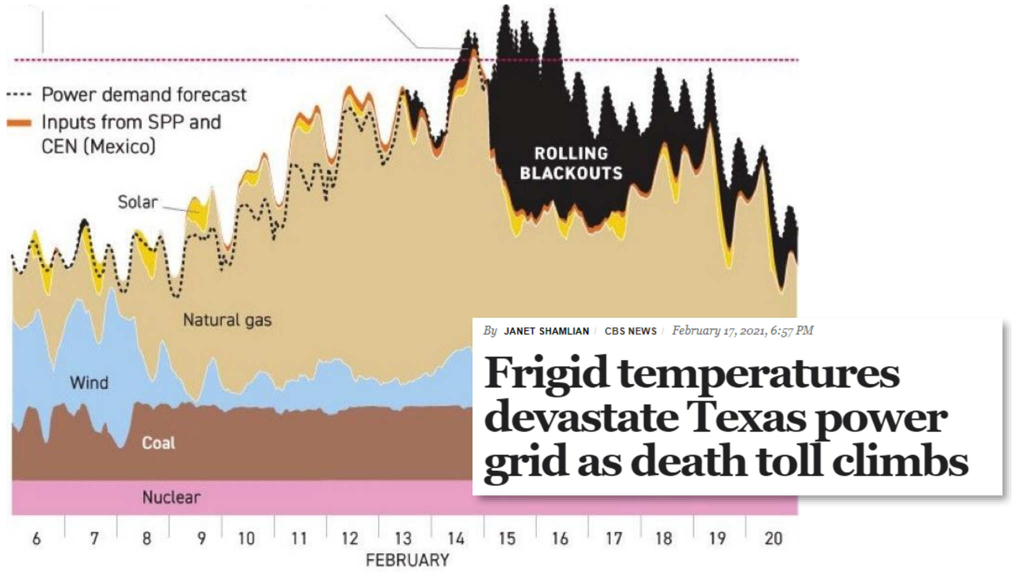
Source: NERC Glossary of Terms

Resource adequacy is increasing in complexity and importance

+ **Transition towards renewables and storage introduces new sources of complexity in resource adequacy planning**
  - The concept of planning exclusively for "peak" demand becoming obsolete
  - Resource adequacy frameworks must be modernized to consider conditions across all hours of the year – as underscored by California's rotating outages during August 2020 "net peak" period
+ **Reliable electricity supply is becoming increasingly important to society:**
  - Ability to supply cooling and heating electric demands in more frequent extreme weather events is increasingly a matter of life or death
  - Economy-wide decarbonization goals will drive electrification of transportation and buildings, making the electric industry the keystone of future energy economy



Graph source: http://www.caiso.com/Documents/Final-Root-Cause-Analysis-Mid-August-2020-Extreme-Heat-Wave.pdf

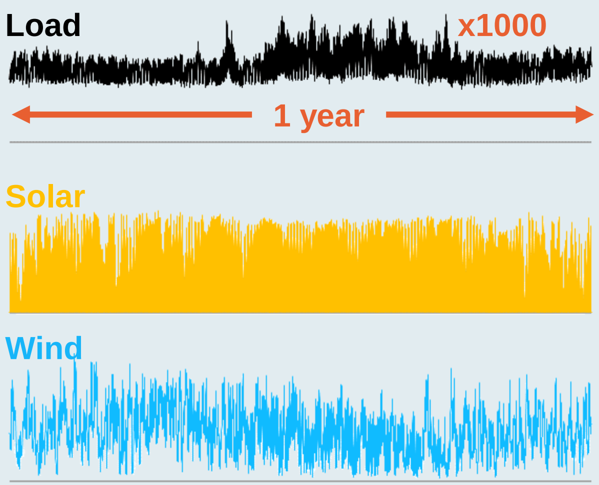


Graph source: https://twitter.com/bcshaffer/status/1364635609214586882

Planners are increasingly using LOLP models to support enhancements to resource adequacy

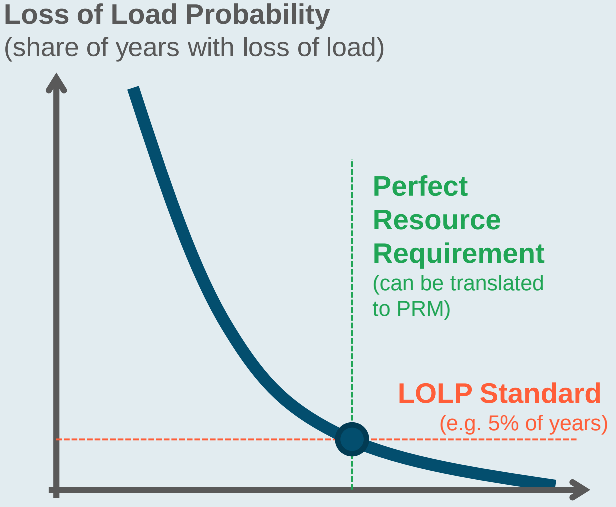
Develop a representation of the loads and resources of an electric system in a loss of load probability model

LOLP modeling allows a utility to evaluate resource adequacy across all hours of the year under a broad range of weather conditions, producing statistical measures of the risk of loss of load



Identify the amount of perfect capacity needed to achieve the desired level of reliability

Factors that impact the amount of perfect capacity needed include load & weather variability, operating reserve needs

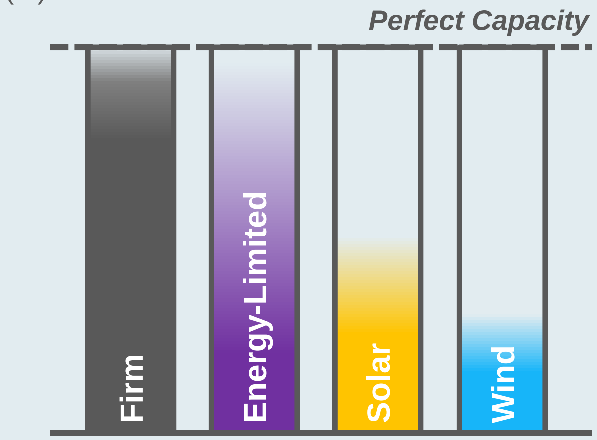


Outputs:

- Total Resource Need (TRN), in MW
- Planning Reserve Margin (PRM) = (TRN ÷ 1-in-2 peak load) - 1

Calculate capacity contributions of different resources using effective load carrying capability

ELCC measures a resource's contribution to the system's needs relative to perfect capacity, accounting for its limitations and constraints



Outputs:

- Individual resource Effective Load-Carrying Capacity (ELCC), in MW and % of nameplate

PRM and ELCC

Planning Reserve Margin (PRM)

The PRM is the total amount of capacity needed to satisfy PSE's reliability target, which is 5% loss of load probability (or 1 in 20 years with loss of load).

"How many MW needed in total"

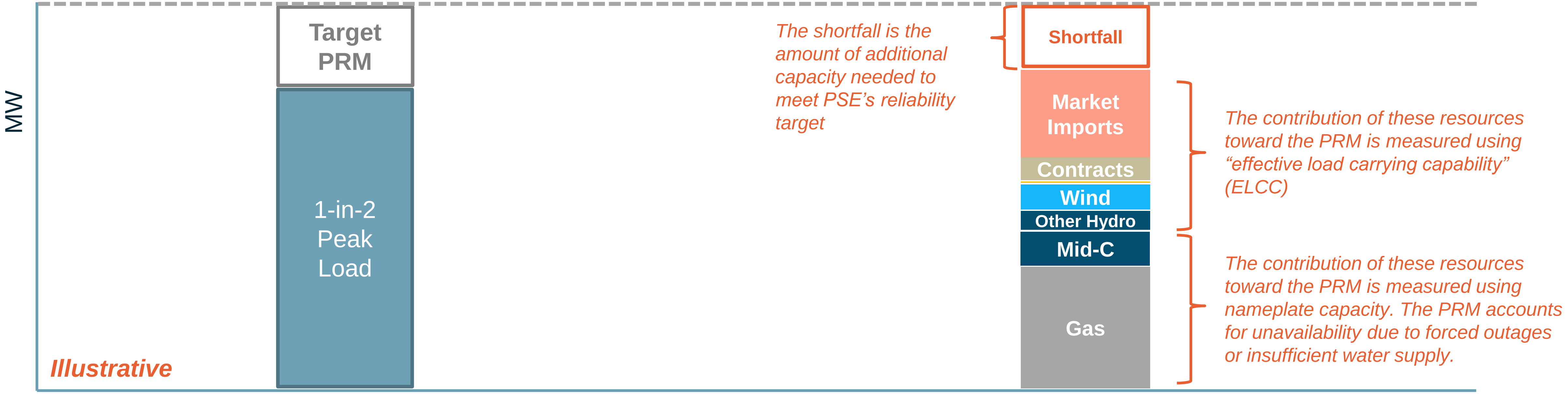
Measured as % above PSE's expected peak load

Effective Load Carrying Capability (ELCC)

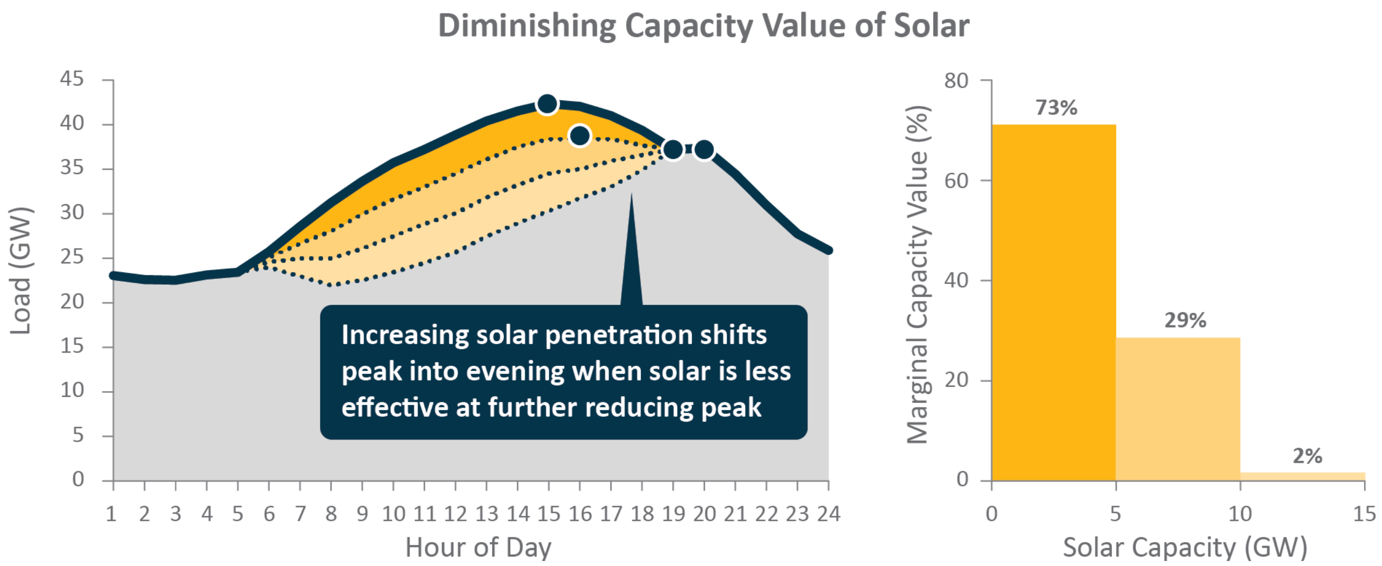
The ELCC is the equivalent "perfect" capacity that a resource provides in meeting PSE's reliability target

"How many MW provided by each resource"

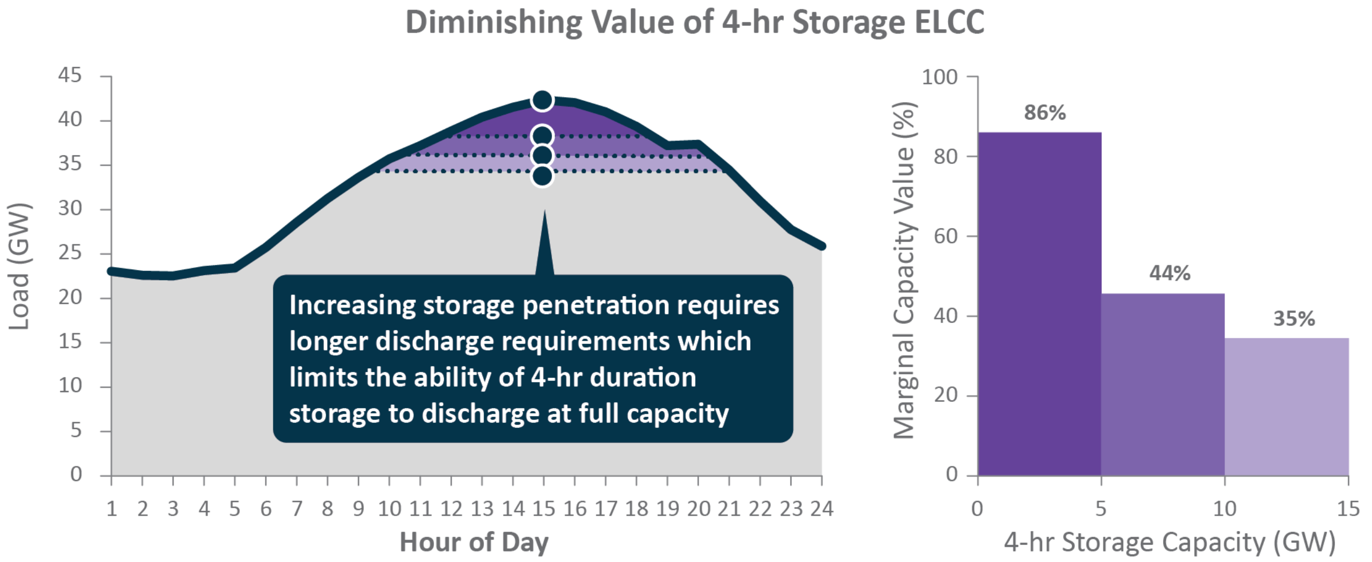
Measured as % of nameplate capacity



ELCC captures saturation effects at increasing penetrations



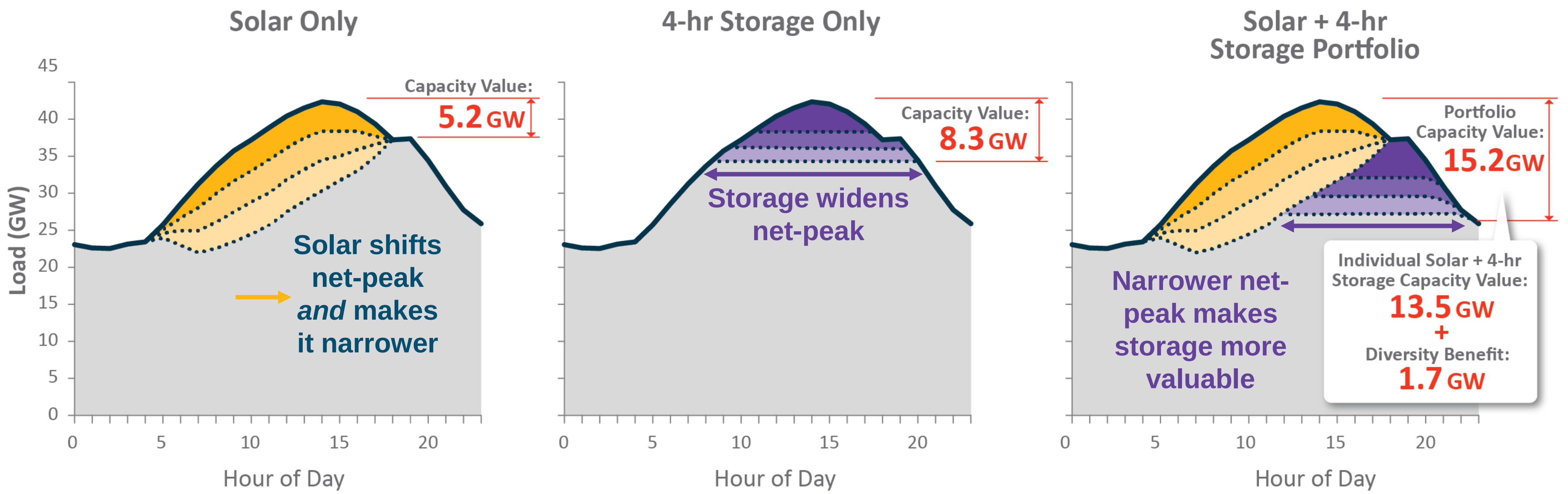
Solar and other **variable resources** (e.g. wind) exhibit declining value due to variability of production profiles



Storage and other **energy-limited resources** (e.g. DR, hydro) exhibit declining value due to limited ability to generate over sustained periods

ELCC captures diversity benefits among technologies

- Resources with complementary characteristics can result in a greater ELCC than the sum of their parts. These synergistic interactions are also described as a "diversity benefit"
- As penetrations of intermittent and energy-limited resource grow, the magnitude of these interactive effects will increase and become non-negligible



Changes in the 2023 IRP

Energy+Environmental Economics

Changes in the 2023 IRP

Input	Changes
Framework	• Seasonal PRM and ELCCs rather than annual values
Climate change	• Modeling across three climate models, which represent different climate futures
Load	• Simulations of the future rather than historical observations • Appropriately incorporating long-term temperature trends when studying a single snapshot year ◆
Operating reserves	• Balancing reserves updated based on modeled intra-hour variability
Hydro	• Simulations of the future rather than historical hydrological conditions • Flexibility to shift Mid-C and Baker generation based on hydrological conditions ◆
Wind and solar	• Simulations for 250 years, provided by DNV
Market imports	• Simulations based on simulated regional loads and resources
Storage	• No minimum state of charge applied to the contracted energy capacity ◆ • Can discharge at rated capacity for the rated duration ◆ • NWPP Reserve Sharing Program can be called when modeling the ELCC of storage ◆ • Forced outages modeled for storage • Can provide operating reserves without fully discharging

◆ *Recommended changes in E3's Sept. 2021 report: "Review of Puget Sound Energy Effective Load Carrying Capability Methodology"*

Market availability

2,031 MW transmission rights can be used to transfer:

- Mid-C generation (560 MW nameplate)
- Wild Horse generation (273 MW nameplate)
- Market imports (subject to availability and transmission)

Market purchase curtailments:

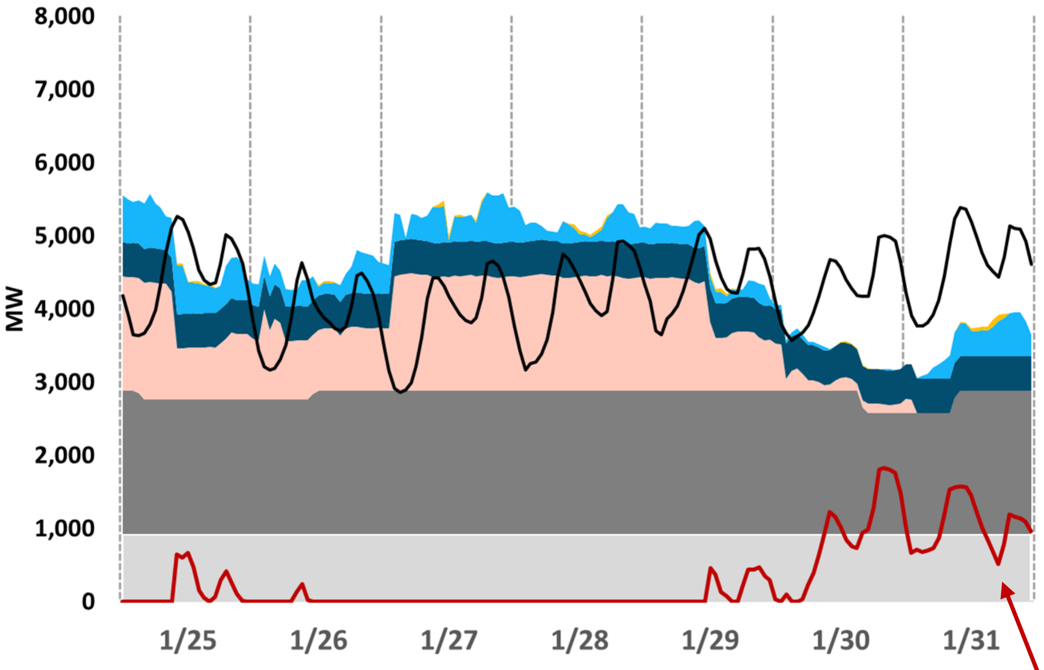
	Winter				Summer			
	2021	2023 A	2023 C	2023 G	2021	2023 A	2023 C	2023 G
Avg. # curtailment events per year	0.22	0.10	0.00	0.18	0.79	22.10	18.93	10.43
Avg. curtailment duration (hr)	37.7	8.8	2.5	28.3	9.4	10.6	9.6	10.4
Avg. MWh curtailment per year	5,792	445	2	5,991	3,234	189,140	143,927	84,398

The 2023 IRP has shorter market purchase curtailment events in winter

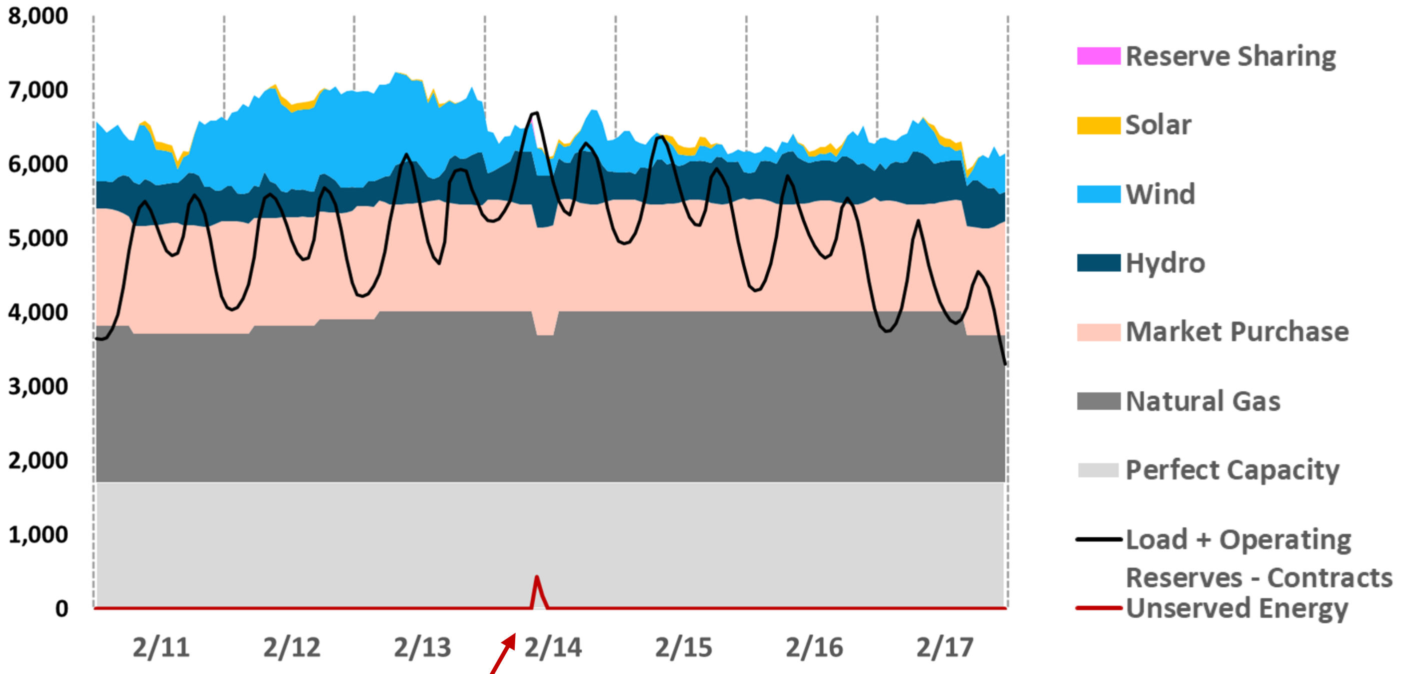
The 2023 IRP has much more market purchase curtailments in summer

Example winter weeks with loss of load

2021 IRP: winter week in 2027



2023 IRP: winter week in 2029, Model G

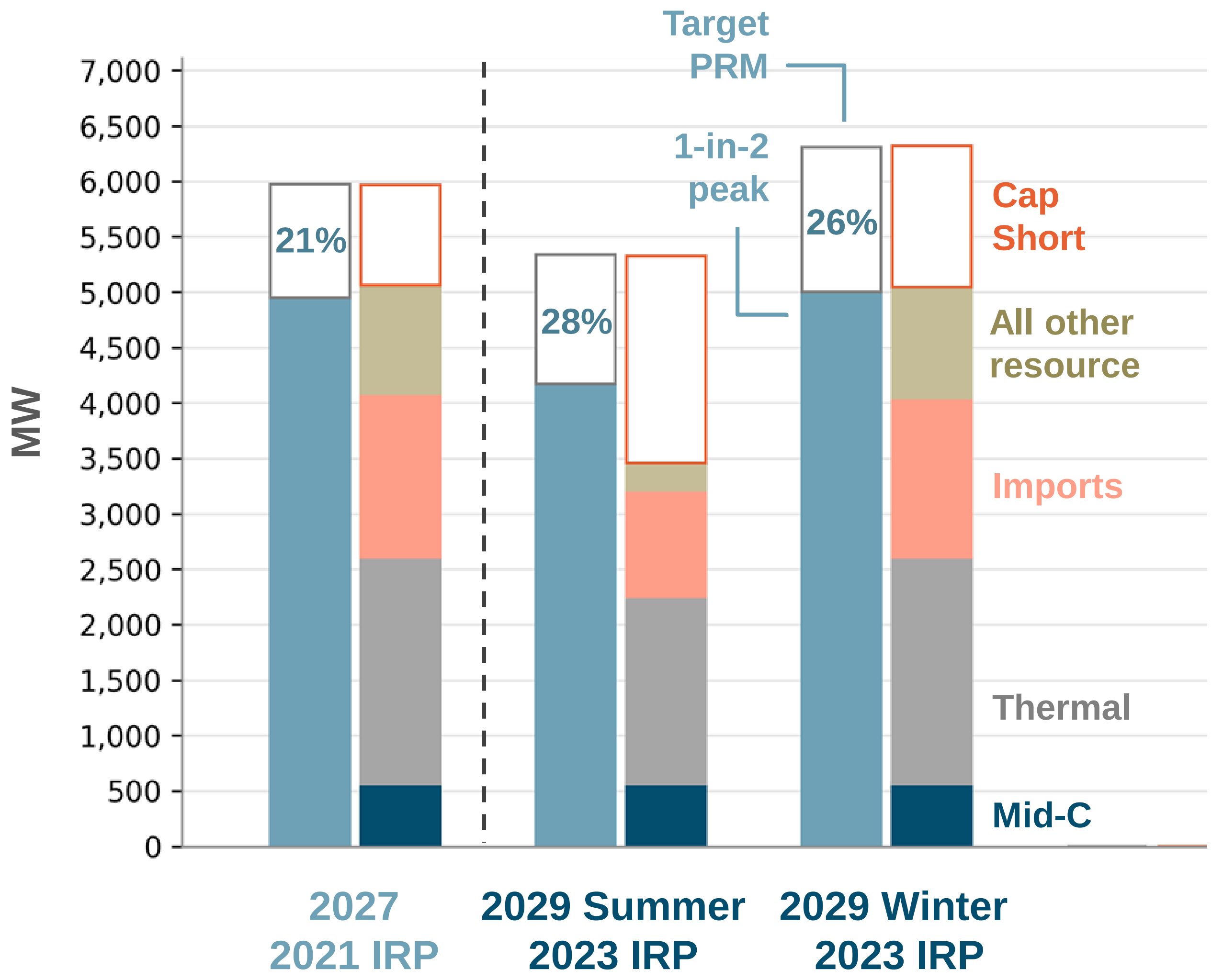


The 2021 IRP results show longer duration loss of load events than the 2023 IRP results

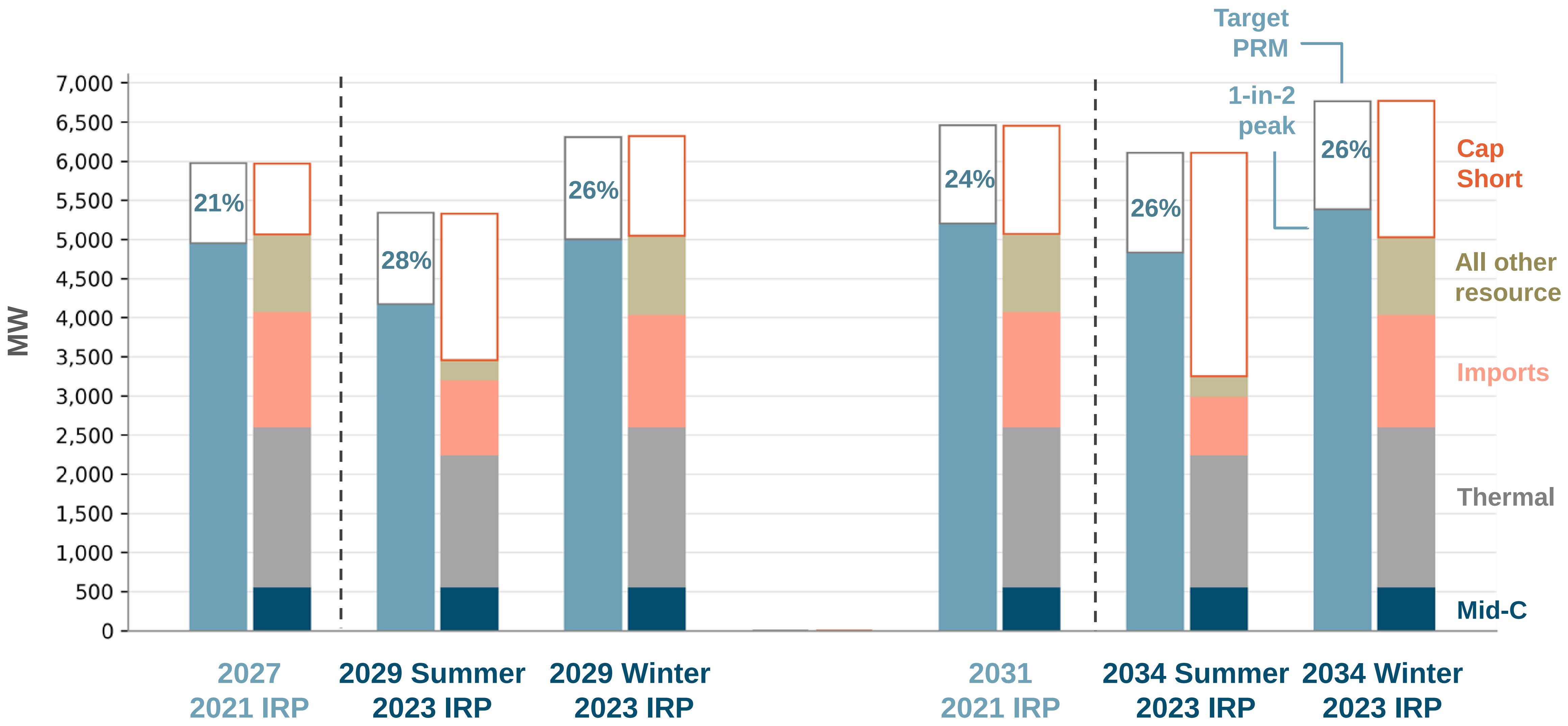
2023 IRP Results

Energy+Environmental Economics

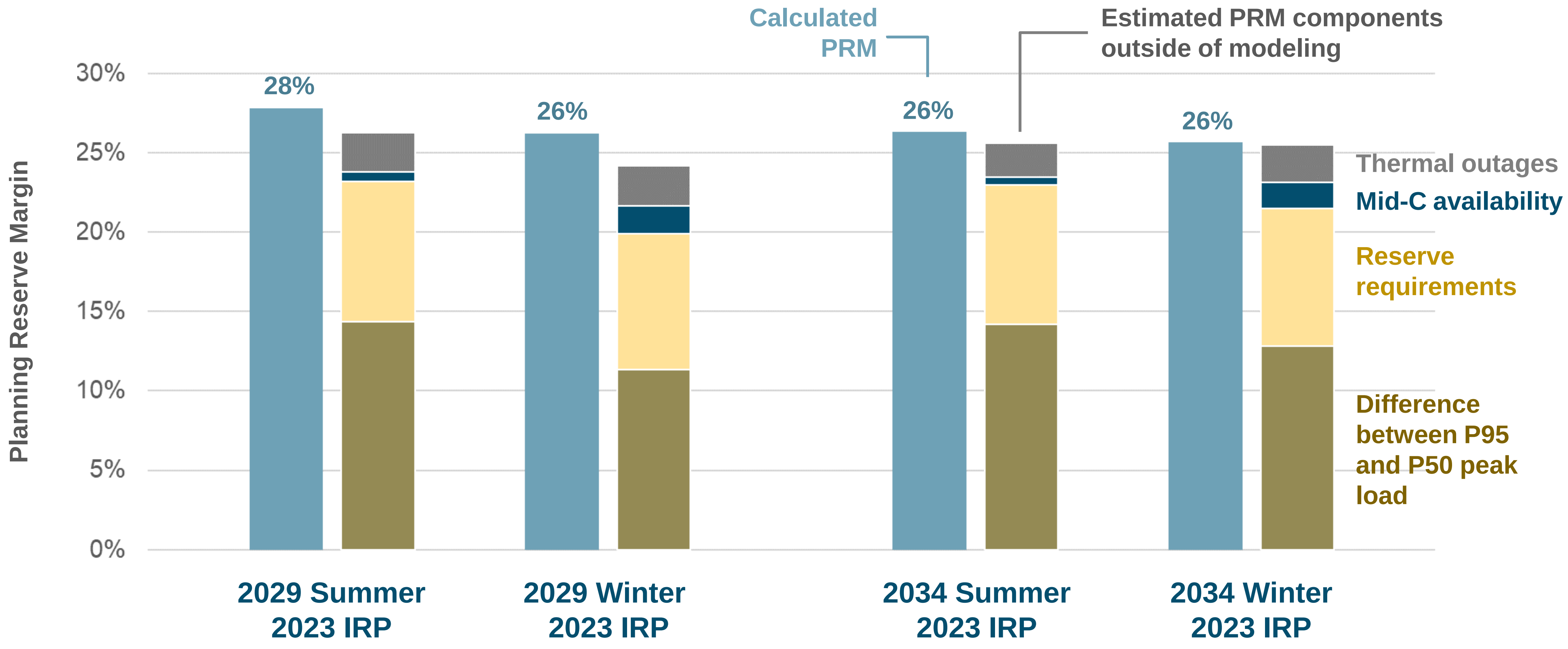
Planning reserve margin



Planning reserve margin



Planning reserve margin components



Effective load carrying capability

	2021 IRP	2023 IRP	2023 IRP
Resource	Annual	Winter	Summer
British Columbia Wind	N/A*	34%	13%
Idaho Wind	24%	12%	17%
Montana Central Wind	30%	39%	27%
Montana East Wind	22%	32%	19%
Offshore Wind	48%	32%	41%
Washington Wind	18%	13%	5%
Wyoming East Wind	40%	52%	34%
Wyoming West Wind	28%	39%	34%
DER Ground Mount Solar	1%	4%	28%
DER Rooftop Solar	2%	4%	28%
Idaho Solar	3%	8%	38%
Washington East Solar	4%	4%	55%
Washington West Solar	1%	4%	53%
Wyoming East Solar	6%	11%	29%
Wyoming West Solar	6%	10%	28%

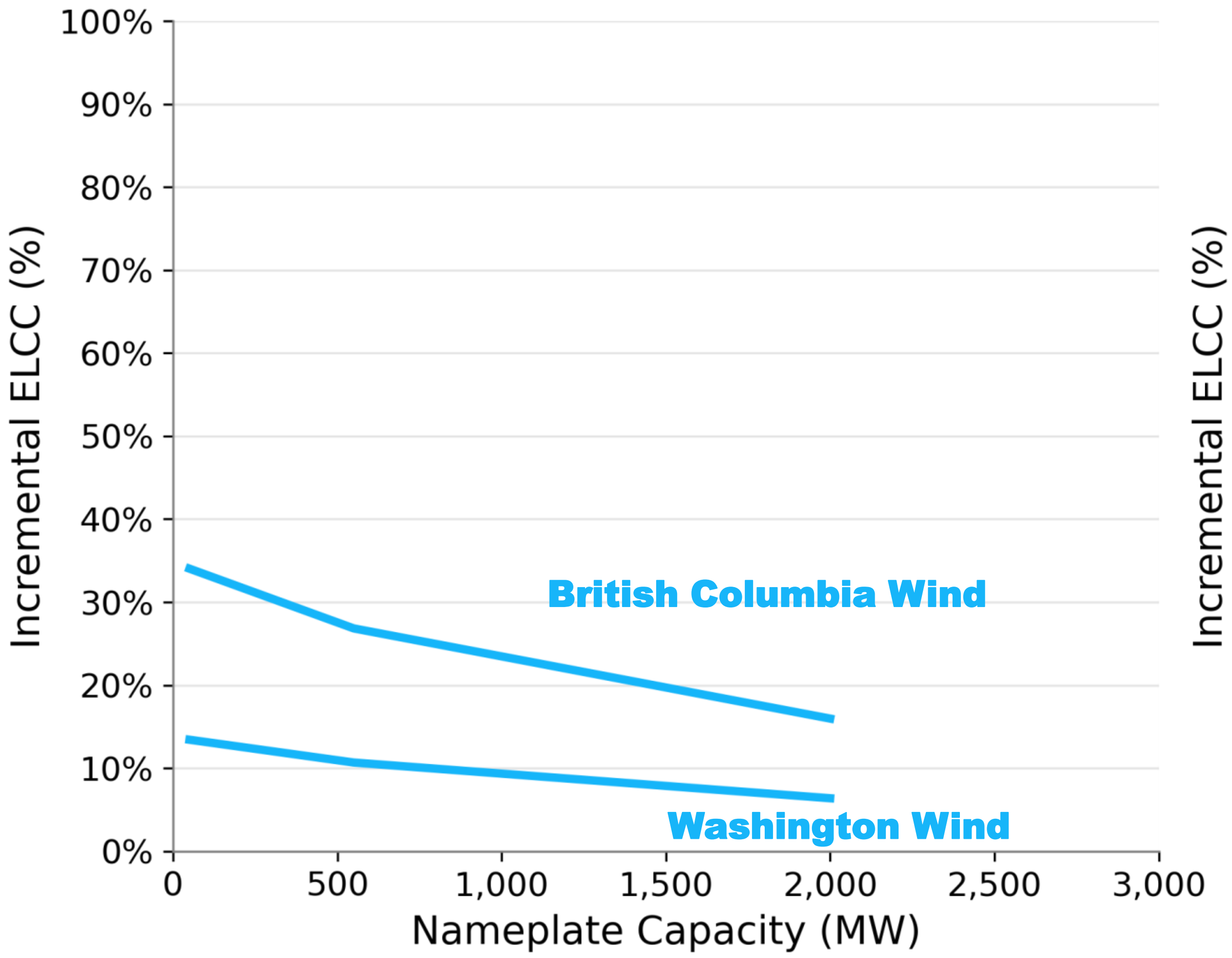
	2021 IRP	2023 IRP	2023 IRP
Resource	Annual	Winter	Summer
Li-ion Battery (2-hour)	12%	84%	88%
Li-ion Battery (4-hour)	25%	96%	95%
Li-ion Battery (6-hour)	N/A*	98%	98%
Pumped Storage (8-hour)	37%	99%	99%
Demand Response (3-hour)	26%	69%	95%
Demand Response (4-hour)	32%	73%	99%
Frame Turbine	N/A*	96%	98%
Reciprocating Engine	N/A*	96%	96%
Combined Cycle	N/A*	84%	92%

- The wind and solar ELCCs for winter are similar to the ELCCs from the 2021 IRP
- Compared with winter ELCCs, summer ELCCs are lower for wind and higher for solar
- The storage and demand response ELCCs are higher than the ELCCs from the 2021 IRP

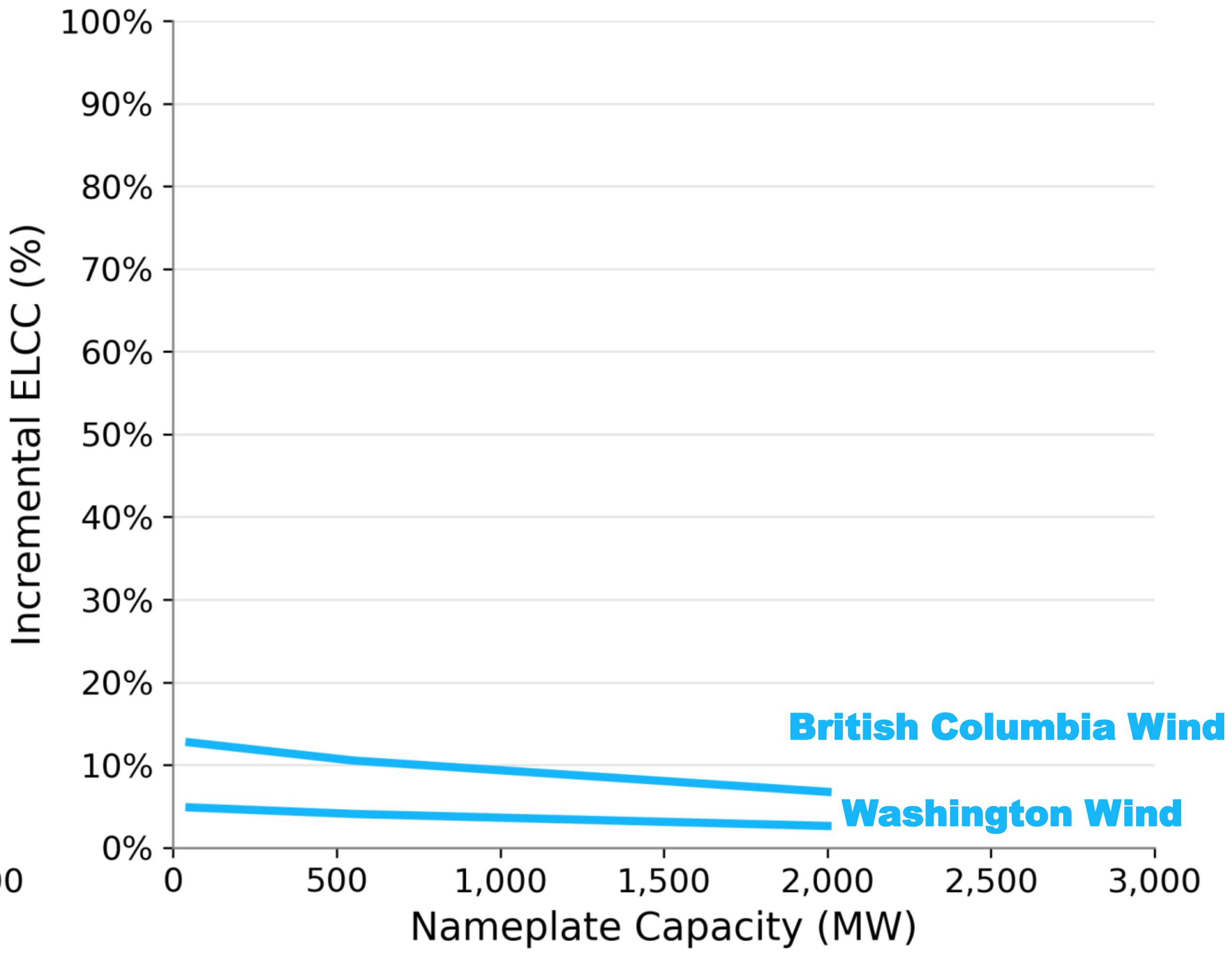
** The 2021 IRP did not include British Columbia Wind or 6-hour Li-ion Battery resource options. The 2021 IRP included gas plant options but did not model ELCC for these resources based on forced outage rates and maintenance schedules*

Pacific Northwest Wind ELCC saturation curves

Winter

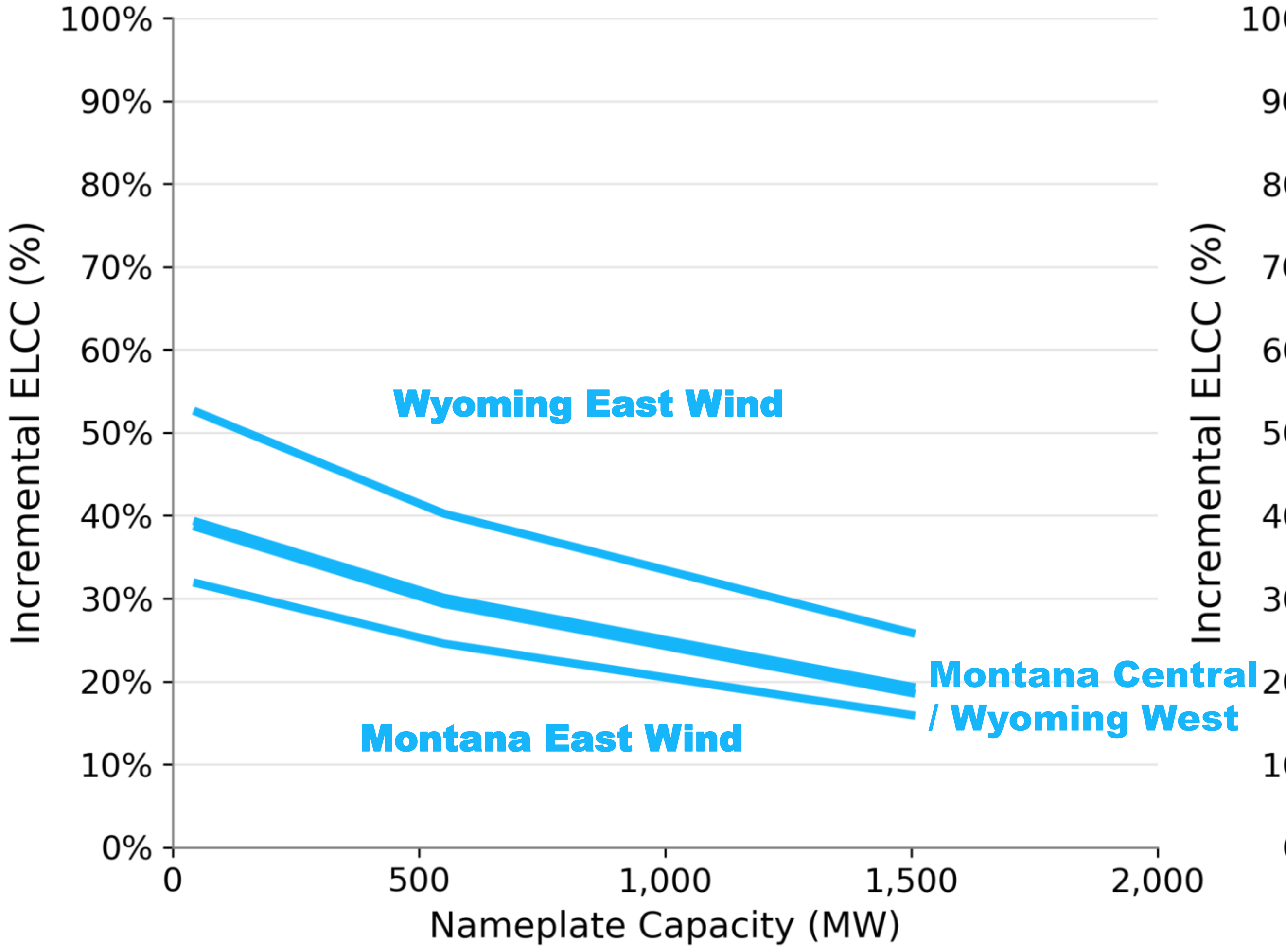


Summer

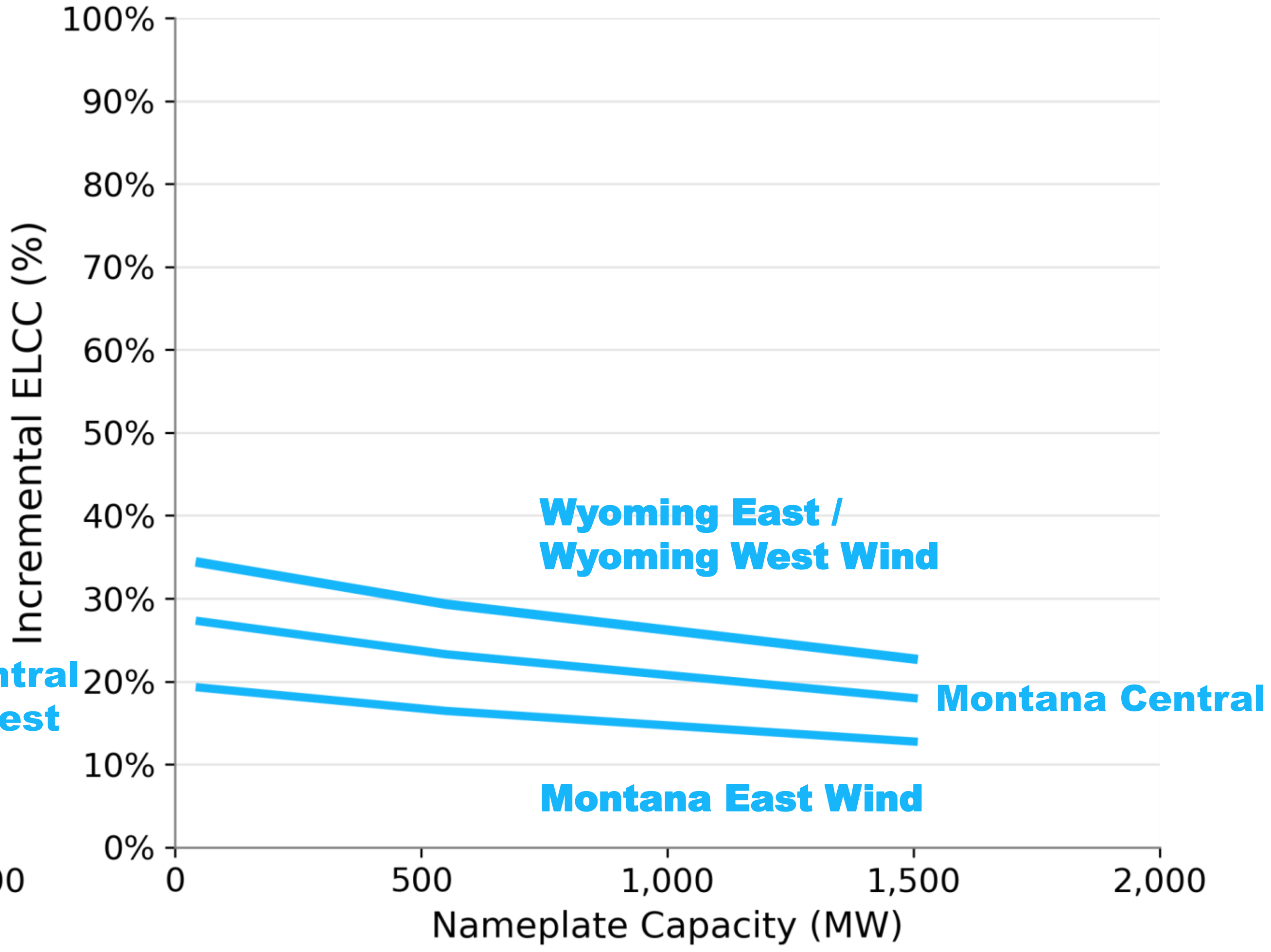


Rockies Wind ELCC saturation curves

Winter

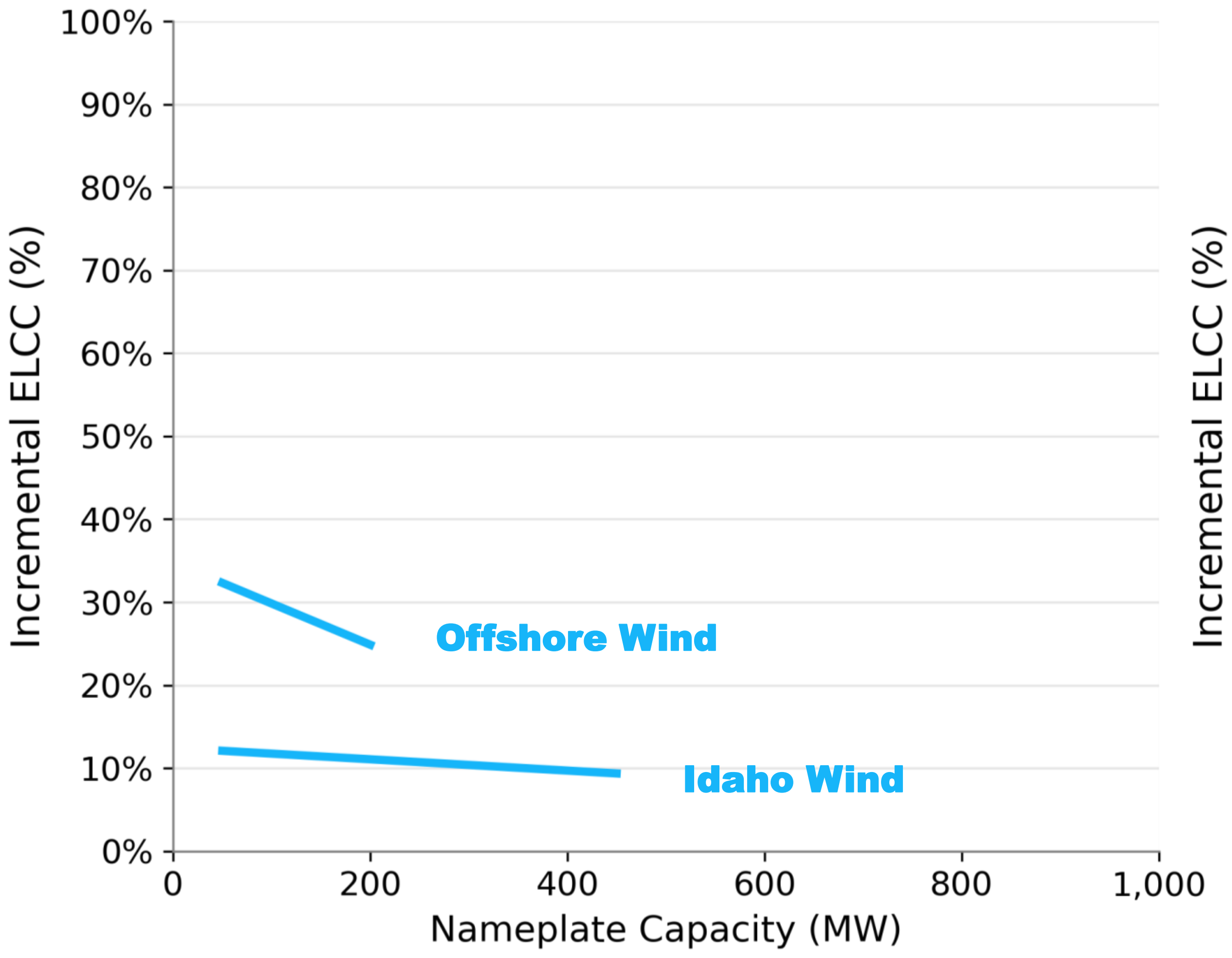


Summer

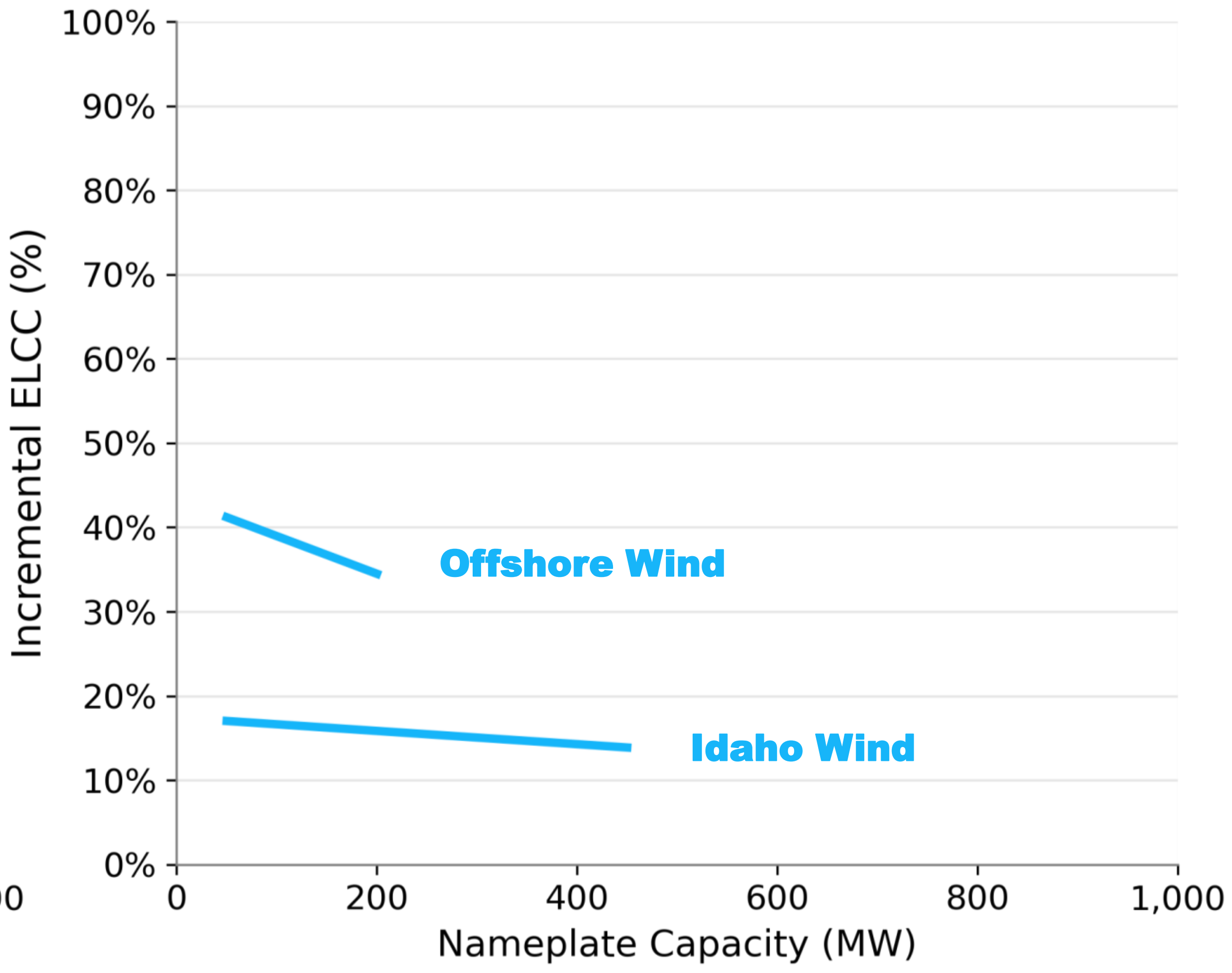


Idaho Wind and Offshore Wind ELCC saturation curves

Winter

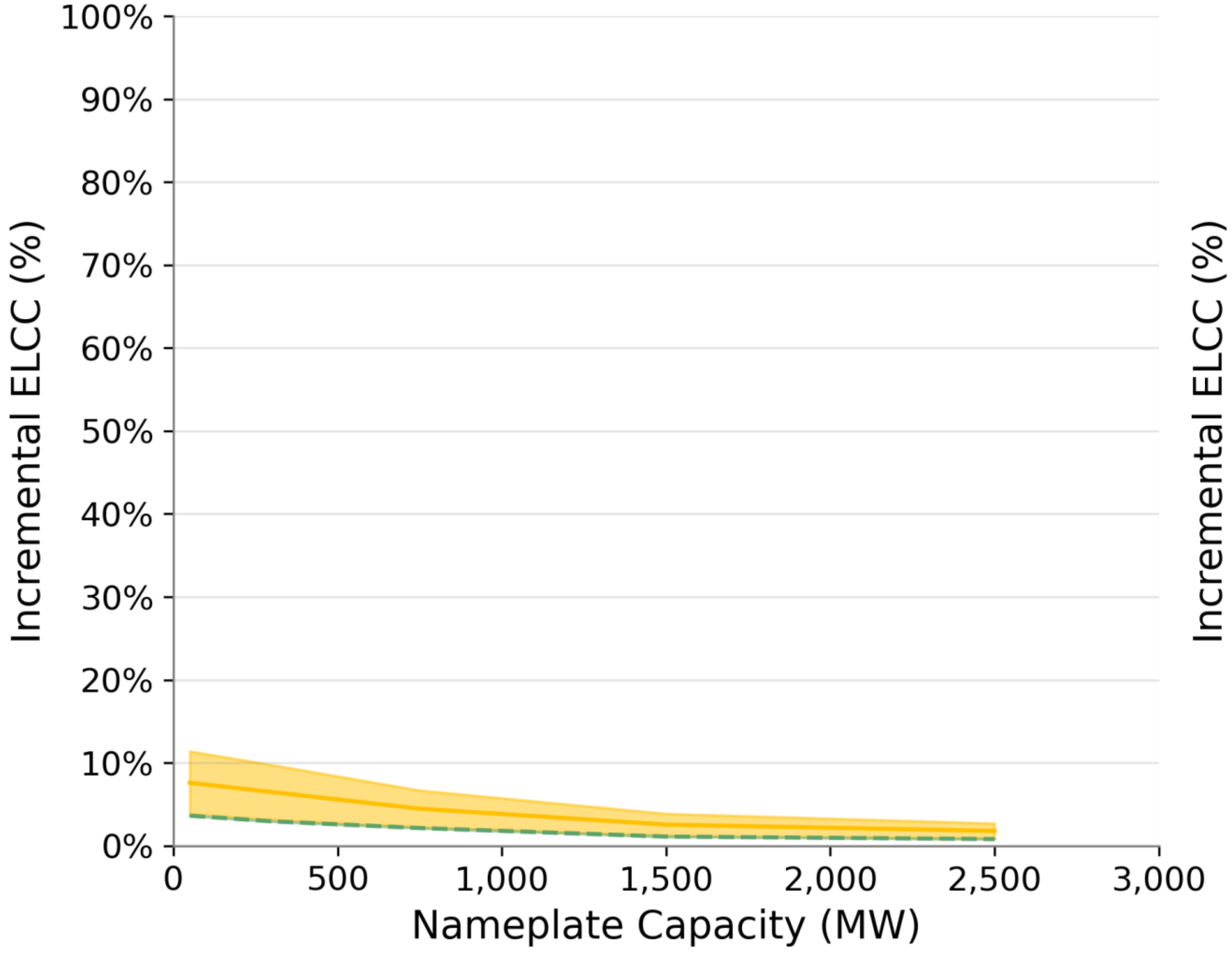


Summer

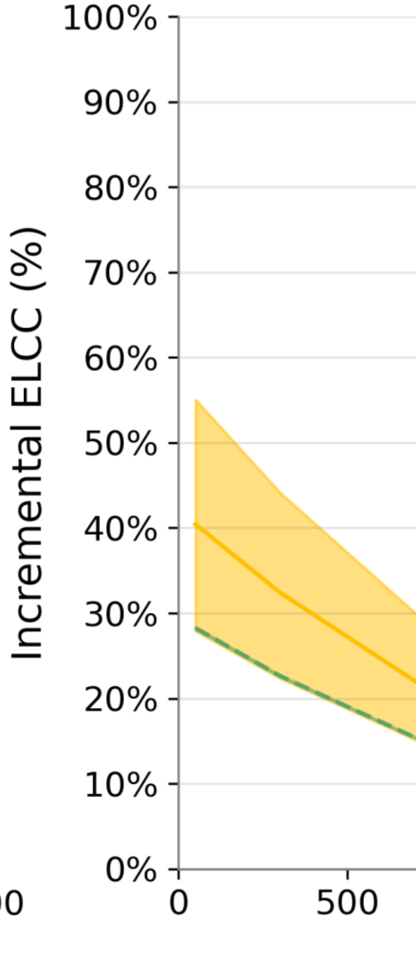


Solar ELCC saturation curves

Winter



Summer



Average utility scale solar across 5 locations:

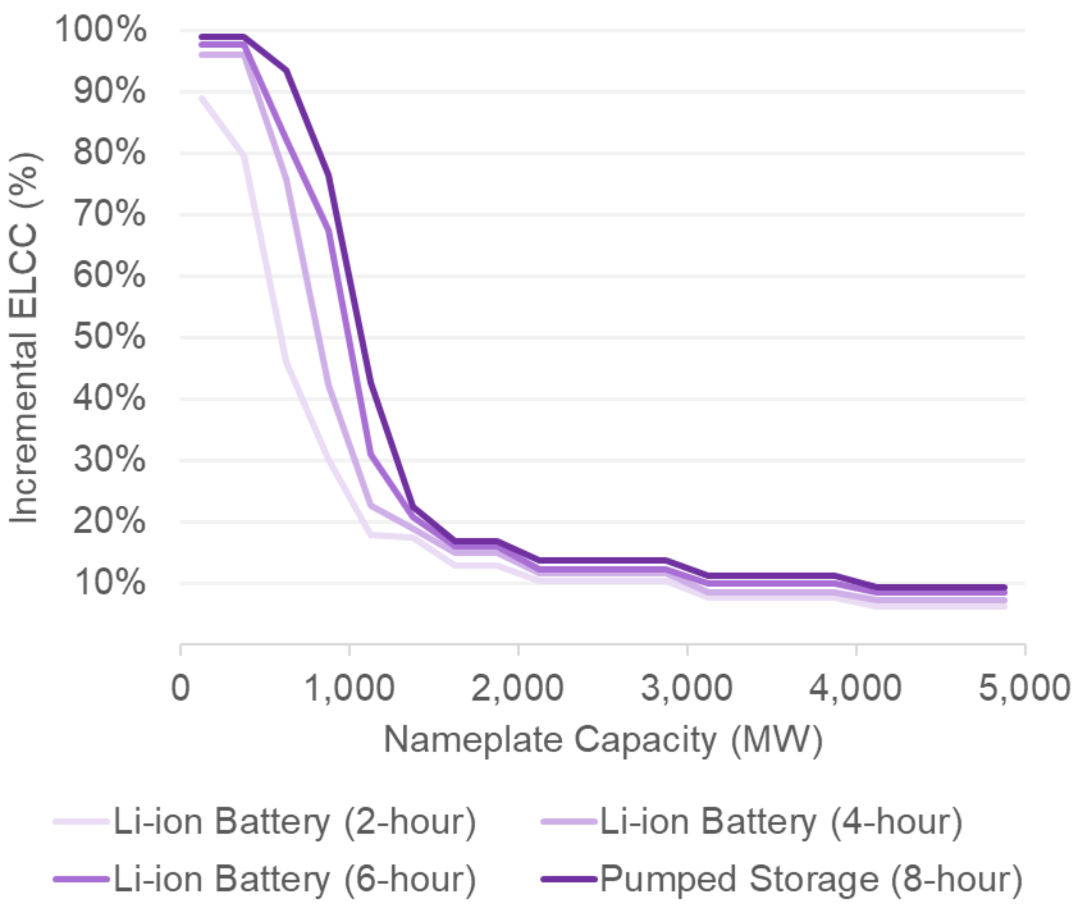
- Washington East
- Washington West
- Idaho
- Wyoming East
- Wyoming West

Average distributed solar for two technologies:

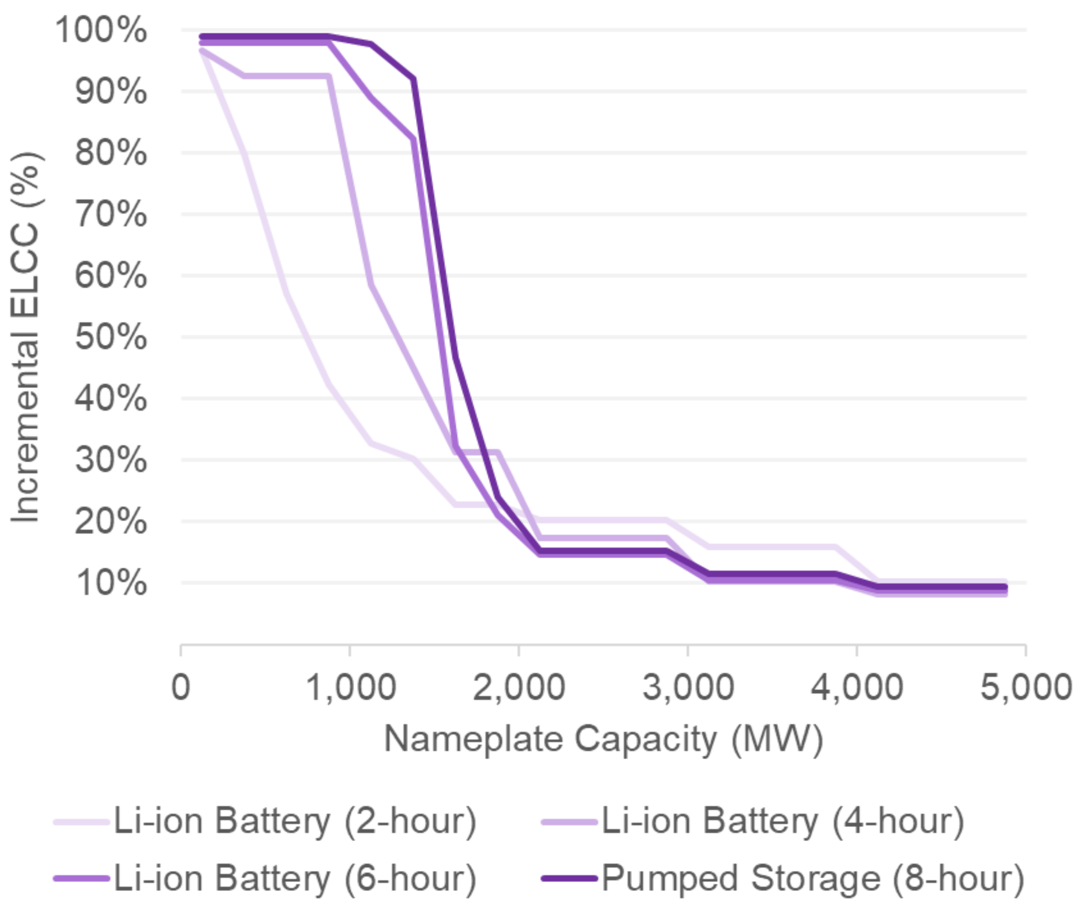
- Ground mount
- Rooftop

Storage ELCC saturation curves

Winter



Summer



Summary of key results

+ The PRM is 26-28%, depending on the year and season
+ The Winter PRM and Winter ELCC results for existing/contracted resources are consistent with results from the 2021 IRP
+ Loss of load events are shorter in duration in the 2023 IRP, resulting in a higher ELCC for storage and demand response
+ Compared with the Winter ELCC results, the Summer ELCC results are higher for solar and storage, lower for wind and market imports

Thank You

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Energy+Environmental Economics

Recommendations not incorporated in the 2023 IRP

Input	Changes not made
Wind and solar	• The modeling does not include correlations between load and renewable output during extreme events. For example, in the Pacific Northwest, intense cold weather could drive increased demand and decreased renewable output at the same time. These impacts are not included in the modeling
Market imports	• The modeling of the Pacific Northwest region does not add sufficient resources in the region to hit a loss of load probability of 5% for the region. E3 recommended performing this as a sensitivity to see if it would result in an increase in the ELCC of storage resource. The new analysis does not include this sensitivity, but it does result in a very high ELCC for storage at initial tranches.

These were recommended changes in E3's Sept. 2021 report: "Review of Puget Sound Energy Effective Load Carrying Capability Methodology." As discussed in the report, E3 recommends exploring load/wind/solar correlations in future IRP cycles. E3 also recommends revisiting the 5% sensitivity in future IRP cycles.

PSE Resource Needs & Market Reliance

2023 IRP Progress Report Check In

Phillip Popoff
Director, Resource Planning Analytics, PSE

PUGET SOUND ENERGY

Capacity Need Before Examining Market Reliance

E3 Results Resources (MW)				
	2029	**2029**	**2034**	**2034**
Resource	Winter	Summer	Winter	Summer
Mid-C Hydro	560	560	560	560
Thermal	2,050	1,688	2,050	1,688
All other resources	997	244	981	252
Short-Term Market Purchases	1,440	961	1,434	751
Additional perfect capacity for 5% LOLP	**1,272**	**1,875**	**1,746**	**2,856**
Total Resources	6,319	5,329	6,771	6,107

PSE PUGET SOUND ENERGY

PSE Resource Adequacy Study – Capacity Needs

E3 2023 IRP Planning Reserve Margin								
	2021 IRP				2023 IRP			
	Annual				2029		2034	
	2027 (MW)	2029 (MW)	2031 (MW)	2034 (MW)	Winter (MW)	Summer (MW)	Winter (MW)	Summer (MW)
Additional perfect capacity for 5% LOLP	907	**1,039**	1,381	1,611	**1,272**	1,875	1,746	2,856
Normal Peak - Before Conservation	4,949	5,058	5,199	5,372	5,104	4,300	5,588	4,845

- **2023 IRP results for winter are similar to the 2021 IRP results**
- **Summer capacity needs for the 2023 IRP increase significantly**
- **Drivers**
  - Increased peak demand
  - Climate change impacts on load and hydro

	Winter 2029		
Variance in Need	2021 IRP	2023 IRP	Change
Additional perfect capacity for 5% LOLP	**1,039**	**1,272**	**233**

	Winter 2029		
Source of Variance	2021 IRP	2023 IRP	Change
Normal Peak Load Forecast	5,058	5,104	46
Planning Reserve Margin	1,045	1,215	170
Capacity Value of Existing Resource	3,586	3,607	22
Import	1,479	1,440	(39)
Total Variance			**233**

PSE PUGET SOUND ENERGY

Market Reliance: Defined

What is market reliance?

Reliance on the availability and purchase of electricity through the wholesale electricity market, which may not be physically firm.

Why is this important?

PSE’s current transmission portfolio assumes approx. 1,500 MW of electricity from the Mid-Columbia (Mid-C) trading hub to the PSE load center for distribution to customers.

Market Reliance: 2021 IRP Background

2021 IRP Market Risk Assessment

- PSE evaluated ongoing availability of short-term power contracts
  - Recommended gradually reducing market reliance on short-term Mid-C market purchases by ~1000 MW by 2027.
  - Reducing PSE's market reliance increases PSE's capacity need.

PSE committed to ongoing review and evaluation of this topic in the 2023 IRP Electric Progress Report, including:

- Consideration of ongoing technological advancements.
- The outcome of the All-Source RFP.
- Regional resource adequacy developments (i.e., the WRAP).

Market Reliance: Update

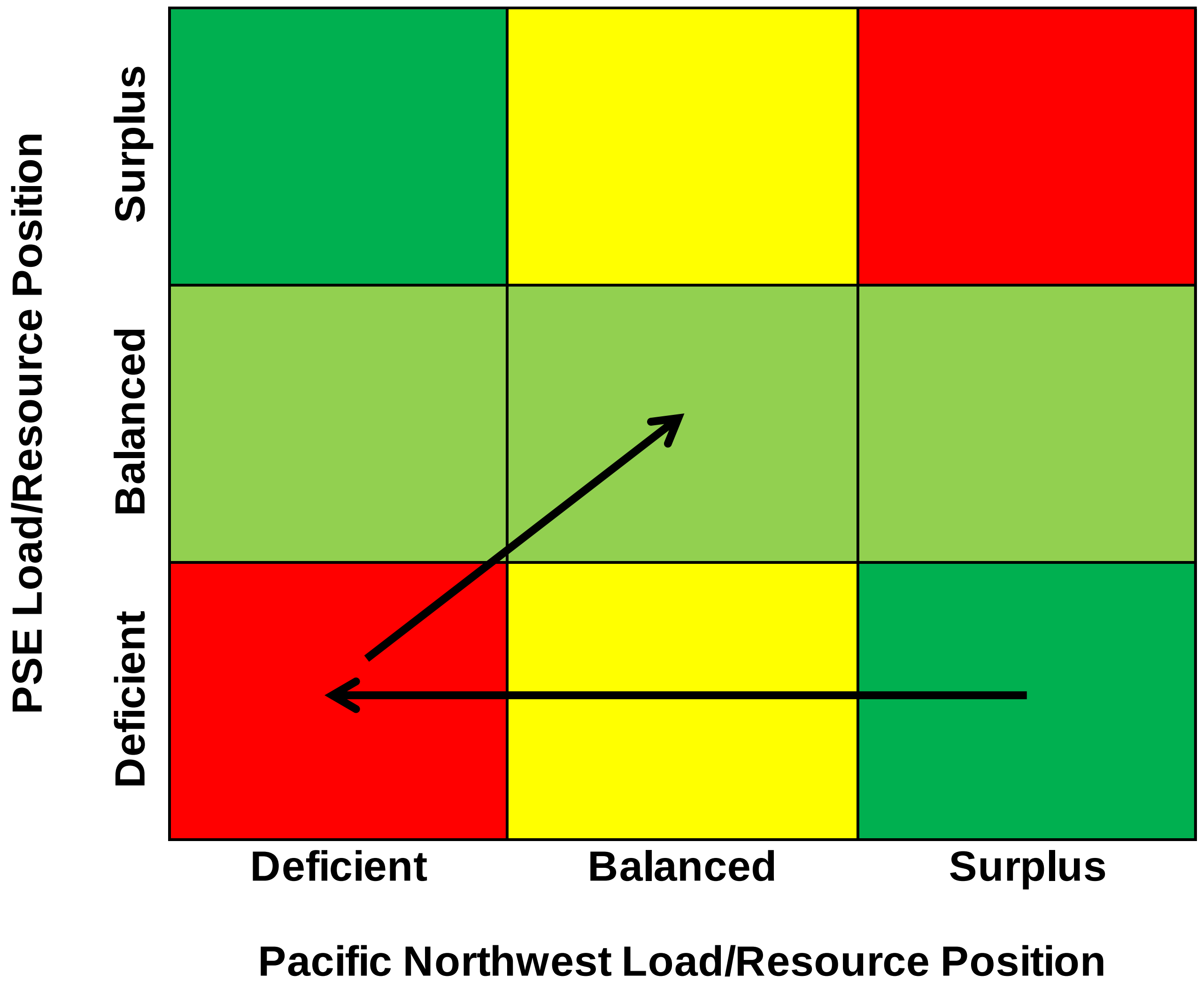
What is changing?

PSE has been closely examining its market reliance assumptions since the 2021 IRP and intends to reduce the amount it relies on market for capacity.

Need to phase out Market Reliance by first WRAP binding period—2028

- Regional resource adequacy assessment studies highlight that the region is moving from surplus to short capacity.
- Significant risk of higher regional load growth with electrification of buildings and transportation, data centers, and possibly hydrogen manufacturing.
- As PSE implements the WRAP, PSE can develop and fine-tune its exposure limits, if appropriate.

Market Reliance: Risk Matrix from Prior IRPs



REUTERS®

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May 13, 2022 · 4:36 PM PDT
Last Updated 16 days ago

United States

Texas grid operator calls for power conservation as temperatures, prices soar

UTILITY DIVE

DIVE BRIEF

California governor floats 5-GW, $5.2B ‘reliability reserve’ amid possible electricity shortfalls

Published May 17, 2022

T&DWorld

TRANSMISSION RELIABILITY

MISO’s Annual Planning Resource Auction Results Underscore the Reliability Imperative

April 21, 2022

Some parts of the region fall short of their Resource Adequacy requirements.

T&D World Staff

NERC Assessment

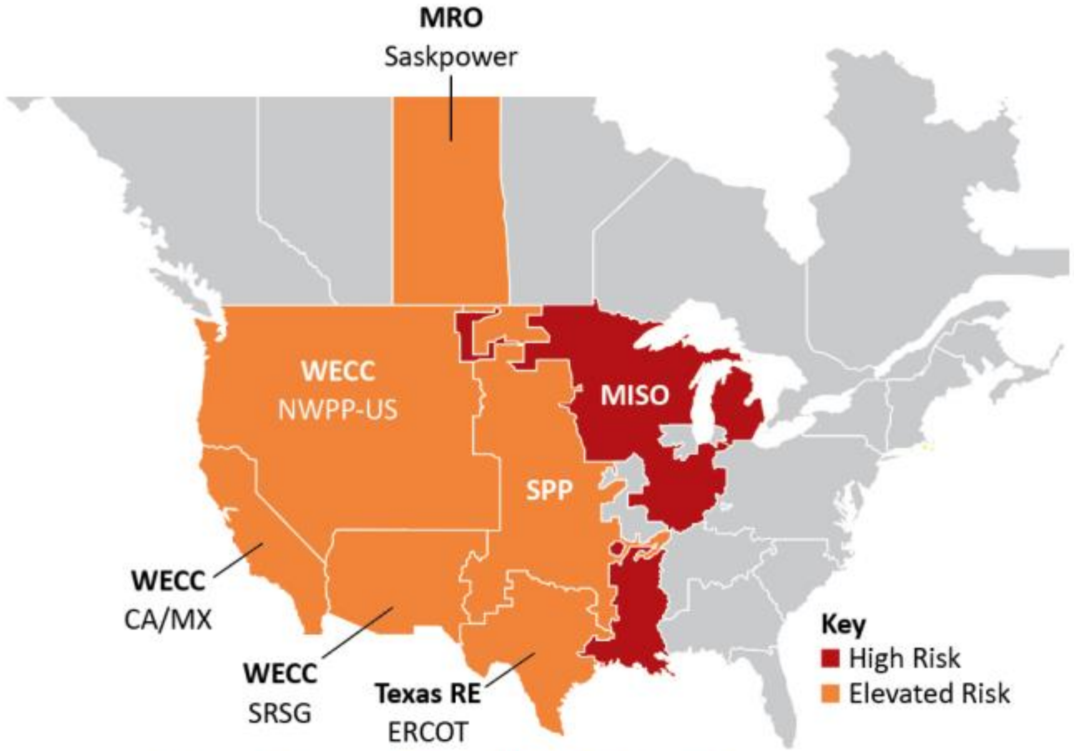

Figure 1: Summer Reliability Risk Area Summary

Seasonal Risk Assessment Summary	
High	Potential for insufficient operating reserves in normal peak conditions
Elevated	Potential for insufficient operating reserves in above-normal conditions
Low	Sufficient operating reserves expected

Inspired
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WECC's analysis of resource adequacy over the next 10 years

- Both demand and resource availability variability are increasing, and the challenges they present appear **worse now than they did in the 2020 Western Assessment of Resource Adequacy.**
- Under current planning reserve margins (PRM), **all subregions in the West show many hours at risk** of load loss over the next 10 years.
- To **mitigate resource adequacy risks** over the near-term (1–4 years) and long-term (5–10 years), **PRMs need to be increased**—in some cases significantly—or other actions taken to reduce the probability that demand exceeds resource availability.
- As early as **2025, all subregions will be unable to maintain the one-day-in-ten-year** (ODITY) resource adequacy threshold—99.98%—because they will not be able to eliminate the hours at risk for loss of load even if they build all planned resource additions and import power.
- Resource adequacy risks **could get worse before they get better if action is not taken immediately** to mitigate near-term risks and prevent long-term risks.

PUGET SOUND ENERGY

Market Resource Adequacy

Northwest Power and Conservation Council - Mixed Messages

- 2019 Adequacy Report: region at 26% LOLP by 2026.
- 8th Power Plan: no formal RA report but draft new model shows region at 0% LOLP.

PNUCC - Northwest Regional Forecast	2029		2034	
	Winter	Summer	Winter	Summer
PNUCC - Regional NRF Short	4,830	5,240	6,060	5,950
Identified Available Firm Resources in Region (Operational)	1,700	-	1,700	-
CA Imports	3,400	-	3,400	-
Net regional shortage	(270)	5,240	960	5,950
Note: PNUCC data not provided past 2031. PNUCC numbers for 2033 persisted from latest year available				

Adjusted PNUCC data shows:

- Winter: Region will be ~balanced by 2029 then **deficit by 2034.**
- Summer: **Severely short before summer of 2029.**

PUGET SOUND ENERGY

Key Elements of Need for Additional Capacity

E3 Results Resources (MW)				
	2029	**2029**	**2034**	**2034**
Resource	Winter	Summer	Winter	Summer
Mid-C Hydro	560	560	560	560
Thermal	2,050	1,688	2,050	1,688
All other resources	997	244	981	252
Short-Term Market Purchases	1,440	961	1,434	751
Additional perfect capacity for 5% LOLP	**1,272**	**1,875**	**1,746**	**2,856**
Total Resources	6,319	5,329	6,771	6,107

Adjusted to Eliminate Short Term Market Reliance Resources (MW)				
	2029	**2029**	**2034**	**2034**
Resource	Winter	Summer	Winter	Summer
Mid-C Hydro	560	560	560	560
Thermal	2,050	1,688	2,050	1,688
All other resources	997	244	981	252
Short-Term Market Purchases	-	-	-	-
Additional perfect capacity for 5% LOLP	**2,712**	**2,836**	**3,180**	**3,607**
Total Resources	6,319	5,329	6,771	6,107

Resource Adequacy: Conclusions

Capacity Need

- PSE will use E3's work that incorporates climate change as the basis of capacity need to meet resource adequacy targets.

Effective Load Carrying Capability

- ELCC's presented by E3 will be used to fill the capacity need.

Reliance on Short-Term Markets for Firm Capacity

- PSE will phase out reliance on short-term markets for capacity, consistent with E3. ELCC calculations.

Impact of Need and ELCC Updates on Resource Plan

- We are excited to see those, too!
- Portfolio analysis will be ramping up.

Next Steps

Sophie Glass, Co-facilitator, Triangle Associates

IRP Stakeholder Feedback Process

Feedback form: PSE IRP - Feedback Form

August 26	A recording of the webinar and the transcript of the chat will be posted to the IRP website so those who were unable to attend can review.
August 31	Feedback forms are due. Feedback should focus on questions regarding the presentation.
September 21	A feedback report of **questions** collected from the feedback form, along with PSE's responses, and a meeting summary will be shared with stakeholders and posted to pse.com/irp

PSE PUGET SOUND ENERGY

Next Steps and How to Stay in Touch

Next meetings with IRP stakeholders

- Sept. 13, 2022 – Electric Progress Report: final resource need and Conservation Potential Assessment (CPA) results
- Sept. 22, 2022 – Gas Utility IRP: Final scenarios and gas alternatives, and CPA results

irp@pse.com

pse.com/irp

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PSE PUGET SOUND ENERGY

Appendix

Common Acronyms

Acronym	Meaning
CCHs	Capacity Critical Hours
CPA	Conservation Potential Assessment
DSW / E	Desert Southwest / East
E3	Energy + Environmental Economics
ELCC	Effective Load Carrying Capacity
LOLE	Loss Of Load Events
LOLP	Loss Of Load Probability
NW	Northwest
ODITY	One-day-in-ten-year
RA	Resource Adequacy
PNUCC	Pacific Northwest Utilities Conference Committee
PO	Program Operator
PRM	Planning Reserve Margin
QCC	Qualifying Capacity Contribution
UCAP	Unforced Capacity
UTC	Washington Utilities and Transportation Commission
WECC	Western Electricity Coordinating Council
WRAP	Western Resource Adequacy Program