Energy+Environmental Economics

Capacity Needs in the Pacific Northwest and California

December 2019

Outline

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  - Key policy drivers and resource adequacy approach
  - Near-term view
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+ **California Analysis**
  - Key policy drivers and resource adequacy approach
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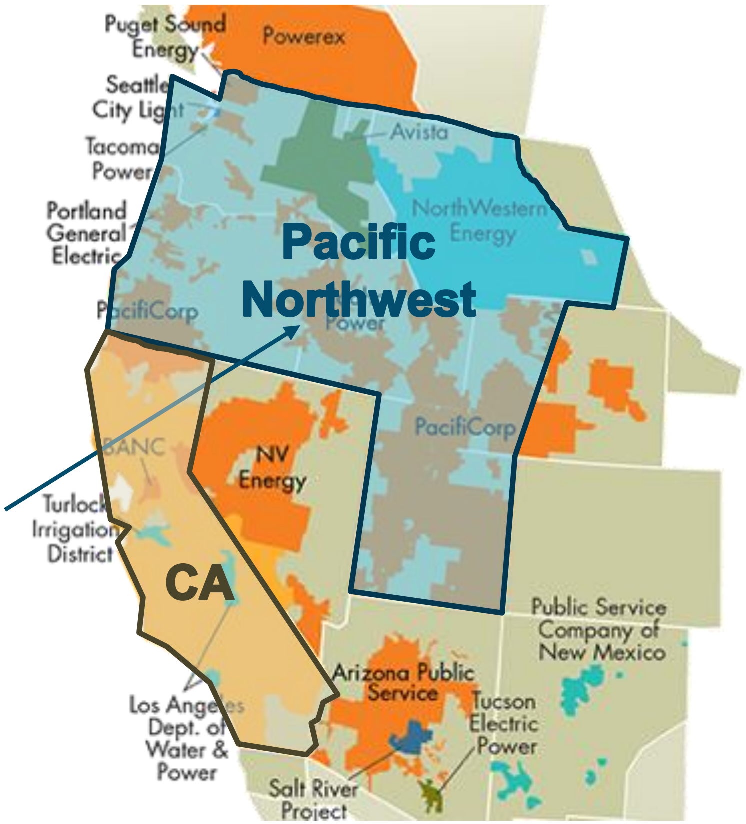
  - Forecasted oversupply available for storage charging
+ **Key Terms & Abbreviations**

Project Background

- National Grid hired E3 to analyze and summarize a fundamentals-based view of the Pacific Northwest (PacNW) and California capacity need
- 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 PacNW 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



Key Takeaways

Summary of PacNW + CA Capacity Needs

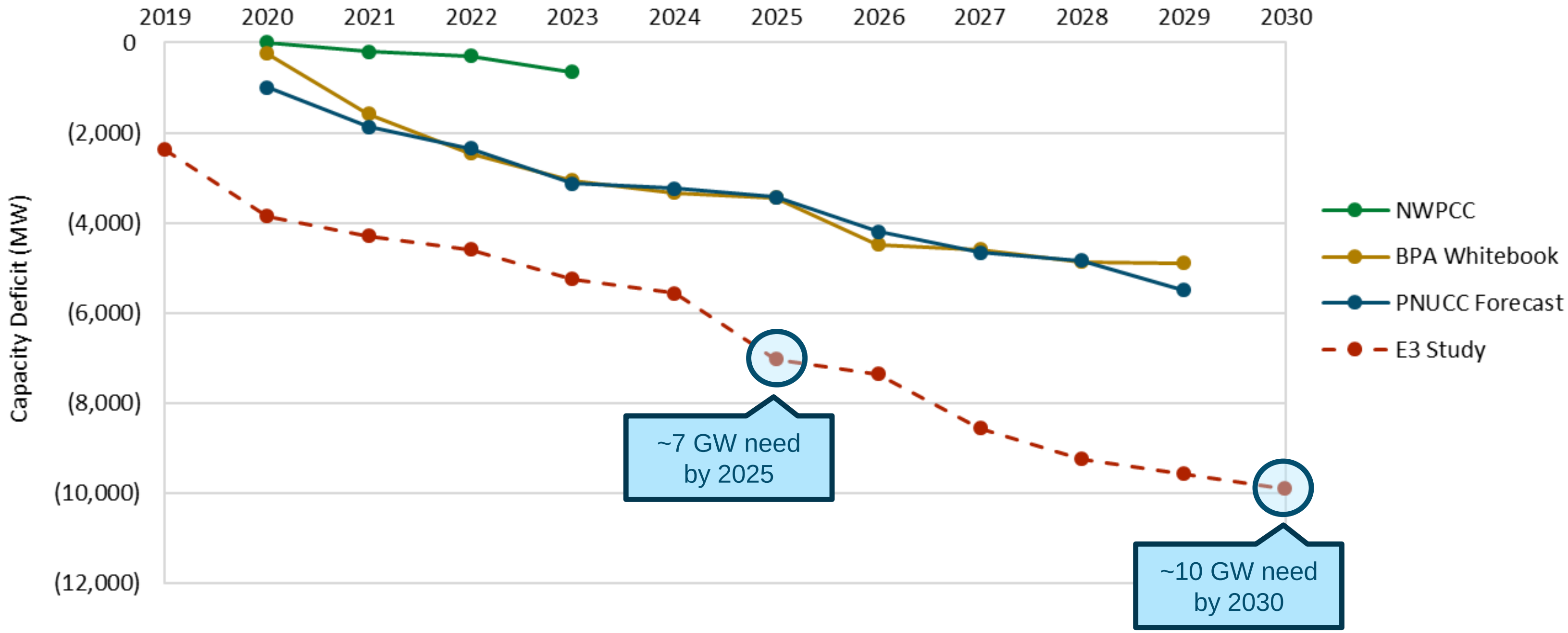
- Near-term (today-2025): both regions face capacity shortfalls
- Mid-term (2025-2030): PacNW need grows while CA need reduced by policy/economic-driven storage additions
- Long-term (2030-2050): both regions need to maintain and even increase firm dispatchable capacity to address deeply decarbonized energy sufficiency challenges

		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
California	Capacity Need	Capacity shortfall by 2021-23 of 2-3 GW	Capacity balance or slight-surplus driven by maintaining existing gas fleet + policy/economic-driven storage additions	High renewable/storage capacity added, but system capacity need driven by maintaining existing dispatchable gas fleet
	Key Drivers	• Policy-driven (once-through cooling) and economic gas + nuclear retirements • Storage begins to replace new and existing gas capacity	• Relatively stable loads • High storage additions driven by RPS/GHG policy and arbitrage economics	• Energy sufficiency-based reliability planning challenge • Decarbonization policies further increase renewables/storage; do not avoid need for firm capacity • Electrification loads may increase winter and summer 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



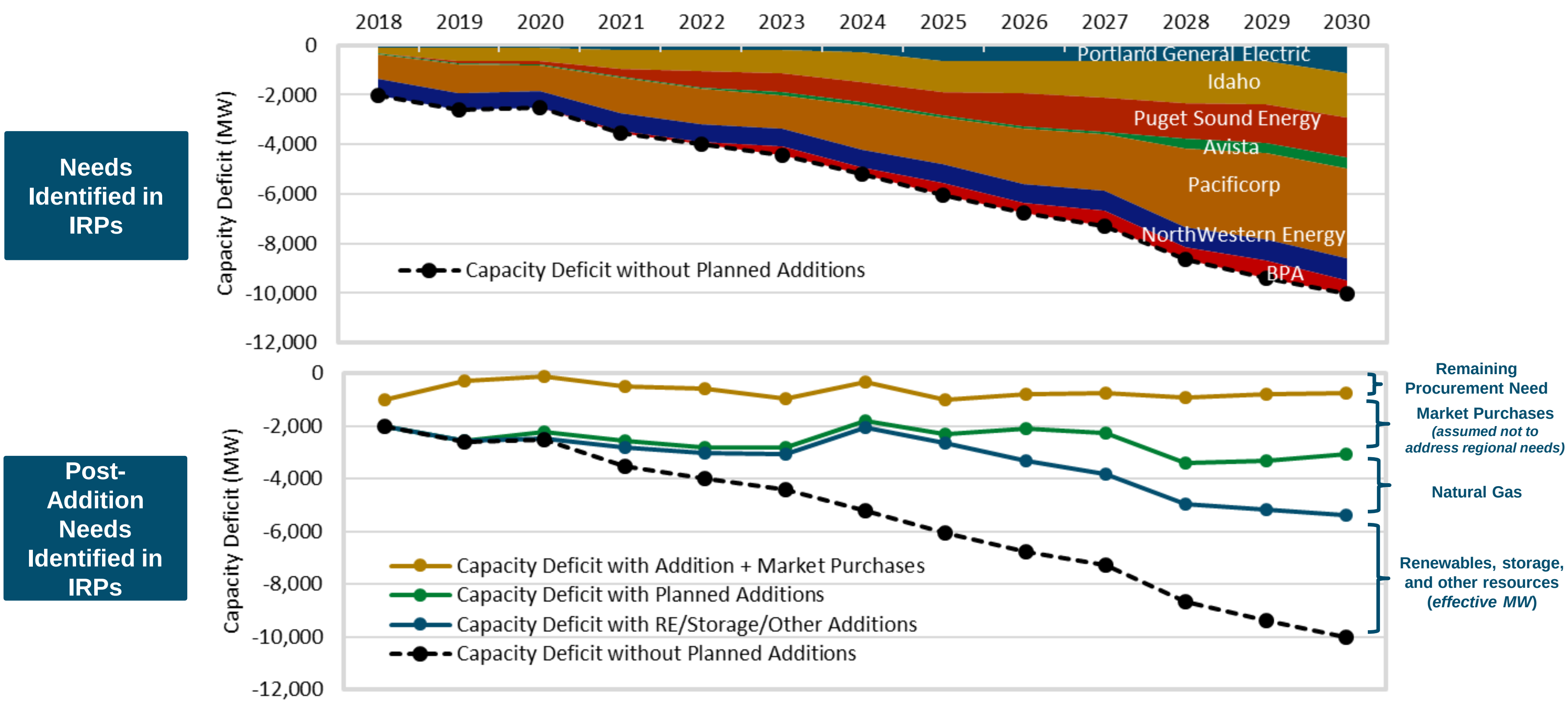
- Key differences are driven by PRM requirements, capacity counting methodologies, and resource additions (*see appendix for comparison of key assumptions*).
- E3 and NWPCC are truly "top-down" stochastic views, while PNUCC and BPA are closer to regional "bottom-up" analyses of utility IRPs.
- E3 study 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

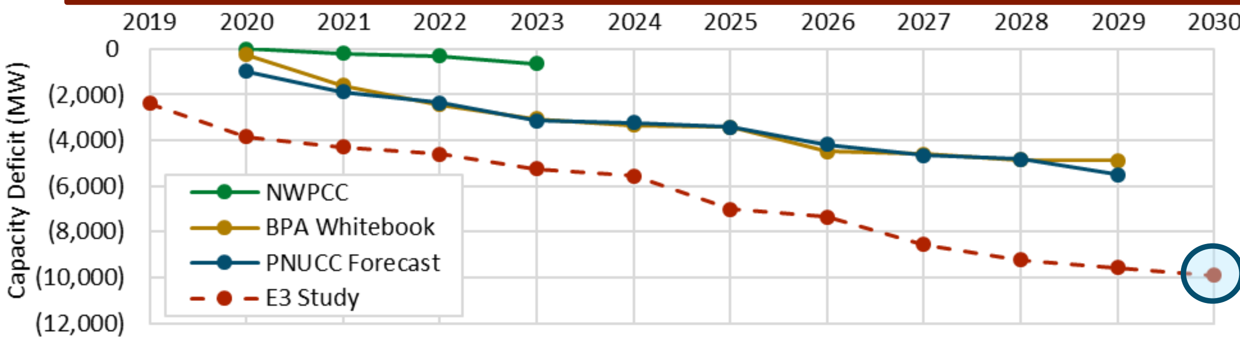
Summary of Utility IRP-based Capacity Needs



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

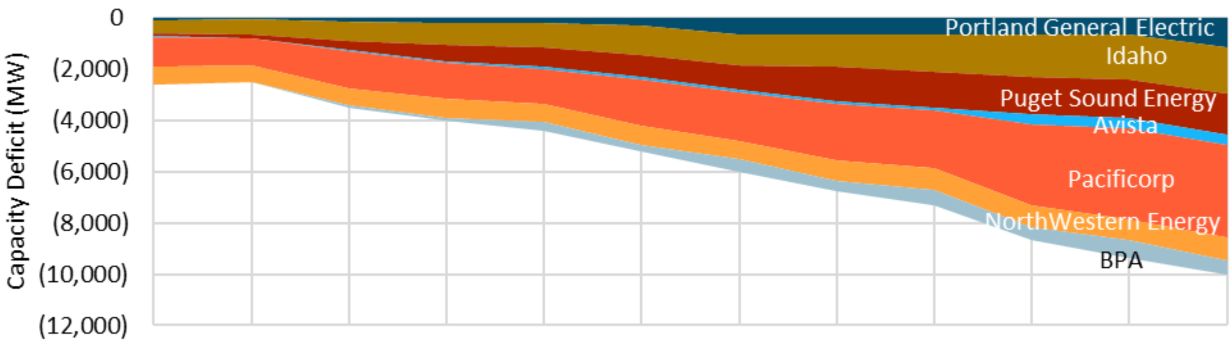
PacNW Capacity Need vs. Planned Additions

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



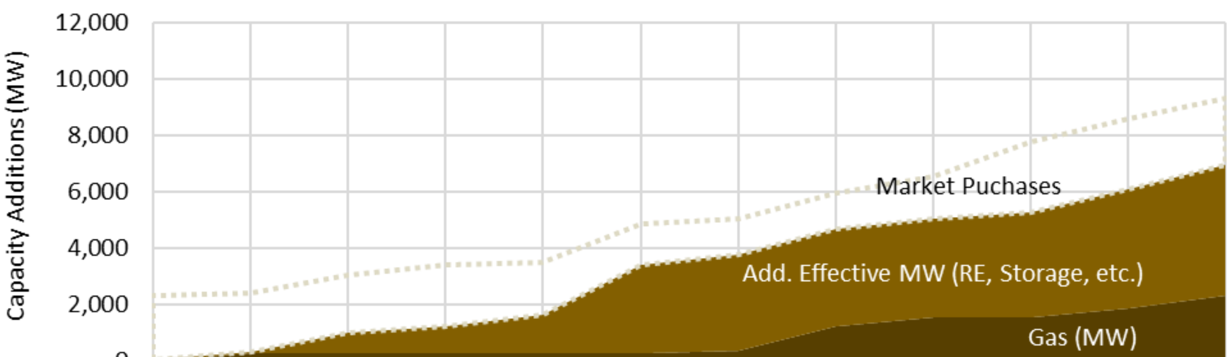
"Top-Down" Regional Assessments

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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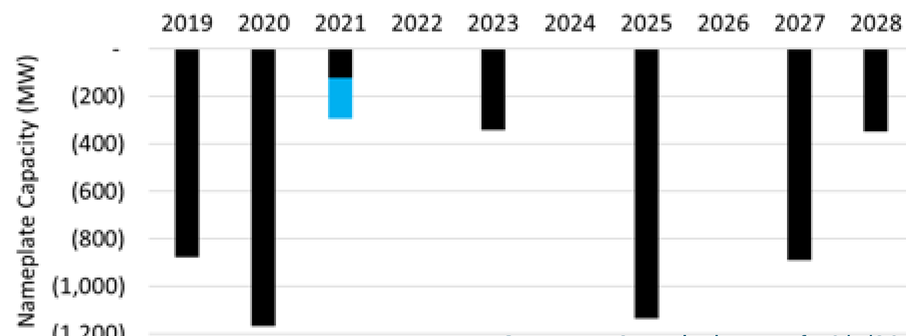
Pacific Northwest Analysis

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	✘	✘	✘	✘

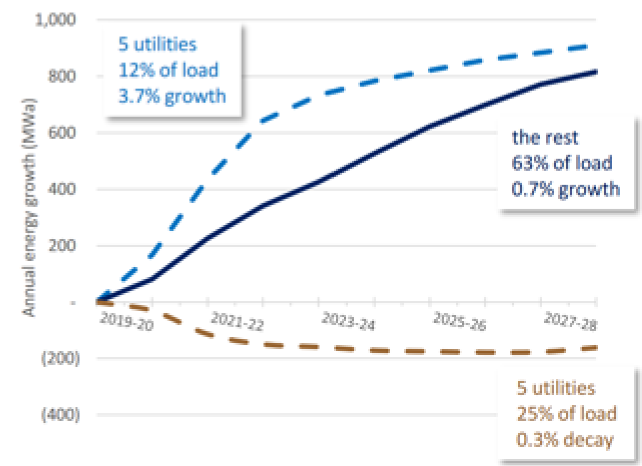
PacNW Resource Adequacy Approach

- **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]

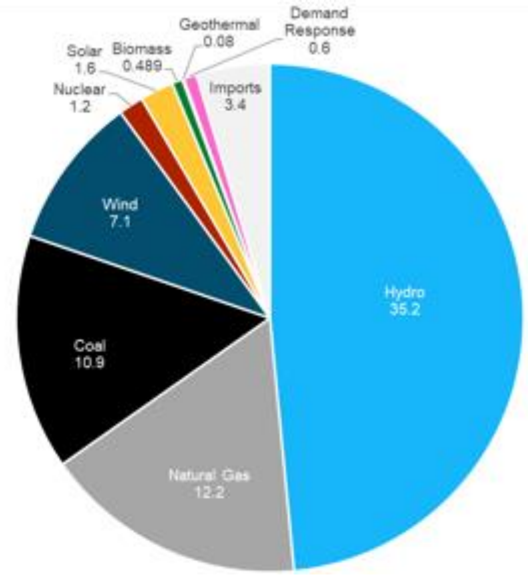
PacNW Existing Resources
2018

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

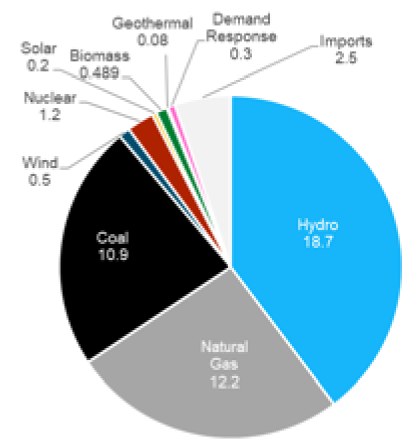
Load			Load GW
Peak Load			42.1
Firm Exports			1.1
PRM (12%)			5.2
Total Requirement			**48.4**
Resources	**Nameplate GW**	**Effective %**	**Effective GW**
Coal	10.9	100%	10.9
Gas	12.2	100%	12.2
Biomass & Geothermal	0.6	100%	0.6
Nuclear	1.2	100%	1.2
Demand Response	0.6	50%	0.3
Hydro	35.2	53%	18.7
Wind	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**

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.

Nameplate GW



Effective GW



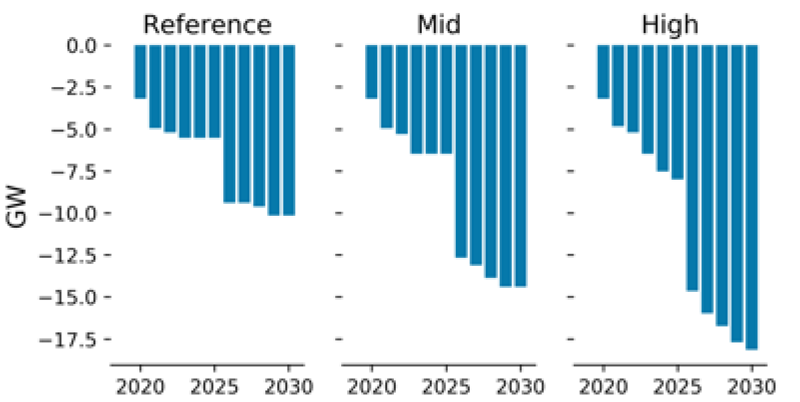
Fossil units are 1/3 of nameplate but 1/2 of effective GW

PacNW Near-Term Capacity Need

Key Drivers

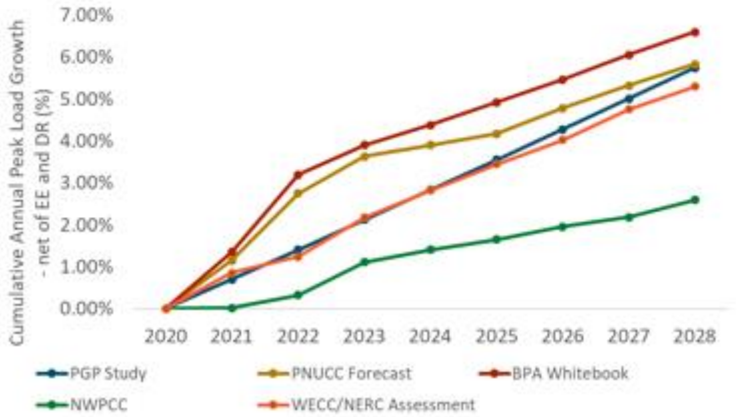
- **A combination of departing industrial loads, generation additions, and sustained attention to energy efficiency left the Northwest with excess capacity for nearly two decades**
- **Two key drivers of the Northwest's capacity challenges have been identified in recent studies:**
  1. Thermal (largely 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

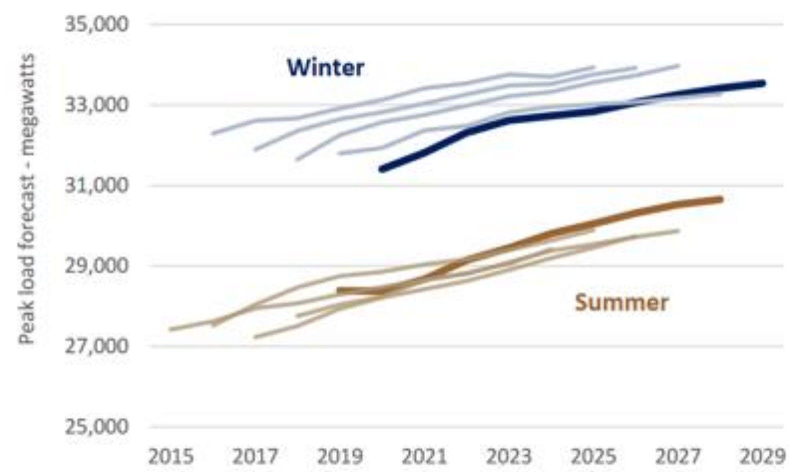


PacNW Near-Term Capacity Need
Winter vs. Summer Needs

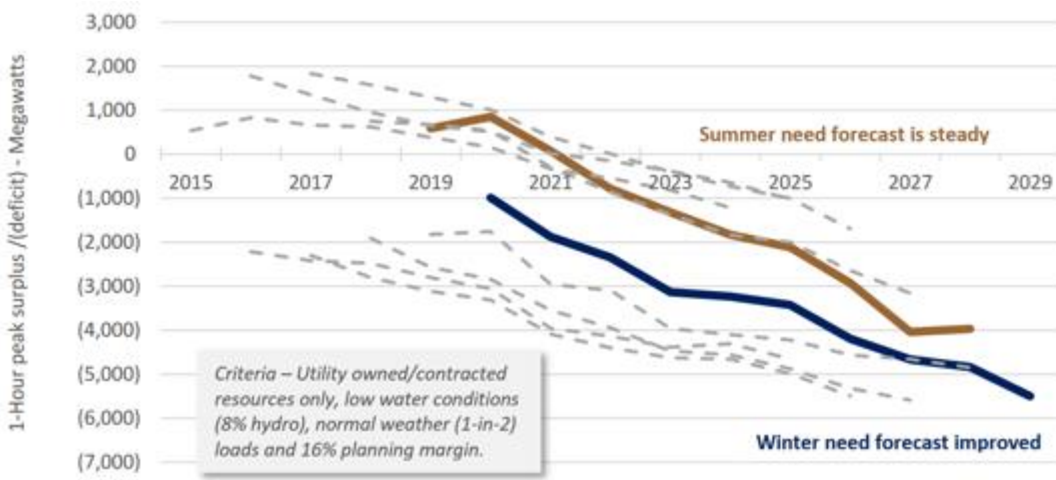
+ **PacNW is a winter peaking region***
    - Summer peak is significant and continues to climb ("dual peaking")
    - Hydro resources and imports are generally less available in summer

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

PNUCC Summer vs. Winter Peak Demand



PNUCC Summer vs. Winter Need Forecast



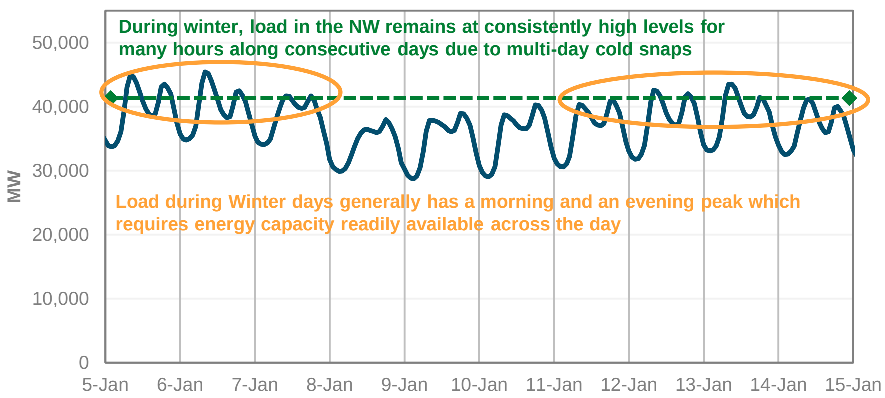
* NOTE: various definitions are used for the Northwest Region. The Northwest Power Pool ("Greater Northwest" region) exhibits a dual winter/summer peak, while the PNUCC region shown here has a stronger winter peak.

PacNW Near-Term Capacity Need

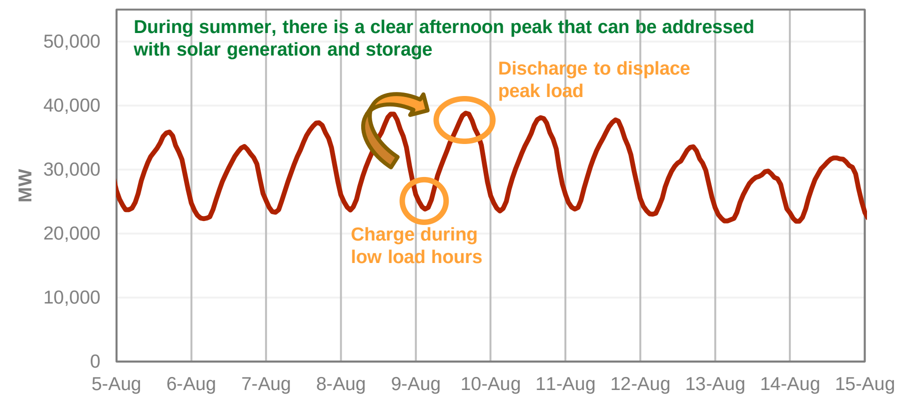
Winter vs. Summer Needs

+ **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**

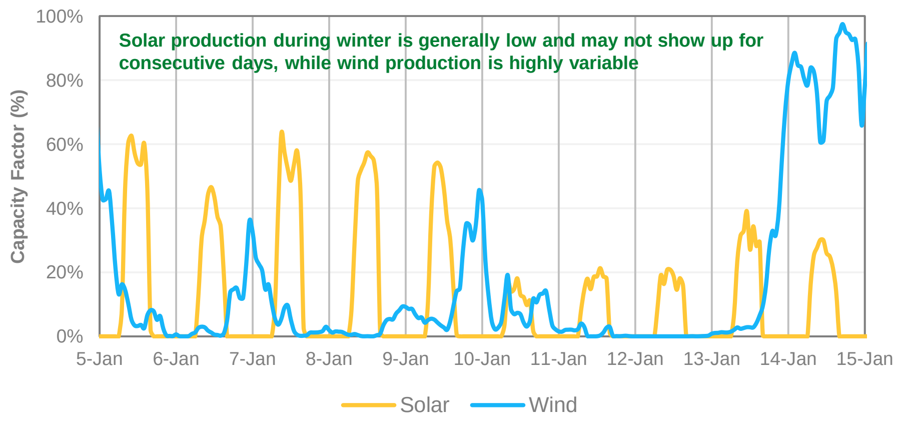
Winter Peak Load



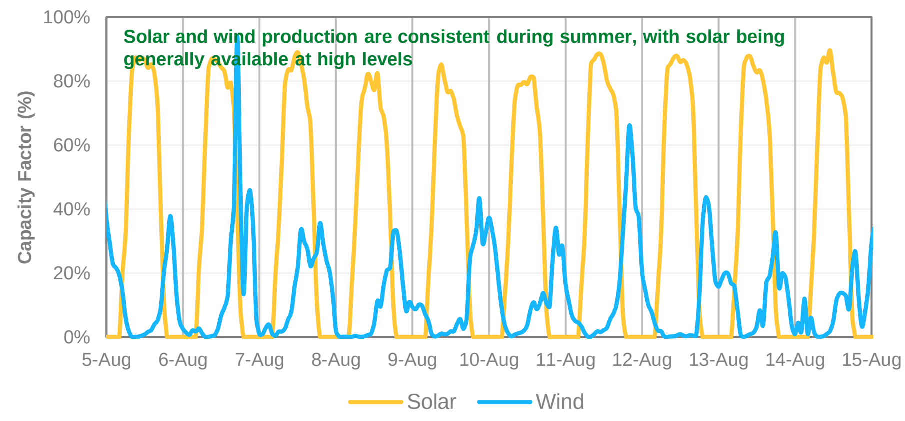
Summer Peak Load



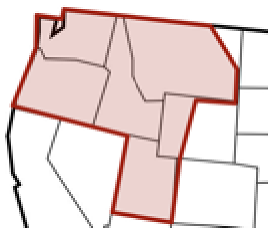
Renewables Winter Profile



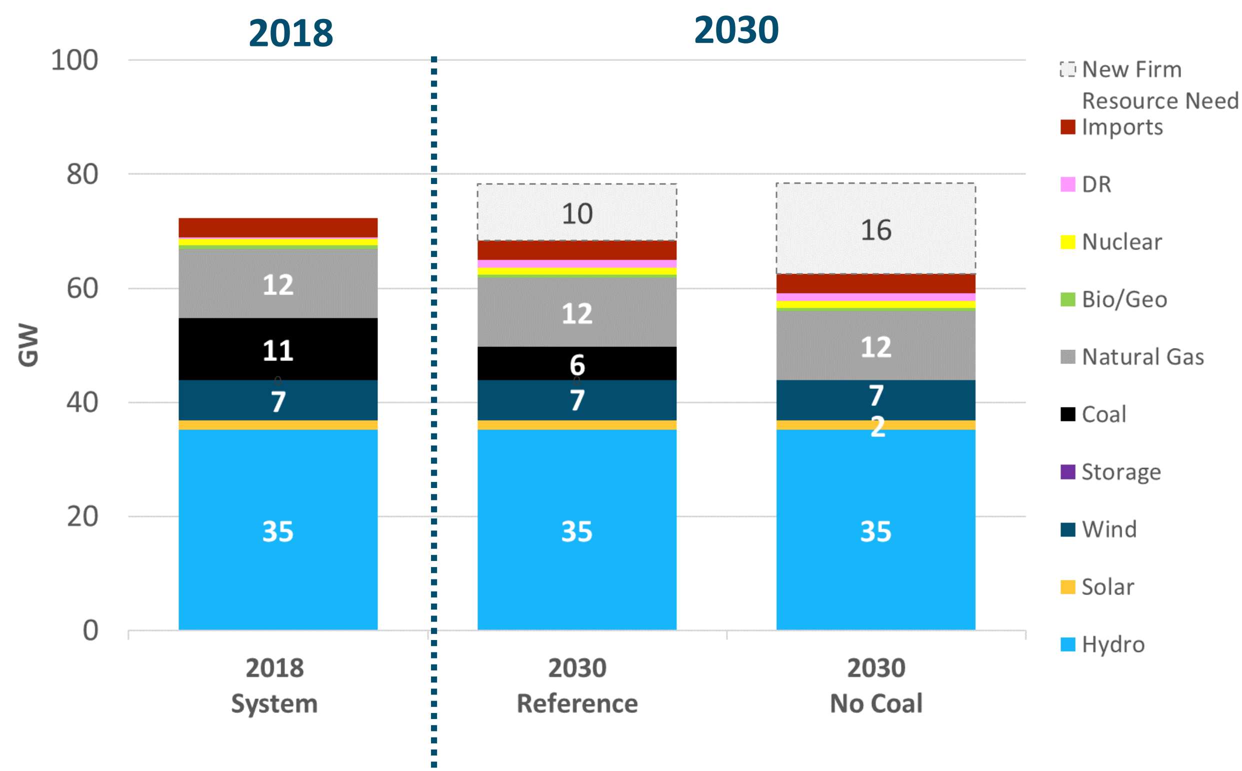
Renewables Summer Profile



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

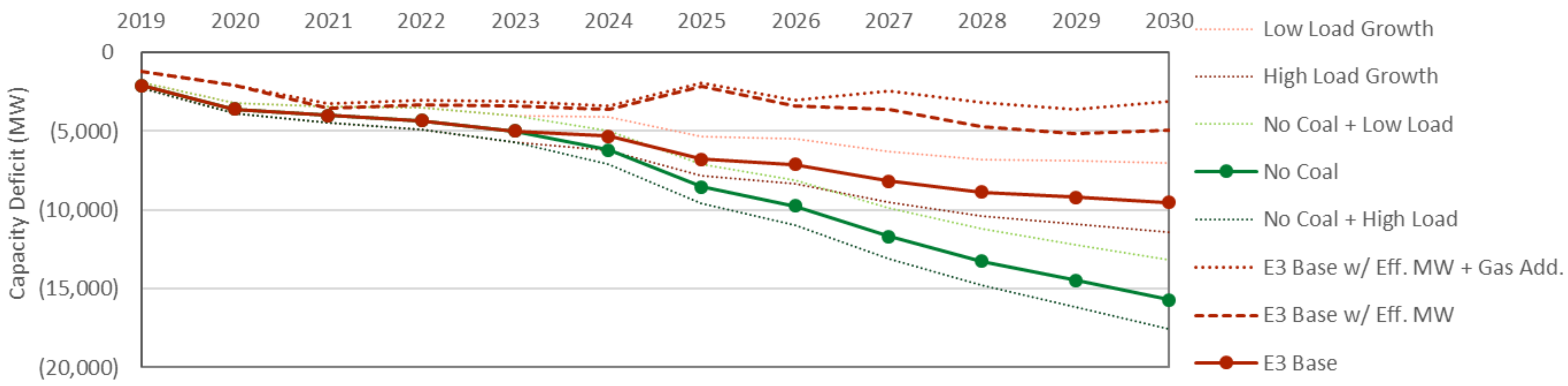
*Does not include EE and DSM

- 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 Near to Mid-term Capacity Need

Top-Down Sensitivities vs. Planned Additions

+ **Top-down sensitivity scenarios were considered based on E3 study 2030 baseline**
  - Key drivers are level of coal retirements and load growth (0.4 – 1.1% / yr considered)
  - Shortfall, before planned additions, ranges from 7.4 to 15.8 GW assuming firm imports of 2.5 GW
  - Even with all planned additions from latest IRP filings, region is still ~3 GW short in 2030



Capacity Deficit Drivers

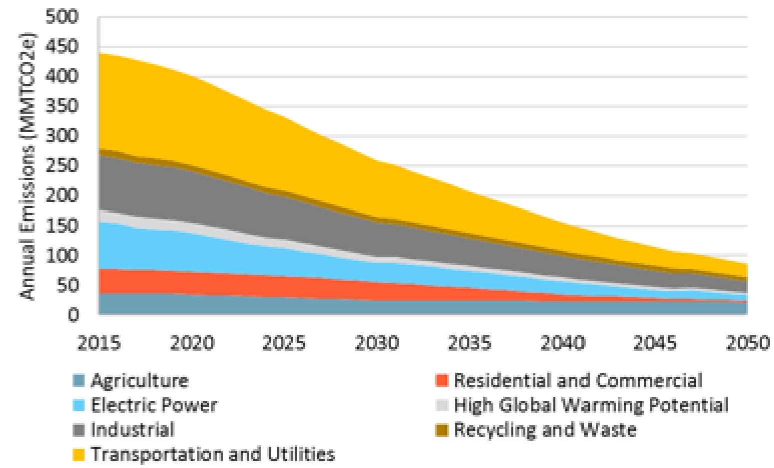
	Scenario	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Load driven	Low Peak Growth (relative to base)	+196	+394	+594	+797	+1,002	+1,209	+1,418	+1,629	+1,843	+2,059	+2,277	+2,498
	Base Peak Growth	**-1,503**	**-1,808**	**-2,116**	**-2,427**	**-2,741**	**-3,058**	**-3,377**	**-3,699**	**-4,024**	**-4,353**	**-4,684**	**-5,018**
	High Peak Growth (relative to base)	-142	-287	-435	-585	-738	-893	-1,052	-1,213	-1,377	-1,544	-1,713	-1,886
Coal driven	**Base Schedule**	**-602**	**-1,770**	**-1,894**	**-1,894**	**-2,251**	**-2,251**	**-3,389**	**-3,389**	**-4,136**	**-4,492**	**-4,492**	**-4,492**
	No Coal by 2030 (relative to base)	0	0	0	0	0	-884	-1,767	-2,651	-3,534	-4,418	-5,302	-6,185

California Analysis

CA Key Policy Drivers

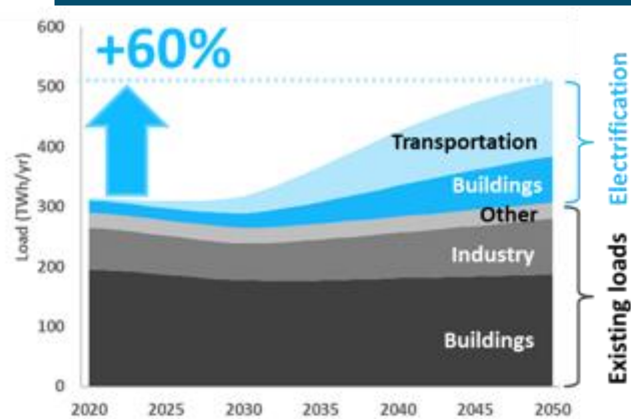
- **Clean energy policy dominates future electric loads and generation trends**
  - SB 100 mandates 100% RPS and zero-carbon (as % of retail sales) by 2045
  - GHG targets likely to drive increasing building and transportation electric loads
- **Retail market fragmentation continues to challenge reliability planning**
  - IOUs generally long on system and flexible RA
  - Increasing CCA and DA loads so far have not been signing long-term PPAs for stand-alone capacity resources, though renewable (i.e. solar+storage) PPAs have been signed
- **Gas plant retirements are impacting the state's capacity needs**
  - Driven by once-through cooling policy, declining energy market revenues, and increasing competitiveness of battery storage
- **While not officially disallowed, recent gas plant approvals have been revoked prior to construction**
  - E.g. [LADWP OTC repowering](), [NRG's Puente and Calpine's Mission Rock plants]()

California GHG Emissions Reduction Targets



Source: E3 PATHWAYS analysis for 80% GHG reduction by 2050. (Note: both SB100 and GHG goals may allow small levels of emissions to remain in the electric sector by 2050.)

California Electric Loads under High Electrification

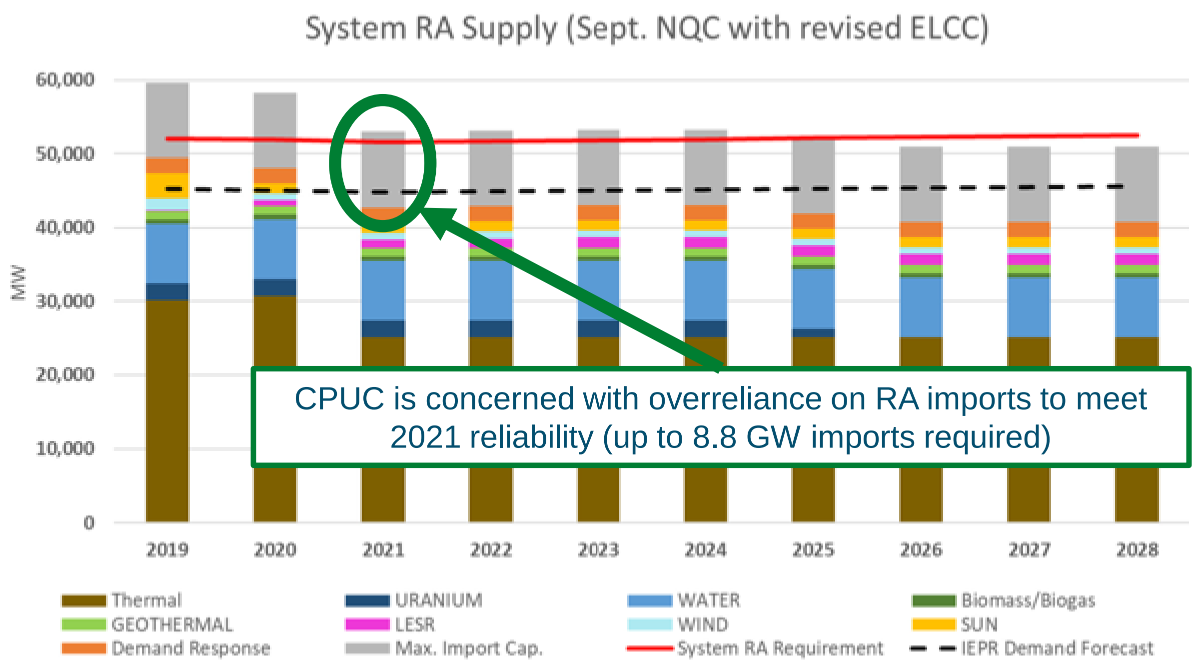


	High Electrification	
	2020	2050
Annual Energy (TWh)	315	511
Peak Load (GW)	65	93

Source: E3 PATHWAYS analysis, High Electrification Scenario.

CA Near-term Capacity Need
CPUC IRP Proceeding View

- **The CPUC's IRP proceeding has identified a tightening of the near-term CAISO capacity balance**
- **November 2019 CPUC Decision (D.19-11-016) includes a 3,300 MW capacity procurement order**
  - Also includes a delay of once-through cooling coastal plant retirements
  - New procurement via all-source solicitations; 50% online by Aug. 2021, 75% by Aug. 2022, 100% by Aug. 2023



Source: CPUC, Assigned Commissioner and Administrative Law Judge's Ruling Initiating Procurement Track and Seeking Comment on Potential Reliability Issues, June 20, 2019 (R.16-02-007)

CA Near-term Capacity Need

CPUC IRP Filings

+ **Given California's centralized market and regulatory structure, it does not have the same distinction between top-down vs. bottom-up as the Northwest**
+ **CAISO reliability needs are coordinated and planned through the CPUC's RA and IRP processes**
  - CAISO ~80% of CA load
  - All CPUC-jurisdictional LSEs and CAISO IPPs are captured through the CPUC's view of near-term capacity need
  - Municipal utilities reliability planning is coordinated with their governing boards
+ **LSEs submitted IRPs through the 2018 CPUC IRP process, but IRPs did not address RA needs**

Capacity need per 2018 LSE IRP Filings

LSE	Need Year	Need Volume (MW)
PG&E	2026	n/a
SCE	n/a	n/a
SDG&E	n/a	n/a
CCAs	n/a	n/a
ESPs	n/a	n/a

IRP filings contain minimal information LSEs' capacity need

% of existing CAISO capacity included in 2018 LSE IRPs

General Type	Resource subcategory	2020	2025	2030
Thermal	CC	47%	32%	32%
	CT	62%	24%	18%
	Cogen	87%	20%	11%
	ICE	77%	77%	77%
	Steam	3%	16%	0%
Geothermal	Geothermal	70%	51%	49%
Biomass	Biomass	27%	27%	27%

Source: CPUC analysis of 2018 LSE IRP filings

CPUC analysis shows LSE IRPs do not include capacity procurement (LSEs will rely on RA market + generators will be subject to merchant status and potential retirement)

CA Near-term Capacity Need
LADWP

+ **LADWP (~10% of CA-wide load)**
  - Last IRP (called the [Strategic Long-term Resource Plan]) released in 2017
    - **~5,000 MW capacity shortfall by 2030** driven by coal retirements + LA basin thermal retirements

Table 4-2. RESOURCES RECOMMENDED FOR RESOURCE ADEQUACY BY CALENDAR YEAR

Capacity (MW)	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Energy Efficiency	72	143	215	281	376	417	565	665	778	897	637	636	638	1084
Demand Response	68	88	125	175	225	275	325	375	425	475	500	500	500	500
New Renewable	14	94	159	201	314	205	364	511	489	546	378	386	455	796
IPP Replacement CC	0	0	0	0	0	0	0	0	553	553	553	553	553	553
Re-Powered In-Basin Thermal	0	0	0	0	0	0	0	0	310	619	619	619	929	1137
Storage	0	0	0	0	0	147	147	147	147	147	147	147	147	147
Capacity Surplus/(Shortfall)	(660)	(59)	(54)	(49)	113	260	257	113	(163)	(272)	(144)	(188)	(520)	(528)
Total Replacement	814	383	554	706	915	1044	1401	1698	2865	3510	2978	3030	3743	4746

Proposed Additions

DER + renewables

~~Fossil repower~~

Storage

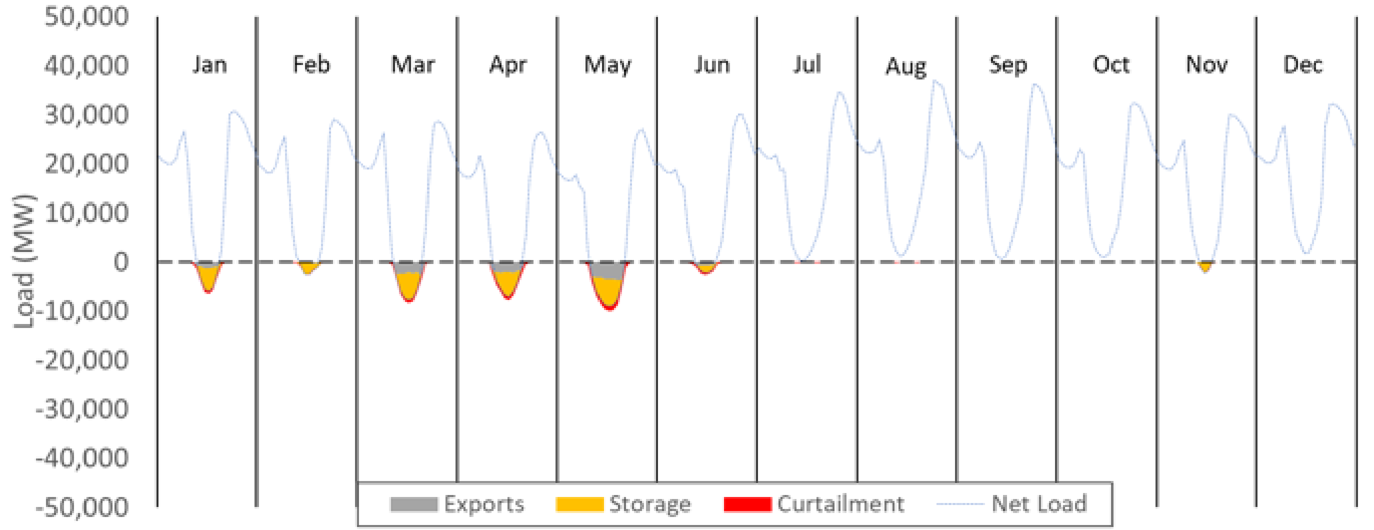
  - Big changes since last IRP…
    - SB 100 + LA Mayor's even more aggressive Green New Deal (100% RPS by 2045)
    - LA Mayor's decision to NOT repower in-basin thermal (creates additional ~1,500 MW need)
    - Next IRP cycle on hold until LA completes "LA100" 100% feasibility study

CA Oversupply (2025)

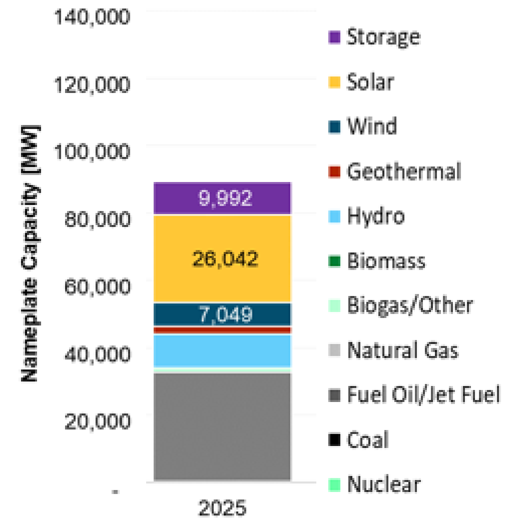
+ E3's modeling shows midday oversupply in winter + spring months in 2025

- Excess energy will be either a) exported, b) stored, or c) curtailed

Hourly Net Load and Oversupply (monthly average)



Modeled Resource Mix



Oversupply in California in 2025

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg Hours/Day	6	5	7	8	8	5	0	0	0	0	3	0	**4**
Avg Oversupply GWh/day	23	8	40	37	56	8	0	0	0	0	5	0	**15**
Total GWh/month	725	236	1,245	1,101	1,722	247	0	0	0	0	146	0	**5,421**

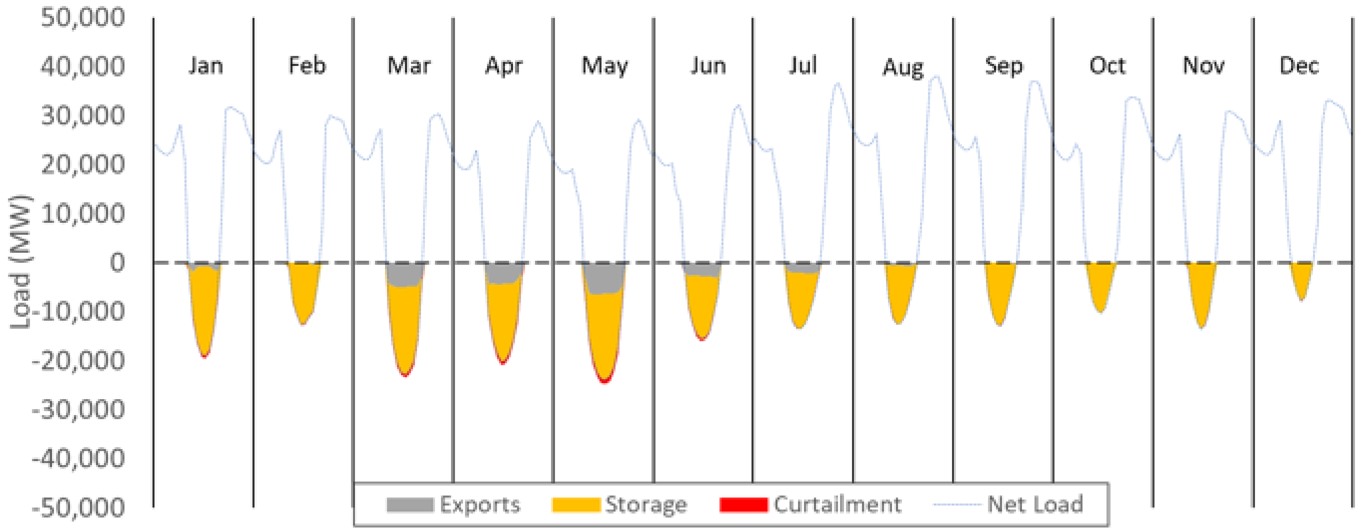
Source: E3's Internal Price Forecasting Model

CA Oversupply (2030)

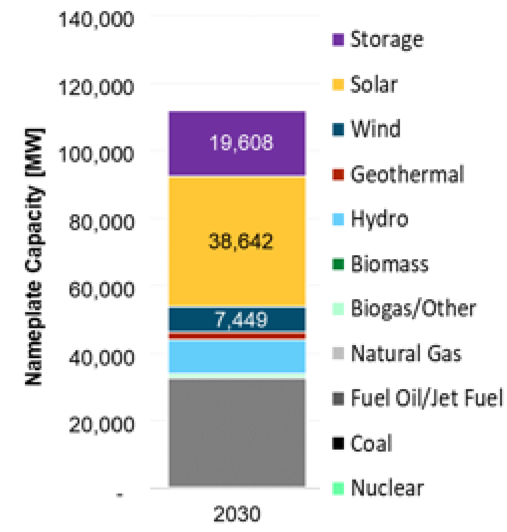
+ E3's modeling shows consistent midday oversupply conditions by 2030

- On average, CA has excess generation for multiple hours per day, every month of the year
- Energy arbitrage value drives increasing levels of storage

Hourly Net Load and Oversupply (monthly average)



Modeled Resource Mix



Oversupply in California in 2030

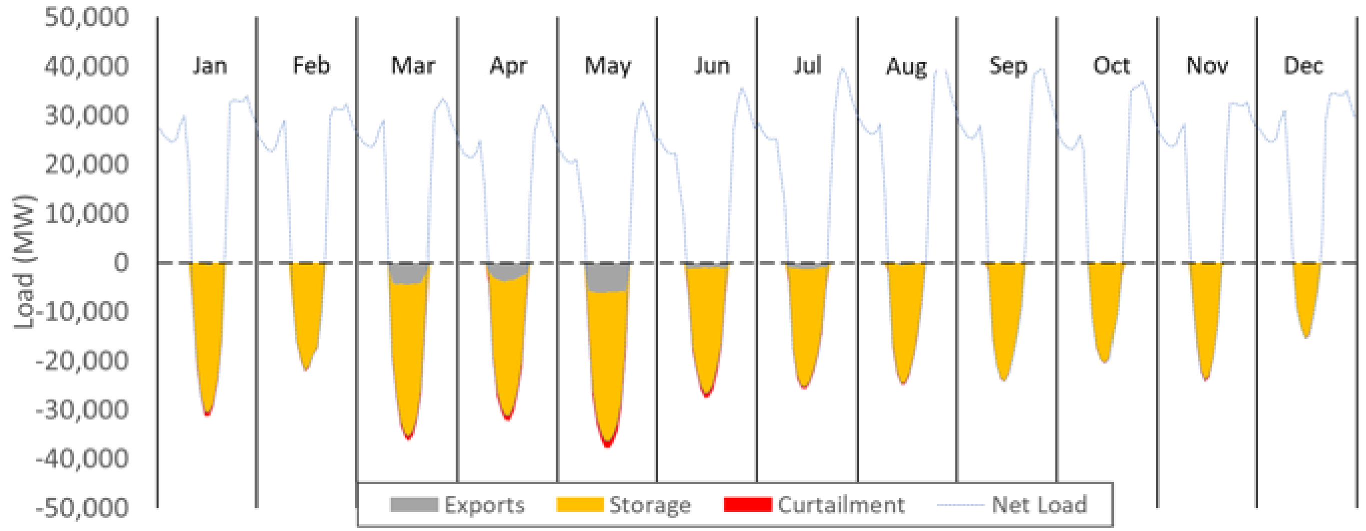
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg Hours/Day	8	8	9	9	10	9	8	7	7	7	7	6	**8**
Avg Oversupply GWh/day	104	70	152	133	181	100	80	66	66	49	62	28	**91**
Total GWh/month	3,237	1,962	4,715	3,977	5,612	3,014	2,485	2,042	1,968	1,513	1,854	864	**33,243**

Source: E3's Internal Price Forecasting Model

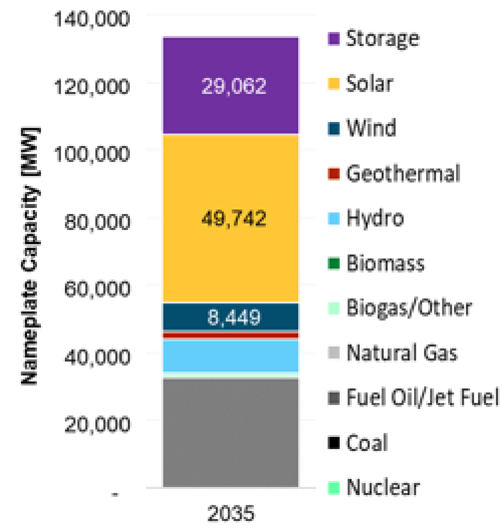
CA Oversupply (2035)

- **E3's modeling shows consistent midday oversupply conditions by 2030**
  - On average, CA has excess generation for multiple hours per day, every month of the year
  - Storage build reaches almost 30 GW

Hourly Net Load and Oversupply (monthly average)



Modeled Resource Mix



Oversupply in California in 2035

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg Hours/Day	8	8	9	10	10	10	10	9	9	8	8	6	**9**
Avg Oversupply GWh/day	185	132	250	224	290	191	177	155	149	115	126	69	**172**
Total GWh/month	5,721	3,687	7,764	6,705	8,991	5,720	5,487	4,803	4,482	3,568	3,770	2,145	**62,845**

Source: E3's Internal Price Forecasting Model

Key Terms & Abbreviations

Key Terms & Abbreviations

- BPA: Bonneville Power Administration
- CAGR: Compound Annual Growth Rate
- CC: Combined Cycle Power Plant
- CCA: Community Choice Aggregator
- CP: Coincident Peak
- DER: Distributed Energy Resource
- ELCC: Effective Load Carrying Capability
- LOLE: Loss of Load Expectation
- LOLP: Loss of Load Probability
- MIC: Maximum Import Capability
- NCP: Non-Coincident Peak
- NWE: NorthWestern Energy
- NWPCC: Northwest Power and Conservation Council
- PNUCC: Pacific Northwest Utilities Conference Committee
- PRM: Planning Reserve Margin
- RECAP: E3's Renewable Energy Capacity Planning Tool (www.ethree.com/recap)
- SCC: Social Cost of Carbon

Thank You

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