Resource Adequacy and the Energy Transition in the Pacific Northwest: Phase 1 Results

Washington Utilities and Transportation Commission
Washington Department of Commerce

Resource Adequacy Meeting, RCW 19.280.065, Docket UE-210096

September 22, 2025

Lacey, Washington

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Energy+Environmental Economics

Overview of Phase 1

E3 was retained by regional utilities and generation owners to evaluate the state of resource adequacy in the Pacific Northwest today and into the future. Key findings of Phase 1:

1. **Accelerated load growth and continued retirements create a resource gap beginning in 2026 and growing to *9 GW by 2030***
   - 9 GW is approximately the load of the state of Oregon
2. **Preferred resources such as wind, solar and batteries make only *small contributions* to meeting resource adequacy needs**
3. ***Timely development of all resources is extremely challenging* due to permitting and interconnection delays, federal policy headwinds, and cost pressures**

STUDY SPONSORS

- Puget Sound Energy
- Public Generating Pool
  - Chelan Public Utility District
  - Clark Public Utility District
  - Cowlitz Public Utility District
  - Eugene Water & Electric Board
  - Grant Public Utility District
  - Lewis Public Utility District
  - Seattle City Light
  - Snohomish Public Utility District
  - Tacoma Power
- Avista Corporation
- Benton Public Utility District
- Douglas Public Utility District
- Emerald People's Utility District
- Franklin Public Utility District
- Idaho Power
- Klickitat Public Utility District
- Mason Public Utility District No. 3
- Northwest & Intermountain Power Producers Coalition
- NorthWestern Energy
- Okanogan Public Utility District
- Pacific Public Utility District
- Portland General Electric

Who is E3?

Our Practice Areas

+ **E3 is the largest consulting firm focused on the clean energy transition in North America**
+ **E3 is a recognized thought leader on decarbonization and clean energy transition topics**
+ **E3 has three major practice areas covering energy systems from bulk grid to behind the meter**

Climate Pathways / Policy Analysis

- Climate and energy policy analysis
- Long-term energy & climate scenarios
- Electrification and low-carbon fuels
- Future of gas

Asset Valuation & Strategy

- Asset valuation and due diligence
- Strategic advisory
- Energy market price forecasting
- Market design
- Transmission planning

Integrated System Planning

- Integrated resource planning for electric systems: reliability and resource mix
- Planning for utility and state RPS + GHG targets
- Utility planning and procurement decisions

Economy-wide energy systems ← Bulk grid power systems → Grid edge & behind-the-meter

E3 has extensive experience planning for deeply-decarbonized power systems for a wide range of clients

+ State agencies

- **California:** E3 provides technical support and advisory services to the CPUC in administration of the state's IRP program, to CARB in implementation of AB32 "cap-and-trade" program, and to the CEC on a variety of research topics including compliance with SB100
- **New York State Climate Act Scoping Plan:** E3 supports NYSERDA with technical analysis of pathways to achieve economy-wide carbon neutrality by 2050 including 100x40 in the power sector
- **Illinois:** E3 supports the Illinois Power Authority and Commerce Commission on a variety of topics including resource adequacy, procurement, and renewable energy transmission studies
- **Massachusetts Department of Energy Resources:** Evaluating the benefits of long-duration energy storage and other topics

+ Utilities

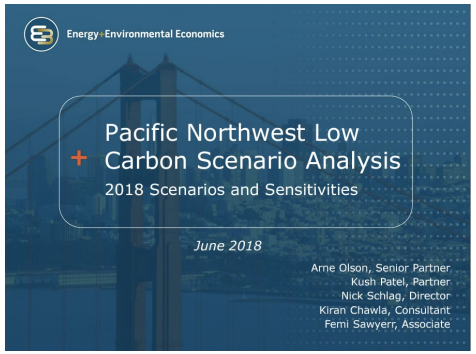
- **E3 has provided IRP support to dozens of utilities** including Puget Sound Energy, Eugene Water and Electric Board, Sacramento Municipal Utilities District, Arizona Public Service, Salt River Project, NV Energy, Public Service Company of New Mexico, El Paso Electric, Xcel Energy, Black Hills Energy, Hawaiian Electric Company, Omaha Public Power District, Florida Power & Light, Tampa Electric Company, Nova Scotia Power, New Brunswick Power, and others

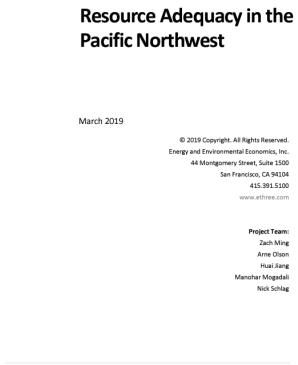
+ Non-profits

- E3 has advised **environmental advocacy organizations** including the Natural Resources Defense Council, Environmental Defense Fund, The Nature Conservancy, Clean Air Task Force, EarthJustice, World Resources Institute, Climate Solutions, and others

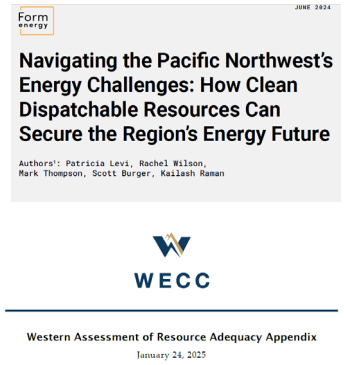
Resource Adequacy and the Energy Transition: Project Background

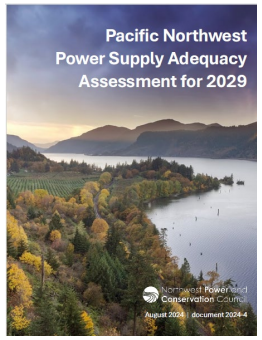
Prior E3 Studies in the Pacific Northwest

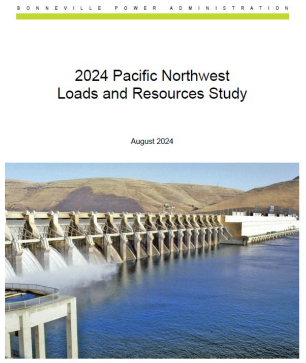


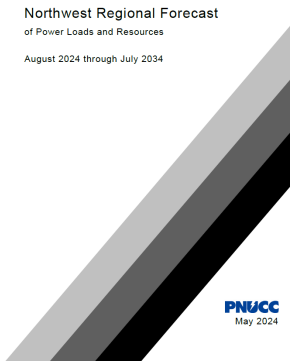


Recent PNW Regional Studies and Forecasts





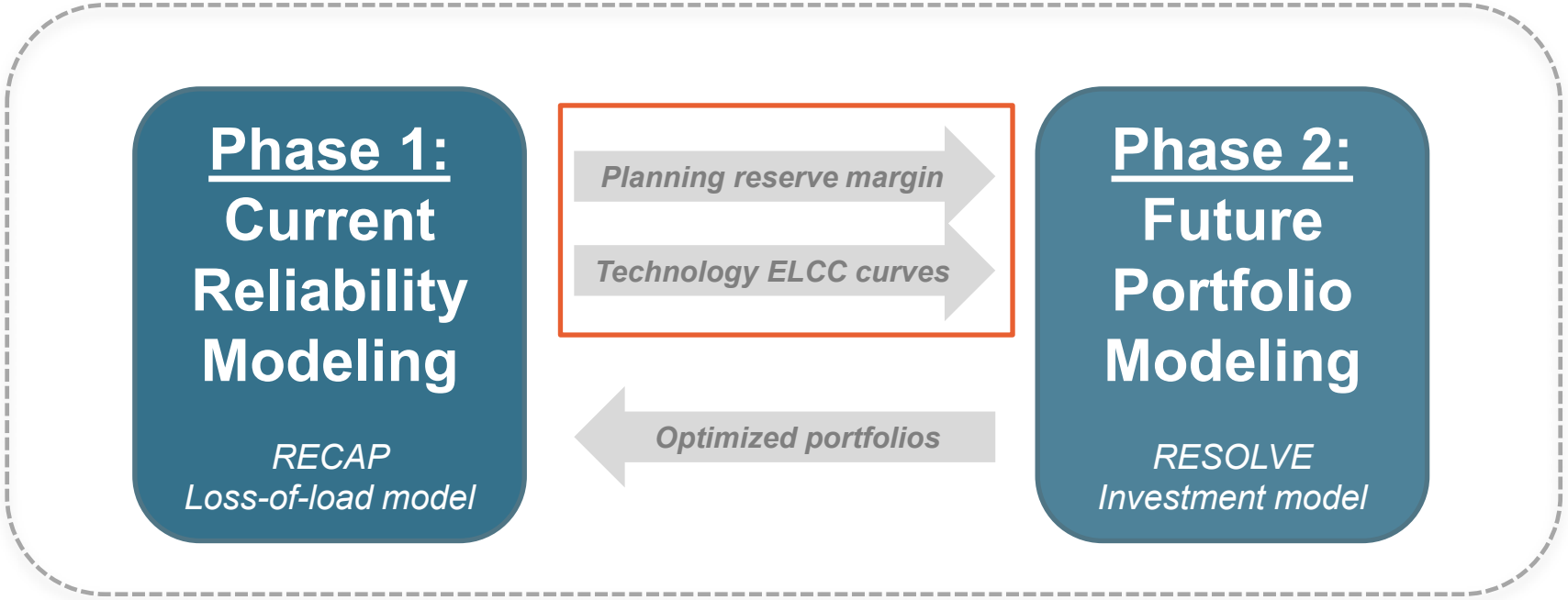




- **Prior E3 studies found that the Pacific Northwest faces *immediate and growing* resource adequacy challenges**
- **Much has happened over the past six years that might change the regional resource adequacy picture**
- **Current study objectives:**
  - Evaluate current load-resource balance
  - Examine the role of various technologies including flexible loads and firm generation for ensuring reliability
  - Identify potential barriers that may prevent the region from meeting its goals in the future

Study uses a two-phased modeling approach

+ **The modeling approach pairs detailed loss-of-load-probability modeling with capacity expansion modeling to provide a robust perspective on system reliability and cost under aggressive clean energy targets**

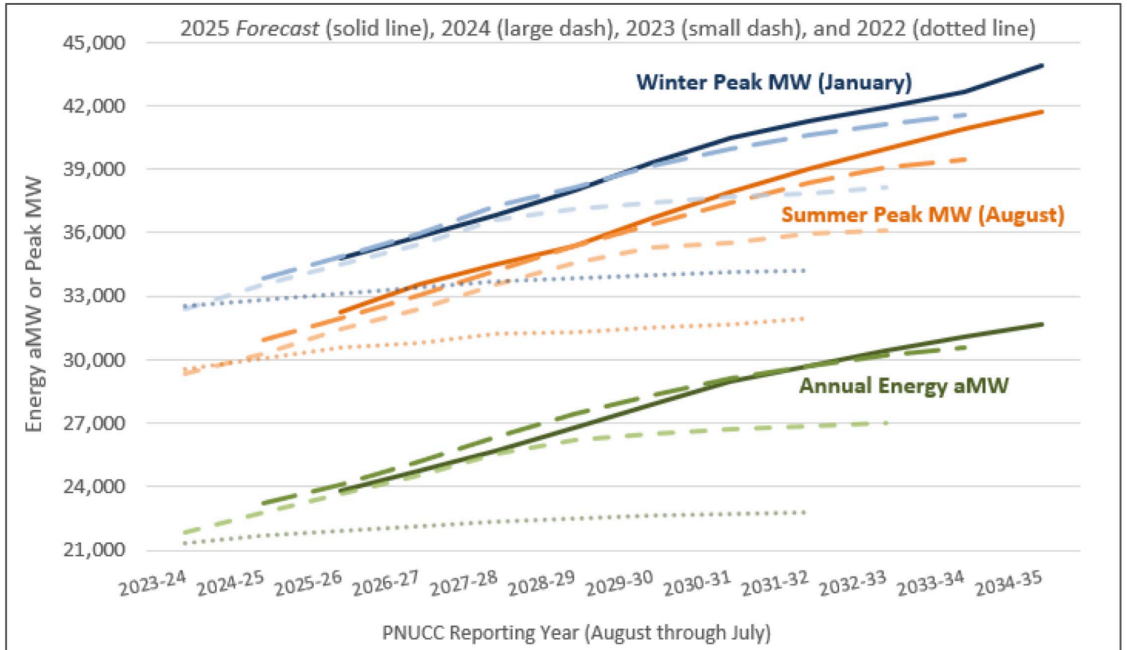


Key Study Topics:

1. Near-term resource adequacy picture
2. Barriers to new resource development
3. How to maintain long-term resource adequacy on a transitioning grid
4. Potential role for DSM and emerging "clean firm" resources
5. Stranding risk for near-term capacity resources

Regional load forecasts continue to increase due to AC adoption, electric vehicles, and data centers

PNUCC 2025 Northwest Regional Forecast
Energy aMW or Peak MW Forecast



Growth Rates

Energy	10 year
2025 *Forecast*	3.2%
2024 *Forecast*	3.1%
2023 *Forecast*	2.4%
2022 *Forecast*	0.9%

Summer Peak	10 year
2025 *Forecast*	2.9%
2024 *Forecast*	2.7%
2023 *Forecast*	2.3%
2022 *Forecast*	1.0%

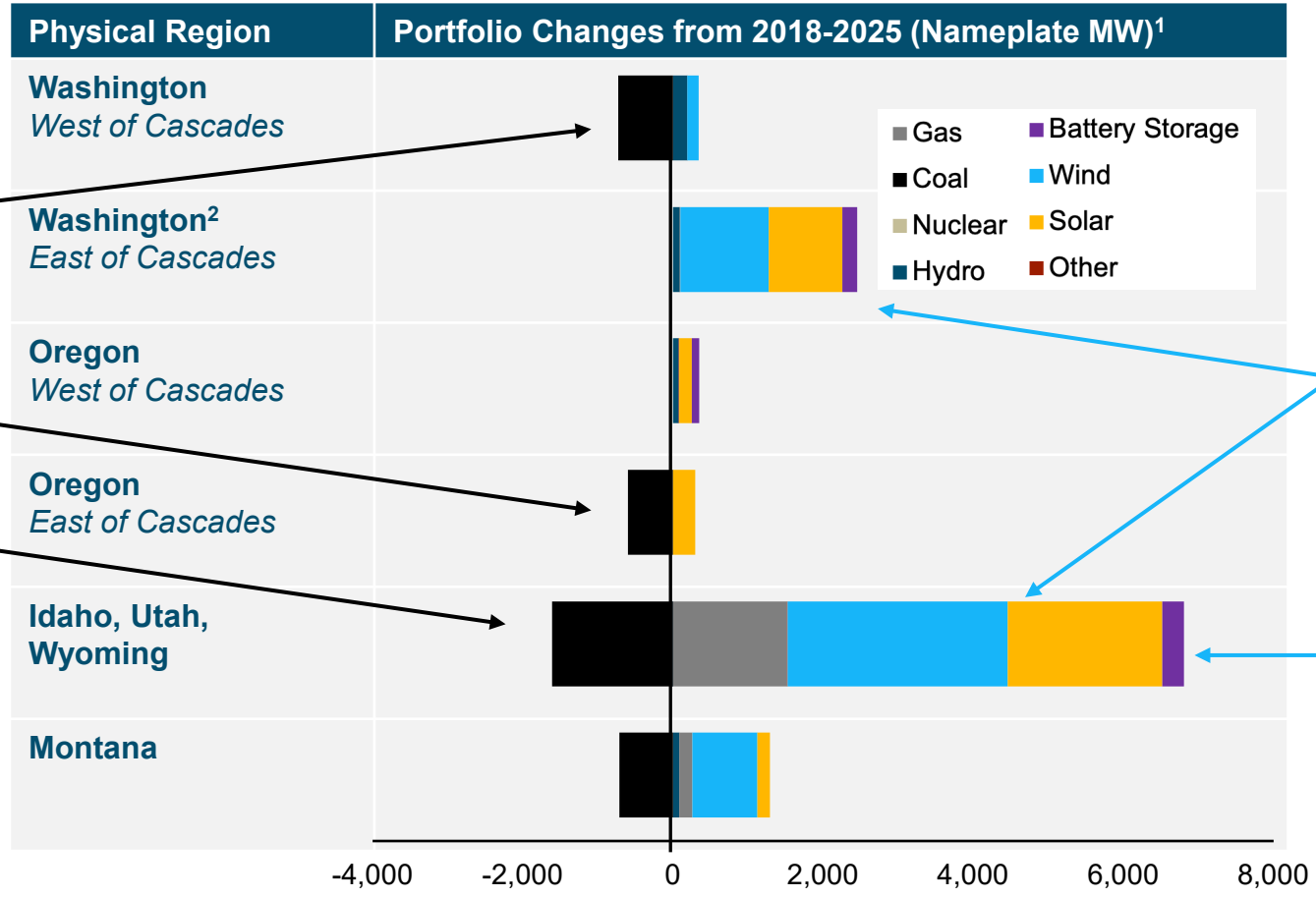
Winter Peak	10 year
2025 *Forecast*	2.6%
2024 *Forecast*	2.3%
2023 *Forecast*	1.8%
2022 *Forecast*	0.7%

+ Load growth acceleration is attributable to multiple distinct drivers, despite impact of energy efficiency

Driver	Near-term Impact
Economywide **energy efficiency**	Small load reductions in both seasons
Higher-than-expected **air conditioning adoption** after recent heat waves	Small-medium peak load growth in the summer
Policy-driven **electric vehicle adoption**	Medium peak load growth in both seasons
Population growth and new building construction	Medium peak load growth in both seasons
Anticipated **data center** interconnection	Large average and peak load growth in both seasons

New resource additions have been slow, and located primarily outside of Washington and Oregon

Coal retirements are reducing the quantity of firm capacity available in the region



Almost all new resources have been wind and solar

New resources are mostly being built in Wyoming and Utah

1. Based on WECC 2034 ADS and recent retirements)

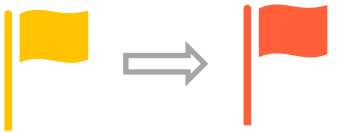
The Greater Northwest faces a supply deficit in 2026 which grows to 8,700 MW by 2030

- **Load growth and retirements mean the region faces a power supply shortfall in 2026**
  - The region currently relies on imports to maintain reliability
- **Nearly 9,000 MW of new capacity is needed by 2030**
- **Projects currently in active development account for only 3,000 MW of new capacity**
  - 850 MW are coal-to-gas conversions
  - 260 MW are hydro upgrades

Greater Northwest
Total Resource Need and Effective Capacity Contribution from Planned Resources (MW)

** Total Resource Need includes peak load + planning reserve margin as well as obligation to serve the Columbia River Treaty Regime*

The Greater Northwest faces a supply deficit in 2026 which grows to 8,700 MW by 2030



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Greater Northwest
Total Resource Need and Effective Capacity Contribution from Planned Resources (MW)

System Needs (MW)	2025	2026	2027	2028	2029	2030
Total Resource Need*	49,245	50,737	52,499	54,184	55,879	57,195
Existing Portfolio w/ Retirements	46,716	45,666	45,395	45,388	45,098	44,757
Firm Imports	3,750	3,750	3,750	3,750	3,750	3,750
Reliability Position Surplus (+) / Shortfall (-)	**+1,221**	**-1,321**	**-3,354**	**-5,046**	**-7,031**	**-8,689**
ELCC from "In-Development" Firm Resources	-	296	407	580	770	1,114
ELCC from "In-Development" Wind, Solar and Battery projects	-	645	1,015	1,316	1,508	1,934

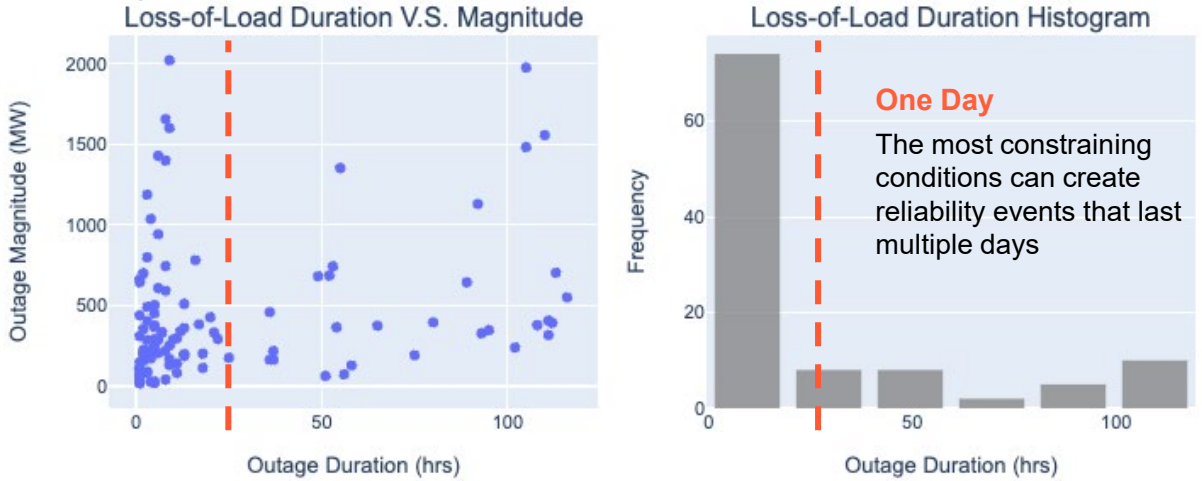
** Total Resource Need includes peak load + planning reserve margin as well as obligation to serve the Columbia River Treaty Regime*

The most constraining reliability conditions are extended wintertime cold weather events during very low water years

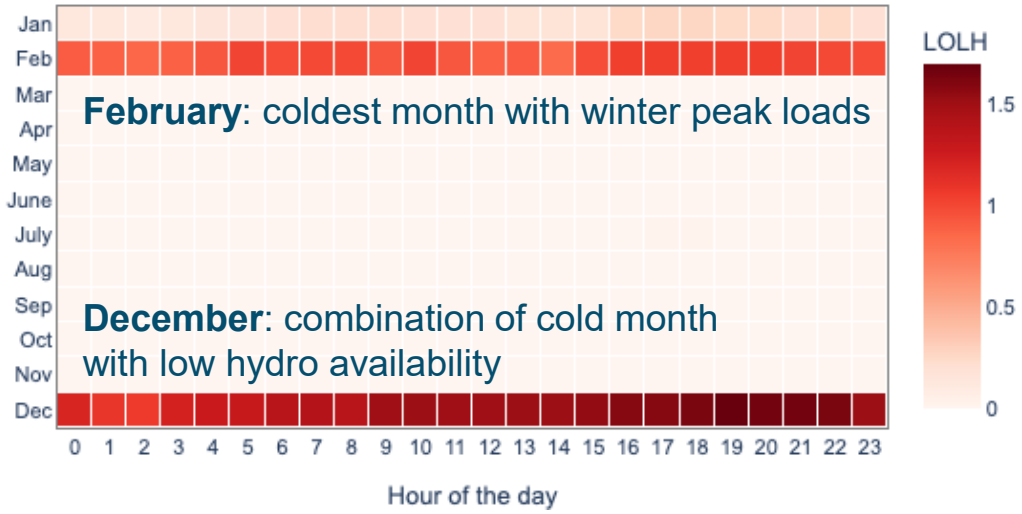
- **Most loss-of-load events occurring during the coldest winter months**
- **Many events exceed 50 hours in duration with some exceeding 100 hours due to energy shortfalls in dry years**

Greater Northwest, tuned to 1-day-in-10-year standard

Distribution of Loss-of-Load Events across over 2,500 years of simulated load, hydro, and renewable conditions



Average Loss-of-Load Hours (LOLH) by Month x Hour*



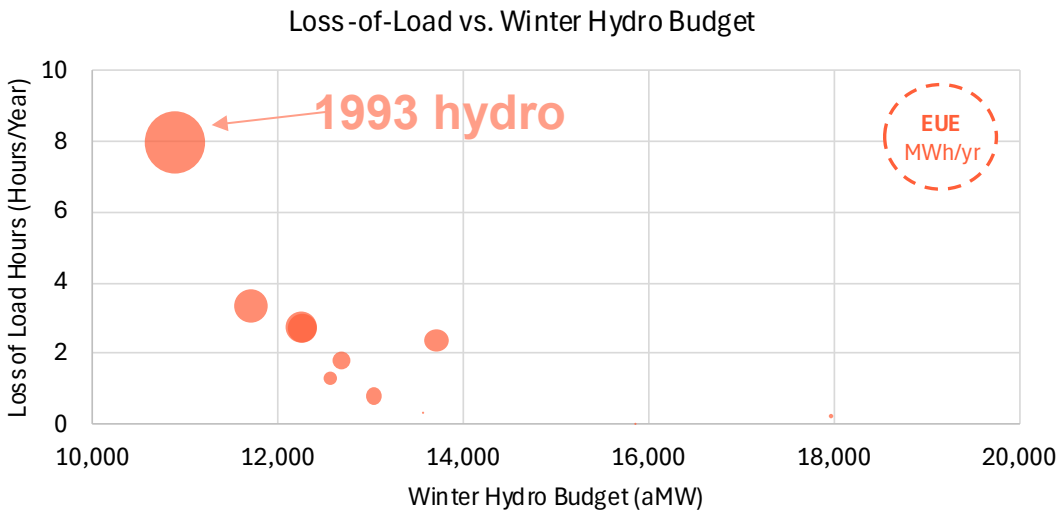
* Metrics + heatmap shown without firm imports

Addressing these events requires resources that can deliver energy over long periods of time

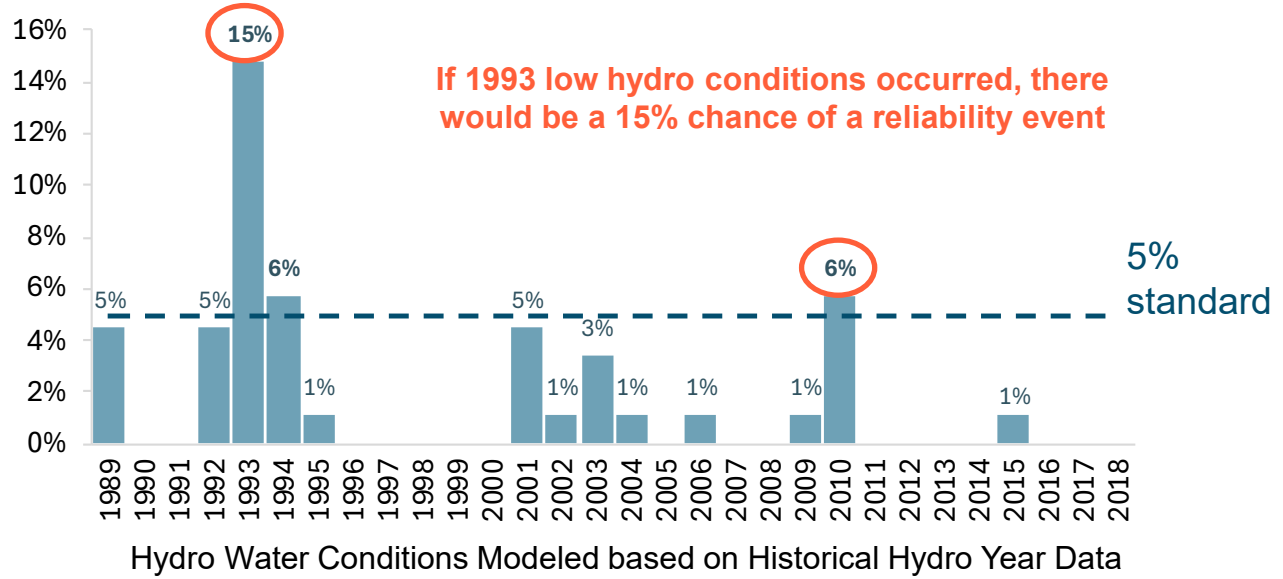
Energy shortfalls that occur during low hydro years contribute significantly to resource adequacy events

- Loss of load events are concentrated during the lowest hydro years (1989, 1990, 1992, 1993, 1994, 2001, 2010)
- January 2024 conditions were consistent with the very low hydro years simulated here

2025 Average Loss-of-Load Hours (LOLH) and Expected Unserved Energy (EUE) by Hydro Year



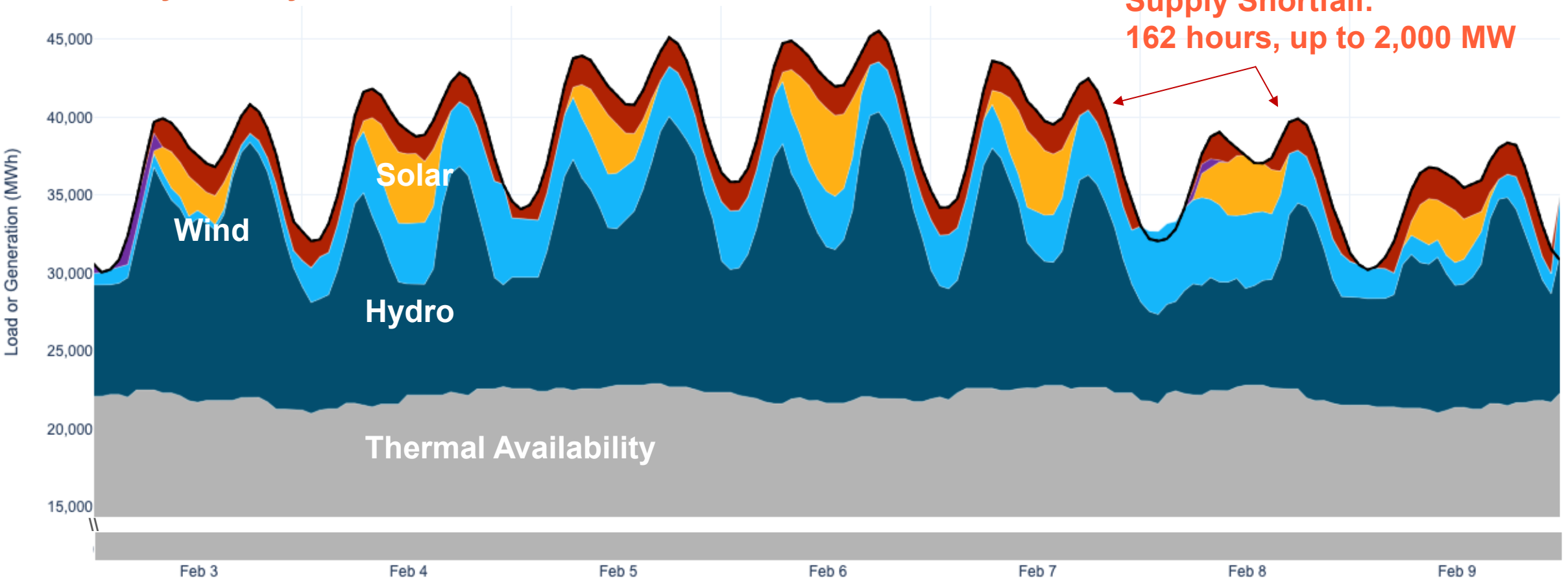
2025 Loss-of-Load Probability (LOLP) by Hydro Year



Resource availability example: February 2014 load conditions combined with 1993 hydro conditions

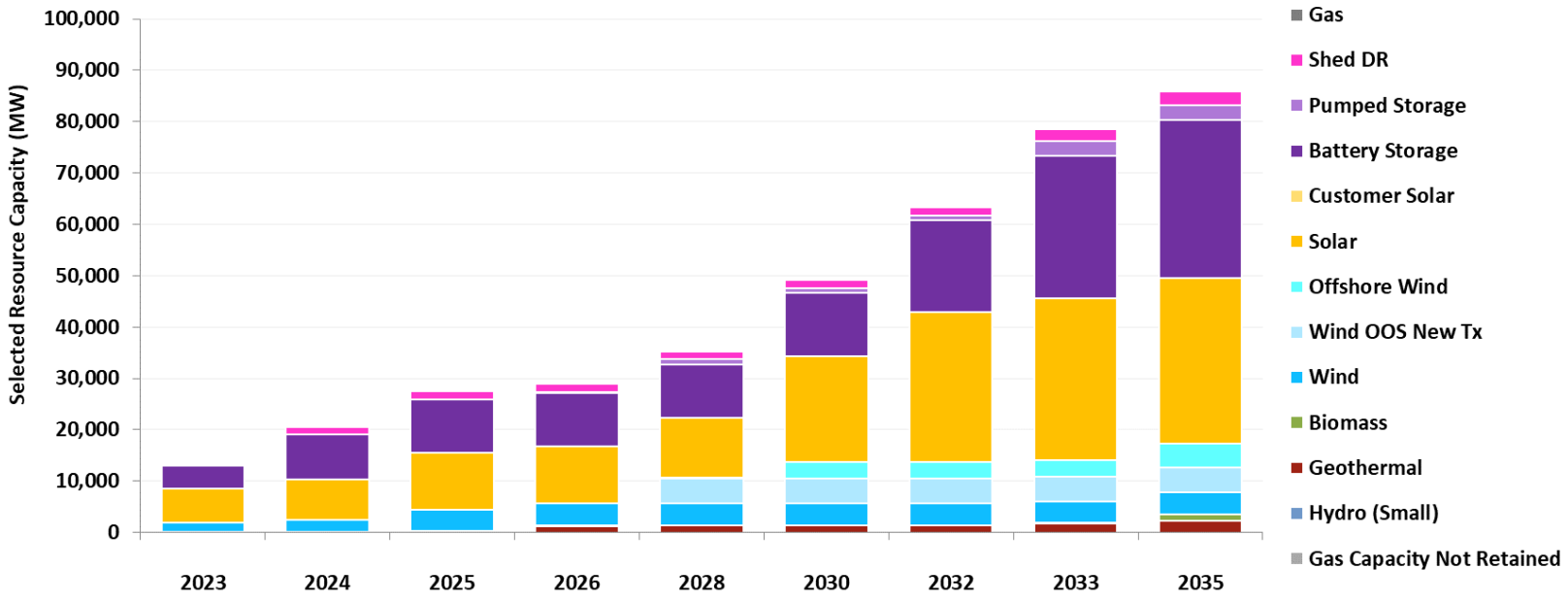
Greater Northwest 2025, RECAP simulated energy-limited event

February 1993 Hydro Conditions

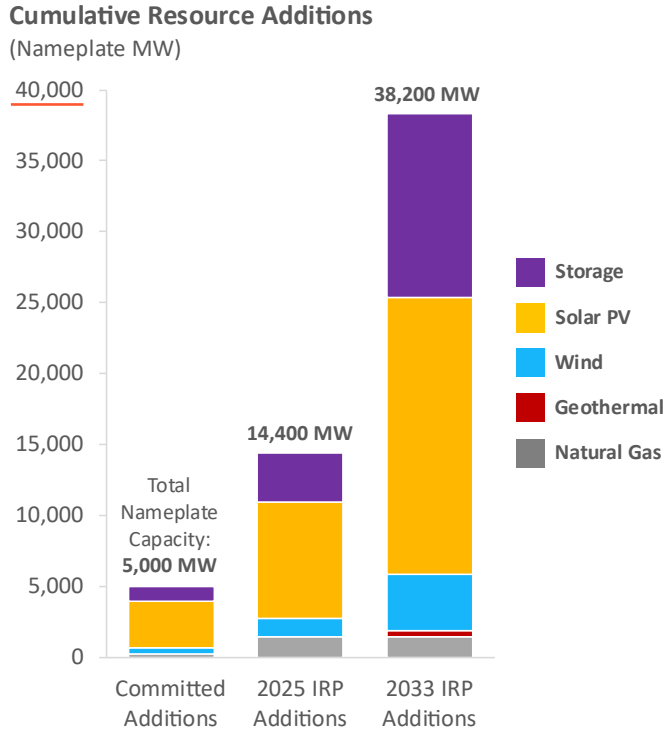


Regional comparison: solar and batteries provide high capacity value in summer-peaking regions like the Southwest

California is planning to build 50 GW of solar and storage resources by 2035 and 100 GW by 2040 (on top of 50 GW installed in 2025)

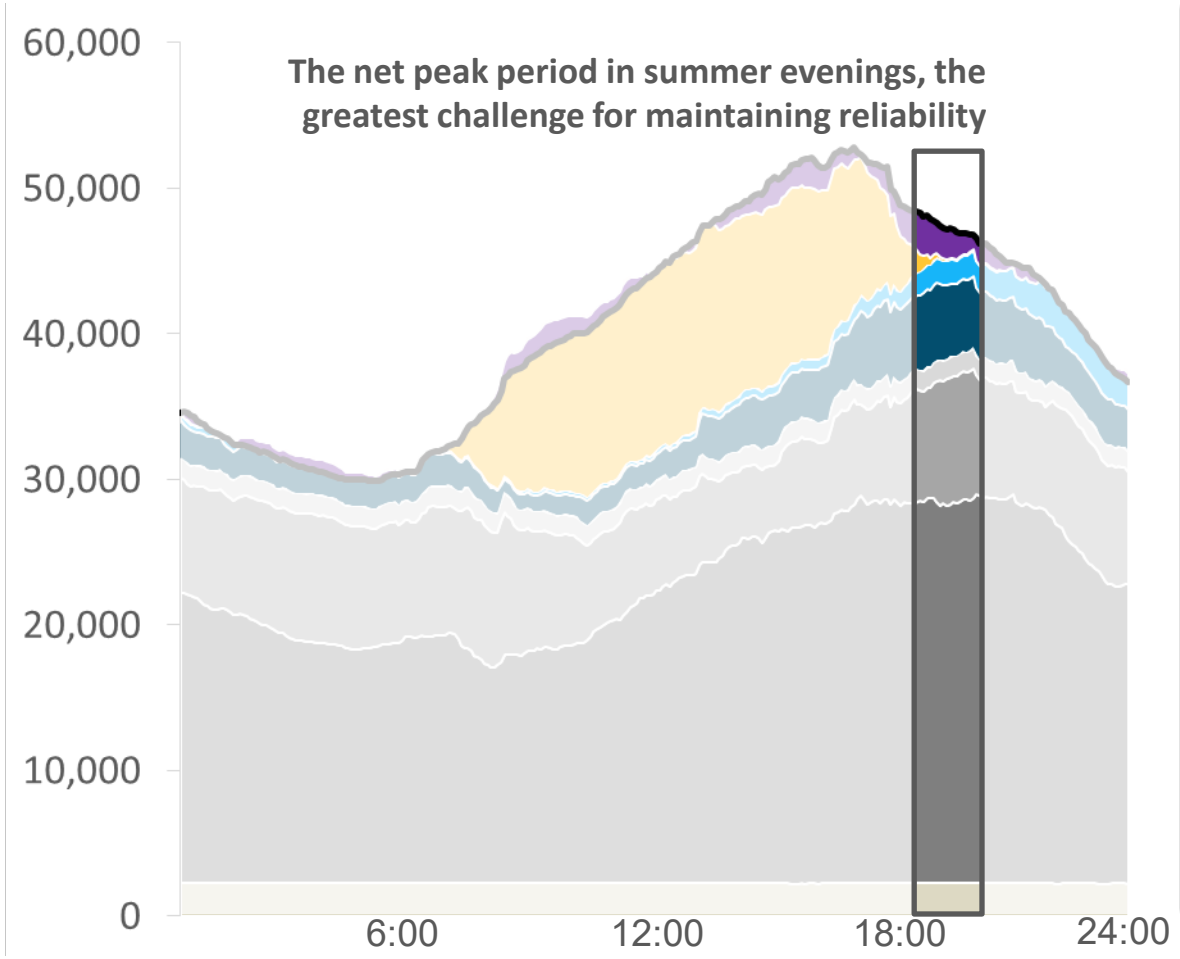


Desert Southwest is planning to build 30 GW of solar and storage resources through 2033

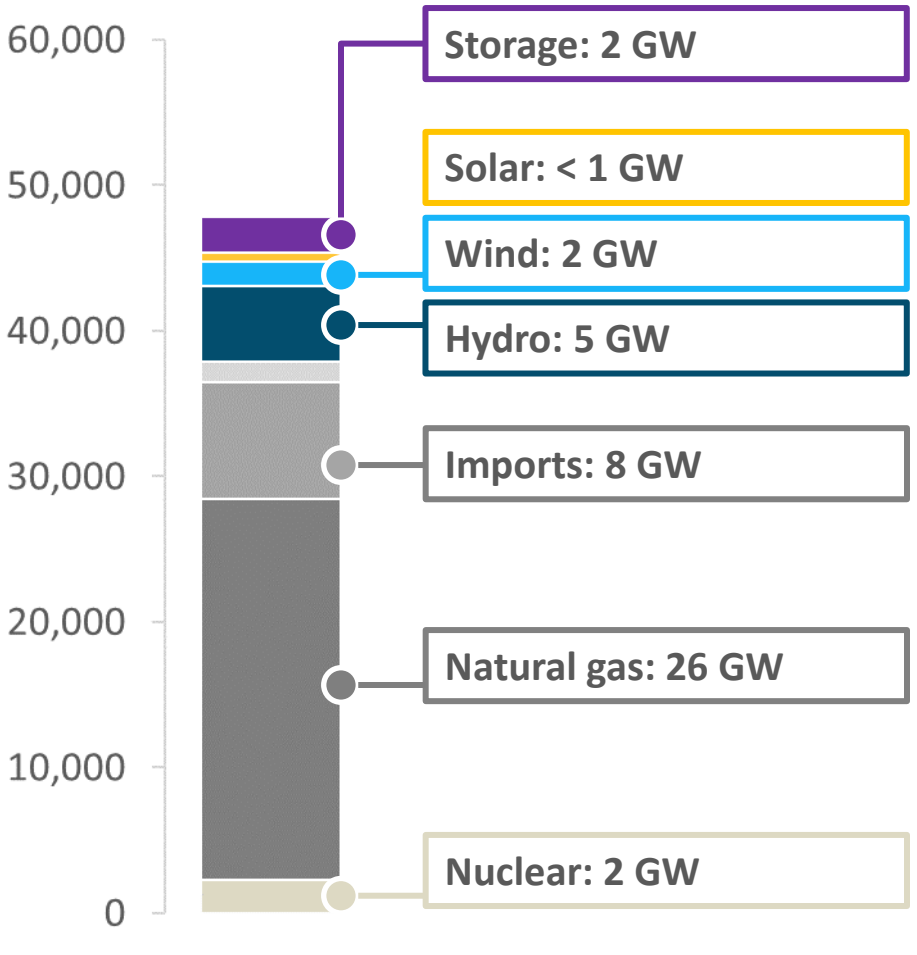


Regional comparison: California's most recent near reliability event was during a historic heatwave in September 2022

CAISO System Operations on September 6, 2022
(MW)

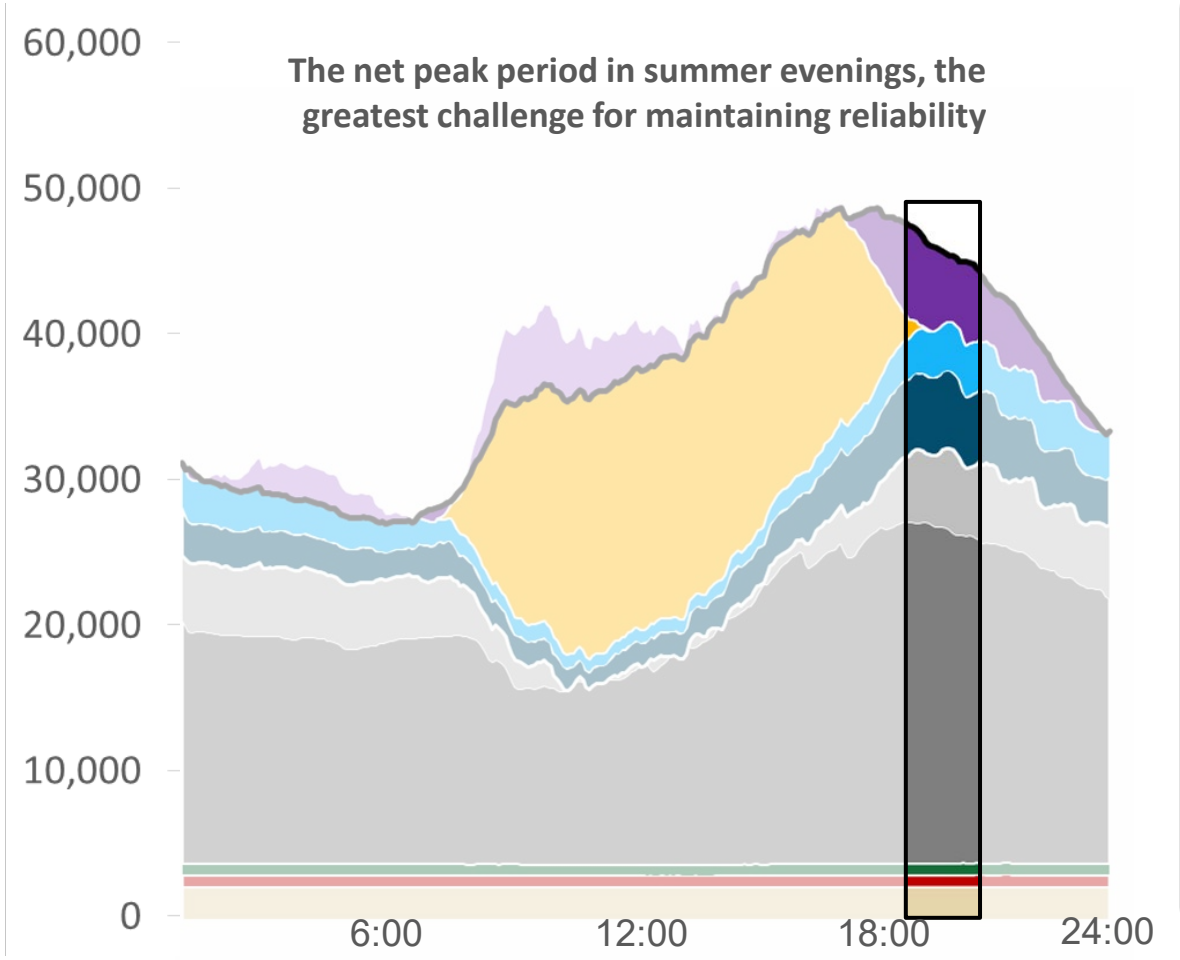


Generation During Hour of Highest Net Load
(MW)



Regional comparison: Significant additions of batteries helped make the next September heatwave in 2024 a non-event

CAISO System Operations on September 5, 2024
(MW)



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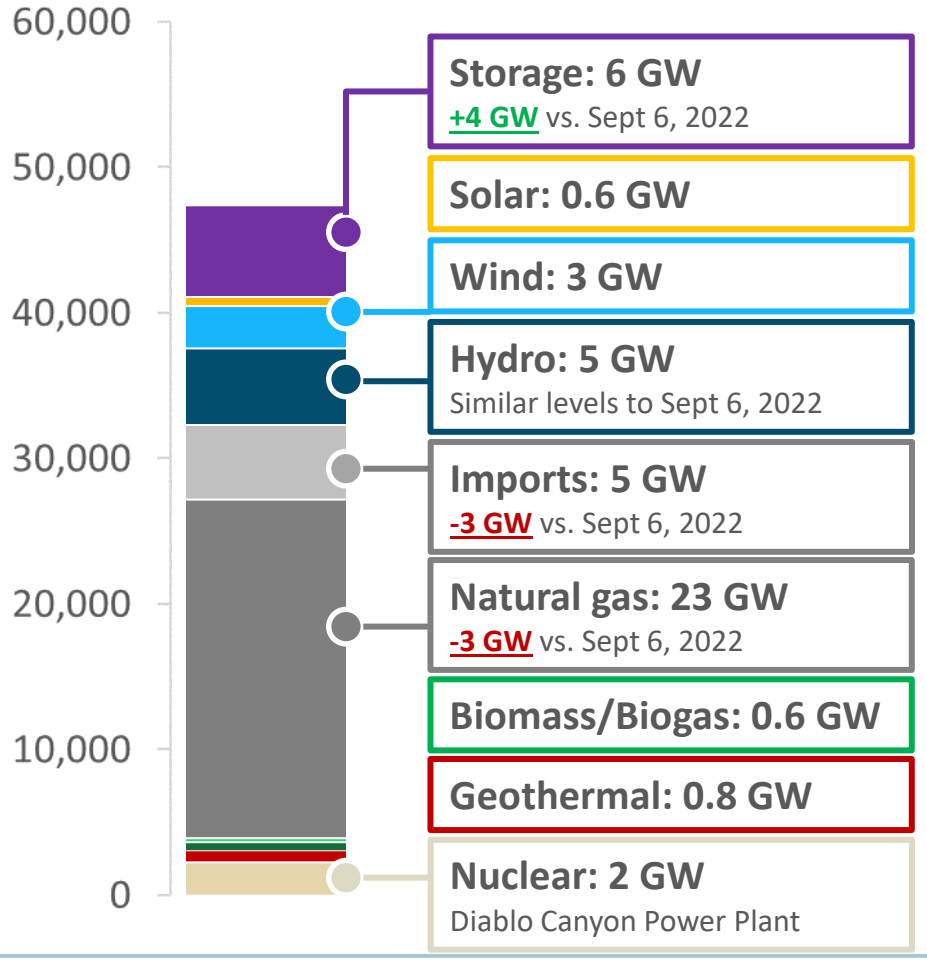
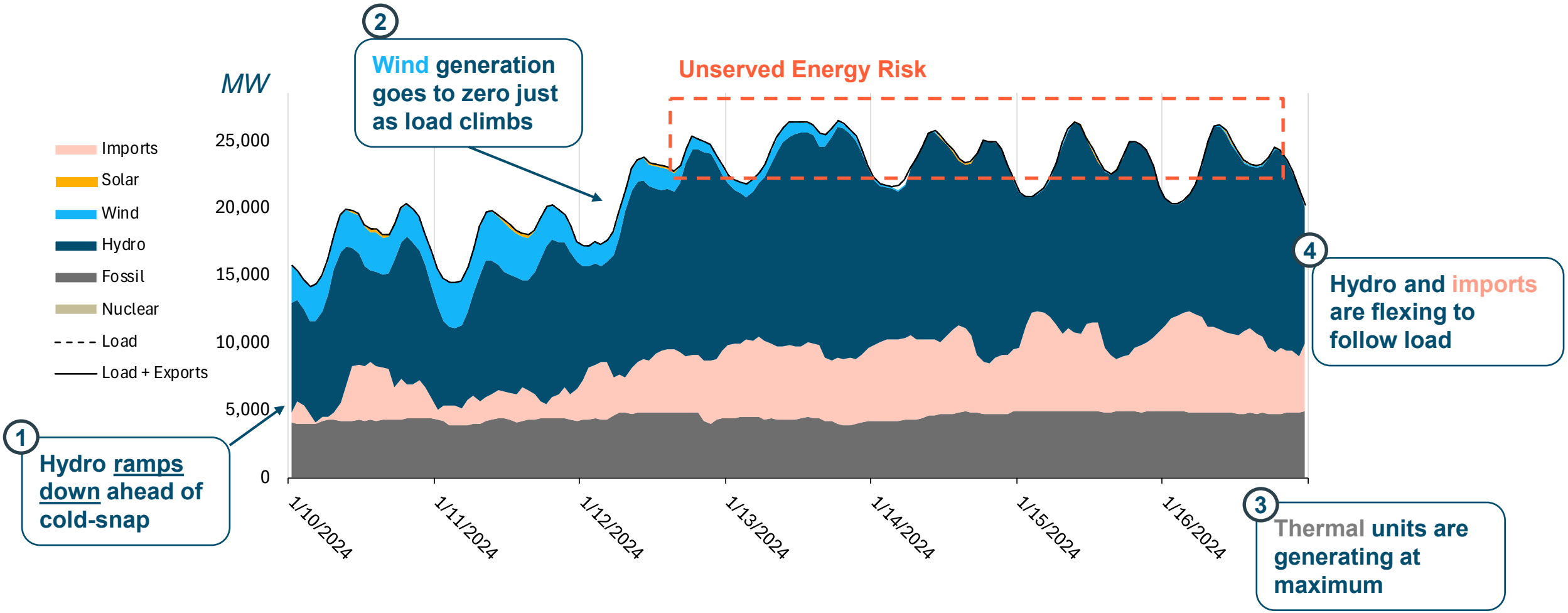


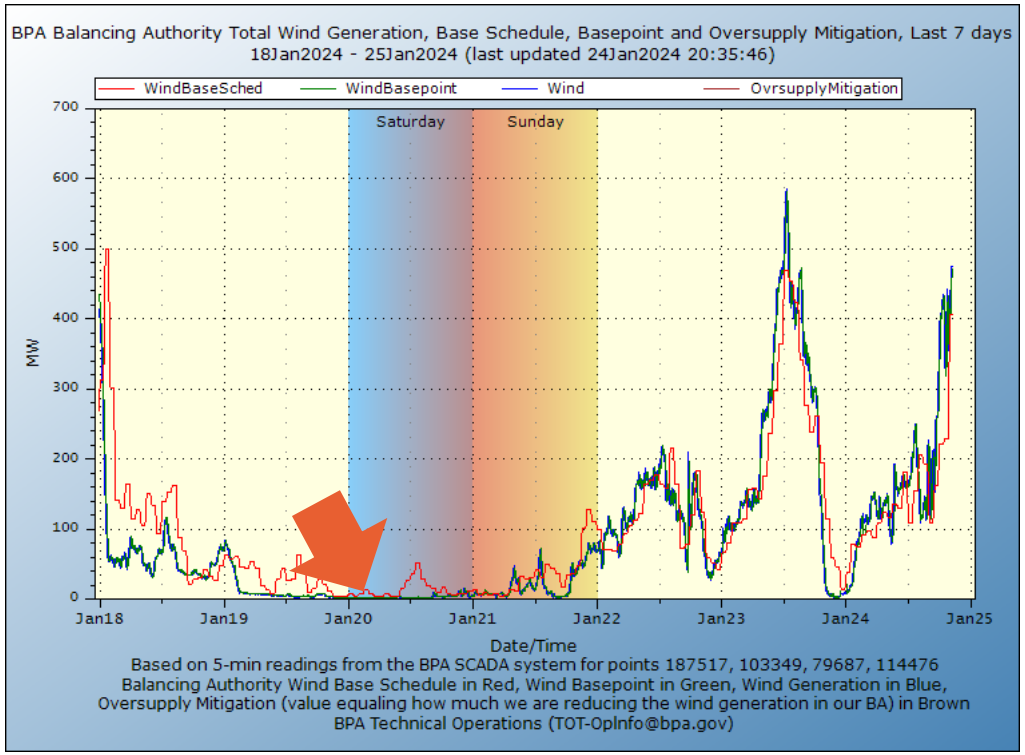
Regional comparison: The Northwest's most recent near reliability event was the multi-day January 2024 cold snap



Source: EIA, BPA

Northwest wind produced at very low levels during most of the January 2024 cold weather event

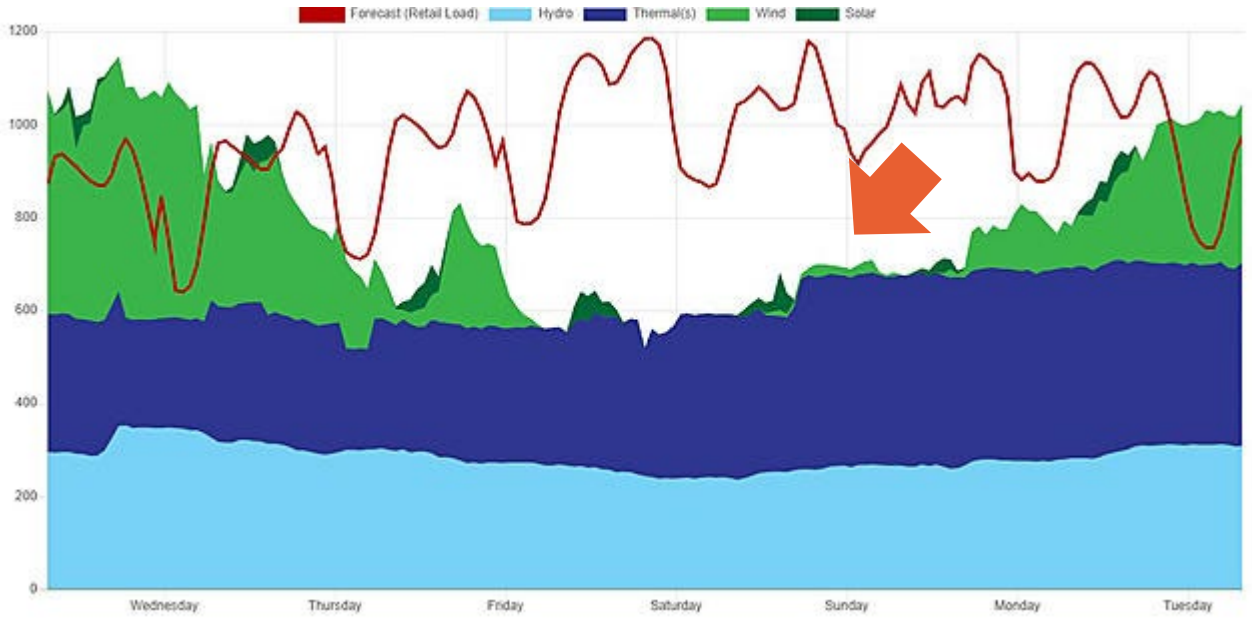
BPA: Almost no wind production on January 15-17 and 19-21



Average Jan 13: **567 MW**

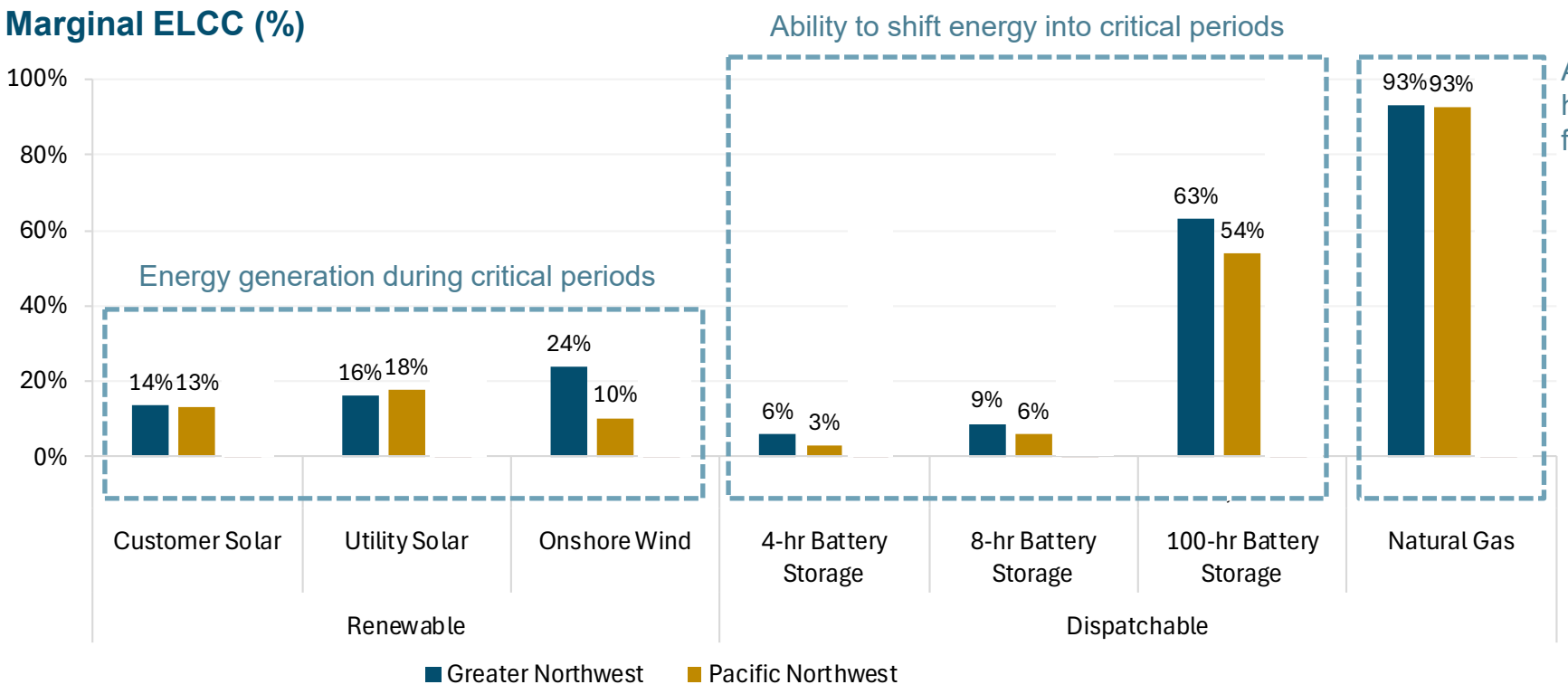
Average Jan 15 5:00 AM – Jan 17 10:00 AM: **8 MW**

NorthWestern Energy: Almost no wind production on January 12-14



Low temperature records set on January 13 in Portland (12 degrees) and Seattle (16 degrees)

Resource reliability value depends on ability to supply energy during multi-day cold snaps under low hydro conditions



These annual marginal ELCC values represent the ability of a marginal resource addition to reduce region-wide reliability risk relative to a firm, always available generator. For these 2025 values, ELCCs are primarily a function of output during the wintertime multi-day energy-constrained events that define risk for the Greater NW and the PNW subregion.

+ **Solar and wind have low capacity factor during reliability events → 10-24% of nameplate**
+ **Short-duration energy storage cannot charge during most energy-constrained events → 3-9%**
+ **Natural gas plants with firm fuel can run when needed → 93%**

Energy storage and flexible loads can be valuable if matched to the duration of the reliability event

+ Short-duration storage and demand response solutions do not have high reliability value
+ Multi-day response is valuable but more difficult to source

	Duration (hours)	# of Calls per year	2030 Marginal ELCC
Energy Storage	4		6%
	8		9%
	100		**63%**
Load-shed Demand Response	6	12	18%
	12	10	30%
	24	8	44%
	48	6	**54%**
	72	4	**57%**
	120	2	**61%**

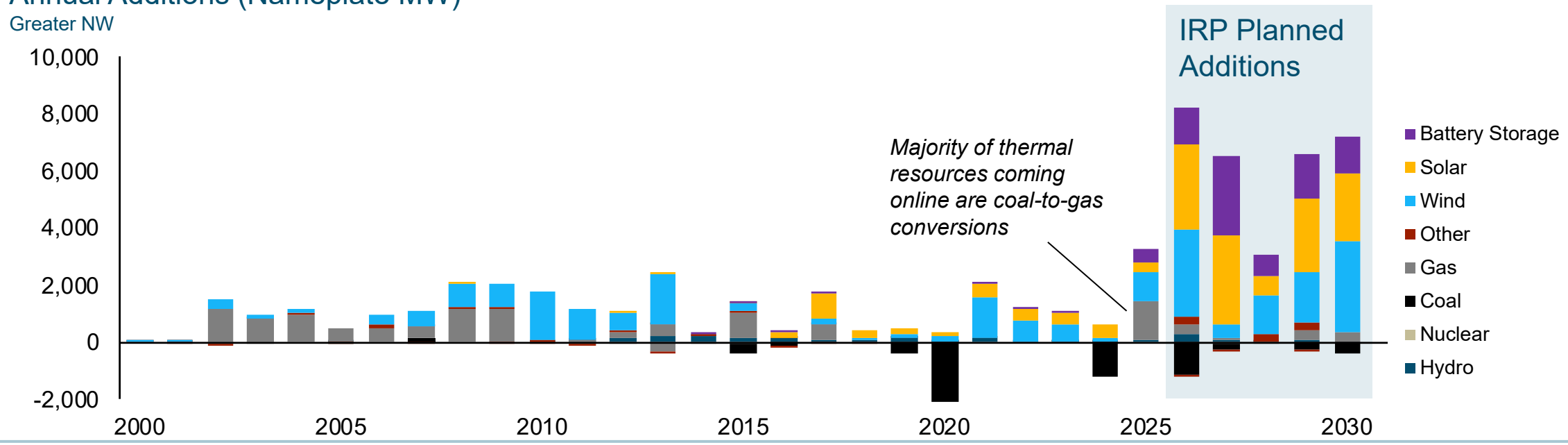
The rate of new resource additions required to meet resource adequacy needs in the next five years is unprecedented

- Meeting the pace of growth anticipated in utility IRPs would require annual resource additions equal to 4-5x historical levels
- Project development is currently experiencing significant headwinds due to changes in federal policy and higher costs

Retirements and New Installed Capacity Additions by Year

Annual Additions (Nameplate MW)

Greater NW



Utility + developers identified transmission, accreditation uncertainty, and new firm capacity barriers as key challenges

Key challenge	Findings from stakeholder interviews	Potential Solutions
1. Transmission access faces physical and institutional constraints	• Separate procurement and transmission planning processes leading to chicken-and-egg challenges • Lack of firm transmission rights for new resources • Difficult terrain and siting challenges	• **Improve regional transmission planning and interconnection processes**
2. Uncertain capacity accreditation metrics	• **WRAP is voluntary** and has not yet become binding • **Accreditation metrics are uncertain**	• **Strengthen the WRAP program with fundamentals-based capacity accreditation**
3. Barriers to building new RA capacity	• Utilities are likely to be challenged by the **sheer volume** of new resources in their IRPs • Existing clean resources make limited contributions to resource adequacy and **"clean firm" options are not yet commercially available** • Natural gas is the only viable near-term firm capacity option, yet siting new gas plants is extremely challenging and may create **stranded asset risks**	• **New firm resources may be needed** if they do not set the region back on long-term carbon reduction goals • **"Clean firm" resources may need policy support to** speed commercialization

Key findings of Phase 1:

1. **Accelerated load growth and continued retirements create a resource gap beginning in 2026 and growing to *9 GW by 2030***
   - 9 GW is approximately the load of the state of Oregon
2. **Preferred resources such as wind, solar and batteries make only *small contributions* to meeting resource adequacy needs**
3. ***Timely development of all resources is extremely challenging* due to permitting and interconnection delays, federal policy headwinds, and cost pressures**

Phase 2 will evaluate resource options for meeting near-term and long-term resource adequacy and clean energy needs

	Scenario	RA contributions	Additional considerations
Mature	Solar	Low and declining ELCCs	Variable energy resource
	Onshore wind	Declining ELCCs	Variable energy resource
	Natural gas	Firm	Carbon emitting, requires pipeline infrastructure
	Biomass/biodiesel	Firm	Uncertain fuel availability and cost
	Short-duration storage (4-8 hr li-ion)	Declining ELCCs	ELCC saturation impacted by hydro fleet interactions
	Long duration storage (10-12 hr pumped hydro)	Declining ELCCs	ELCC saturation impacted by hydro fleet interactions
	Geothermal	Limited potential	High cost per kWh and limited PacNW sites
	Energy efficiency	Limited potential vs. cost	Can reduce new load but cannot serve existing load
	Demand response	Declining ELCCs	Duration and use limited
Emerging	Floating offshore wind	Declining ELCCs	High enabling infrastructure costs + long timelines
	Natural gas to H2 retrofits	Firm	High enabling infrastructure costs + long timelines
	New dual fuel gas + H2-ready plants	Firm	High enabling infrastructure costs
	New H2-only plants	Firm	High enabling infrastructure costs + long timelines
	Gas w/ 90-100% carbon capture and storage	Firm	High enabling infrastructure costs + long timelines
	Nuclear small modular reactors	Firm	Uncertain costs + long timelines
	Enhanced geothermal	Firm	Uncertain costs and potential
	Multi-day storage (100 hr)	Slower declining ELCCs	Uncertain costs, high round-trip energy losses
	Direct air capture	n/a	Can offset emitting gas that serves RA needs

Note: emerging technologies face cost uncertainty, unclear commercialization timelines, and/or high enabling infrastructure needs

Thank you!

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