Assessing Resource Adequacy in Montana

December 2023

MEBA

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Purpose

This study aims to explore how Montana's resource adequacy risks are evolving in the near-term and mid-term given resource plan uncertainties and evolving regional coordination opportunities such as under the Western Resource Adequacy Program (WRAP)

GridLab is a non-profit organization that provides pro-bono technical assistance to a variety of organizations in the US to support a reliable and affordable electricity sector transition. Resource adequacy is a core focus.

Energy Strategies is an independent energy consulting firm founded in 1986. The firm's markets and transmission practice provides analysis and modeling services to utilities, non-profits, ISOs and other stakeholders with emphasis on the Western US market.

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Prepared for

MEBA

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The project team especially thanks Elaine Hart for support in using the GridPath RA Toolkit; John Fazio for support in analyzing hydro conditions; and Maya McNichol, Rebecca Sexton, and Ryan Roy from the Western Power Pool for understanding how to emulate the WRAP.

Disclaimer: The views in this document do not reflect the Technical Review Committee members' organizations or their individual views.

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Background

- Background: NorthWestern Energy's (NWE) Montana Integrated Resource Plan (IRP) 2023 identifies an "elevated risk" of capacity need in the region
  - Within Montana, NWE observes less capacity need early in the planning period, with that need increasing in the future
  - The IRP identifies WRAP participation, planned resources, resource retirements, and market depth among the major uncertainties impacting resource adequacy in Montana
- How the study analyzes NWE's capacity needs
  - Incorporates NWE's IRP resource portfolio, historic load, and model scenarios to reflect NWE's resource adequacy perspective as a baseline for 2026 and 2030
  - Features load growth and resource trajectories for the rest of the WECC system and emulates the WRAP
  - Includes scenario analysis to understand the magnitude and timing of NWE capacity needs if it leverages the WRAP, with an additional scenario that considers a hypothetically expanded WRAP footprint to include the entire WECC region

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Capacity Position from NWE's 2023 IRP

Figure 6-4. NorthWestern's Winter Capacity with Existing Resources Based on NorthWestern Historical ELCCs

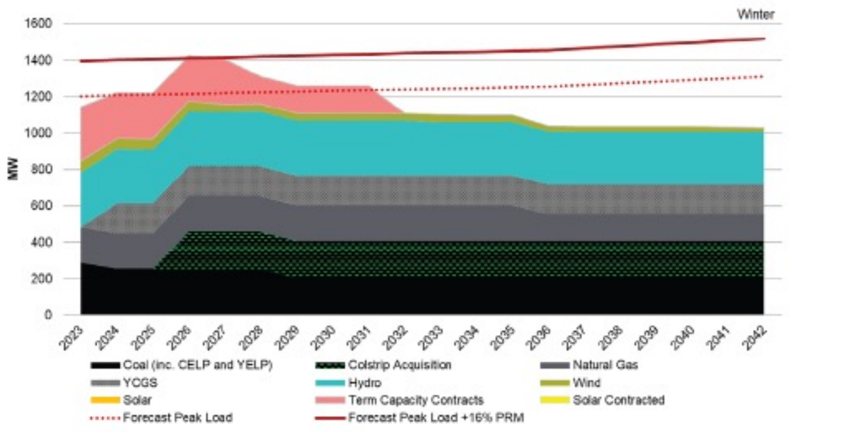
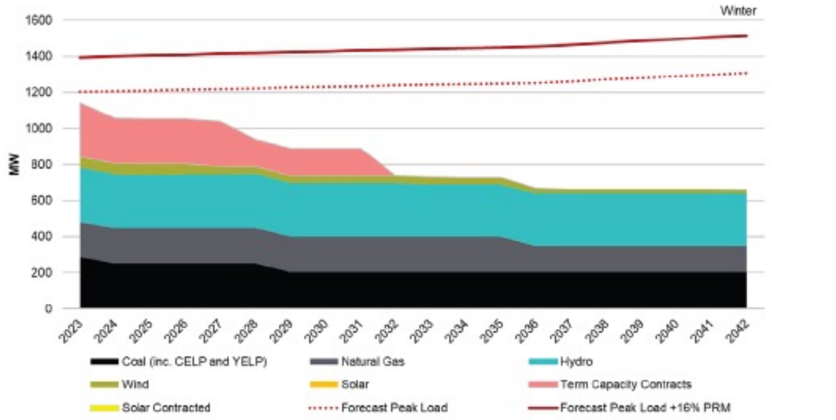


Figure 6-8. NorthWestern's Winter Capacity without YCGS and Colstrip Acquisition, Historical ELCCs



Without YCGS and the Colstrip acquisition, NorthWestern's capacity falls well below the PRM target of 16% in both winter and summer seasons.

https://www.northwesternenergy.com/about-us/gas-electric/electric-supply-resource-procurement-plan/montana-integrated-resource-plan-2023

Study Methodology

- The study uses the GridPath RA Toolkit (Toolkit), an open-source RA analysis modeling tool with a public Western US dataset
  - Considers 14 years of coherent weather data and 20 years of hydro generation data
  - Implements generator outages randomly according to the units forced outage rate
  - Includes both Monte-Carlo based and weather synchronised simulation modes to explore how weather drives RA risk
  - See gridlab.org/GridPathRAToolkit for more details
- In this study, Toolkit inputs and scenarios are tailored to evaluate future resource adequacy in NEW
  - The 2023 NWE IRP informs resource capacities and historical loads: Historical NWE loads, from the IRP, are passed to the Toolkit's load regression model to generate forecasted hourly loads for the study years
  - Non-NWE resource capacities are informed by the 2030 WECC anchor dataset: Historical WECC loads, from FERC-714 filings, are passed to the Toolkit's load regression model to generate forecasted hourly loads
- The study defines Base, WRAP and WRAP+ market footprints for potential RA coordination
  - In the Base scenario, no regional imports are permitted into NWE
  - In the WRAP scenario, regional imports are permitted into NWE from neighbors in the pacific northwest (PNW)
  - The WRAP+ scenario assumes that regional imports are permitted into NWE from all of WECC

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Inputs

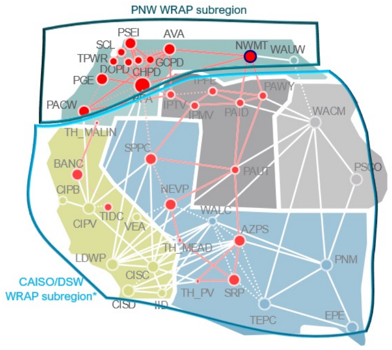
NorthWestern Energy — Delivering a Bright Future: Loads | Resources

WECC — Electric Reliability and Security for the West: Loads | Resources

Data-driven forecasted loads
Benchmarked future resources

Scenarios

WRAP — POWERED BY WPP



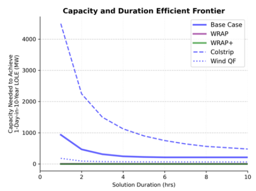
Three coordination footprint scenarios

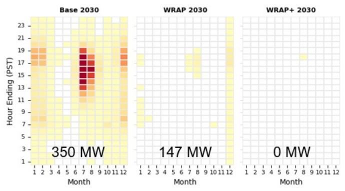
Model

GridPath RA Toolkit

440-year RA simulation

Outputs

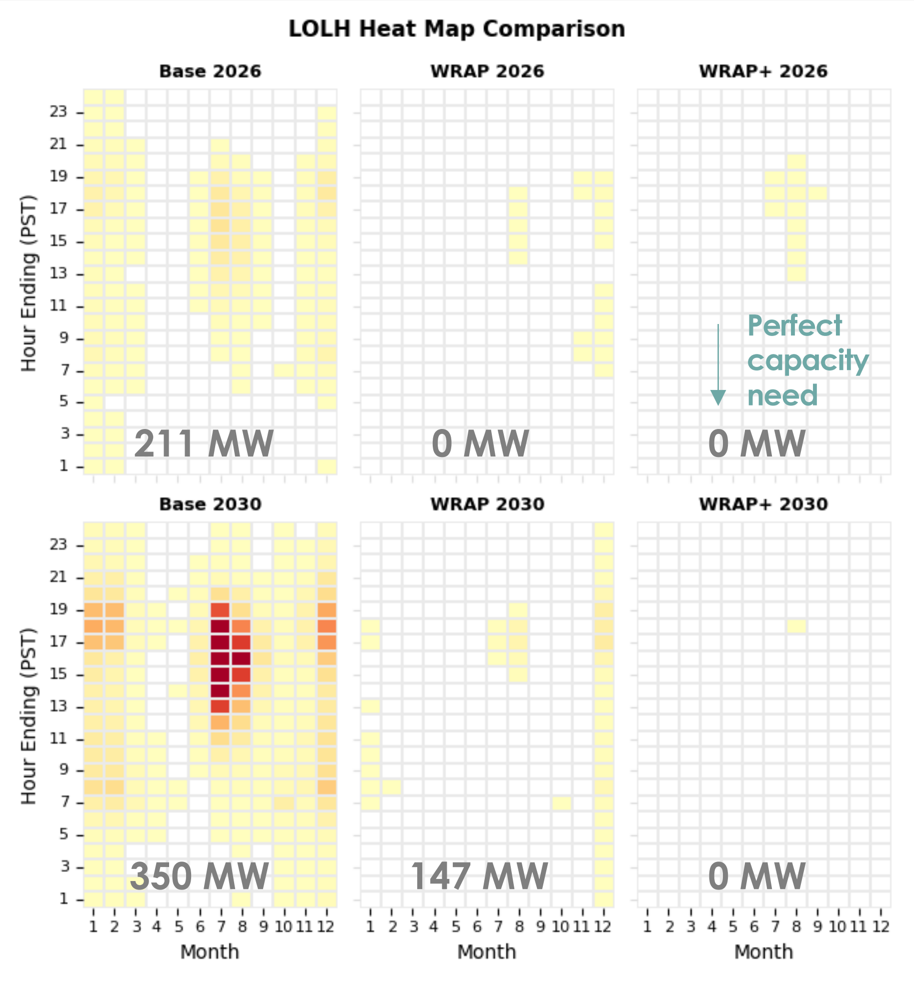




Loss-of-load expectation
Loss-of-load hours
Peak shortage events
Perfect capacity need

Key Study Findings

- NWE's capacity shortfall is likely to grow over time and RA coordination with other PNW and WECC utilities is a viable means to help meet some of those capacity needs
  - Our analysis estimates a Base Case capacity need for NWE of 211 MW in 2026, growing to 350 MW in 2030
  - In both time horizons, our analysis indicates the current WRAP footprint may help reduce that capacity deficit by ~200 MW
- More broadly, regional RA sharing programs that capture load and generation diversity, like WRAP, can significantly reduce the magnitude and timing under which a utility may need to procure capacity
  - This study and NWE's IRP support this finding for Montana
  - As electrification increases demand, the reliability and economic benefits of RA sharing programs are likely to grow
- This work demonstrates the importance of considering regional RA sharing (e.g., WRAP) scenarios in integrated resource planning processes
  - Regional RA sharing scenarios like those considered in this study can help utilities and states navigate policy decisions regarding how to factor in the planning efficiencies offered by these programs
  - The approach that NWE used to explore the impact of RA sharing in its 2023 IRP is a reasonable starting point and provides useful information to decision-makers
- Open-source software like GridPath can be used to inform resource planning efforts in a transparent and sophisticated manner



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Study Setup

Study Steps

1. Develop Models and Datasets

Establish the modeling framework and datasets to represent a "business-as-usual" (BAU) view of the NorthWestern's power supply and resulting resource need with the GridPath RA Toolkit.

2. Base Case Simulations

Analyze NorthWestern's capacity needs under the BAU "island" scenario with limited interaction with neighboring areas using LOLP, LOLE, LOLH, EUE, average event duration & capacity need reliability metrics.

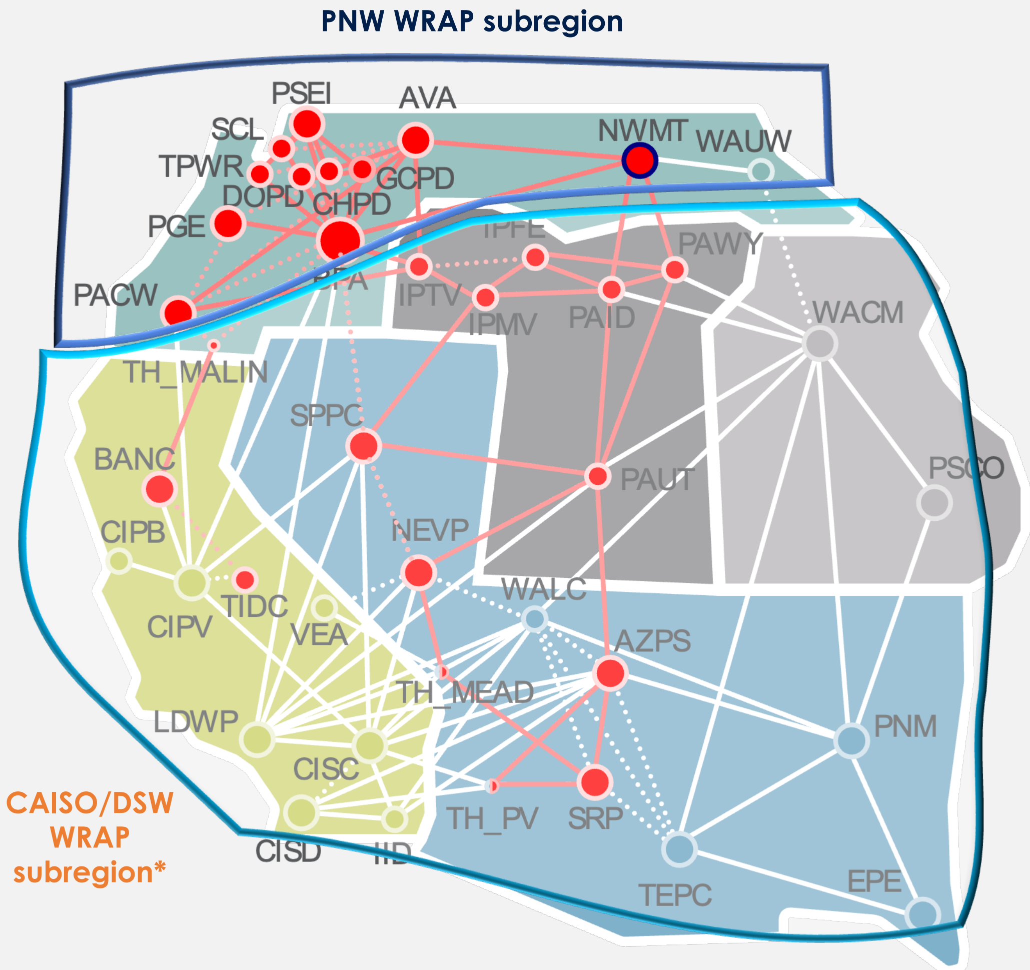
3. Develop & Conduct Scenario Studies

Investigate how NorthWestern's capacity needs are impacted by reliance on planned RA programs (e.g., WRAP) including a WRAP BAU footprint and a hypothetical WECC-wide WRAP footprint.

Study Review

- The base case represents a business-as-usual (BAU) view of NWE capacity needs assuming limited capacity sharing
  - This "island" base case adopts NWE IRP data as a single, self-supplying zone without interchange with neighboring zones
- Additional scenarios explore how the WRAP, a planned resource adequacy program, impacts NWE's capacity needs
  - Definition of WRAP operation and transmission assumptions are sourced from the WRAP detailed design documentation and consultation with the Western Power Pool
  - Transmission assumptions are extrapolated to the Pacific Northwest (PNW) subregion of WRAP and all of WECC in the WRAP+ scenario
    - Within a given WRAP subregion, the study assumes zero transmission constraints
    - Note: The NWE (NWMT) zone is in the Pacific Northwest (PNW) subregion of WRAP
    - Across WRAP subregion seams, the study adopts path transmission capacities consistent with GridPath RA Toolkit
- For all three model scenarios, a Colstrip Early Retirement and Wind Qualifying Facility sensitivities are studied

Core Scenarios	Study Sensitivities
Base Case: NWE Island	• Colstrip Early Retirement • Wind Qualifying Facilities Addition
WRAP: BAU Footprint	• Colstrip Early Retirement • Wind Qualifying Facilities Addition
WRAP+: WECC Footprint	• Colstrip Early Retirement • Wind Qualifying Facilities Addition



*In the WRAP+ scenario, a CAISO/DSW WRAP subregion is assumed to exist, which may not ultimately be consistent with how future WRAP subregions are implemented. The study assumes the CAISO/DSW and PNW subregions have transmission constraints that limit transfers.

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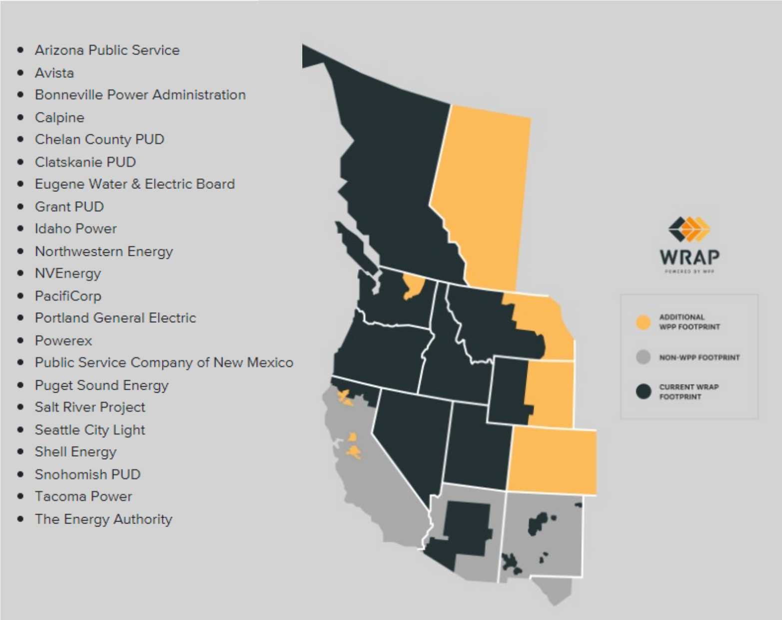
Representing WRAP in GridPath

A critical component of understanding NWE's RA needs is representing the Western Power Pool's WRAP program, which takes advantage of operational efficiencies, diversity of loads, and the sharing of pooled supply resources to improve resource adequacy among participants

The study reflects the WRAP footprint as currently planned per the WPP website:



We reviewed the WRAP detailed design document and engaged WPP staff to arrive at the following modeling assumptions designed to represent planning efficiencies likely to be realized through the WRAP's forward showing program (which is informed by modeling done in this study).

- **Key assumptions include:**
  - WRAP zones – The study assumes NWE enrollment in the WRAP "PNW zone" for purposes of determining reliability metrics (ELCCs, PRMs) for participants. The modeling assumes 0 MW of transmission access to the DSW/East Zone that is anticipated to operate in parallel.
  - Intra-zonal constraints – The study assumes the WRAP PNW zone has no intra-area (inter-participant) constraints (approach from detailed design document is on hold). Therefore, the study assumes PNW zone participants bring sufficient transmission for their resources in program.
  - Inter-zonal constraints – The study assumes no transfer capability between the PNW and DSW/East zone in the WRAP scenario and assumes default GridPath RA Toolkit transmission limits between the "rest of WECC" zone and the PNW in the WRAP+ scenario.
  - Imports – In the WRAP scenario, imports from non-WRAP areas are not allowed. NWE's capacity contracts from such areas are modeled explicitly.

This approach causes each WRAP zone to arrive at a single PRM and single set of reliability metrics. Impacts of the WRAP scenarios to NWE needs are evaluated using the GridPath import functionality.

Reliability Metrics Used in this Study

Metric	What it means…	Common Standard
Loss of Load Probability (LOLP)	Probability of lost load (event). Convention can be in days or years.	Varies. NWPCC uses $LOLP_{year}$ 5%.
Loss of Load Expectation (LOLE)	Expected number of reliability events (shortages) faced over a given time period.	**One-day-in-ten-year – this study generally adopts this planning standard, although others are reported.**
Loss of Load Hours (LOLH)	Expected number of hours per year that face lost load.	24 hours in 10 years, or LOLH of 2.4 hours per year (reinterpretation of LOLE standard)
Expected Unserved Energy (EUE)	Average amount of energy shortages experienced per year. Can be load normalized.	This metric is an assessment of reliability risk and has no common standard but helps shape portfolios and define need.
Average Event Duration	Average number of hours of lost load within a day that experiences lost load. May not be continuous.	
Perfect Capacity Need (PCAP)	Account of perfect capacity need to achieve one-day-in-10-year LOLE standard after considering capacity contributions, forced outages, and additional portfolio effects in analyzing resources and loads. Perfect capacity has no energy limitations, outages, or operational constraints.	Not a standard but does represent the magnitude of RA challenges and facilitates scenario comparisons. Represents MWs of perfectly firm capacity needed to ensure reliability per LOLE metric.

- The CPUC IRP planning process has generated excellent materials that explore these metrics and tradeoffs in resource adequacy modeling approaches. Check out this resource for more info.
- The GridPath RA Toolkit Report contains additional background on metrics. **The definitions above are generally paraphrased from this work to ensure consistency with GridPath functionality/reporting.**

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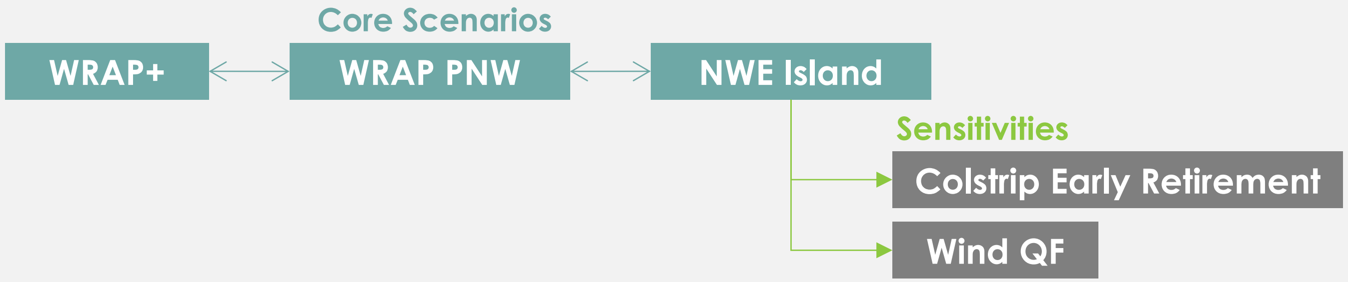
Results for the 2026 analysis

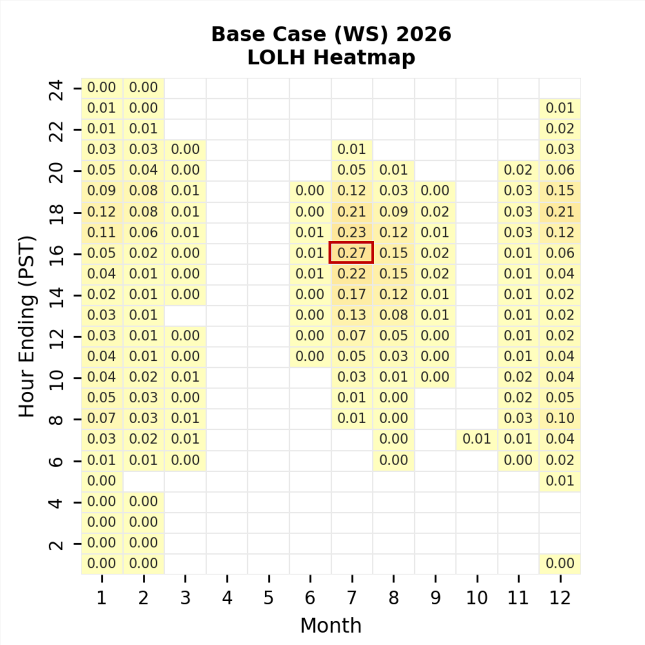
Scenario Descriptions

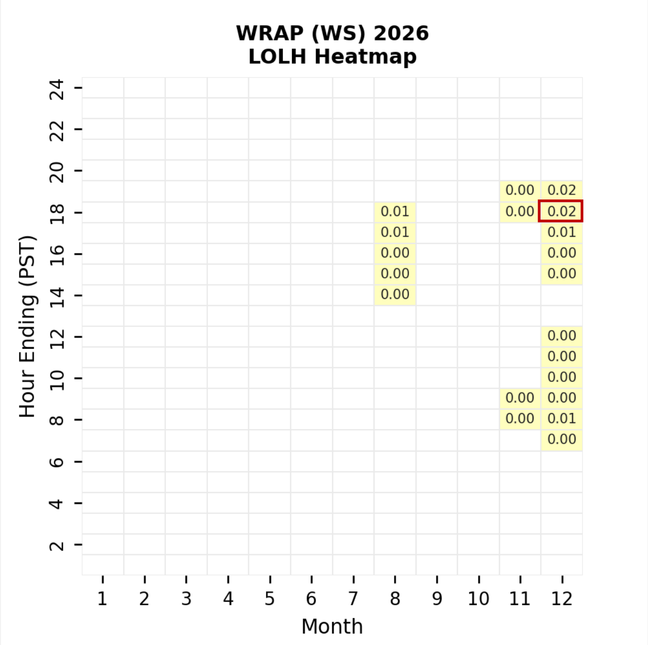
Study Year	Scenarios	Loads and Resources	Transmission / Coordination	Notes
2026	Base Case (NWE as an island)	• NWE retail loads and resources sourced from IRP.	• NWE does not engage in any regional RA coordination • Study captures import of capacity contracts and power purchases from off-system	• Other LSEs in NWMT BA are not included in study footprint, which focuses on NWE load and supply
2026	WRAP (NWE joins PNW WRAP subregion)	• NWE retail loads and resources sourced from IRP. • Other PNW zone loads and resources sourced from GridPath RA Toolkit Study.	• NWE participates in PNW WRAP subregion, which allows for regional RA coordination (imports and resource/load diversity). • Assumes unconstrained transmission capacity within the subregion.	
2026	WRAP+ (NWE joins PNW subregion as part of WECC-wide WRAP program)	• NWE retail loads and resources sourced from IRP. • Other zone loads and resources sourced from GridPath RA Toolkit Study.	• NWE participates in future RA coordination program that includes all Western areas. • Assumes transmission constraints between CAISO/DSW and PNW RA subregions. (consistent with GridPath RA Toolkit)	



2026 Results: Base Case (“Island”) vs WRAP

- **Scenario assumptions**
  - Base Case: No imports or coordination beyond existing capacity contracts
  - WRAP (PNW): NWE may import capacity from PNW subregion of WRAP and benefits from regional load and resource diversity are realized
- **Summary of results**
  - Base Case: Without imports/regional diversity, NWE’s planned system has a 211 MW capacity need and does not meet planning targets
  - WRAP (PNW): LOLE is well under the 1-day-in-10-year standard and planning requirements are met
  - Both scenarios have capacity shortages during summer and winter days: Base Case shortage peaks July 15:00-16:00
  - All but one shortage event avoided due to participation in WRAP
- **Results suggest that WRAP participation could lead to significant planning efficiencies, avoiding 207 MW of capacity that would otherwise need to be built**





Scenario	LOLPyear	LOLE (days per 10 years)	LOLH (hours per year)	EUE (MWh per year)	Average Event Duration (hrs)	Perfect Capacity Need (MW)
Base Case	48%	13.5	5.3	373	3.9	211
WRAP	3%	0.5	0	7	2.3	0

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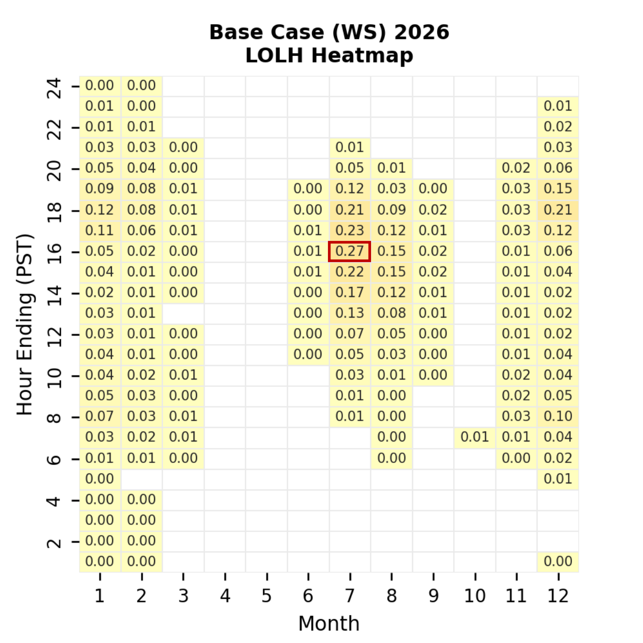
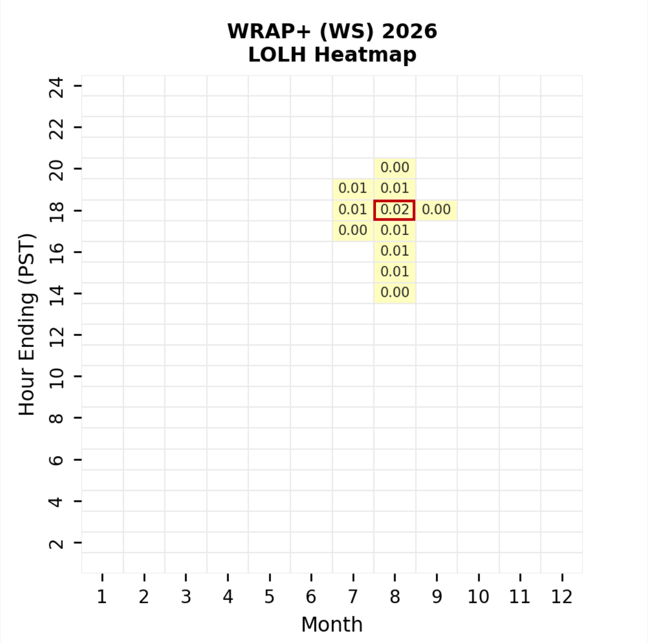
2026 Results: Base Case (“Island”) vs WRAP+

- **Scenario assumptions**
  - Base Case: No imports or coordination beyond existing capacity contracts
  - WRAP+: NWE may import capacity from hypothetical WECC-wide WRAP
- **Summary of results**
  - Base Case: Without imports/regional diversity, NWE’s planned system has a 250 MW capacity need and does not meet planning targets
  - WRAP+: WRAP+ program helps achieve adequate levels of reliability in NWE.
  - Note the inclusion of WRAP+ import helped cover all of the winter shortage events.
- **WRAP+ scenario demonstrates, even with the larger footprint and capacity needs of CAISO/DSW, NWE maintains the LOLE 1-day-in-10-year standard and avoids the 210 MW of otherwise needed capacity**





Scenario	$LOLP_{year}$	LOLE (days per 10 years)	LOLH (hours per year)	EUE (MWh per year)	Average Event Duration (hrs)	Perfect Capacity Need (MW)
Base Case	48%	13.5	5.3	373	3.9	211
WRAP+	3%	0.5	0.1	9	2.2	0

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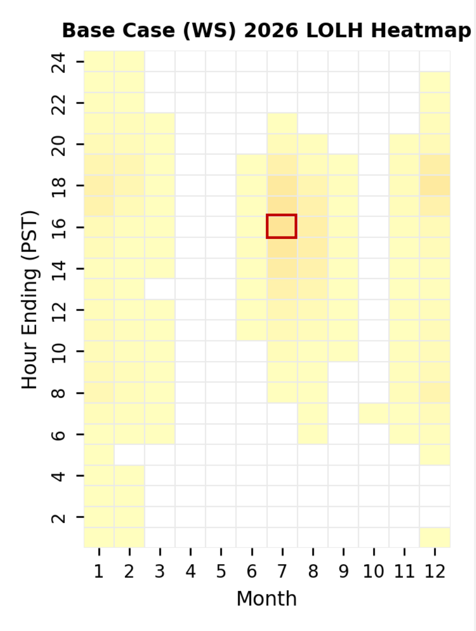
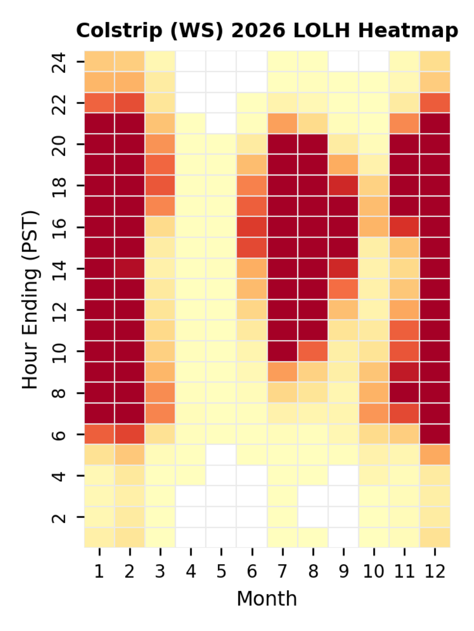
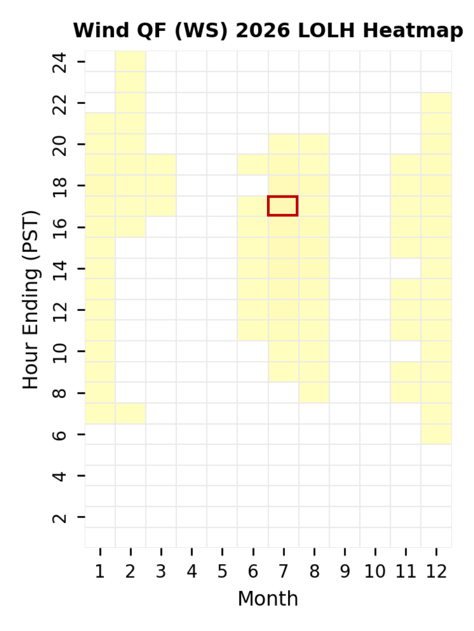
2026 Scenario Results: Base Case vs. Sensitivities

- **Resource Sensitivities**
  - Base Case: Resource plan matches IRP resources
  - Colstrip Early Retirement: Current capacity and planned acquisition of additional capacity from Colstrip is not included (i.e., 444 MW less capacity than the Base Case)
  - Wind QF: Adds additional Wind+Battery Hybrid Qualifying Facilities from NWE IRP to resource mix (Additional 220 MW of wind and 100 MW of 4-hr batteries)
- **Summary of results**
  - The Colstrip Early Retirement sensitivity shows an increase in LOLE across more hours and results in a greater capacity shortfall
  - Alternatively, the Wind QF sensitivity demonstrates the potential for hybrid facilities to support resource adequacy in place of conventional resources – adding this resource reduces NWE's capacity need by ~150 MW



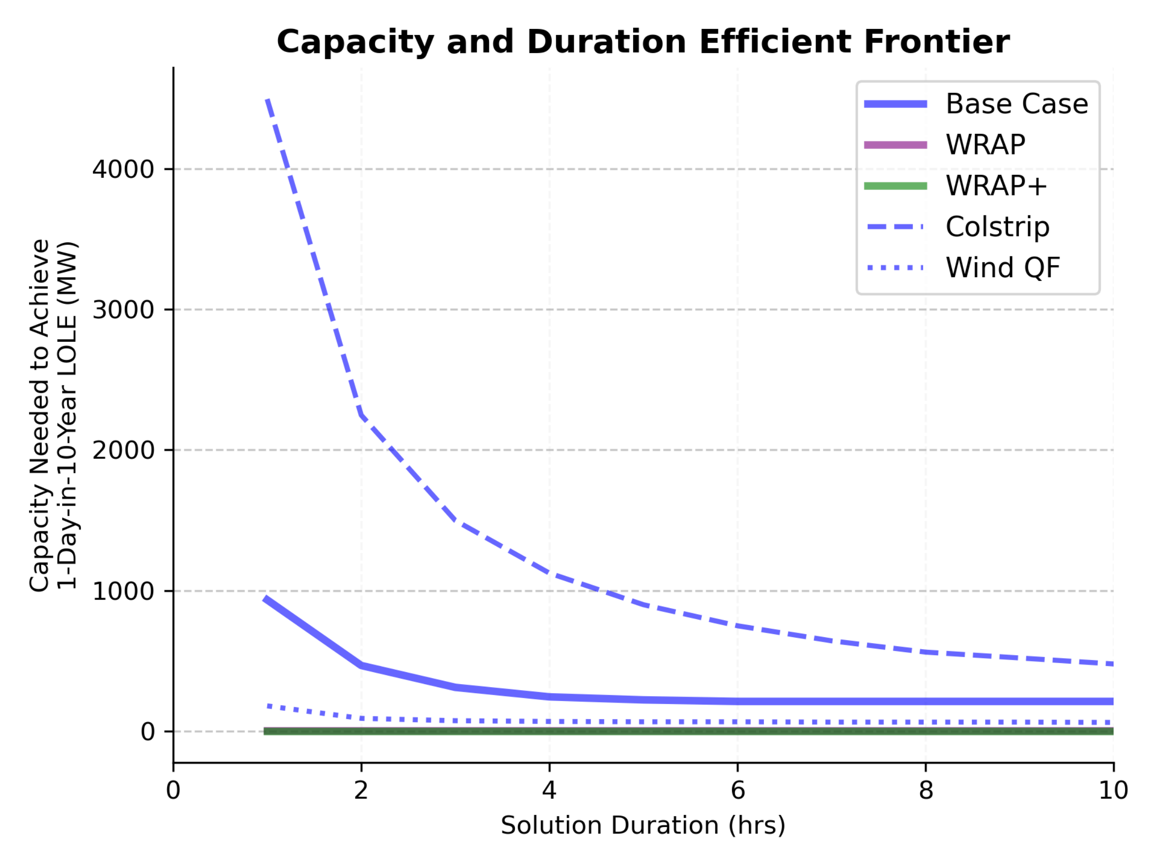




Scenario/ Sensitivity	$LOLP_{year}$	LOLE (days per 10 years)	LOLH (hours per year)	EUE (MWh per year)	Average Event Duration (hr)	Perfect Capacity Need (MW)
Base Case	48%	13.5	5.3	373	3.9	211
Colstrip	100%	664.1	386.3	31,694	5.8	437
Wind QF	17%	2.4	1.0	66	4.3	62

Summary of 2026 Scenario and Sensitivity Results

Scenario	$LOLP_{year}$	LOLE (days per 10 years)	PCAP (MW)
Base Case	48%	13.5	211.3
→ Colstrip	100%	664.1	436.7
→ Wind QF	17%	2.4	61.8
WRAP	3%	0.5	0
WRAP+	4%	0.5	0



- RA Solution Needs
  - New resources considered to fill the LOLE gap must provide both capacity and duration to adequately solve RA needs.
  - The loss of Colstrip significantly impacts both the magnitude and duration of shortages.
  - The inclusion of regional imports tends to reduce the duration of shortage and the need for longer duration solutions: **Ignoring regional imports, may lead to suboptimal RA solutions and significant overbuilds.**

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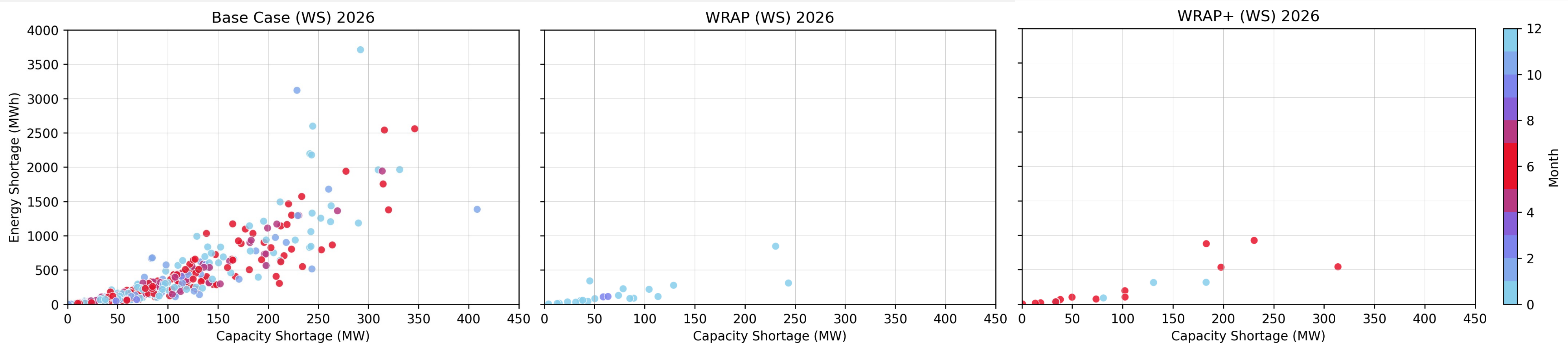
Additional Analyses for 2026

2026 Outage Event Energy / Capacity

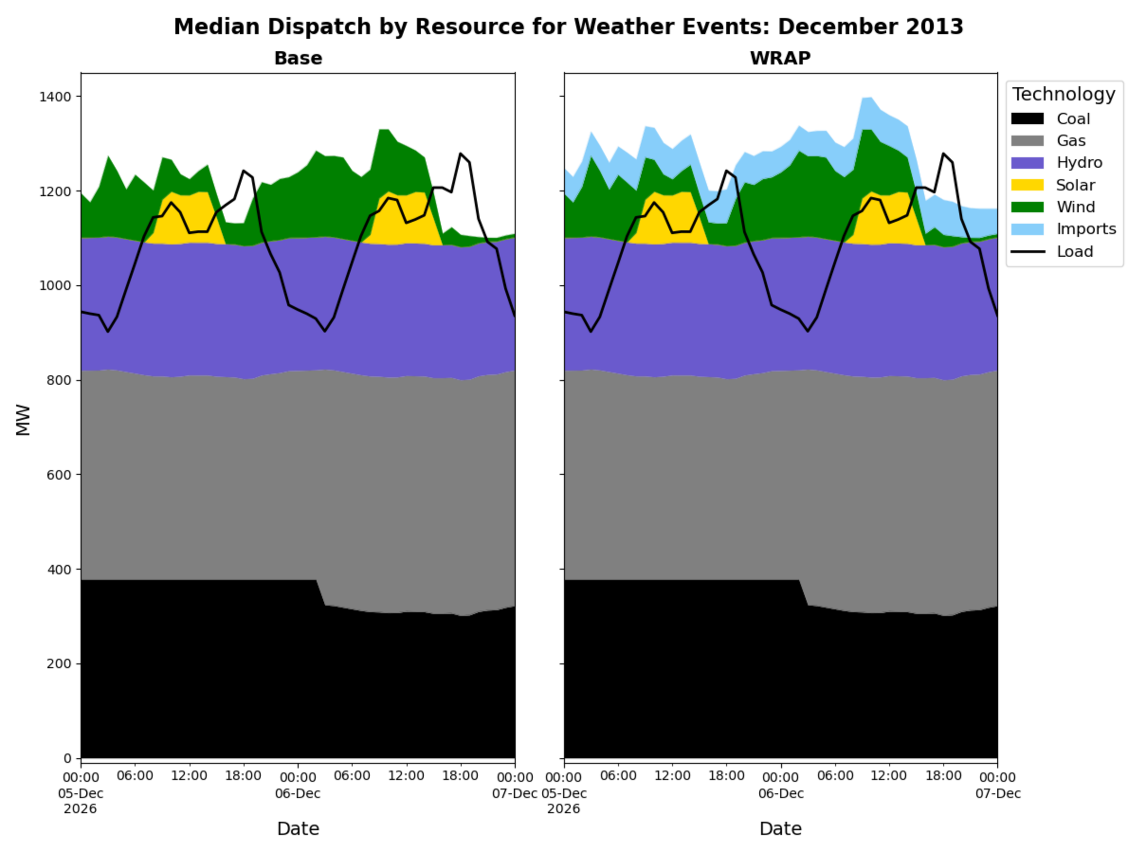


- **The seasonality of shortage events evolves as the RA coordination footprint changes**
  - On average, Base Case shortages are approximately 2.4 hours and occur in July.
    - All months' exhibit at least 1 shortage event except April & May.
    - The seasonal nature of shortage events is most variable under the Base Case.

- **Adopting regional imports under the WRAP (PNW subregion) or WRAP+ (WECC-wide) illustrates the seasonal nature of regional import availability**
  - On average, WRAP Case shortages are approximately 1.9 hours and occur in November.
    - Heating demands in the PNW region compete for regional import availability into NWE during the winter.
  - On average, WRAP+ Case shortages are approximately 1.7 hours long and occur in July.
    - Alternatively, cooling demands in the desert-southwest and CAISO subregions that comprise the addition to WRAP+ limit regional import availability into NWE during the summer.
  - Note: 2026 results are depicted here as the seasonal nature of shortage events is less pronounced in the 2030 results as 2030 overall results in many fewer shortage events in the WRAP and WRAP+ scenarios.

Resource Dispatch Capacity Under Extreme Weather

- **Extreme weather increasingly drives severe shortage events**
  - In this study, shortage events occurred most often with weather samples drawn between December 5 – 10th of 2013.
  - The historical record confirms this as a period of extreme cold in NWE territory.
    - The high temperature on Dec 6 was –2°F.
- **Isolating dispatch capacities for Dec 5 – 6 dates illustrate how hourly loads could be served by the system**
  - In the Base Case (or NWE island), a shortage event of approximately 200 MW is experienced in the afternoon on Dec 6. Dec 5 experiences a smaller shortage.
  - With the benefit of regional imports from WRAP coordination, this extreme shortage is reduced by about 50% and the Dec 5 shortage is nearly eliminated.



Results for the 2030 analysis

Scenario Descriptions and Adjustments for 2030

Study Year	Scenarios	Loads and Resources	Transmission / Coordination	Notes
2030	**Base Case** (NWE as an island)	• NWE retail generation resources sourced from IRP plans.	• NWE does not engage in any regional RA coordination • Study captures import of capacity contracts and power purchases from off-system	• Other LSEs in NWMT BA are not included in study footprint, which focuses on NWE load and supply. • 2030 forecasted loads do not account for additional electrification.
2030	**WRAP** (NWE joins PNW WRAP subregion)	• NWE retail generation resources sourced from IRP plans. • Other zone loads developed for this study according to GridPath RA Toolkit forecasting process. • Other zone resources sourced from the 2030 WECC Anchor Data Set (ADS).	• NWE participates in PNW WRAP subregion, which allows for regional RA coordination (imports and resource/load diversity). • Assumes unconstrained transmission capacity within the subregion.	• 2030 forecasted loads do not account for additional electrification.
2030	**WRAP+** (NWE joins PNW subregion as part of WECC-wide WRAP program)	• NWE retail generation resources sourced from IRP plans. • Other zone loads developed for this study according to GridPath RA Toolkit forecasting process. • Other zone resources sourced from the 2030 WECC ADS.	• NWE participates in future RA coordination program that includes all Western areas. • Assumes transmission constraints between CAISO/DSW and PNW RA subregions. (consistent with GridPath RA Toolkit)	• 2030 forecasted loads do not account for additional electrification.

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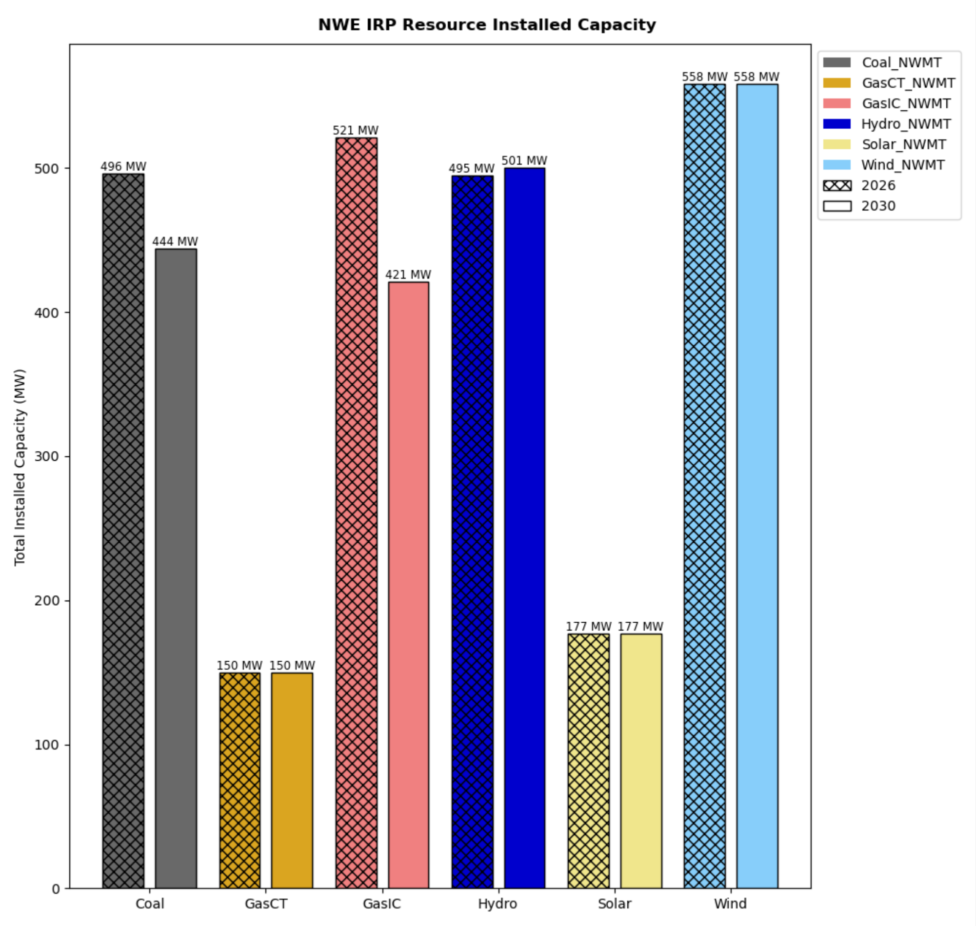
NWE 2030 Load and Resources

- Resource capacities drawn from NWE IRP
  - Unit-level capacities are specified for Coal, Natural Gas, and Wind resources
  - Hydro and Solar unit-level capacities are totaled to define aggregate resources
    - Note: Generation potential for hydro and solar are driven by Run-of-River and Irradiance shapes
    - By 2030 NWE IRP retires 46 MW of resources and ends 100 MW capacity contracts (modeled as a firm Gas IC resource), in total a **6% decrease in resource** capacity from 2026
- Load for 2030 forecasted according to GridPath RA Toolkit methodology
  - Methodology:
    - Bin historical load by month, hour, and day type
    - Build a regression model based on daily weather data and annual economic data for the load in each bin
    - Forecast hourly load in a future year informed by the forward-looking economic data
  - Given this 2030 load forecast methodology, winter peak load increases by 1% (14 MW) and the **summer peak load increases by 5%** (64 MW) over 2026 load values



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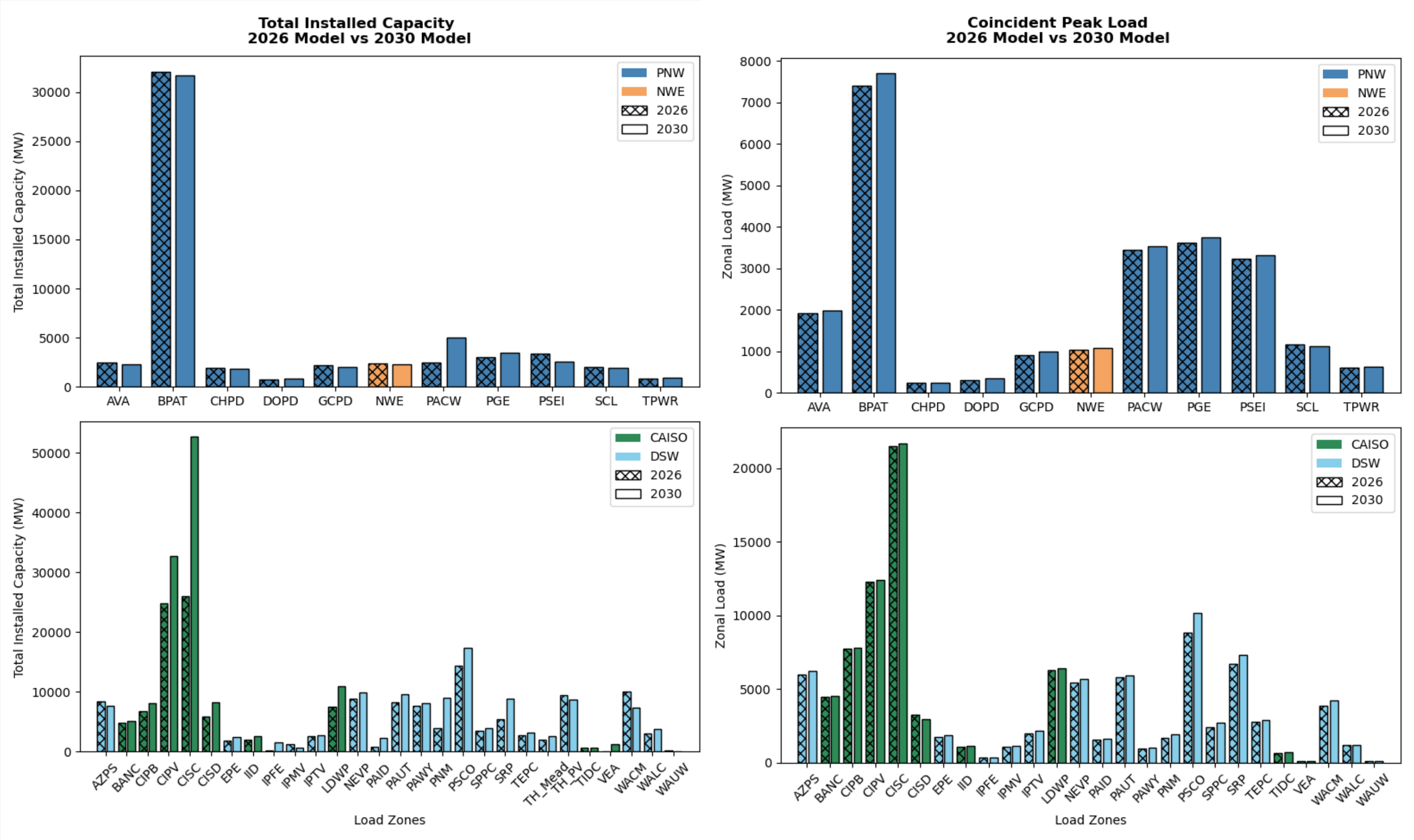
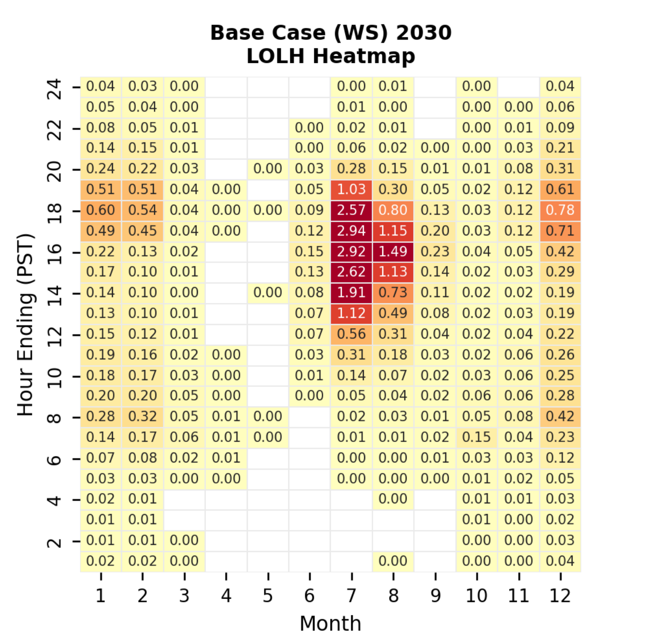
Non-NWE 2030 Load and Resources

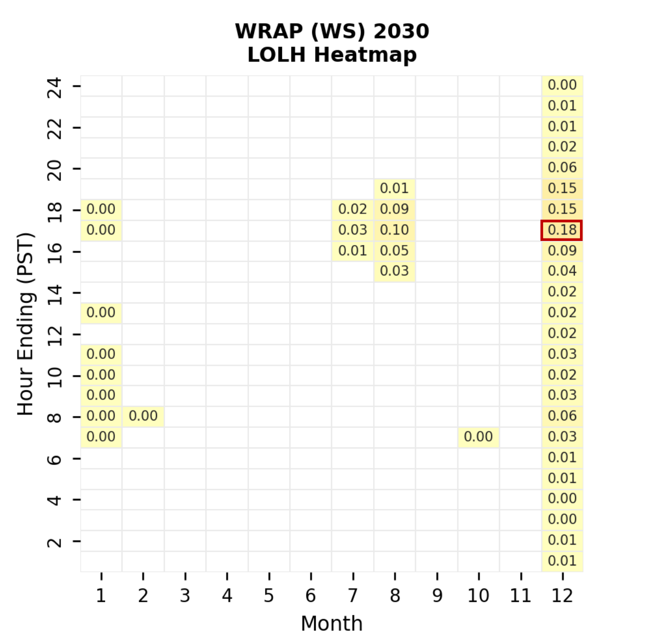
- Zonal resource capacities sourced from 2030 WECC ADS
  - Generation units are aggregated by resource type and introduced into the GridPath RA Toolkit inputs
    - Installed capacity **increases by 27% (60.6 GW)** from 2026 to 2030 across WECC
    - Of that increase, 43.7 GW is within the CAISO subregion, 15.4 GW is within the DSW subregion, and 1.5 GW is within the PNW subregion
- Zonal loads are developed according to the GridPath RA Toolkit load forecasting method based on the 2026 Toolkit data
  - WECC-wide coincident peak load **increases by 3.9% (5.2 GW)** from 2026 to 2030
  - 78% of that load increase occurs in the DSW subregion:
    - DSW: 4057 MW
    - CAISO: 354 MW
    - PNW: 795 MW
    - NWE: 39 MW



2030 Results: Base Case ("Island") vs WRAP

- Scenario assumptions
  - Base Case: No imports or coordination beyond existing capacity contracts
  - WRAP (PNW): NWE may import capacity from PNW subregion of WRAP and benefits from regional load and resource diversity are realized
- Summary of results
  - Base Case: Without imports/regional diversity, NWE's planned system has a 350 MW capacity need and does not meet planning targets
  - WRAP (PNW): LOLE is close to the 1-day-in-10-year standard, but still fails to meet planning targets
  - Both scenarios have capacity shortages during the summer and winter evenings
    - Base Case peak shortage occurs in July 16:00-17:00
    - WRAP peak shortage occurs in Dec 17:00-18:00
- **Results suggest that WRAP participation could lead to significant planning efficiencies, avoiding 204 MW of capacity that would otherwise need to be built to meet planning standards**





Scenario	$LOLP_{year}$	LOLE (days per 10 years)	LOLH (hours per year)	EUE (MWh per year)	Average Event Duration (hr)	Perfect Capacity Need (MW)
Base Case	97%	103.3	41.2	3,210	4.0	350
WRAP	21%	4.3	1.4	107	3.2	147

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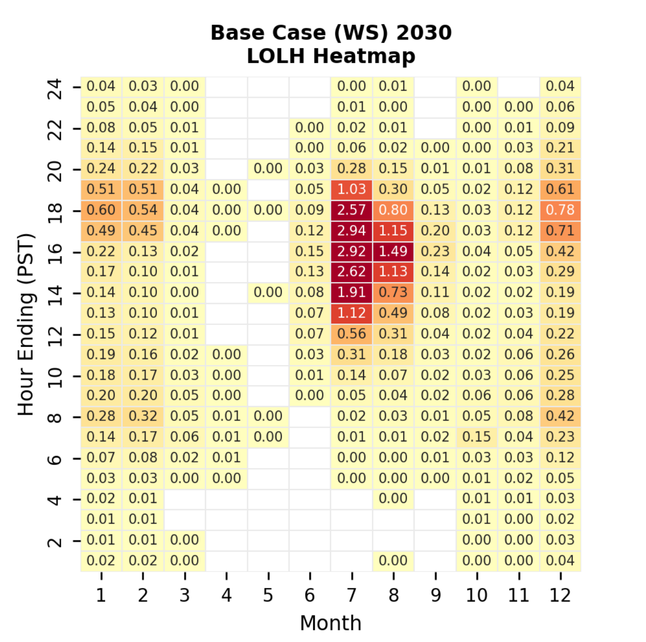
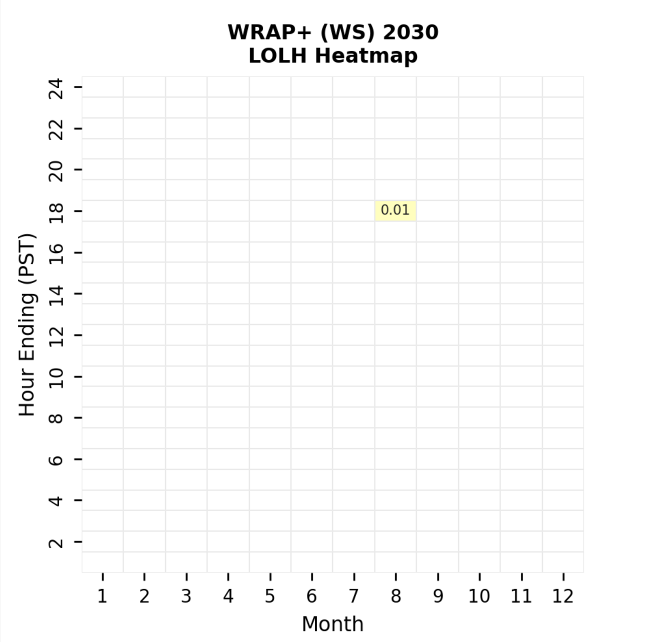
2030 Results: Base Case (“Island”) vs WRAP+

- Scenario assumptions
  - Base Case: No imports or coordination beyond existing capacity contracts
  - WRAP+: NWE may import capacity from hypothetical WECC-wide WRAP
- Summary of results
  - Base Case: Without imports/regional diversity, NWE’s planned system has a 350 MW capacity need and does not meet planning targets
- WRAP+: Regional imports helps achieve adequate levels of reliability in NWE by a wide margin
  - Over the 440 simulated weather-synch years the model experienced fewer than 44 shortage events (1 day in 10 years) leading to a LOLE less than 1.0 and PCAP need of 0 MW
- **Results suggest that WRAP+ participation could lead to significant planning efficiencies, avoiding 350 MW of capacity that would otherwise need to be built**





Scenario	$LOLP_{year}$	LOLE (days per 10 years)	LOLH (hours per year)	EUE (MWh per year)	Average Event Duration (hr)	Perfect Capacity Need (MW)
Base Case	97%	103.3	41.2	3,210	4.0	350
WRAP+	1%	0.1	0.0	0	1.0	0

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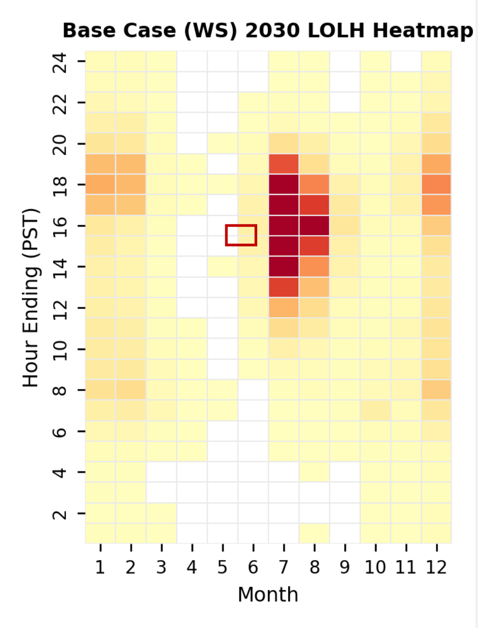
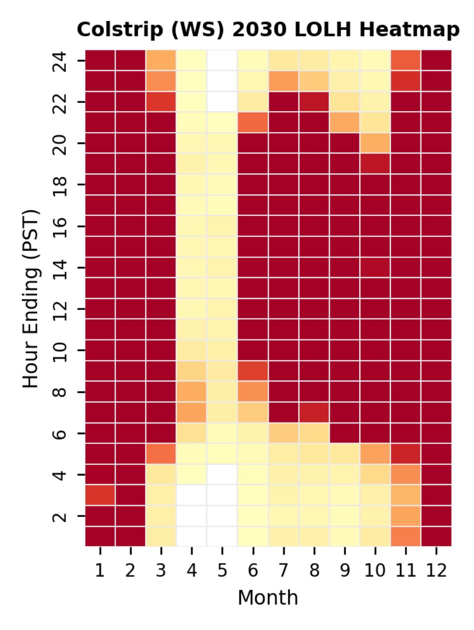
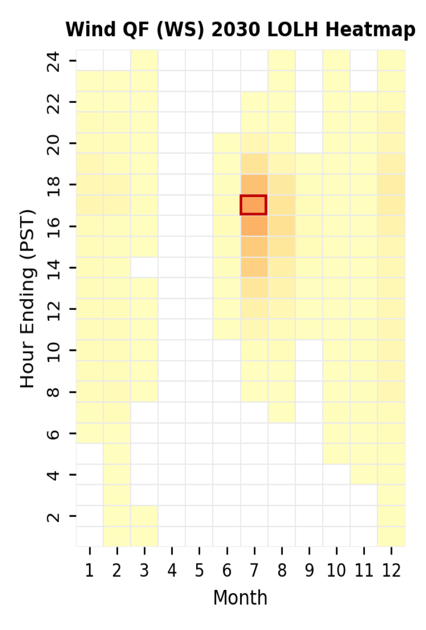
2030 Scenario Results: Base Case vs. Colstrip & Wind Sensitivities

- **Resource Sensitivities**
  - Base Case: Resource plan matches IRP resources
  - Colstrip Early Retirement: Current capacity and the planned acquisition of additional capacity from Colstrip are not included (i.e., 444 MW less capacity than the Base Case)
  - Wind QF: Adds additional Wind+Battery Hybrid Qualifying Facilities from NWE IRP to resource mix
    - Additional 220 MW of wind and 100 MW of battery (4-hrs)
- **Summary of results**
  - The Colstrip Early Retirement sensitivity shows an increase in LOLE across more hours and results in a greater capacity shortfall
  - Alternatively, the Wind QF sensitivity demonstrates the potential for hybrid facilities to support resource adequacy in place of conventional resources – adding this resource reduces NWE's capacity need by ~134 MW







Scenario/ Sensitivity	LOLPyear	LOLE (days per 10 years)	LOLH (hours per year)	EUE (MWh per year)	Average Event Duration (hr)	Perfect Capacity Need (MW)
Base Case	97%	103.3	41.2	3,210	4.0	350
Colstrip	100%	1,562.1	1,279.6	157,055	8.2	602
Wind QF	59%	20.0	8.1	649	4.0	216

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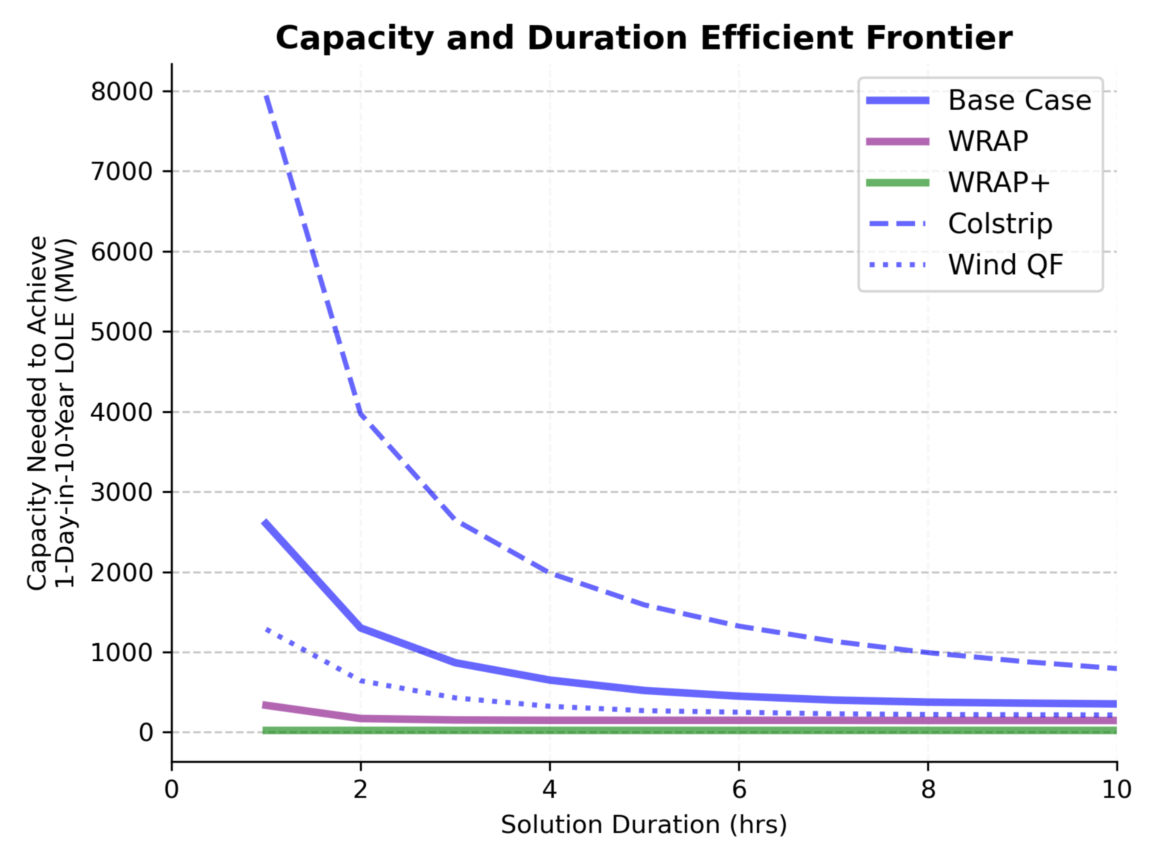
Summary of 2030 Scenario and Sensitivity Results

Scenario	$LOLP_{year}$	LOLE (days per 10 years)	PCAP (MW)
Base Case	97%	103.3	350.1
→ Colstrip	100%	1562.1	602
→ Wind QF	59%	20.0	216
WRAP	21%	4.3	146.5
WRAP+	1%	0.1	0.0

- **New resources considered to fill the reliability gap must provide both capacity and energy to adequately solve RA needs**
- **Overall, RA needs increase significantly in 2030, but follow the same trends illustrated in 2026**
  - Namely, resource adequacy analysis that treats subareas or RA programs as islands can distort the observed RA challenges and may lead to suboptimal RA solutions



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Comparison of 2026 and 2030 Results

2026 Recap

- 2026 results show that coordination of RA over an increasing regional footprint provides reliability benefits to NWE
  - Peak shortage seasons shift in response to import availability over predominately winter peaking (PNW) and summer peaking (desert southwest) regions
  - Colstrip retirement increases reliability risk significantly
    - Measures to add qualifying facilities or adopt regional capacity sharing play a role in mitigating this risk.

2026 Study Results

Scenario	Peak Shortage Hour	LOLE (days per 10 years)	Perfect Capacity Need (MW)
Base Case	Jul. 15:00	13.5	211
WRAP	Dec. 18:00	0.5	0
WRAP+	Aug. 17:00	0.4	0

2030 Takeaways

- In 2030, NWE loads increase by 5% (peak) and resource capacities decrease by 6%
  - Across WECC, outside of NWE, coincident peak load increased by 3.9% and installed capacity increased by 27%
- 2030 results are consistent with those found in 2026, with the benefits of RA coordination resulting in even more pronounced impacts on resource planning, potentially helping to avoid procurement or construction of significant new capacity
  - Coordination over increasing regional footprints continues to demonstrate significant reliability benefits for NWE
  - Benefits are realized through a combination of both resource diversity and load diversity
  - This study does not consider load electrification that may occur by 2030 and therefor and may understate RA benefits
  - Participation in RA coordination programs does not preclude LSEs from developing local capacity to further reduce their own loss-of-load risks
  - However, utilities should consider RA coordination in IRP proceedings to achieve reliable, lowest-cost planning