Energy+Environmental Economics

Capacity Needs of the Pacific Northwest—2019 to 2030

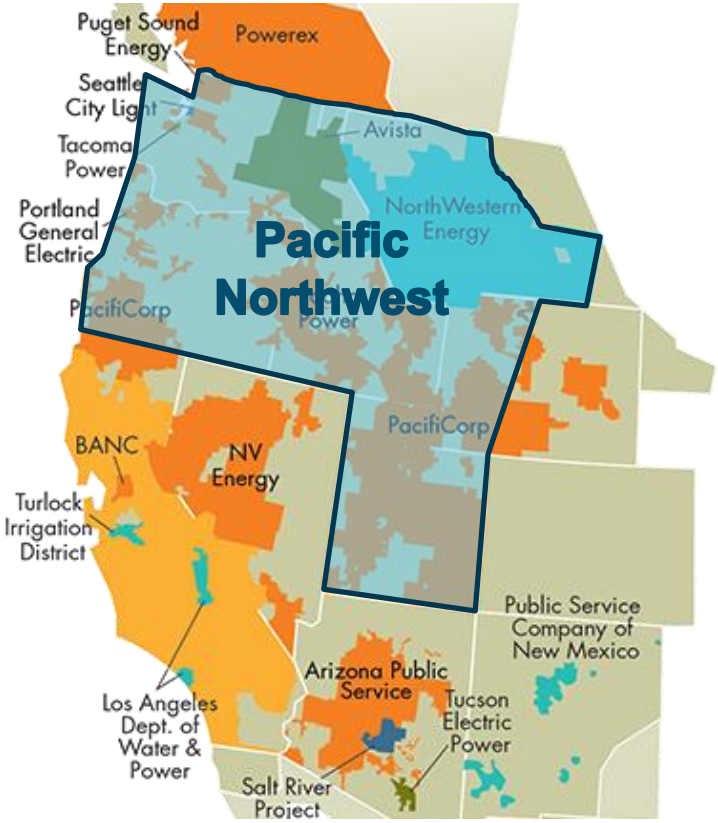
December 2019

Outline

- **Project Background**
- **Key Takeaways**
- **Analysis**
  - Key policy drivers and resource adequacy approach
  - Near-term view
  - Mid-term view
  - Long-term view
- **Appendix**

Project Background

- **E3 analyzed a fundamentals-based view of the Pacific Northwest (PacNW) regional capacity need and generated this public report on behalf of Rye Development**
- **Study Approach**
  - **Top down view**: Compares regional level studies on capacity need, which included updating a previous E3 study based on latest public information and comparing it against other regional studies
  - **Bottom up view**: Aggregates capacity need and planned additions from utility integrated resource plans (IRPs) across the region
  - The study region is defined as the "Greater NW," consisting of the US portion of the Northwest Power Pool, excluding Nevada
    - Other studies of regional need utilizing smaller regions are noted
- **The views contained herein are solely those of the authors and based on public information as well as E3's analysis for its own study**



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Key Takeaways

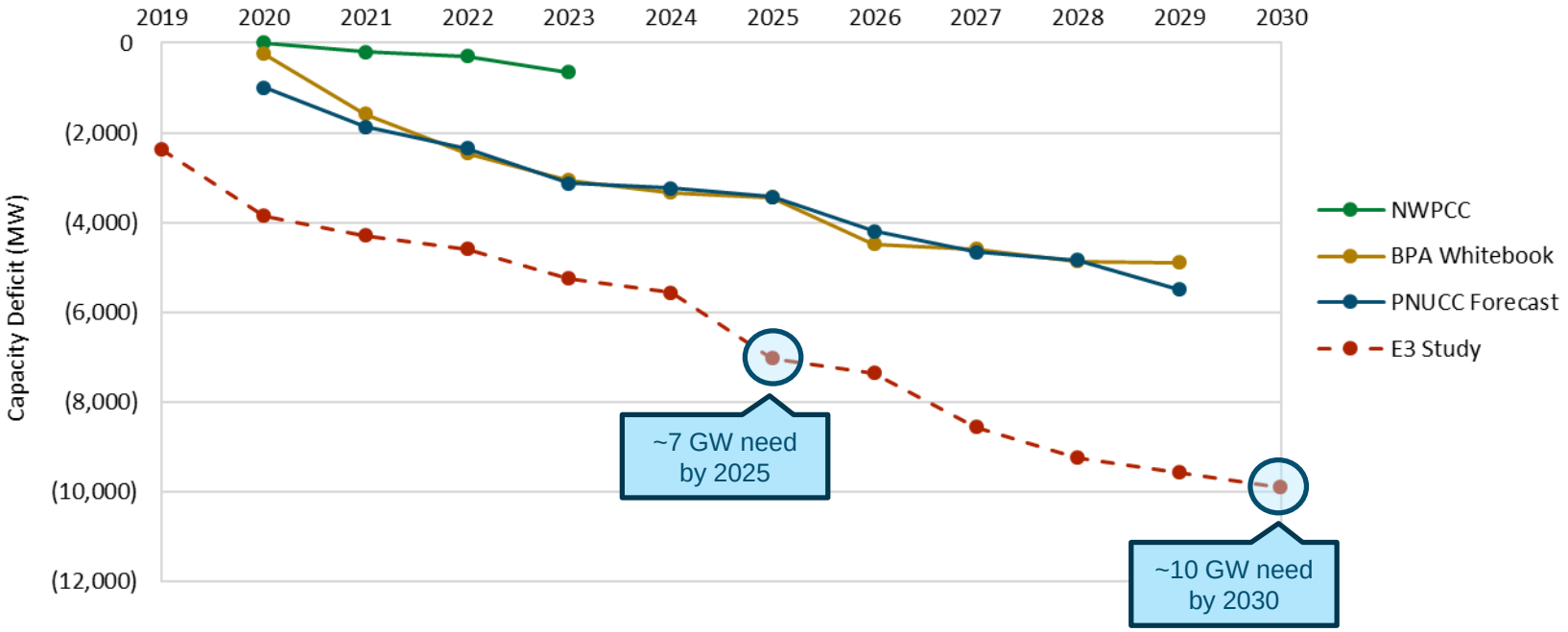
The PacNW is Facing a Significant Capacity Shortfall

- **Near-term (today-2025): the Pacific Northwest faces a near-term capacity shortfall of 3-7 GW**
- **Mid-term (2025-2030): capacity need grows to as much as 10 GW as additional firm capacity retires and this need is not fully replaced by planned additions**
  - All planned capacity additions, and significantly more, are required by 2030
  - Even in an optimistic scenario (if all planned capacity additions detailed in the reviewed utility IRPs are approved and constructed), the region remains approximately 3 GW short by 2030
- **Long-term (2030-2050):** the region needs to grow or maintain firm dispatchable capacity to address the energy sufficiency challenges created by a deeply decarbonized grid

		Near-term (today-2025)	Mid-term (2025-2030)	Long-term (2030-2050)
Pacific Northwest	**Capacity Need**	**Immediate capacity shortfall of 0-1.2 GW, rising to 3-7 GW by 2025**	**Growing capacity shortfall of ~10 GW in 2030** (higher if more coal retires than currently planned for)	**Capacity shortfall grows to ~20 GW by 2050**, possibly even higher under high electrification scenarios
	Key Drivers	• Increasing winter and summer peak demand • Coal retirements w/ few firm replacements • Consideration of a regional RA program	• Continued load growth and coal retirements • Renewable and storage additions with diminishing capacity benefit • Additional capacity additions needed	• Energy sufficiency-based reliability planning challenge • Decarbonization policies further drive renewables/ storage; do not avoid need for firm capacity • Electrification loads could drive even higher winter peak

PacNW Near to Mid-Term Capacity Need
Top-Down Forecast

+ **Multiple regional assessments point to a near-term shortfall of winter-peaking physical capacity in the Northwest region**
  - Shortfall grows to ~5,000-10,000 MW over next 10 years



- Key differences are driven by PRM requirements, capacity counting methodologies, and resource additions (*see appendix for comparison of key assumptions*).
- E3 and NWPCC are truly "top-down" stochastic views, while PNUCC and BPA are closer to regional "bottom-up" analyses of utility IRPs.
- E3 study based on 2018 and 2030 RECAP LOLE modeling, shaped between those years based on forecasted coal-retirement schedules. This study updated previous analysis to include coal retirements from PacifiCorp's 2019 Draft IRP. E3's need does not incorporate any planned additions.

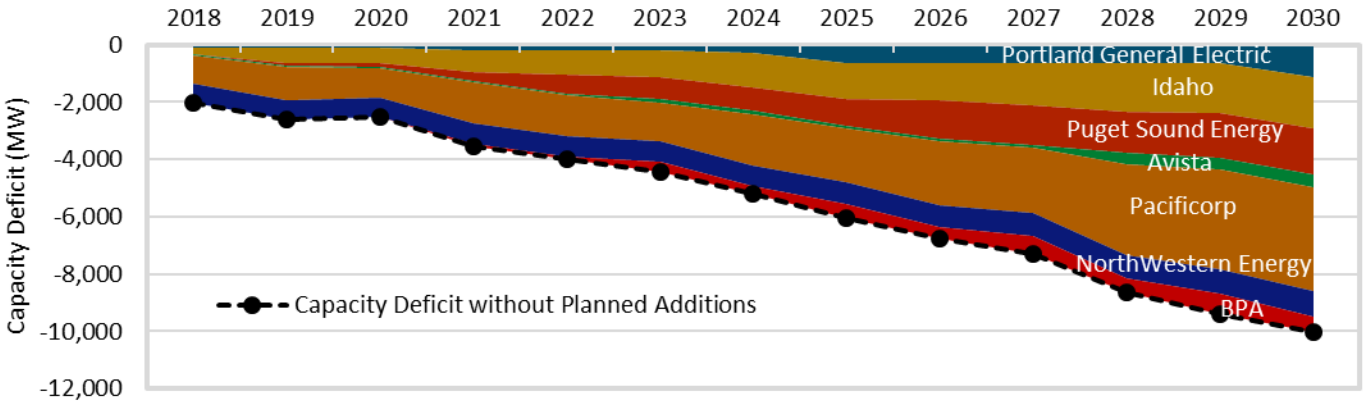
PacNW Near to Mid-Term Capacity Need

Bottom-Up Capacity Need vs. Planned Additions

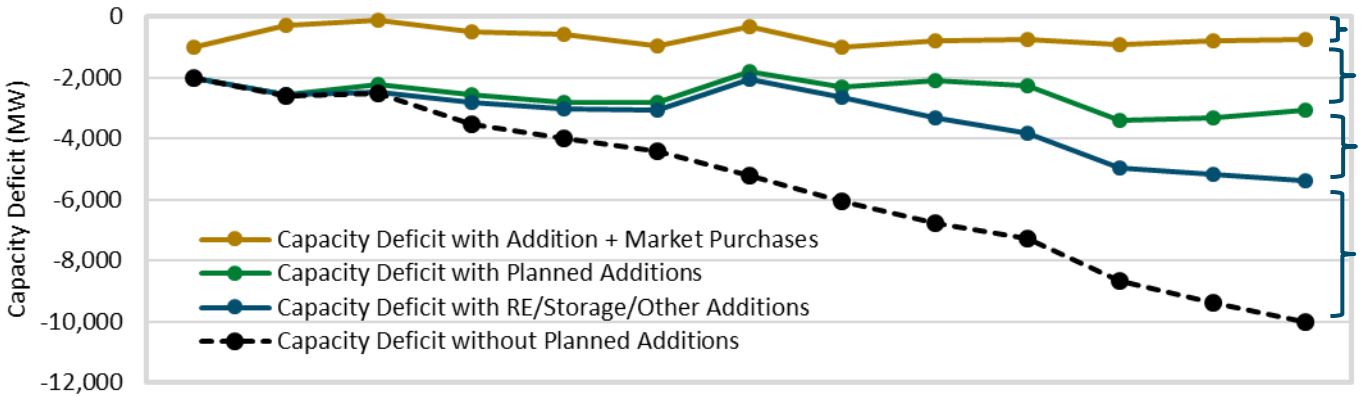
+ **Through their IRPs, individual utilities have identified their capacity needs over a 20-year horizon**
  - Aggregate "bottom-up" need reaches ~10,000 MW by 2030
  - IRP planned additions do not adequately address full capacity need, leaving ~3,000 MW of additional need

Summary of Utility IRP-based Capacity Needs

Needs Identified in IRPs



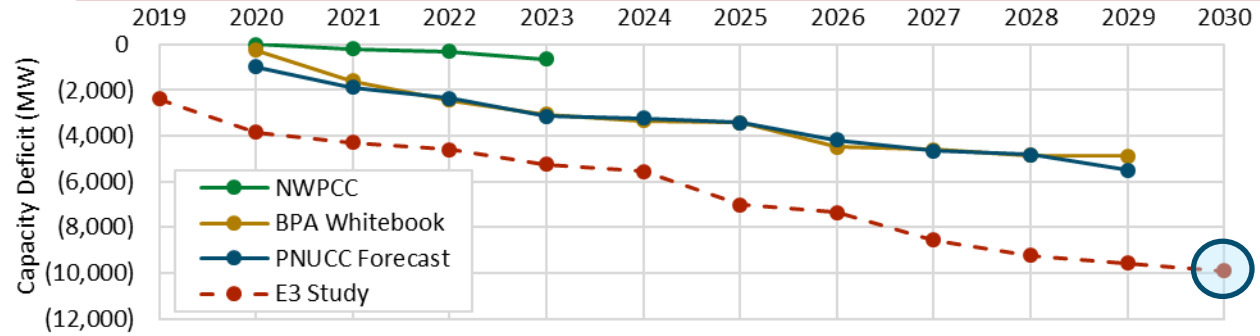
Post-Addition Needs Identified in IRPs



*E3 also considered Grant, Chelan, and Douglas Counties but they do not report a shortage in capacity

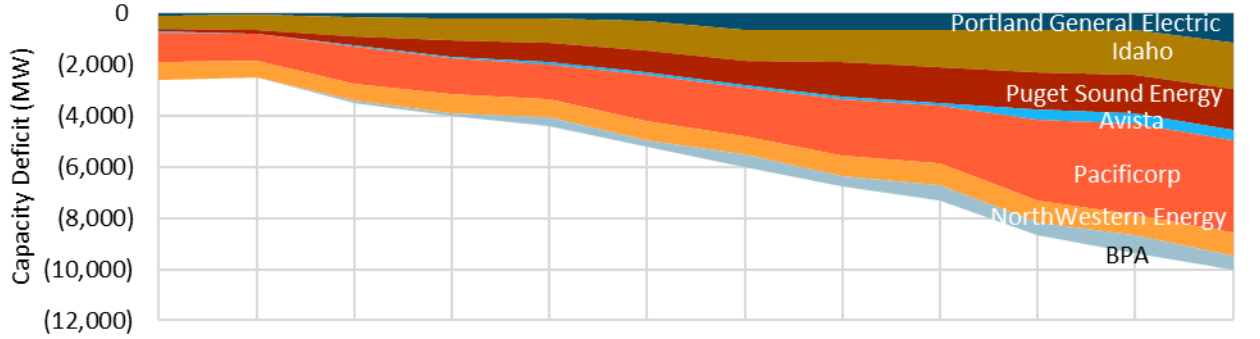
PacNW Capacity Need vs. Planned Additions

By 2030, the region faces a 10,000 MW need that is not adequately met by currently planned additions



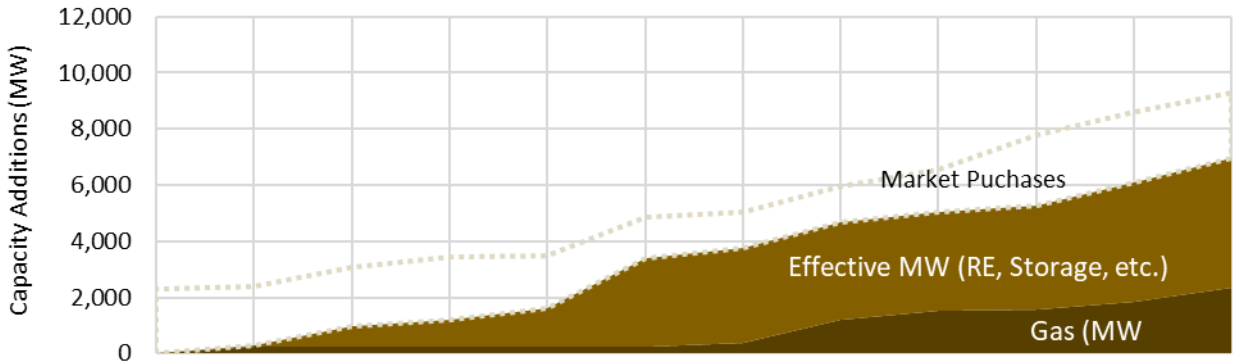
"Top-Down" Regional Assessments

5,000 – 10,000 MW capacity need by 2030



"Bottom-Up" Review of Utility IRPs

10,000 MW capacity need by 2030, before planned additions



IRP Planned Resource Additions

Only ~7,000 MW effective capacity additions…
2,300 MW of market purchases generally do not address regional need

Note: E3 top-down assessment utilizes RECAP modeling results from E3's 2019 study Resource Adequacy in the Pacific Northwest. This study further shapes the annual capacity need based on the latest proposed coal retirements schedules (as of Oct 2019). E3's capacity deficit does not include any planned additions.

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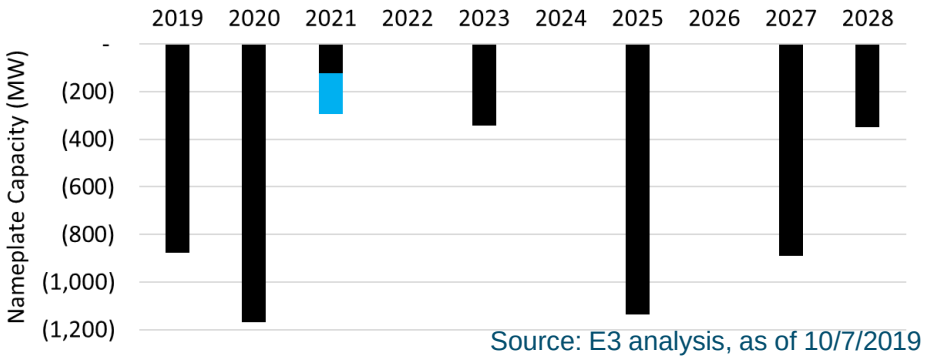
PacNW Capacity Need Drivers and Analysis

PacNW Key Policy Drivers

- **Coal retirements are driven by policy, planning, and politics**
  - 4.5 GW by 2030
- **Clean energy legislation and voluntary goals are expanding**
  - WA/OR coal prohibitions
  - WA 100% carbon-free by 2045 - OR may follow
  - Idaho Power voluntary goal of 100% clean energy by 2045
- **Economy-wide GHG reductions will drive additional impacts**
  - Electrification of transportation and building loads may significantly increase peak loads

Planned PacNW Coal Retirements

Units to Retire						
2019	2020	2021	2023	2025	2027	2028
Colstrip 1,2 Naughton 3	Boardman Centralia 1	North Valmy 1 Klamath Hydro	Jim Bridger 1	Centralia 2 North Valmy 2 Naughton 1,2	Colstrip 3,4 Johnston 1-4	Jim Bridger 2



Source: E3 analysis, as of 10/7/2019

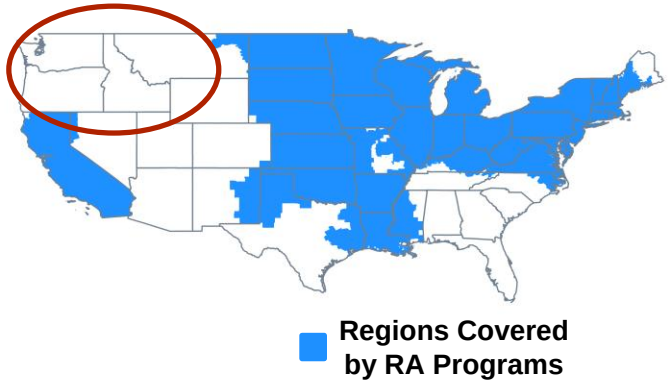
NOTE: includes coal retirements in PacifiCorp's draft 2019 IRP

	RPS or Clean Energy Standard?	Coal Prohibition?	Carbon price?	Voluntary Goals?
WA	✓ Carbon neutral by 2030, 100% by 2045	✓ Eliminate by 2025	✓ SCC in utility planning	✓ Corporations + Cities
OR	✓ 50% by 2040	✓ Eliminate by 2035	✗	✓ Utilities + Cities
ID	✗	✗	✗	✓ Idaho Power 100% by 2045
MT	✓ 15% by 2015	✗	✗	✗
UT	✓ 20% by 2025	✗	✗	✓ SLC + other cities
WY	✗	✗	✗	✗

PacNW Resource Adequacy Approach

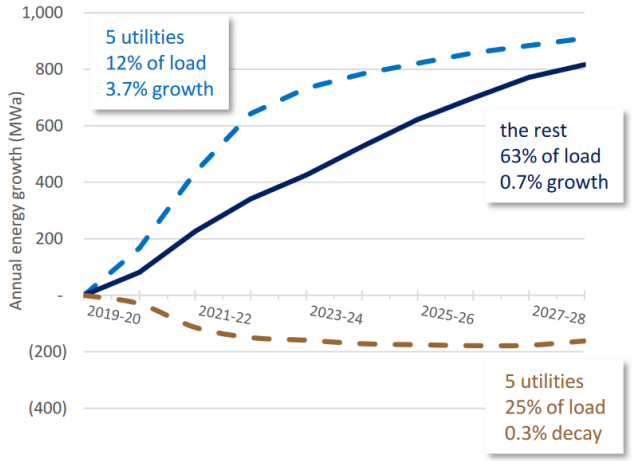
- **The Northwest has no existing regional RA program**
  - There are independent regional RA assessments (BPA, PNUCC, etc.), but no regulatory program to coordinate RA planning and procurement
- **Reliability planning done through utility IRPs**
  - Lack of consistency in assumptions (e.g. load growth, capacity contributions)
  - Lack of consistency in reliability standards (e.g. PRM vs. LOLE vs. other reliability metrics)
- **Top-down view of regional need may not match the bottom-up (IRP-based) view**
  - Reliance in IRPs on market purchases (aka front-office transactions) may lead to double counting
- **The region (led by the Northwest Power Pool) is considering developing a regional RA program**

Geographic Extent of U.S. RA Programs



Regions Covered by RA Programs

Different Loads Forecast in Utility IRPs



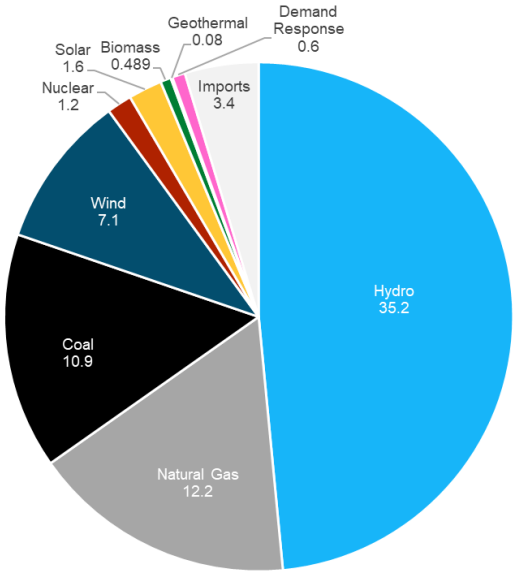
Source: PNUCC 2019 Northwest Regional Forecast

PacNW Existing Resources
2018

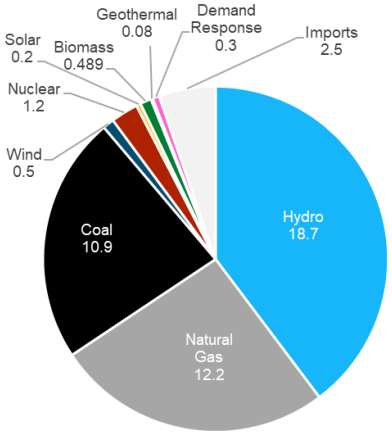
Load + Resource Balance (Greater NW = WA, OR, ID, parts of UT, WY)

Load			Load GW
Peak Load			42.1
Firm Exports			1.1
PRM (12%)			5.2
Total Requirement			**48.4**
Resources	**Nameplate GW**	**Effective %**	**Effective GW**
Coal	10.9	100%	10.9
Gas	12.2	100%	12.2
Biomass & Geothermal	0.6	100%	0.6
Nuclear	1.2	100%	1.2
Demand Response	0.6	50%	0.3
Hydro	35.2	53%	18.7
Wind	7.1	7%	0.5
Solar	1.6	12%	0.2
Storage	0	—	0
Total Internal Generation	**69.1**		**44.7**
Firm Imports	3.4	74%	2.5
Total Supply	**72.5**		**47.2**
Surplus/Deficit			
Capacity Surplus/Deficit			**-1.2**

Nameplate GW



Effective GW



Fossil units are 1/3 of nameplate but 1/2 of effective GW

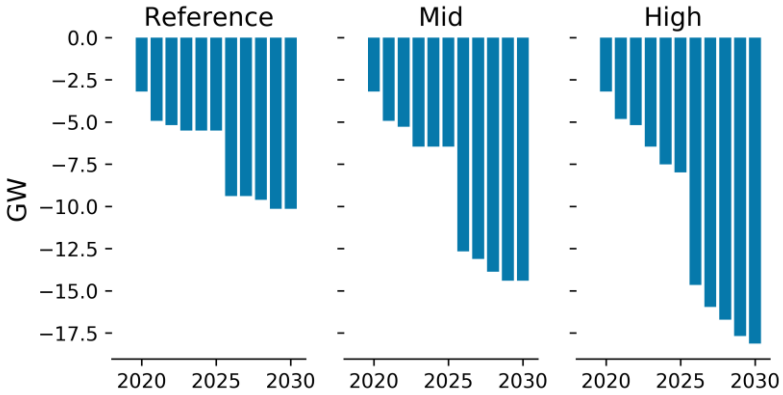
Source: E3 Resource Adequacy in the Pacific Northwest, 2019
Note: other top-down analyses (e.g. NWPCC) suggest need starting in the 2020-2021 timeframe.

PacNW Near-Term Capacity Need

Key Drivers

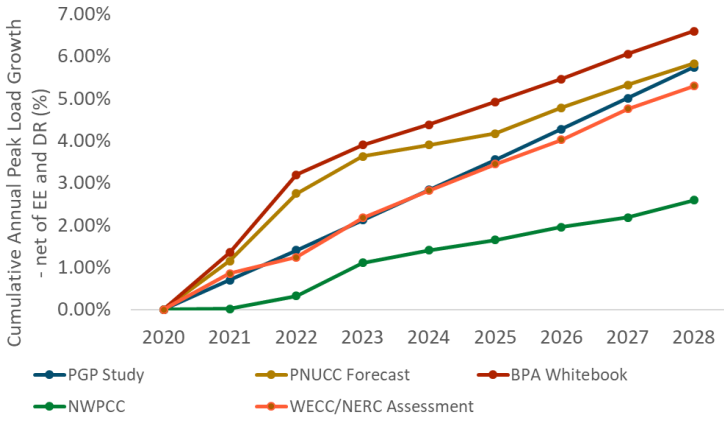
- **A combination of departing industrial loads, generation additions, and sustained attention to energy efficiency left the Northwest with excess capacity for nearly two decades**
- **Two key drivers of the Northwest's capacity challenges have been identified in recent studies:**
  1. Thermal (largely coal) resource retirements
  2. Peak load growth
- **Both trends are expected to continue across the West as states and provinces continue to pursue decarbonization of both the economy and the electric supply**

WECC Coal Retirement Scenarios (cumulative)



NOTE: in 2019, ~35 GW coal in WECC (11 GW in Greater NW)

NW Peak Load Growth in Recent Studies



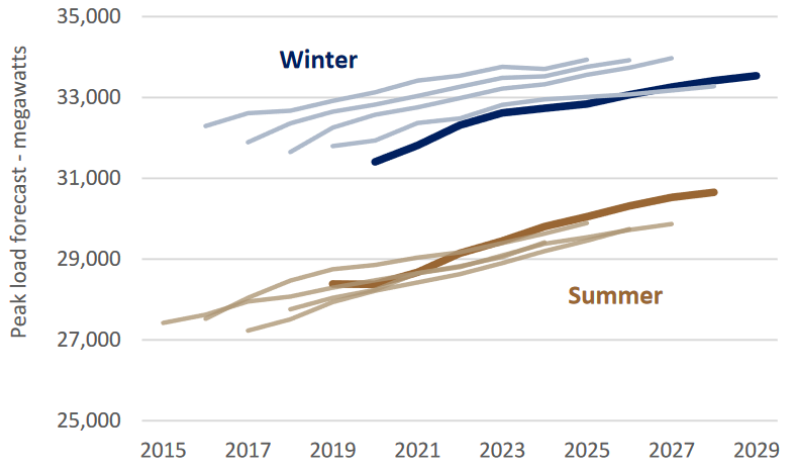
PacNW Near-Term Capacity Need

Winter vs. Summer Needs

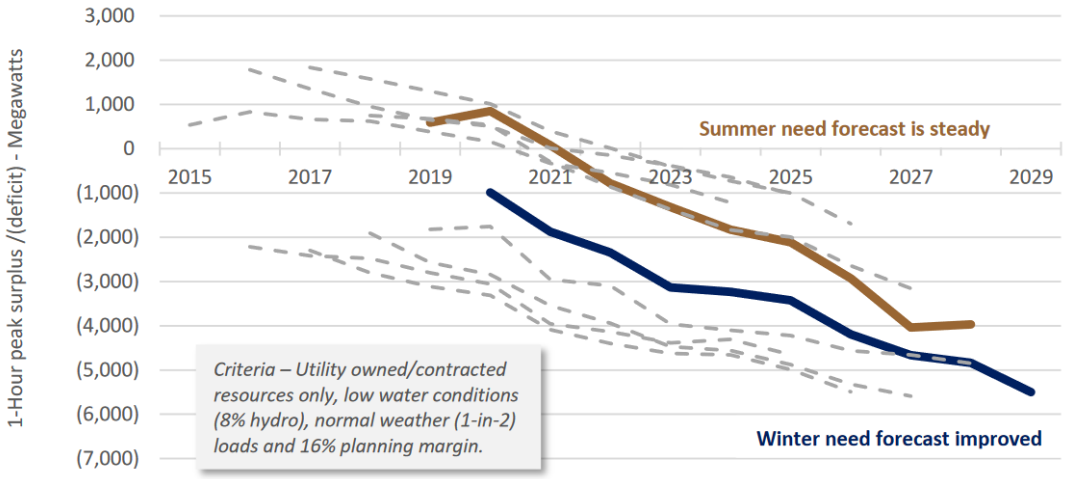
+ **PacNW is a winter peaking region***
  - Summer peak is significant and continues to climb ("dual peaking")
  - Hydro resources and imports are generally less available in summer

+ **The region faces both winter and summer load-resource balance deficits**

PNUCC Summer vs. Winter Peak Demand



PNUCC Summer vs. Winter Need Forecast



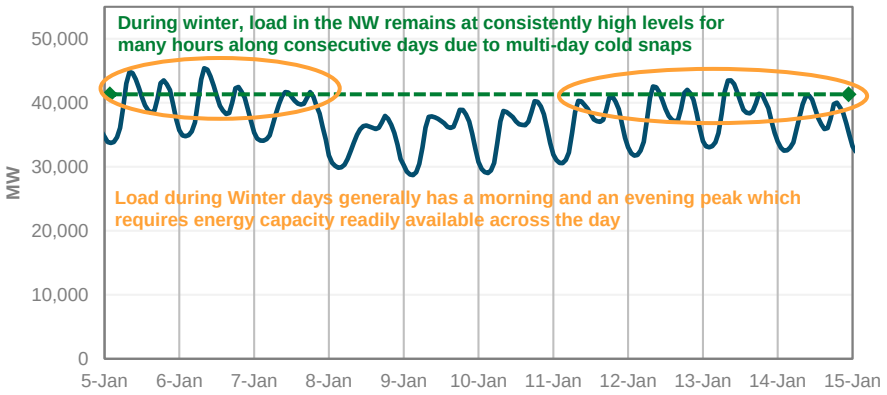
* NOTE: various definitions are used for the Northwest Region. The Northwest Power Pool ("Greater Northwest" region) exhibits a dual winter/summer peak, while the PNUCC region shown here has a stronger winter peak.

PacNW Near-Term Capacity Need

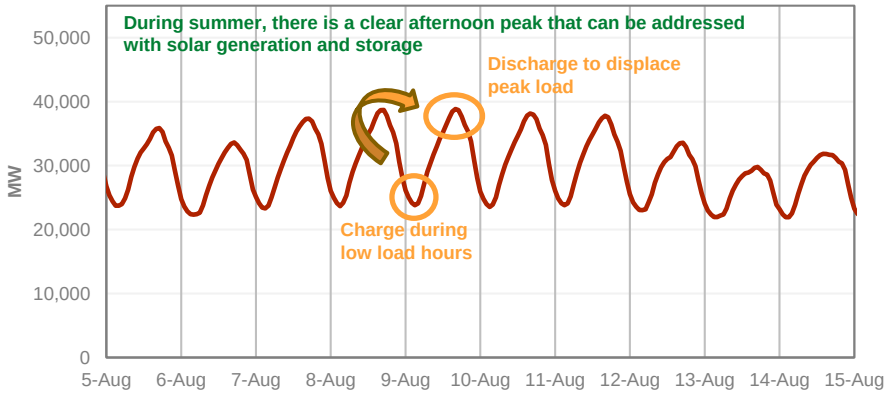
Winter vs. Summer Needs

+ **Reducing the winter peak in the NW is challenging due to its multi-day duration & daily dual-peak nature coupled with inconsistent wind and solar availability**

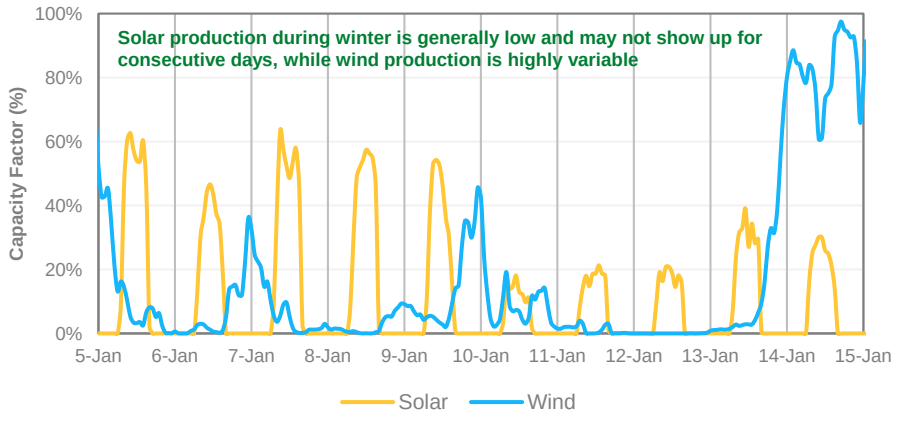
Winter Peak Load



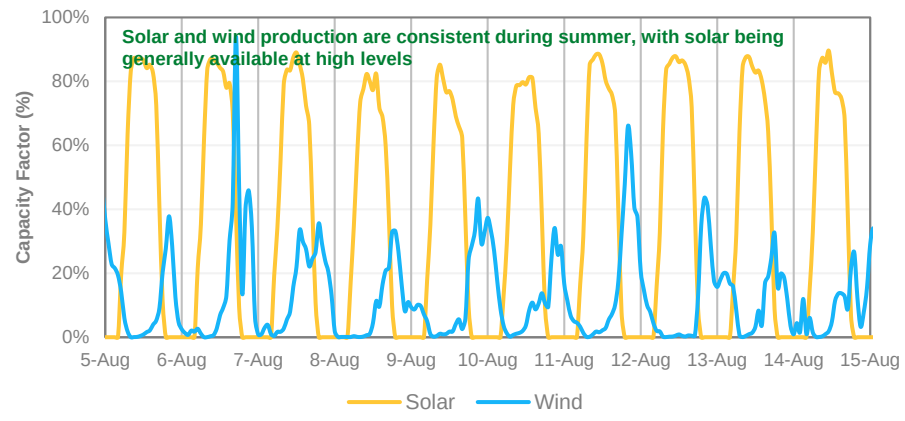
Summer Peak Load



Renewables Winter Profile

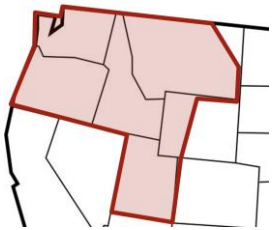


Renewables Summer Profile

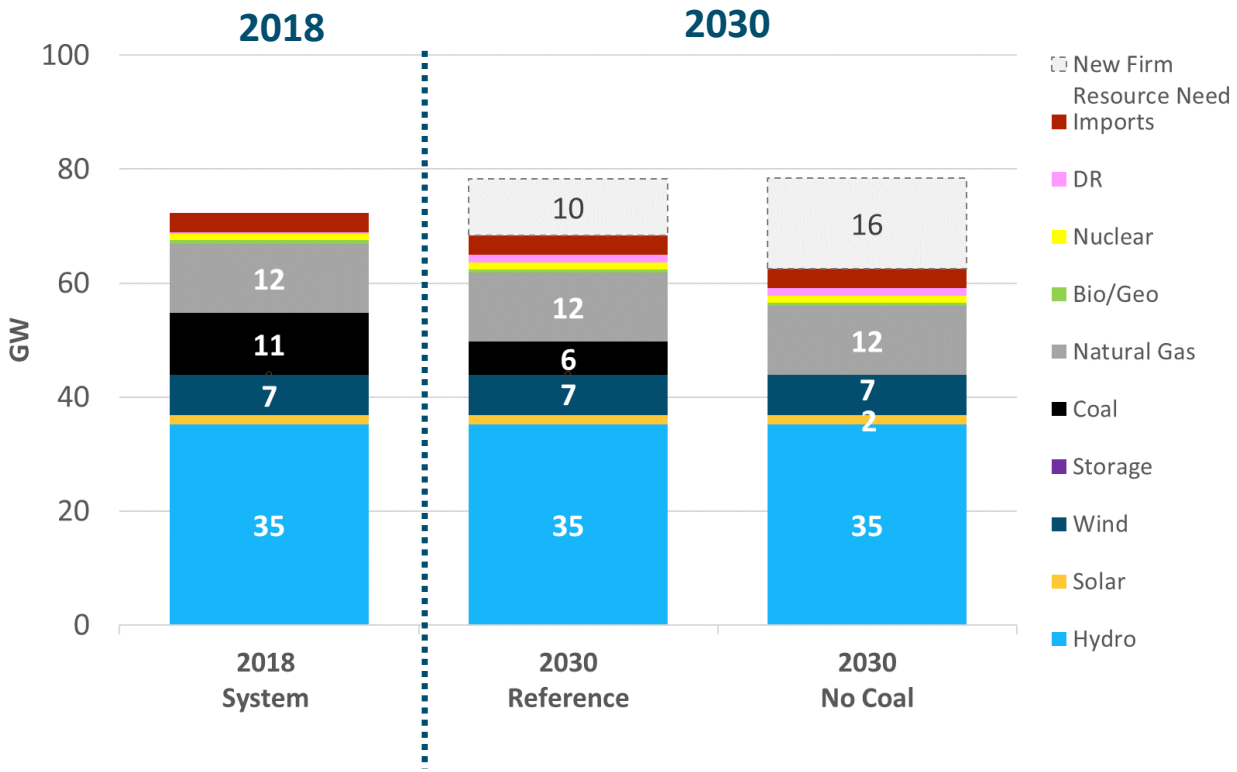


PacNW Near to Mid-Term Capacity Need

2019 E3 Study Details



- E3 2019 RA study considered Greater NW capacity needs under changing resource portfolios
- The study region consists of the U.S. portion of the Northwest Power Pool (excluding Nevada)
- Did NOT consider high electrification loads, which may further increase capacity needs



Peak Demand (+ firm exports + PRM)	48 GW	53 GW	53 GW
Coal Capacity	11 GW	6 GW	0 GW
Capacity Shortfall	**1.2 GW**	**10 GW**	**16 GW**
Annual Additions ('18-'30)	n/a	~600 MW/yr	~1,300 MW/yr

By 2030, load growth + coal retirements lead to a 10-16 GW capacity need

Note: utilizes RECAP modeling results from E3's 2019 study Resource Adequacy in the Pacific Northwest, but includes the latest proposed coal retirements schedules (as of Oct 2019).

PacNW Near to Mid-Term Capacity Need
Bottom-Up Planned Additions (By Technology)

- **Planned capacity additions reach over 13,000 MW by 2030**
  - Most new additions are wind and solar
  - Little new firm capacity online before 2025
  - Over-reliance on "market purchases" may stress the region's available physical capacity

Planned Addition By Resource (Nameplate MW)

	2020	2025	2030
Gas	247	362	2326
Coal	0	0	0
Hydro	0	0	0
Solar	121	2951	5176
Wind	0	4068	4068
Storage	20	297	930
Others (BPA + NWE)	0	735	798
Total Planned Additional Capacity (MW)	388	8413	13298
Market Purchases	2101	1288	2332

Limited firm capacity additions before 2025

Resource types TBD

Effective capacity only ~7,000 MW*

High reliance on the market may double count physical resources

2030 "top-down" regional need vs. "bottom-up" planned additions:

9.9 GW need – 7.0 GW effective additions = 2.9 GW remaining

* Estimate of effective capacity estimated using marginal ELCCs from E3's RECAP Study of 25% for solar, 40% for wind, 98% for storage
Note: storage's ELCC quickly declines after the first tranche of additions

PacNW Near to Mid-Term Capacity Need
Bottom-Up Planned Additions (By Utility)

+ **Multiple utilities are planning large capacity additions to address their needs**
  - Utilities subject to strong clean energy policies may seek or require non-emitting new capacity
  - PacifiCorp has the majority of the regional capacity need / planned additions, after their planned coal retirements
+ **A PacNW regional RA program may further facilitate utility coordination needed for new large infrastructure investments in new resource adequacy capacity**

Planned Addition By Utility (Nameplate MW)	2020	2025	2030
Portland General Electric	0	805	805
Idaho	0	276	967
Puget Sound Energy	126	430	1170
Avista	15	15	360
Pacificorp	247	6153	9198
NorthWestern Energy	0	735	798
Bonneville Power Administration	0	0	0
Municipal Utilities	0	0	0
Total Planned Additional Capacity (MW)	388	8413	13298

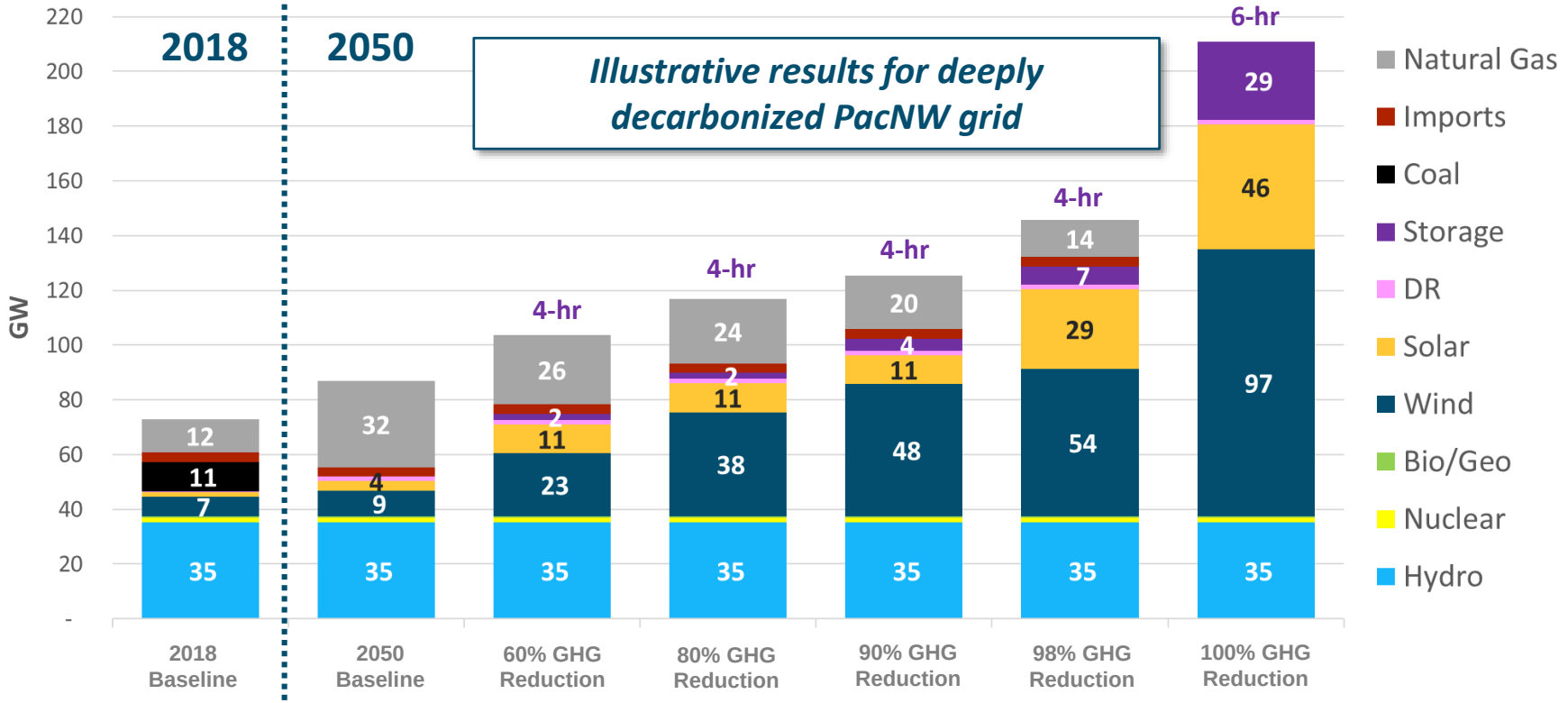
*Does not include EE and DSM

- Significant need by 2025 for utilities w/ mandatory or voluntary clean energy policies
- Market opportunity for non-emitting capacity, though some gas may be needed for reliability

PacNW Long-Term Capacity Need

2019 E3 Study: 2050 Portfolios

- Firm dispatchable resources are built and maintained for reliability in low carbon scenarios
- Relatively low storage demand (0-7 GW) in all scenarios (except zero-carbon)…driven by low ELCCs



GHG Free Generation (%)[1]	60%	80%	90%	95%	99%	100%
Annual Renewable Curtailment (%)	Low	Low	4%	10%	21%	47%
Annual Cost Delta ($B/yr)	Base	$0 - $2	$1 - $4	$2 - $5	$3 - $9	$16 - $28
Additional Cost ($/MWh)	Base	$0 - $7	$3 - $14	$5 - $18	$10 - $28	$52 - $89
Gas Capacity Factor (%)	46%	27%	16%	9%	3%	0%

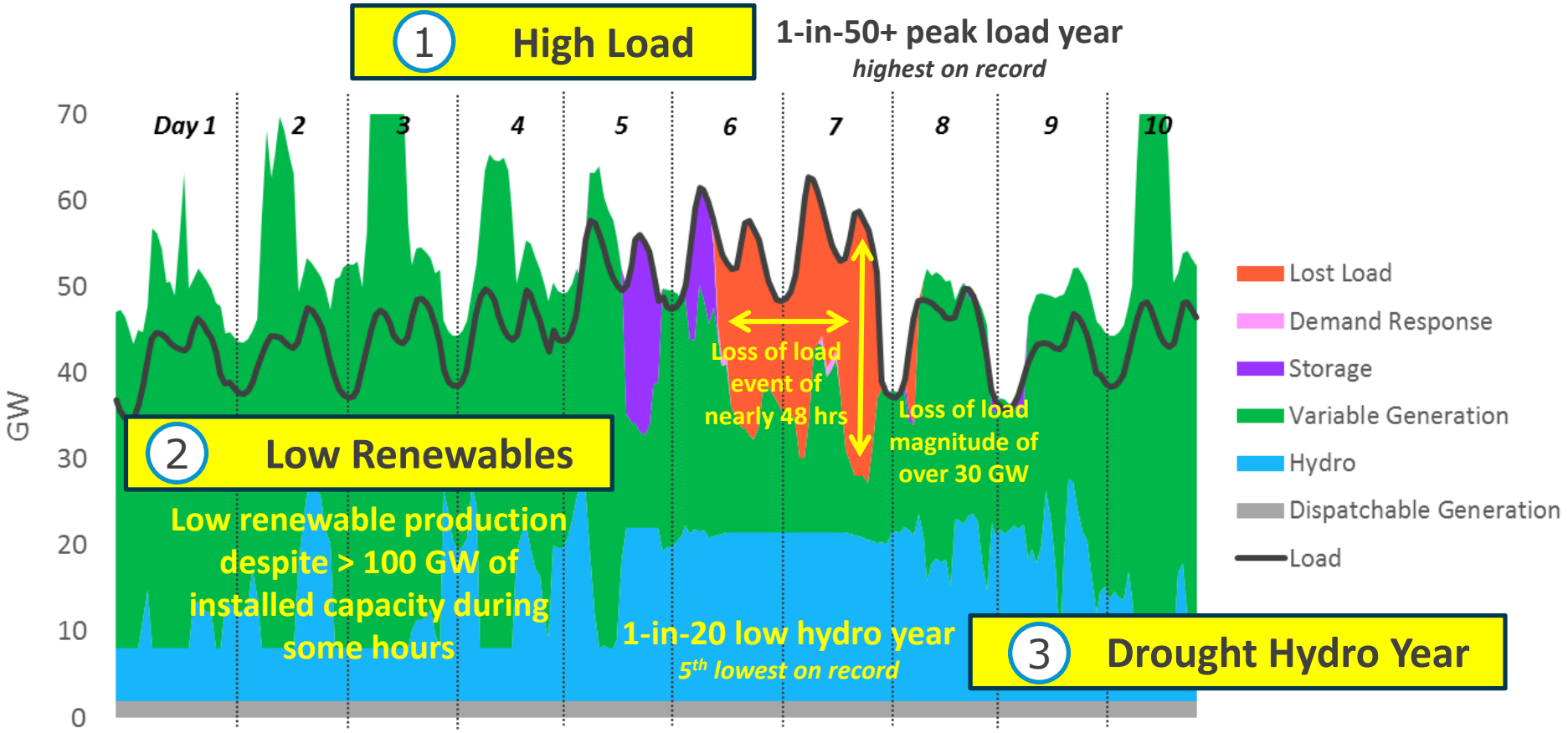
[1]GHG-Free Generation % = renewable/hydro/nuclear generation, minus exports, divided by total wholesale load

Source: https://www.ethree.com/wp-content/uploads/2019/06/E3_Long_Run_Resource_Adequacy_CA_Deep-Decarbonization_Final.pdf

PacNW Long-Term Capacity Need

2019 E3 Study: The 2050 Reliability Planning Challenge

+ **2050 reliability challenge is driven by high load and low renewable periods in low hydro years**
  - Multi-day, high magnitude loss-of-load events require firm dispatchable resources (high energy + capacity need)
  - Even multiday storage limited by energy availability to address loss-of-load
  - Seasonal storage may be able to address, but technology is not yet commercialized and likely to be costly



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Appendix

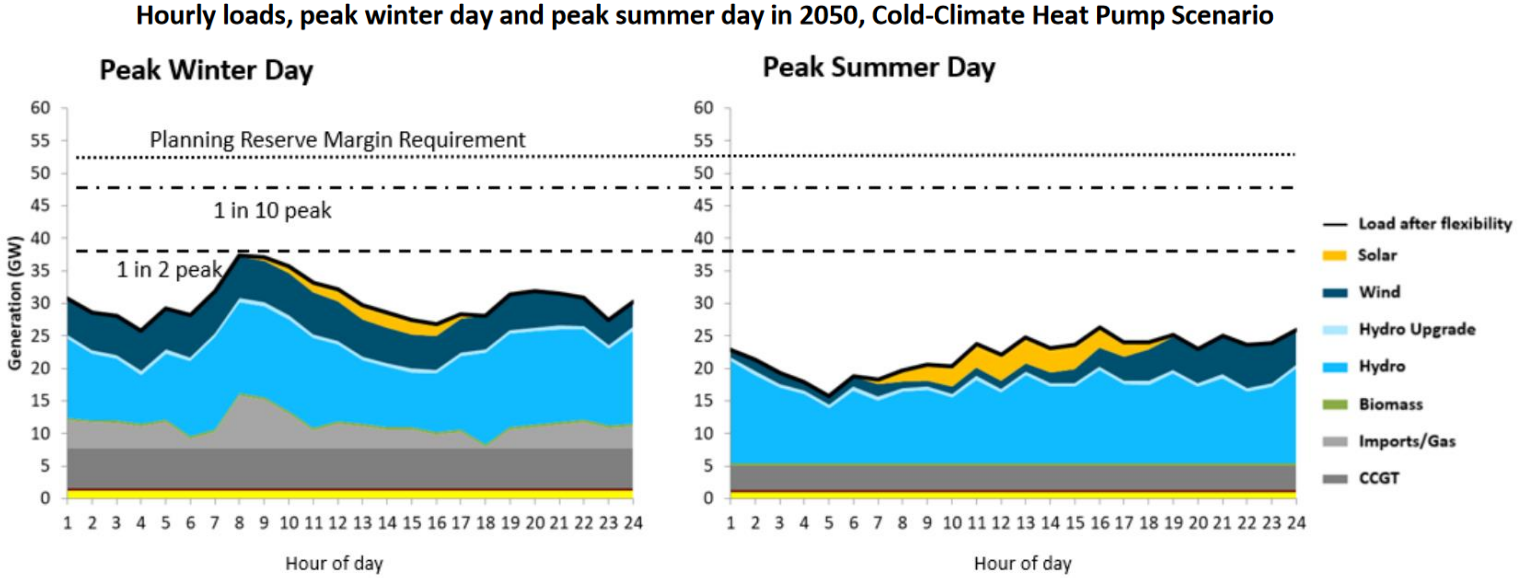
PacNW Near-Term Capacity Need

Details of Top-Down Regional Studies

Characteristic	E3 Study	NWPCC	BPA WB	PNUCC
Study Year	2019	2018	2018	2019
Region	GNW (WA, OR, ID, UT, MT, WY)	PNW (ID, MT, OR, WA)	PNW (ID, MT, OR, WA)	OR, WA, ID; portions of MT (west), NV, UT, WY
Resources Included	Existing	Existing & Planned	Existing & Planned	Existing & committed excludes non-contracted from load/resource balance
Import / Exports	Imports: 2.5 GW Exports: 1.1 GW	1.5 – 3 GW	1.2 GW	2.5 GW
Coal Retirements	3 GW in GNW 2019-2028	2.1 GW by 2022	2.1 GW by 2022 3 GW by 2026	3.6 GW
Hydro ELCC	53%	80 years of water availability	120-hour sustained capacity (44%)	8th percentile of monthly average conditions (67%)
Peak Load	CP of all utilities in dataset	Distribution of peak loads for 80 temperature years	BPA load forecasts	NCP of all participating utilities
Peak Load Growth (2020-2028)	0.70% CAGR	0.32% CAGR	0.80% CAGR	0.71% CAGR
ELCC (2018)	Endogenously calculated in RECAP - Thermal (outages) - DR 50% - Wind 7% - Solar 12%	Endogenously calculated in GENESYS	Renewables do not count for firm capacity	Existing projects - Wind 5% - Solar 8%
PRM	12%	Annual LOLP of 5%	~12%	16%

Potential Peak Demand Impacts of Building Electrification in the PacNW

- **Long-term GHG reduction may drive electrification loads in the Northwest that will further increase peak loads**
  - 2018 E3 PATHWAYS study considered impact on "Core NW" (WA, OR, parts of ID+MT)
- **Electric space heating drives significantly higher peak demand in cold climates**
  - "Peak heat" drives very high 1 in 10 peak demand
    - Requires increased planning reserve margins
    - Core NW peak + PRM increases >50% compared to today with high heat pump loads
- **Expanded transportation electrification loads may also increase capacity needs**



Source: E3 Pacific Northwest Pathways to 2050, assumes 96% fuel switching of space/water heating to electric

Key Terms & Abbreviations

- BPA: Bonneville Power Administration
- CAGR: Compound Annual Growth Rate
- CP: Coincident Peak
- DSM: Demand Side Management
- EE: Energy Efficiency
- ELCC: Effective Load Carrying Capability
- GHG: Greenhouse Gas
- GW: Gigawatt
- LOLE: Loss of Load Expectation
- LOLP: Loss of Load Probability
- MW: Megawatt
- NCP: Non-Coincident Peak
- NWPCC: Northwest Power and Conservation Council
- PNUCC: Pacific Northwest Utilities Conference Committee
- PRM: Planning Reserve Margin
- RA: Resource Adequacy
- RECAP: E3's Renewable Energy Capacity Planning Tool: www.ethree.com/recap
- SCC: Social Cost of Carbon

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Thank You

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