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

May 9, 2023

MEMORANDUM

TO: **Council Members**

FROM: **Dor Hirsh Bar Gai and Dan Hua**

SUBJECT: **Multi-Metric Approach to Adequacy: Progress Report**

BACKGROUND:

Presenters: Dor Hirsh Bar Gai and Dan Hua

Summary: Staff will review progress on evaluating the thresholds for the proposed multi-metric adequacy standard. Since releasing the 2027 Adequacy Assessment in January 2023 with provisional threshold ranges, staff have developed an engagement strategy with the region to determine appropriate and precise values. The leading approach is to quantify the aggregate regional emergency capabilities as an indicator for the potential thresholds. Engagement efforts started in March 2023 and will be ongoing until mid-2025 to provide a recommendation for the next Power Plan.

Relevance: The Council is required to develop a 20-year power plan that ensures an adequate, economical, efficient, and reliable power supply. Over the last several years, the Council has been moving towards a new approach to assess adequacy; one that accounts for the frequency, magnitude, and duration of events. Staff is currently working with the region to determine the appropriate level of risk across these metrics. This approach will better enable the Council to assess regional adequacy and develop the next power plan.

Workplan: B.2.3 Refine new multi-metric adequacy standard approach, focusing on risk thresholds.

Background: In January 2023 the Council approved a transition towards a multi-metric approach for characterizing system adequacy with the completion of the 2027 Adequacy Assessment. The objectives of this new standard include (1) preventing overly frequent use of emergency measures, (2) limiting the risk of long duration shortfall events, (3) limiting the risk of big capacity shortfalls, and (4) limiting the risk of big energy shortfalls. To achieve these objectives, the Council proposed utilizing frequency, duration and magnitude metrics based on a combination of expected and tail-end event statistics, known as value at risk (VaR). Given the transitional nature of exploring new adequacy standards, the Council is currently evaluating provisional ranges for each metric. The next phase for the Council is to collaborate with regional utilities and stakeholders to evaluate and determine precise and appropriate regional adequacy thresholds.

While the 5% loss of load probability (LOLP) corresponds to an acceptable shortfall risk threshold of one-in-20 years, the proposed risk threshold for the duration and magnitude metrics corresponds to one-in-40 years; in other words, achieving a power system that limits the occurrence of long duration and big magnitude (capacity and energy) events to not more than once-in-40 years. The task at hand is to determine what appropriate and precise emergency capabilities are acceptable for this risk.

The process to determine precise non-range metric thresholds is fluid and will evolve over time. To align with the work plan, a recommendation for the thresholds will be provided by mid-2025, in preparation for the next Power Plan. An interim limit (non-range) will be recommended by April/May 2024 in time for the next adequacy assessment scheduled for June 2024.

Multi-Metric Approach to Adequacy

Progress Report

Dan Hua & Dor Hirsh Bar Gai
May 2023

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Outline

- Adequacy and Shortfalls
- The Proposed Metrics
- Approach to setting the thresholds
- Engagement Strategy and Status
- Preliminary Findings
- Next steps

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Adequacy and Shortfalls

- Adequacy studies simulate the NW power system to meet NW load
- In each simulation, representing one year, a shortfall event occurs over a time period when load cannot be served by available generating resources
- However, a shortfall in the model **does not** necessitate an actual curtailment
  - Rather, it signals non-modeled emergency measures are necessary to avoid curtailment:

Type 1: Within utility control-
"you might not lose your job if this happens"

- High operating cost resources not in utility's active portfolio
- High-priced market purchases over max import limits
- Load buy-back provisions
- Industry backup generators

Type 2: Extraordinary measures-
"you will likely lose your job if this happens"

- Official's call for conservation
- Reduce less essential public load (e.g., gov't buildings, streetlights, etc.)
- Utility emergency load reduction protocols
- Curtail F&W hydro operations

- Adequacy metrics evaluate shortfalls to inform risk of using emergency measures

Proposed Metrics

Frequency metric

- ***LOLEV*** *– Prevent overly frequent use of emergency measures*
  - Expected number of shortfall events/year, counting all shortfall events
  - Adequacy Limit = Provisional threshold of 0.1 or 0.2 shortfall events/year

Duration metric

- ***Duration VaR$_{97.5}$*** *– Limit the risk of long shortfall events to 1/40 years*
  - Longest shortfall event for the 97.5th worst simulation year
  - Adequacy Limit = Provisional threshold of 8 to 12 hours (e.g., start of a cold snap or heat wave)

Magnitude metrics

- ***Peak VaR$_{97.5}$*** *– Limit the risk of big capacity shortfalls to 1/40 years*
  - Highest single-hour shortfall for the 97.5th worst simulation year
  - Adequacy Limit = Provisional threshold of 2,000 to 3,000 MW
  - Limit set to aggregate emergency capacity or acceptable amount of single-hour demand at risk
- ***Energy VaR$_{97.5}$*** *– Limit the risk of big energy shortfalls to 1/40 years*
  - Total annual shortfall energy for the 97.5th worst simulation year
  - Adequacy Limit = Provisional threshold of 4,000 to 8,000 MWh
  - Limit set to aggregate emergency energy or acceptable amount of annual energy demand at risk

Shortfall Events for One Simulation Year

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
12 AM							
1 AM							
2 AM							
3 AM							
4 AM							
5 AM							
6 AM							
7 AM							
8 AM							
9 AM							
10 AM							
11 AM							
12 PM							
1 PM							
2 PM							
3 PM							
4 PM							
5 PM							
6 PM							
7 PM							
8 PM							
9 PM							
10 PM							
11 PM							

Western Resource Adequacy Program (WRAP):

Though Saturday has two events, it is considered 1 event-day.

Therefore, for this simulation Event-Day = 4

- In this illustrative example, all shortfalls (*pink boxes*) take place in a week (*for simplicity*)
- A shortfall event is a set of contiguous hours with shortfall
- For the event metric, we calculate the ***sum*** of all events: ***5*** shortfall ***events***

Illustrative purposes only

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Shortfall Durations for One Simulation Year

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
12 AM							
1 AM							
2 AM							
3 AM							
4 AM							
5 AM							
6 AM							
7 AM			2 hour duration				
8 AM							
9 AM							
10 AM							
11 AM		5 hour duration					
12 PM							
1 PM							
2 PM							
3 PM					14 hour duration		
4 PM							
5 PM							1 hour duration
6 PM							
7 PM							
8 PM							1 hour duration
9 PM							
10 PM							
11 PM							

- For the duration metric, we calculate the ***maximum*** duration of all events: ***14 hours***

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Shortfall Capacity for One Simulation Year

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
12 AM							
1 AM							
2 AM							
3 AM							
4 AM							
5 AM					200 MW		
6 AM			800 MW		400 MW		
7 AM			900 MW		600 MW		
8 AM		100 MW			1200 MW		
9 AM		300 MW			2000 MW		
10 AM		700 MW			2500 MW		
11 AM		200 MW			300 MW		
12 PM		200 MW			700 MW		
1 PM					100 MW		
2 PM					200 MW		
3 PM					500 MW		
4 PM					300 MW		
5 PM					700 MW		400 MW
6 PM					100 MW		
7 PM							
8 PM							100 MW
9 PM							
10 PM							
11 PM							

- For the capacity metric, we calculate the ***maximum*** capacity of all shortfalls: ***2500 MW***

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Annual Shortfall Energy for One Simulation Year

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
12 AM							
1 AM							
2 AM							
3 AM							
4 AM							
5 AM					200 MW		
6 AM			800 MW		400 MW		
7 AM			900 MW		600 MW		
8 AM		100 MW			1200 MW		
9 AM		300 MW			2000 MW		
10 AM		700 MW			2500 MW		
11 AM		200 MW			300 MW		
12 PM		200 MW			700 MW		
1 PM					100 MW		
2 PM					200 MW		
3 PM					500 MW		
4 PM					300 MW		
5 PM					700 MW		400 MW
6 PM					100 MW		
7 PM							
8 PM							100 MW
9 PM							
10 PM							
11 PM							

- For the annual energy metric, we calculate the ***sum*** of all shortfall magnitudes: ***13,500 MW-hours***

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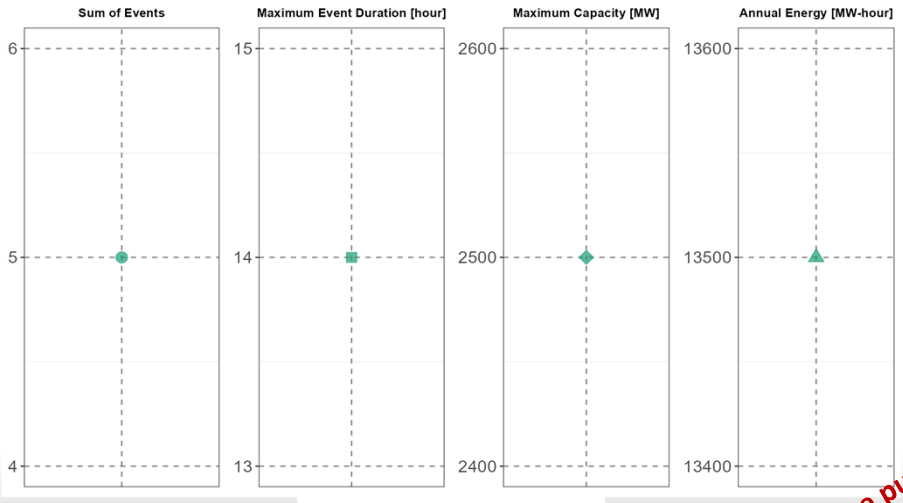
Plots of Shortfall Statistics for One Simulation Year



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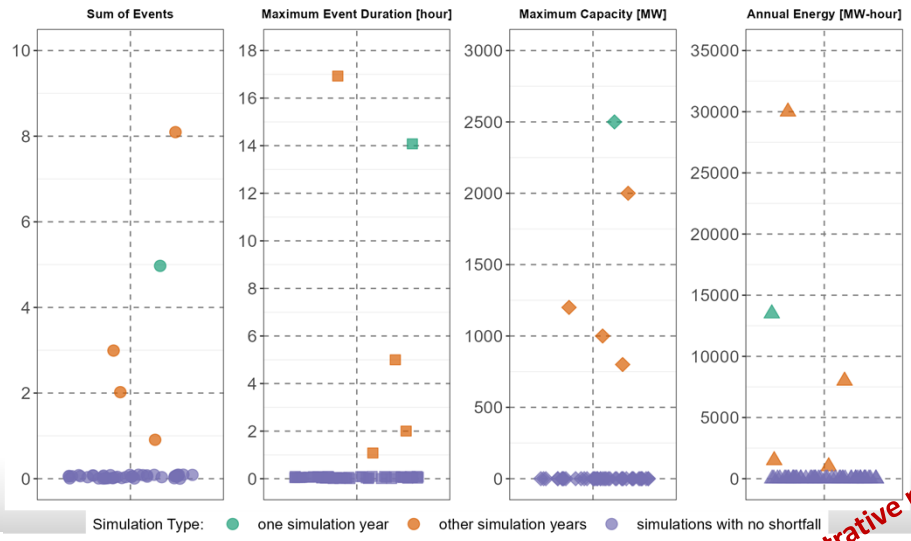
(*jitter*) Plots of Shortfall Statistics for 100 Simulation Years



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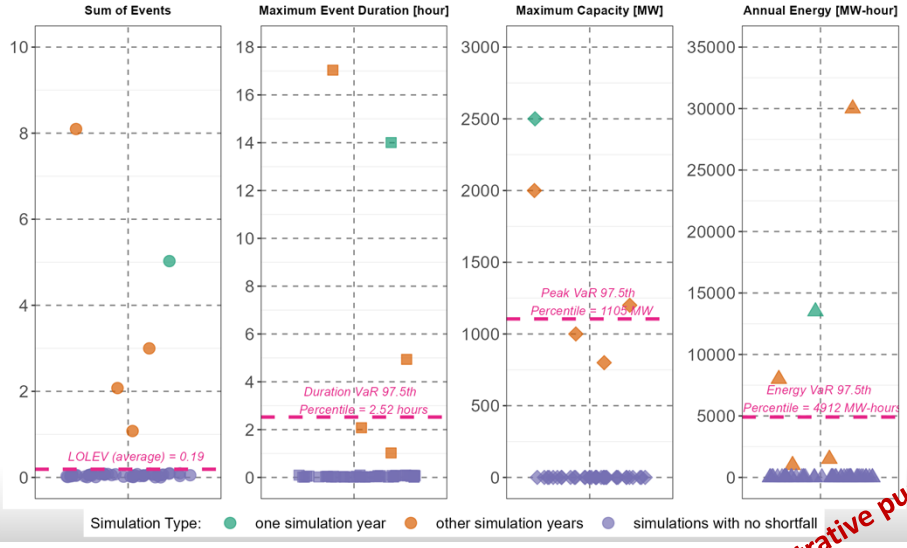
Calculating The Adequacy Metrics



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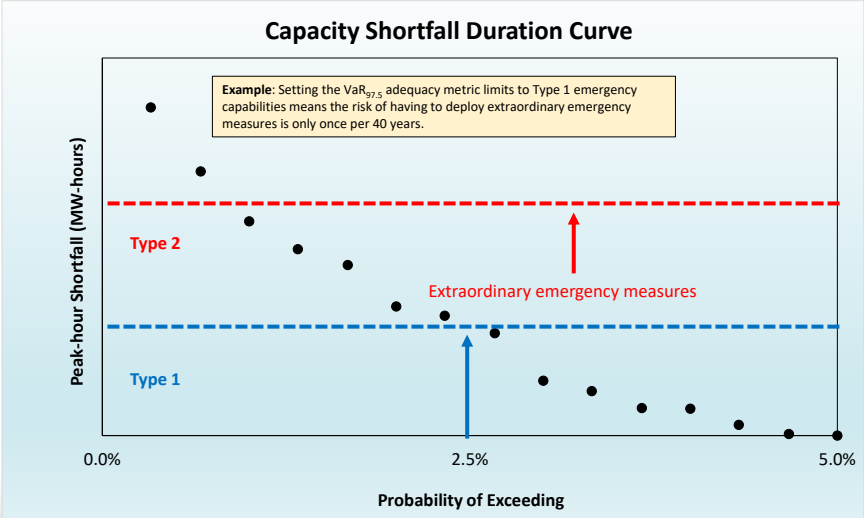
Summary

- The adequacy metrics are calculated over two steps:
  - Calculate statistics of shortfalls for each simulation (e.g., the *sum* or the *maximum*)
  - which results in various *distributions* of shortfall statistics from all the simulations
  - The adequacy metrics are calculated as statistics of the distributions (e.g., the *average* or the *97.5th percentile*)

Using Emergency Measure Capabilities to set Adequacy Limits



Quantifying Emergency Capability is Difficult

Rephrasing The Adequacy Perspective

- LOLEV:
  - Every time we have a shortfall event, an emergency measure (type 1,2 or both) will be used, let's not do it too often.
- Duration VaR97.5:
  - 39 out of 40 years, let's make sure the shortfalls don't last too long
- Peak & Energy VaR97.5:
  - 39 out of 40 years, let's make sure the shortfalls are not too big

Philosophical Approach to Thresholds

Emergency Capabilities

Available emergency capabilities for the region is the main driver for the initial provisional limits

Risk Tolerance

What level of risk is the aggregate emergency capabilities of the region able to protect?

Collaborate with regional utilities and stakeholders to evaluate and determine **precise and appropriate** regional adequacy thresholds.

Engagement Strategy

Utilities

Stakeholder survey

Follow-up meetings

Regional Organizations

Input and coordination efforts

PUCs & Government

Publicize analysis efforts

Input and coordination effort

Stakeholder Survey

Goals

- Feedback on provisional adequacy limits
- Aggregate emergency capacity and energy in the region
- Regional utilities definition of adequacy and derivation of planning reserve margins

Questions

- Type of problems
- Timing of most concern
- Market dynamics
- Transmission implications
- Planning Reserve Margins
- Emergency capabilities
- Adequacy metrics

Outreach Status

- Survey response:
  - BPA
  - Avista
  - Idaho Power
  - Tacoma Power
  - Puget Sound Energy
  - Northwestern Energy
  - Chelan PUD
- Meetings:
  - Utilities:
    - BPA
    - Idaho Power
    - Puget Sound Energy
  - Regional organizations:
    - Pacific Northwest Utilities Conference Committee (PNUCC)
    - Western Power Pool (WPP)

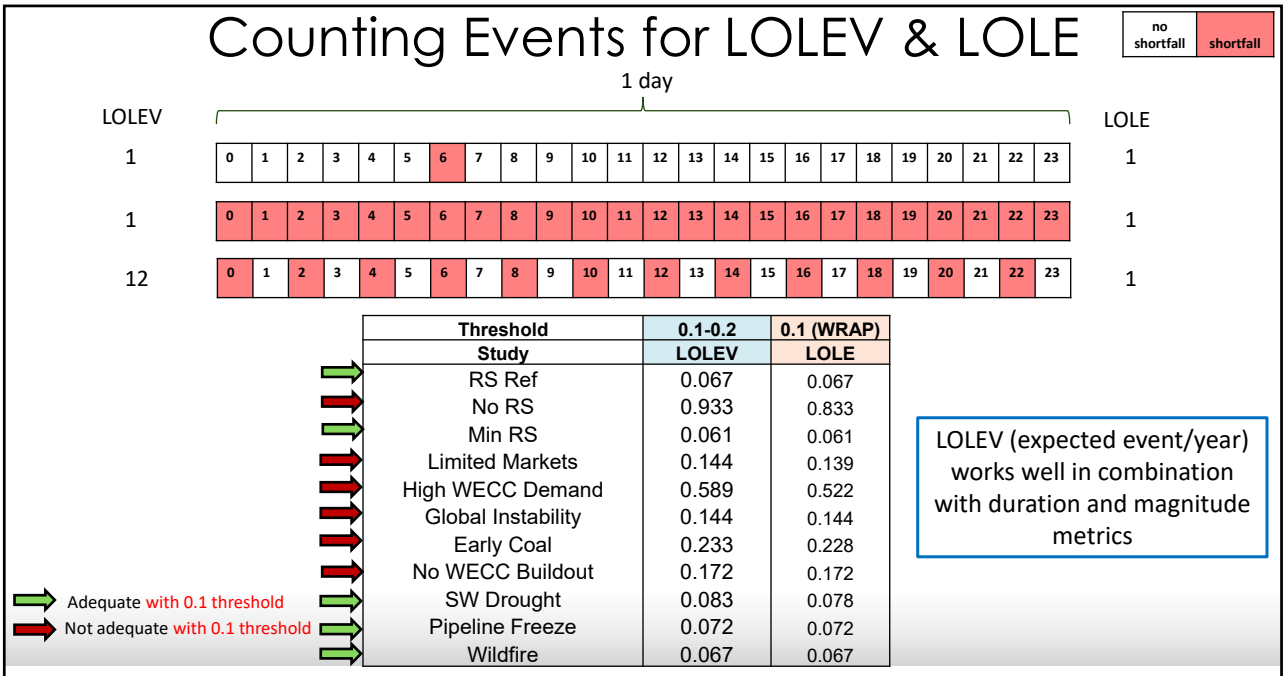
Preliminary Findings - Metrics

- Support for transitioning towards multiple metrics covering frequency, duration, and magnitude
- Continued discussion on role of seasonality
- Preference for binary adequate/non-adequate perspective
- Reliance on WRAP

Preliminary Findings - Thresholds

- Frequency:
  - Comfort level with 0.1 LOLEV as similar in nature to WRAP's 0.1 (LOLE) event-day/year
  - Reliance on WRAP
- Duration:
  - Suggestions to further explore financial/societal elements of shortfalls to evaluate the longest allowable event
- Peak and Energy:
  - Difficult to quantify aggregate emergency capabilities
  - Consideration of utilizing normalized values instead
  - Further evaluation of risk tolerance (1-in-X years)

Counting Events for LOLEV & LOLE



Threshold	0.1-0.2	0.1 (WRAP)
Study	LOLEV	LOLE
RS Ref	0.067	0.067
No RS	0.933	0.833
Min RS	0.061	0.061
Limited Markets	0.144	0.139
High WECC Demand	0.589	0.522
Global Instability	0.144	0.144
Early Coal	0.233	0.228
No WECC Buildout	0.172	0.172
SW Drought	0.083	0.078
Pipeline Freeze	0.072	0.072
Wildfire	0.067	0.067

Adequate with 0.1 threshold

Not adequate with 0.1 threshold

LOLEV (expected event/year) works well in combination with duration and magnitude metrics

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Preliminary Findings – Planning Reserve Margins

- Continued exploration of translating the proposed metrics to planning reserve margins
- Necessary discussions on role of reserves in renewable-rich systems
  - Role of market dynamics
  - Role of existing thermal and hydro system

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Preliminary Findings – "What regional events keep you up at night?"

- Multi-day heat domes
- Multi-day severe cold snaps
- Wildfires taking out transmission lines

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WRAP & the Council?

The Council provides the recommended recipe for how large the cake should be in 5 years …

so by that deadline the WRAP ensures all participants have enough to share over 1-2 years.

Otherwise, there won't be enough cake for everyone.

Photo by Caitlyn de Wild on Unsplash

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The Vision

- Facilitate regional conversations
- Broaden discussion about reserves
- Unified approach to adequacy

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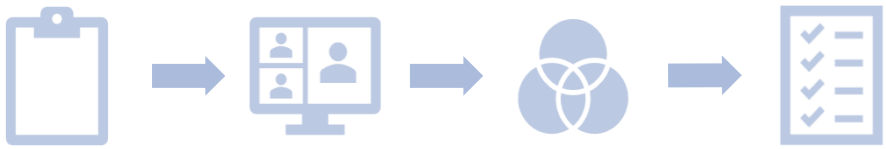
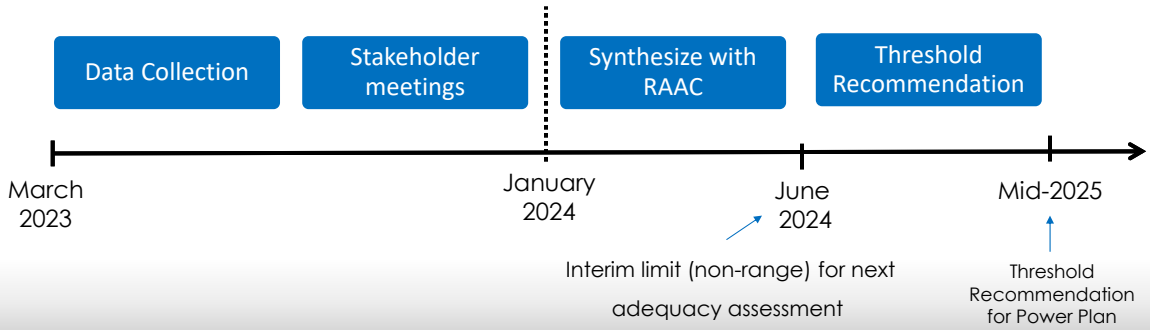
Next Steps For an Evolving Nature





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Questions

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Extra Slides

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2027 Adequacy Results Reminder

Adequate with tested resource mix

Not adequate with tested resource mix

Borderline with tested resource mix

Provisional Limit	Not greater than 5%	0.1-0.2 Event-year	8-12 Hours	2,000-3,000 MW	4,000-8,000 MWh
Study	**LOLP**	**LOLEV**	**VaR Duration**	**VaR Peak**	**VaR Energy**
RS Ref	4.4	0.067	2	357	590
No RS	46.1	0.933	6	2922	12504
Min RS	4.4	0.061	2	837	1666
Limited Markets	7.8	0.144	2	1450	3147
High WECC Demand	17.2	0.589	5	4792	36617
Global Instability	7.2	0.144	3.5	2041	5969
Early Coal	13.9	0.233	2.5	1895	3807
No WECC Buildout	8.3	0.172	3.5	2015	6410
SW Drought	5	0.083	2	744	1421
Pipeline Freeze	5	0.072	1.5	505	710
Wildfire	4.4	0.067	2	357	590

RS Ref resource mix used for these scenarios

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