

Resource Adequacy Risks in the Pacific Northwest

September 2026



Resource Adequacy and the Energy Transition in the Pacific Northwest

Final Report

April 2026



Energy+Environmental Economics

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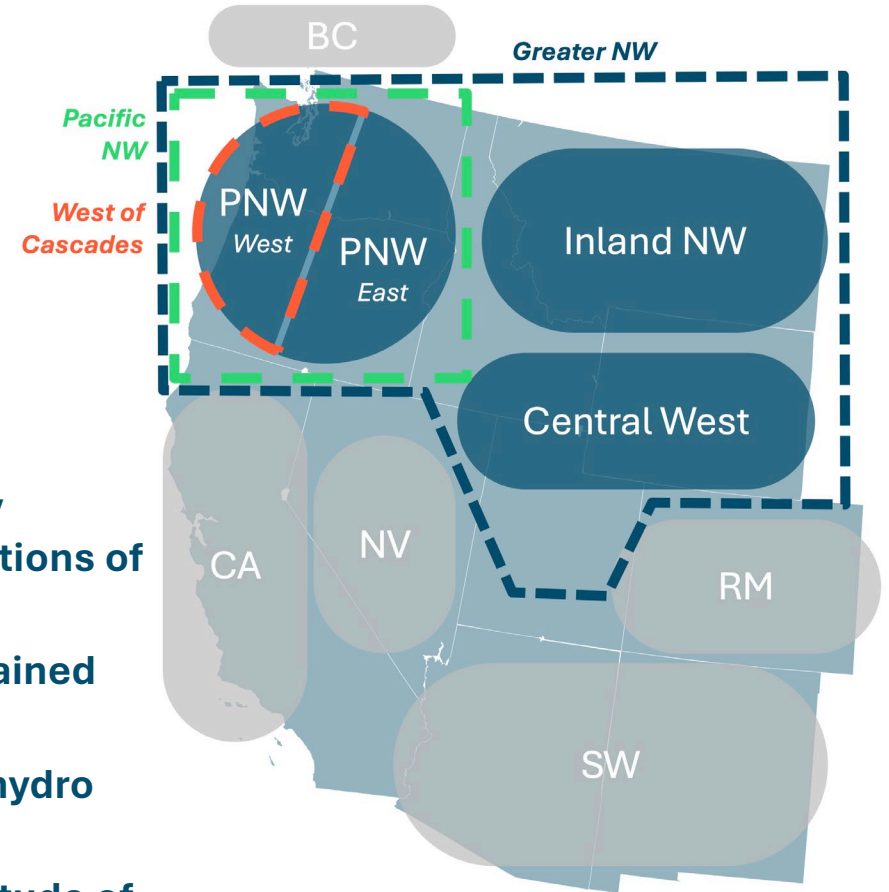
E3 Project Overview

STUDY SPONSORS

- Puget Sound Energy
- Public Generating Pool
 - Chelan Public Utility District
 - Clark Public Utilities
 - 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

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

- + **Greater Northwest Region includes utility footprints across OR, WA, ID, MT, and portions of UT and WY**
- + **Study assesses two transmission-constrained subregions**
- + **Key inputs include loads, resources and hydro operations**
- + **Key outputs are reliability metrics, magnitude of any shortfalls, and how different resource types contribute to filling shortfalls**



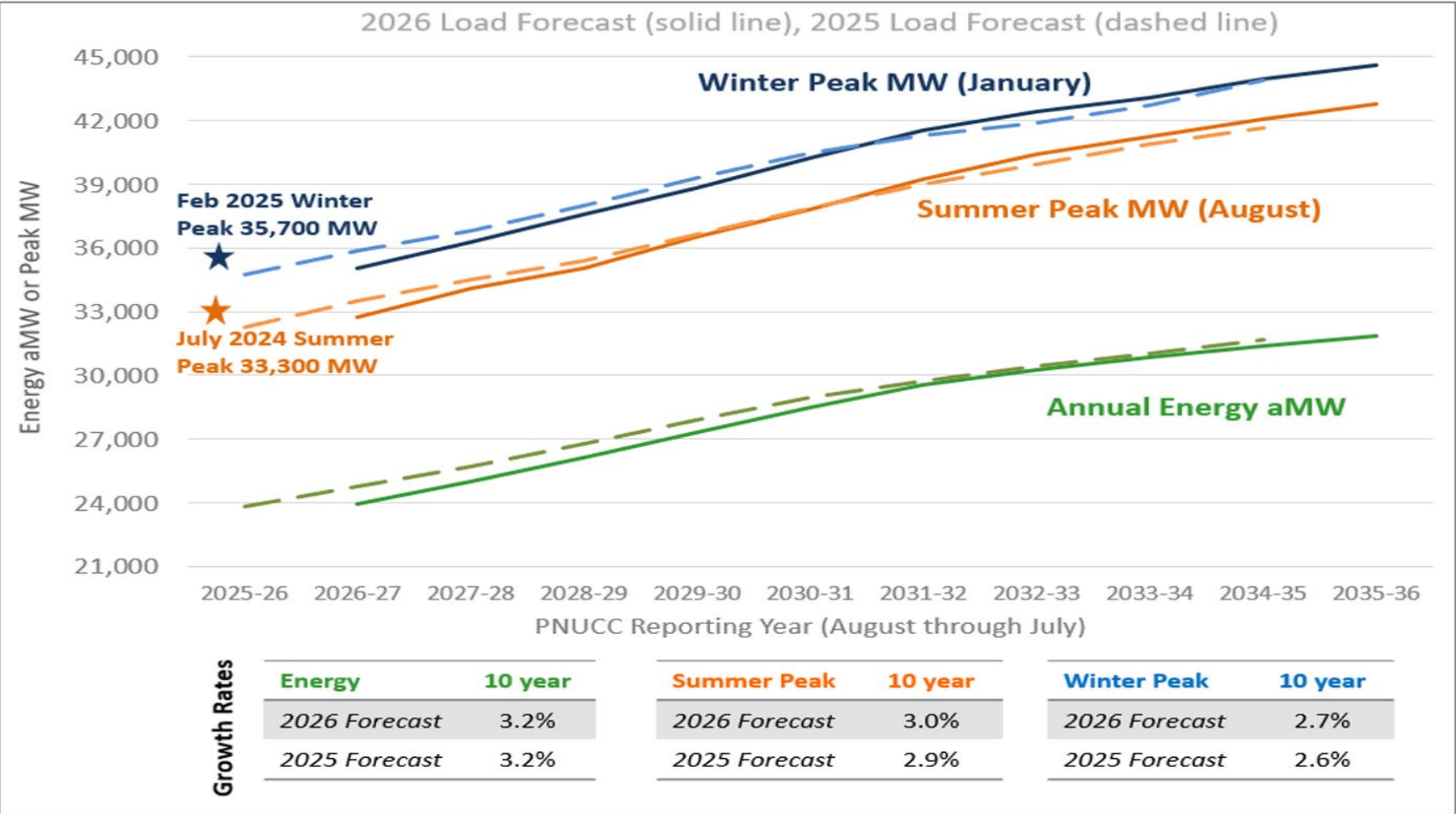
Regional Load Growth & Resource Additions



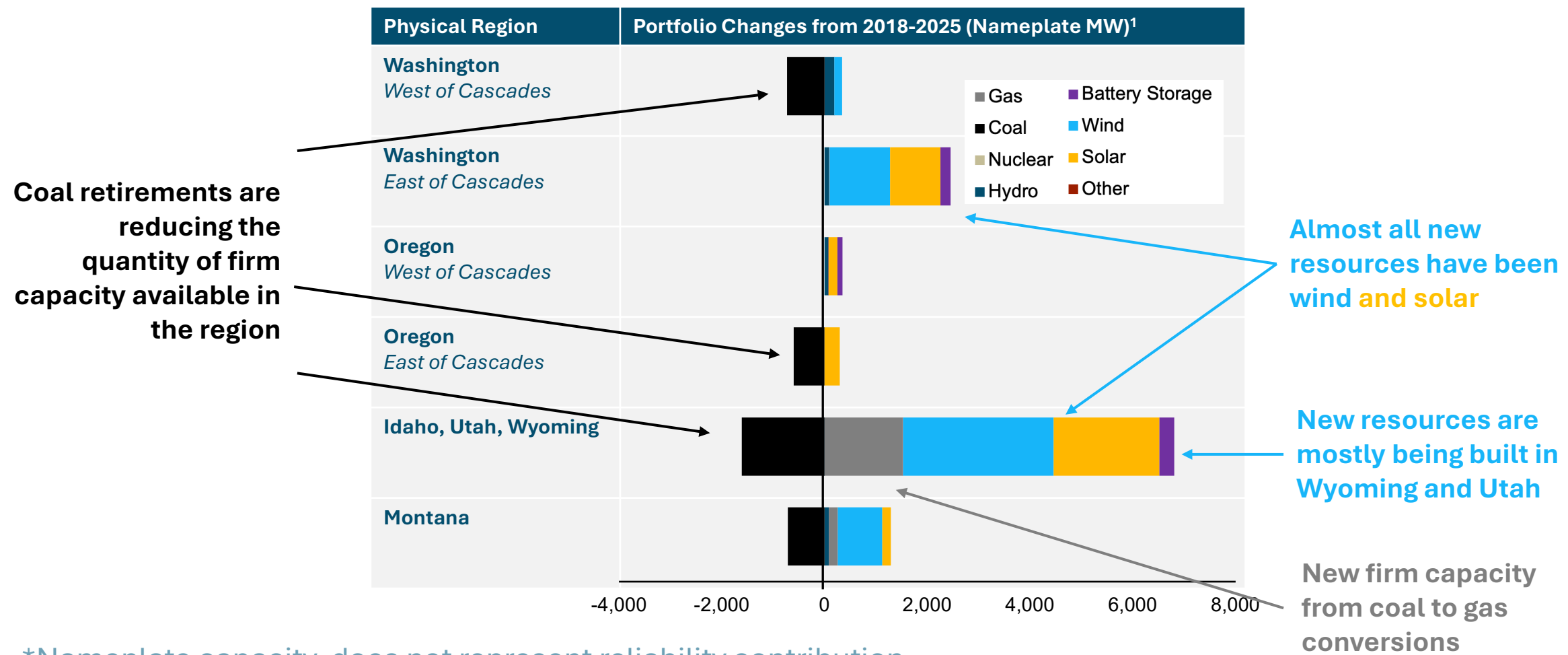
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Actual loads are growing, and projected loads are rising

PNUCC 2026 Northwest Regional Forecast Energy aMW and Peak MW



Resource development has not kept pace with growing loads and resource retirements, particularly in Washington and Oregon*



*Nameplate capacity, does not represent reliability contribution

1. Based on WECC 2034 ADS and recent retirements)

Pacific Northwest, the Winter Problem & Resource Availability

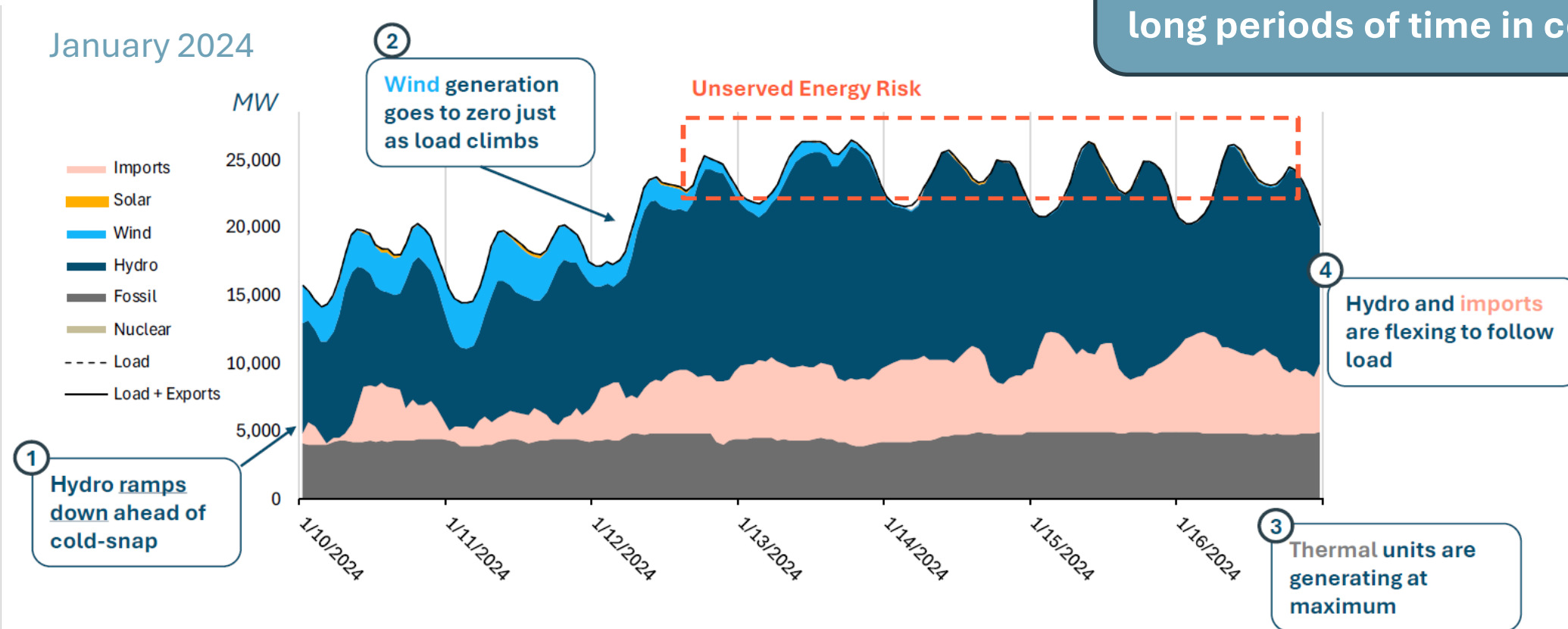


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In the NW, the reliability challenge is wintertime cold weather events where hydro plays a critical role

- + The role of hydroelectric resources and water variability is critical for resource adequacy in our region
- + Most shortfall events occur during the cold winter months

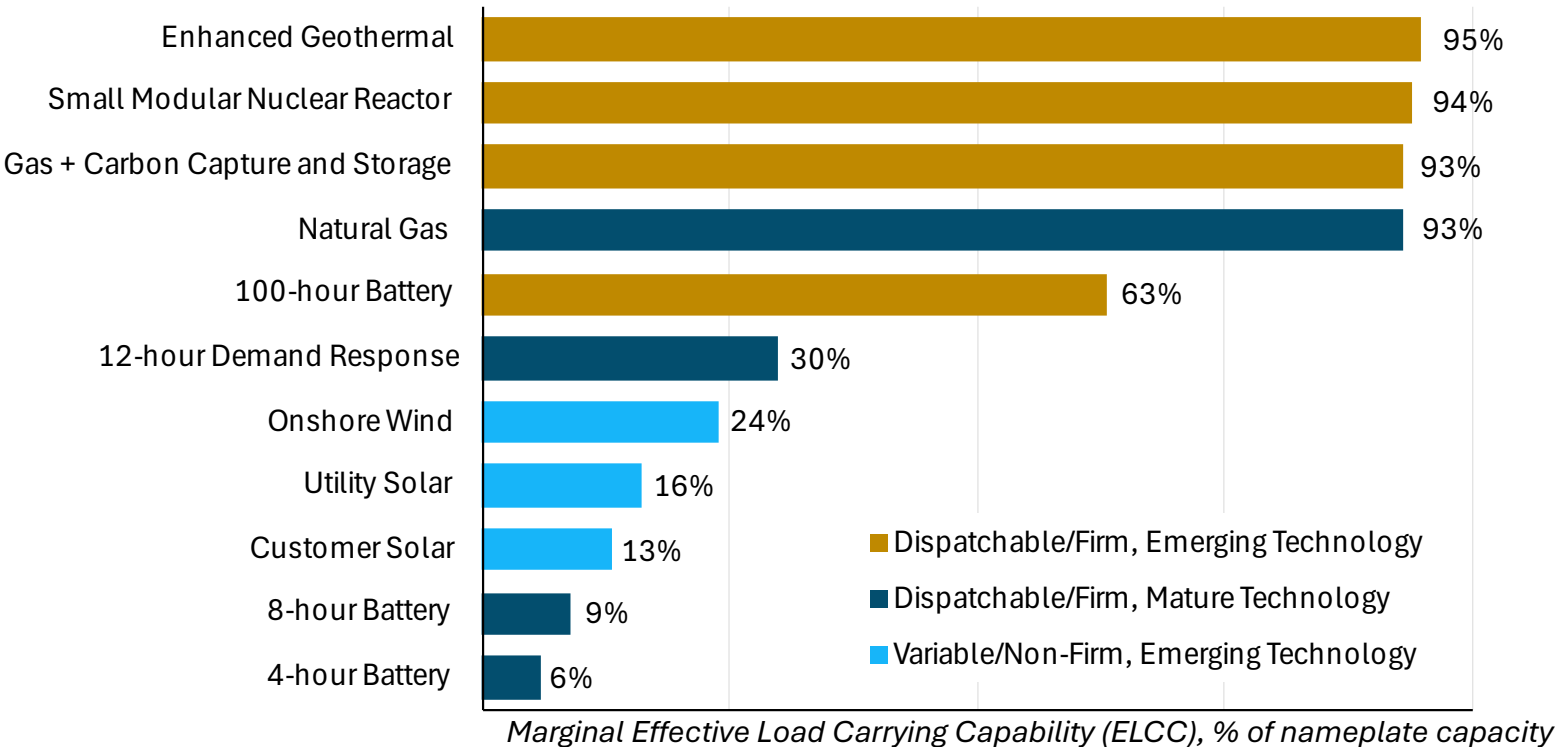
Addressing these events requires resources that can deliver energy over long periods of time in cold conditions



Different energy resources play different roles during winter events

Reliability Contribution by Resource Type (2025)

Driven by loss of load events occurring primarily during wintertime multi-day low hydro conditions



- + Wind, solar, short-duration battery storage, demand response, and natural gas are commercially available today
- + In evaluating resource adequacy, we look at the ability of resources to produce energy during critical conditions
- + Wind and solar provide valuable clean energy, but cannot always produce energy when needed most
- + Many innovative “clean firm” technologies are in development, but none is ready for large-scale deployment in the near term

Greater Northwest region faces a resource shortfall in 2026 and beyond

Greater Northwest Load and Resource Balance

Effective Capacity (ELCC) 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

Available resources includes firm imports from other regions

The region faces a power supply shortfall starting in 2026 that grows to almost 9 GW by 2030

In development resources amount to only 3 GW of effective capacity, leaving 6 GW shortfall

* Total Resource Need includes median peak load + 9% PCAP planning reserve margin as well as obligation to serve the Columbia River Treaty Regime

** In-development resources are based on WECC ADS 2034 facilities with confirmed project location, project name, or can be verified online

*** Centralia unit 2's repower from coal to gas was not in the WECC ADS data source and is not included here; it would bring down the shortfall by ~700 MW in 2029 and 2030

Key Study Assumptions

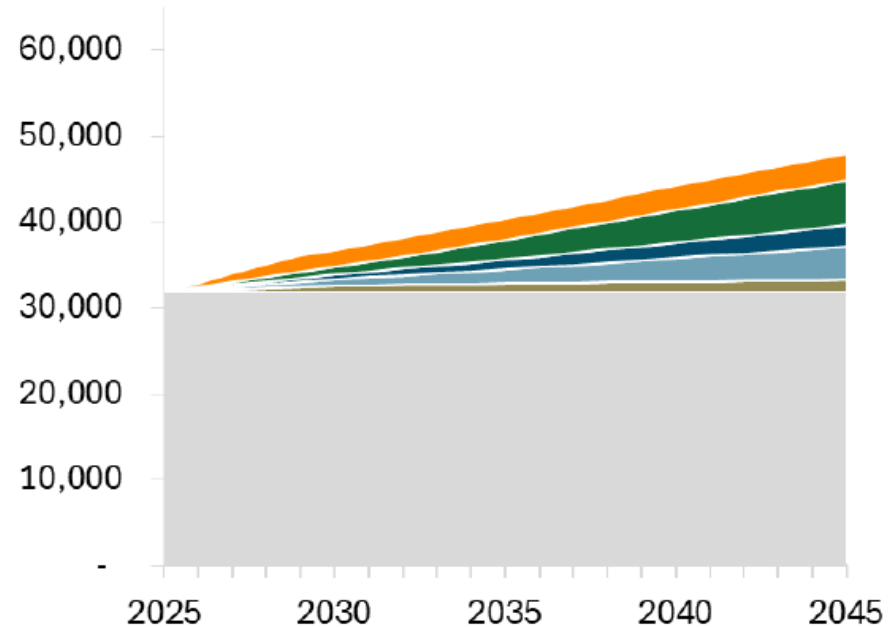


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E3 load assumptions: conservative data center growth with high electrification for economy-wide net zero goals

Reference Loads

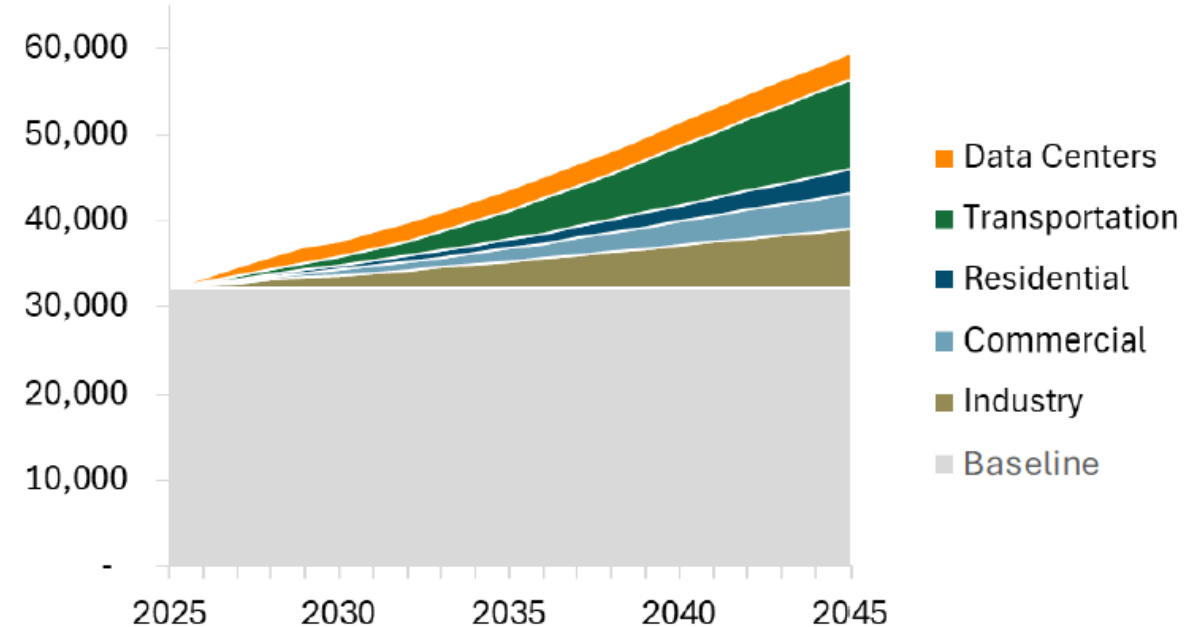
Incremental Load Growth by Sector over Baseline (aMW)



Annual Load by Sector aMW	2025	2030	2035	2040	2045
Baseline	31,916	31,916	31,916	31,916	31,916
Industry	-	681	900	1,129	1,367
Commercial	-	762	1,663	2,748	3,943
Residential	-	558	1,176	1,814	2,449
Transportation	-	895	2,273	3,787	5,129
Data Centers	-	1,862	2,438	2,800	3,105

High Loads

Incremental Load Growth by Sector over Baseline (aMW)



Annual Load by Sector aMW	2025	2030	2035	2040	2045
Industry	-	1,545	3,139	5,064	6,950
Commercial	-	681	1,548	2,754	4,125
Residential	-	446	1,024	1,850	2,818
Transportation	-	990	3,383	6,850	10,386
Data Centers	-	1,864	2,441	2,800	3,103

Candidate Resources

Mature and Emerging Technology Resource Options Studied

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
	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 (embedded in load forecast)	High, but takes time to scale	Can reduce new load but cannot serve existing load
	Demand response	Declining ELCCs	Duration and use limited
Emerging	Natural gas to clean CT retrofits (H2, RNG, etc.)	Firm	High enabling infrastructure costs + long timelines
	New clean CTs (H2, RNG, etc.)	Firm	High enabling infrastructure costs + long timelines
	Gas w/ 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

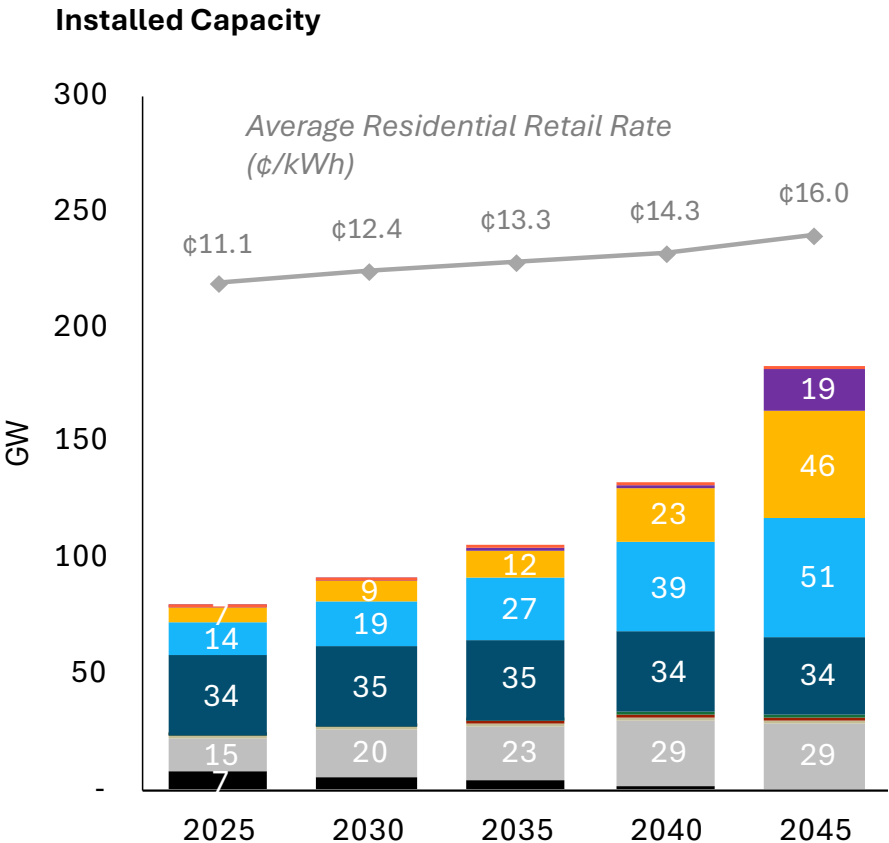
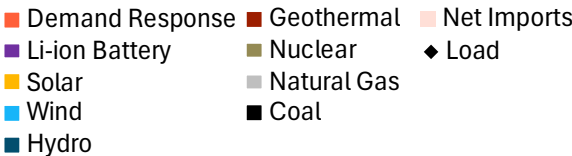
E3 Resource Portfolio & Comparison to Council Draft 9th Plan Resource Recommendations



E3 resource portfolio includes significant amount of new resources – demand response, wind, solar, natural gas

Greater Northwest

Reference Load 96% GHG Reduction



Resource	Amount by 2035
Demand Response	0
Wind	13,000 MW
Solar	5,000 MW
Storage	0
Natural Gas	8,000 MW

- + Large increase in wind, solar are needed by 2035 to meet growing load and reduce emissions
- + Natural gas capacity is added as the reliability backstop, but additions of renewable generation reduces how much natural gas is actually used



Northwest **Power** and **Conservation** Council



The 9th Northwest Regional Power Plan

- **The NW Power & Conservation Council is an interstate compact agency created by Congress under the 1980 NW Power Act that links regional power planning and Columbia Basin stewardship**
 - 8 members serve: two appointed by each governor of Idaho, Montana, Oregon, and Washington
 - Two primary functions:
 - Develops the **NW Regional Power Plan**, a 20-year regional strategy for an adequate, efficient, economical, and reliable electricity system, updated at least every five years
 - Recommends measures to protect, mitigate, and enhance **Columbia Basin fish and wildlife** affected by hydropower – and guides BPA’s project funding
- **A draft of the Council’s Ninth Regional Power Plan was published August 13th and is expected to be finalized by the end of 2026**
- The NW Power Act links the Council’s recommendations to BPA actions—under the NW Power Act, BPA conservation and resource acquisition provisions generally must be consistent with the Plan

Council Draft Ninth Plan Resource Recommendations

Develop new demand and supply side resources consistent with the portfolio approach outlined in this recommendation. The Council recommends the region, including Bonneville, its customers, investor-owned utilities, and others, acquire a portfolio of resources as described in the table below:

Resource	Amount by 2032
Conservation	1,060 aMW total 860 aMW OR/WA (up to \$150/MWh) 200 aMW ID/MT (up to \$70/MWh)
Demand response	590 MW
Voltage regulation	220 MW
Renewables	9,000 MW
Storage	5,200 MW
Natural Gas	2,100 MW

- **Diverse by design: renewables, storage, gas, conservation & demand-side resources perform unique functions**
- **Large amounts of renewables produce energy subject to weather conditions and reduce emissions when generating**
- **Demand response, storage, and gas as reliability resources:**
 - Demand response *avoids* or *shifts* consumption
 - Storage *shifts* energy production for short-durations, and provides intra-day flexibility
 - Gas *produces* sustained energy during extended shortages—winter events coupled with low hydro

Council Ninth Plan (Draft) & E3 Study Comparison

➤ Basic findings and recommendations are highly aligned

- The NW has a significant and material near-term resource adequacy need particularly during winter events & low hydro conditions
- West side is constrained (more on next slide)
- To address this need, a diverse portfolio of resources is needed:
 - **Renewables** to produce significant amounts of energy—economically displaces fossil resources, generates based on weather patterns, meets clean energy goals and requirements
 - **Backstop natural gas reliability resources** primarily for reserves to produce energy during long-duration winter events

➤ Also some key differences

- Study footprint and identified dates for adding resources are not aligned—E3 footprint is larger and looks at 2035 versus 2032 as does the Council action plan window
- E3 study has more conservative lens from a reliability perspective
 - Volumes generally larger
 - Embeds energy efficiency / conservation in load forecast
 - Includes more gas and less storage and demand response
 - Assumes high electrification adoption

Both E3 Study & Ninth Plan Emphasize Need for Transmission to the West Side

➤ E3 Study

- Pacific Northwest (OR+WA) and the West-of-Cascades subregions become locally constrained, requiring new delivery capacity
- Local resource options are limited West of Cascades given low wind and solar availability
- Energy storage may be able to help meet some of the local need – further study is needed
- In high load case, 9 GW of new transmission selected implies 5-6 new cross-Cascades corridors

➤ Draft Council Ninth Plan

- Resource recommendations assume Cross Cascades North (650 MW across Washington) & South (1,500 MW across Oregon) by 2031
- Most high quality renewable resources are located east of the Cascades and not near West-side load centers
- Delay in transmission causes:
 - More west-side conservation and DR
 - More storage closer to load (though insufficient transfer capability may limit value)
 - More gas located west of the cascades
 - Larger and more expensive overall build

Role of Energy Efficiency & Demand Response



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Demand side management strategies can help if tailored to address winter resource adequacy needs

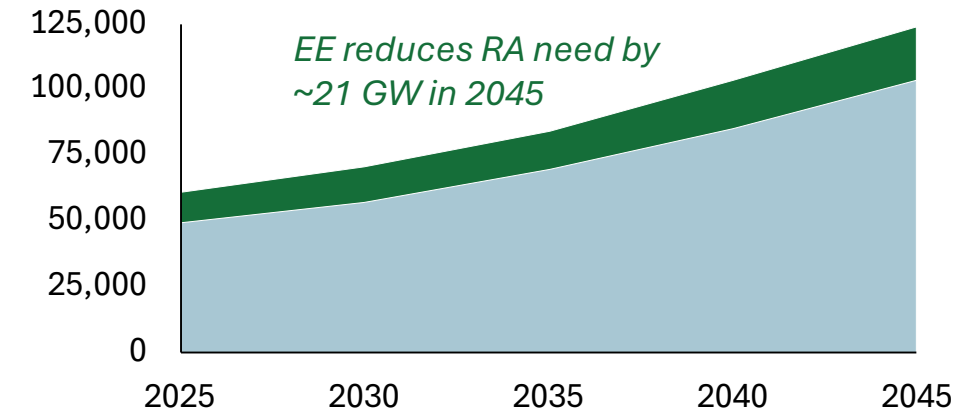
+ Energy efficiency measures are build into E3 load forecast

- Embedded efficiency in E3's load forecast grows by ~300-400 MW/yr 2025-2035 and 500-600 MW/yr 2035-2045
- Continued investment in EE will be necessary to achieve this level of savings

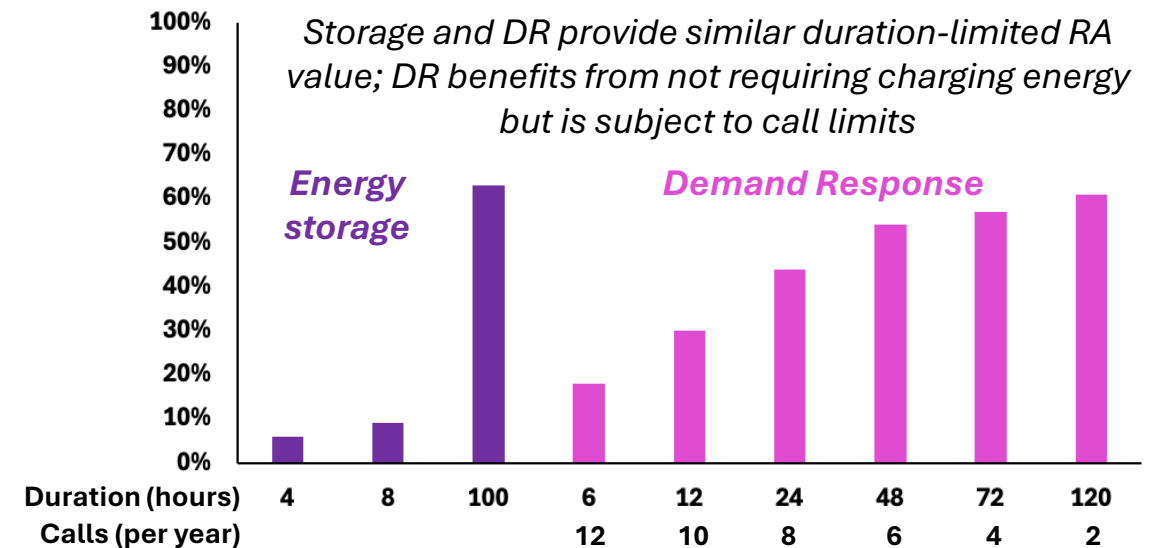
+ Additional energy efficiency or demand response can help avoid some further RA investments, if tailored to the unique NW energy-based reliability challenge

- Hybrid heating could reduce RA need up to 7 GW in 2045
- Demand response with extended duration
- Large load demand flexibility
- Flexible EV charging

Effect of EE Embedded in High Loads Forecast on RA Need (MW)



Effective Load Carrying Capability (% , 2025)



Study Hot Topics



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Electrification Assumptions & Large Load Flexibility

- **E3 high case assumes economy-wide net zero across the entire study footprint (incl. states without net zero goals)**
 - Consistent with Oregon and Washington energy strategies
 - But may not reflect trending reality
 - Higher loads drive higher infrastructure needs
- **E3 conservatively does not incorporate large load flexibility that could reduce demand**
 - Large load programs are nascent and largely untested – amount and price of flexibility is unknown so not modeled
 - Potential is worth exploring further, and many efforts are underway
- **Sylvan Energy Analytics performed independent review of E3 Phase 1 results https://gridlab.org/pnw_nearterm_winterra/**
 - Corroborates basic E3 shortfall findings
 - Finds significantly smaller shortfall (0-1 GW) by 2030 assuming data centers are curtailable & lower electrification trends
 - Affirms need to add significant amount of renewables and transmission

