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

January 4, 2023

MEMORANDUM

TO: **Council Members**

FROM: **John Fazio, Senior Power Systems Analyst**

SUBJECT: **2027 Resource Adequacy Assessment**

BACKGROUND:

Presenters: John Ollis, John Fazio, Dan Hua, Dor Hirsh Bar Gai

Summary: Staff will brief the Council on the results of the resource adequacy assessment for 2027. Analysis indicates that the regional power supply will not be adequate when relying solely on existing resources, existing reserve levels, and on no new energy efficiency measures. However, adequacy is expected to be maintained if resources and reserves identified in the 2021 Power Plan's resource strategy are added to the supply. If future electricity market supplies are significantly limited or if demand increases rapidly (e.g., with the implementation of accelerated electrification policies) or if major resources are retired earlier than expected without replacement, then additional resources and reserves will be required to maintain adequacy, as anticipated by the 2021 Power Plan.

Staff is asking the Council to agree to release of the 2027 Resource Adequacy Assessment publicly, including any committee amendments to the executive summary and after any needed editorial edits to the report. In addition, staff is asking the Council to direct staff to continue the development of the multi-metric approach for future assessments, as we believe it provides a more robust approach for assessing adequacy.

Staff is anticipating that the Power Committee will make a recommendation to the Council for both release of the report and the continued work on new metrics. Note that staff is seeking the informal endorsement of the Council members, not a formal decision of the Council by motion and vote.

Relevance: Resource adequacy is a critical component of the Council's mandate to develop a regional power plan that "ensures an adequate, efficient, economic and reliable power supply." To test the efficacy of the plan's resource strategy, the Council – in cooperation with regional stakeholders – annually assesses the adequacy of the power supply with planned resource additions derived from the plan's resource strategy. The annual assessment is based on a resource adequacy standard established by the Council in 2011. However, for this year's assessment, the Council enhanced its assessment by also examining measures related to shortfall frequency, duration, and magnitude.

Background: An adequate power supply should meet the electric energy requirements of its customers within acceptable limits, considering a reasonable range of uncertainty in resource availability and in demand. Resource uncertainty includes forced outages, early retirements and variations in wind, solar and market supplies. Demand uncertainty includes variations due to temperature, economic conditions, and other factors. Resource availability and demand are also affected by environmental policies, such as those aimed at reducing greenhouse gas emissions.

The Council uses a Monte-Carlo simulation model to assess the likelihood of a future year having one or more disruptions to service, when considering the many different combinations of future resource availabilities and demands described above. The metric used, referred to as the annual LOLP, has been instrumental in the development of the Council's power plans since the early 2000s. However, due to increasing complexities (e.g., significant development of renewable and distributed resources, adoption of clean-air laws and a more dynamic market environment), LOLP is no longer sufficient to accurately measure the adequacy of the region's power supply and the risk to customers.

An enhanced adequacy assessment includes metrics related to the frequency, duration, and magnitude of potential shortfalls. The objectives for the new standard are to:

- Prevent high use of emergency measures
- Limit occurrences of very long shortfall events
- Limit occurrences of big capacity shortfalls
- Limit occurrences of big energy shortfalls

With the approval of the Council, staff will continue to develop this approach to assess adequacy and will work with all stakeholders to refine the limits set for all adequacy measures.

2027 Adequacy Assessment

January 11, 2023
Council Meeting

Objectives

Seeking Council agreement on the following two items:

1. Release the 2027 Resource Adequacy Assessment publicly
2. Direct staff to continue the development of the multi-metric approach for future assessments

Overview

- Role of the Adequacy Assessment
- Adequacy Metrics
- Results Overview
- Next Steps

Role of Assessment (1)

- Assess bulk power system adequacy of the plan's resource strategy.
  - In recent times, this has primarily been the energy efficiency target accompanied with sited, licensed and constructed new resources built since the plan. Since the 2021 Power Plan resource strategy has more specific direction when it comes to interpreting the resource strategy for new generating resources and demand response this assessment includes those in the analysis as well.
- A resource adequacy assessment is only a relative measure of customer risk.
  - It does not draw a bright line between a system with no risk and one with risk. An "adequate" system is not immune to resource shortfalls nor is an "inadequate" system certain to have them.

Role of Assessment (2)

- The assessment focuses on bulk system supply-side adequacy, not distribution.
  - Pertinent given the recent severe storm across the US as clarification, a supply-side adequacy assessment of a severe storm considers the impact of a prolonged increase of heating demand, and not the risk of downed transmission lines or damaged substations. While important to evaluate, these are excluded from the scope of Council adequacy assessments.
- By examining additional adequacy measures, the Council can identify the risks associated with shortfalls in regional power supply more precisely.
  - The Council has used a Loss of Load Probability threshold in the past to protect against low hydro conditions in conjunction with high load conditions and thermal forced outage events. Large additions of variable energy resources (wind, solar, etc.) throughout the system changes the prevailing risks. These additional adequacy measures better identify these risks and help the region target more specific mitigation options.

Transitioning to a Multi-Metric Adequacy Standard

- *Current standard*
  - Power supply is adequate if the annual LOLP is 5% or less
  - Measures the likelihood of a future year having *one or more* shortfall events of any size and duration

- *Limitations*
  - No measure of *shortfall event* size, duration or frequency
  - No indication of shortfall timing (i.e., seasonality)

Objectives for the New Standard

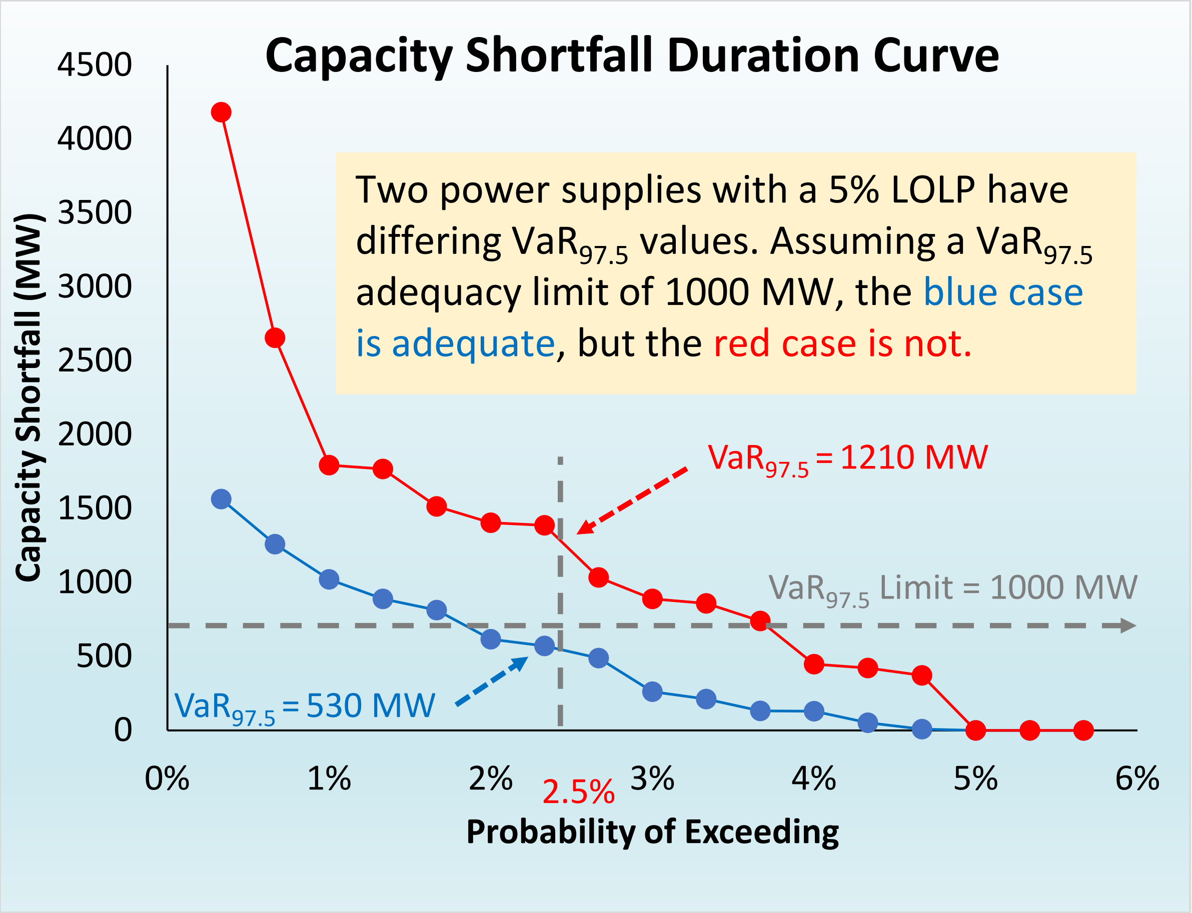
- Prevent overly frequent use of emergency measures
- Limit occurrences of very long shortfall events
- Limit occurrences of big capacity shortfalls
- Limit occurrences of big energy shortfalls

Value at Risk Metric

Value-at-risk is a statistical measure of the risk of shortfall for a <u>specified confidence level</u> and is often referred to as a "tail-end" metric.

For example, $VaR_{97.5}$ is the 97.5th highest shortfall out of all possibilities, reflecting a once per 40-year risk of a shortfall equal to or greater than the $VaR_{97.5}$ value.

A power supply is deemed adequate if its $VaR_{97.5}$ value is less than the predetermined $VaR_{97.5}$ adequacy limit.



Proposed Metrics

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

- ***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 = TBD, possible range 8 to 12 hours (e.g., start of a cold snap or heat wave)

- ***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 = TBD, possible range 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 = TBD, possible range 4,000 to 8,000 MWh
  - Limit set to aggregate emergency energy or acceptable amount of annual energy demand at risk

Examples of Non-modeled Emergency Measures

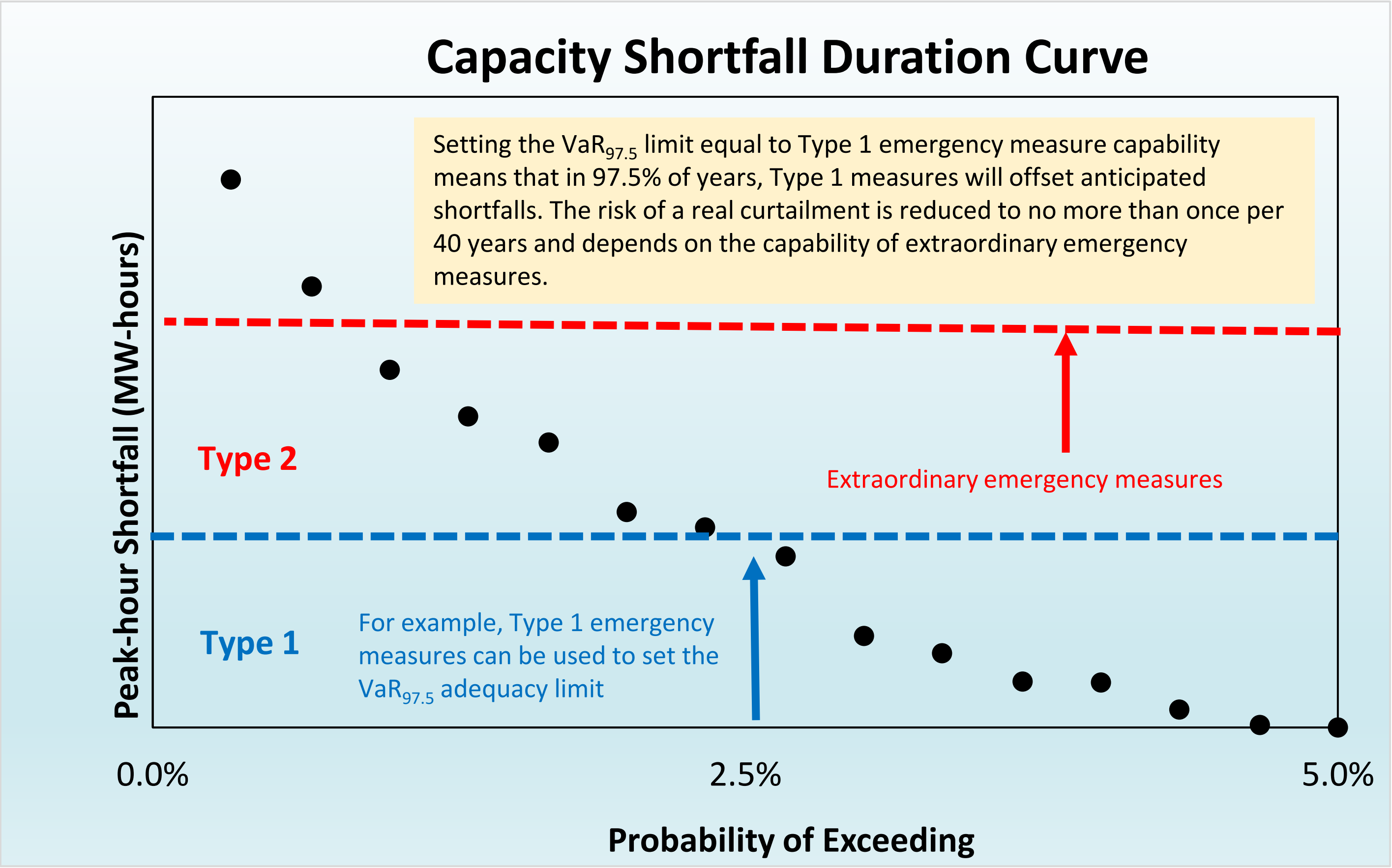
Quantifying Emergency Capability is Difficult

Type 1:

- 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
- Banks Lake emergency generation

Type 2:

- 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



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

Evaluating the Resource Strategy

2021 Plan Strategy

- Energy Efficiency: 750-1,000 aMW
- Renewable Resources: at least 3,500 MW (wind, solar, etc.)
- Demand Response: 720 MW
  - 520 MW of demand voltage regulation
  - 200 MW from time-of-use rates
- Additional reserves for adequacy: at least 3,100 MW

- Resource Strategy (RS Ref)
  1. 1,000 aMW of new EE
  2. 720 MW of new DR
  3. 5,410 MW of additional new Renewables
     - 590 MW of new renewables already built since plan
  4. 6,000 MW of Up Reserves
     - 3,100 MW of additional balancing up reserves over current regional reserve assumptions
- Resource Strategy (Min RS)
  1. 750 aMW of new EE
  2. 720 MW of new DR
  3. 2,910 MW of additional new Renewables
     - 590 MW of new renewables already built since plan
  4. 6,000 MW of Up Reserves
     - 3,100 MW of additional balancing up reserves over current regional reserve assumptions
- No Resource Strategy (No RS)
  - Just the 590 MW of new renewables already built since plan

Reminder of Studies

Plan Resource Strategy

- Resource Strategy baseline (*RS Ref*)
- No Resource Strategy (*No RS*)
- Minimum Resource Strategy (*Min RS*)

Market Conditions

- Limited Markets (*RS Ref*)
- High WECC Demand (*RS Ref, +200 aMW EE*)
- Global Instability (*RS Ref*)
- Early Coal Retirement (*RS Ref*)
- No WECC Buildout (*RS Ref*)

WECC Stress

- SW Drought (*RS Ref*)
- Pipeline Freeze (*RS Ref*)
- Wildfire (*RS Ref*)

Limited Markets

- Removed planning reserve margins
  - Implemented by setting operating pool planning reserve margins to -99 in AURORA
  - All other inputs the same as the baseline

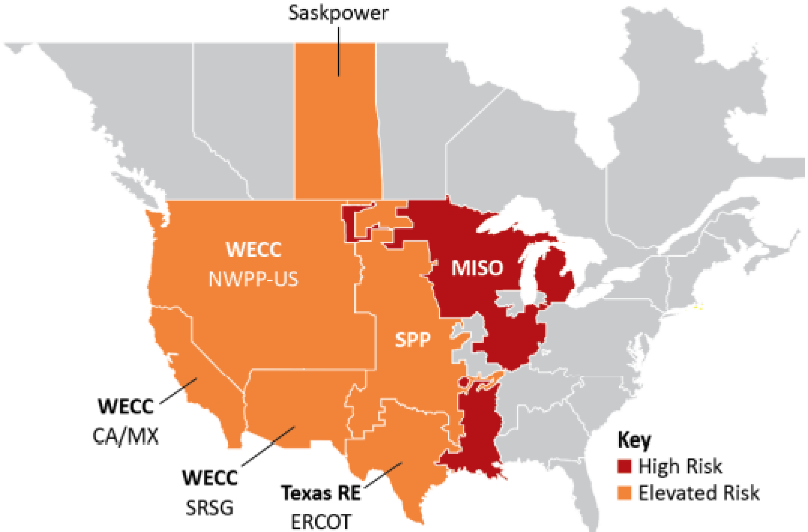


Figure 1: Summer Reliability Risk Area Summary

High WECC Demand

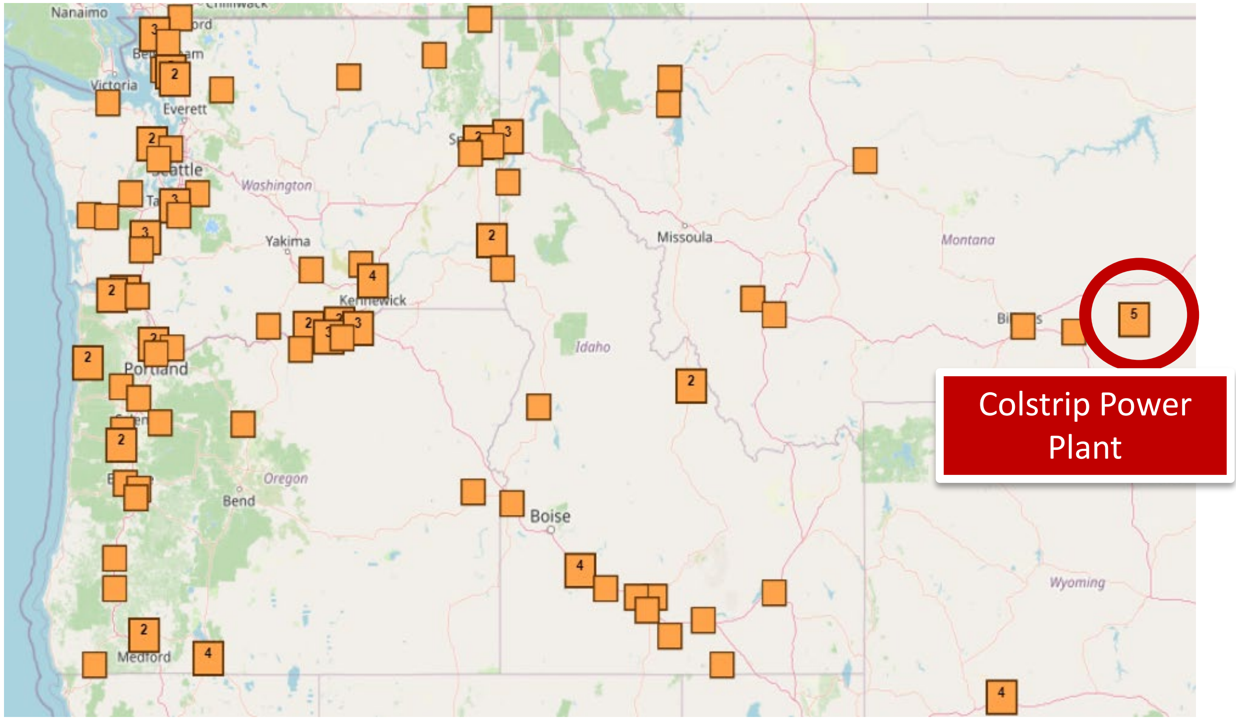
- High electrification Pacific NW, California, BC and Alberta
  - High demand only in those areas, baseline forecast elsewhere
- All other inputs the same as the baseline, except updating policy targets (in MWhs)

Persistent Global Instability

- Higher fuel costs and delayed renewable deployment.
  - Implemented by changing maximum annual new additions on short duration storage, solar and wind generation until 2030.
  - Other resource ramps unchanged due to online date or previous restrictions
  - All other inputs the same as the baseline

Early Coal Retirement

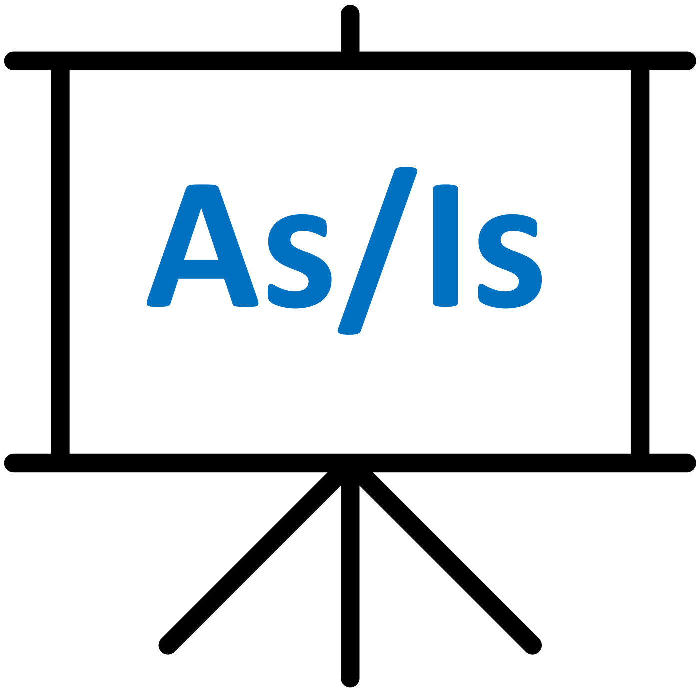
- Removal of Colstrip 3 and 4 from the adequacy analysis without replacement



No WECC Buildout

- Only existing resources across the WECC, except the NW

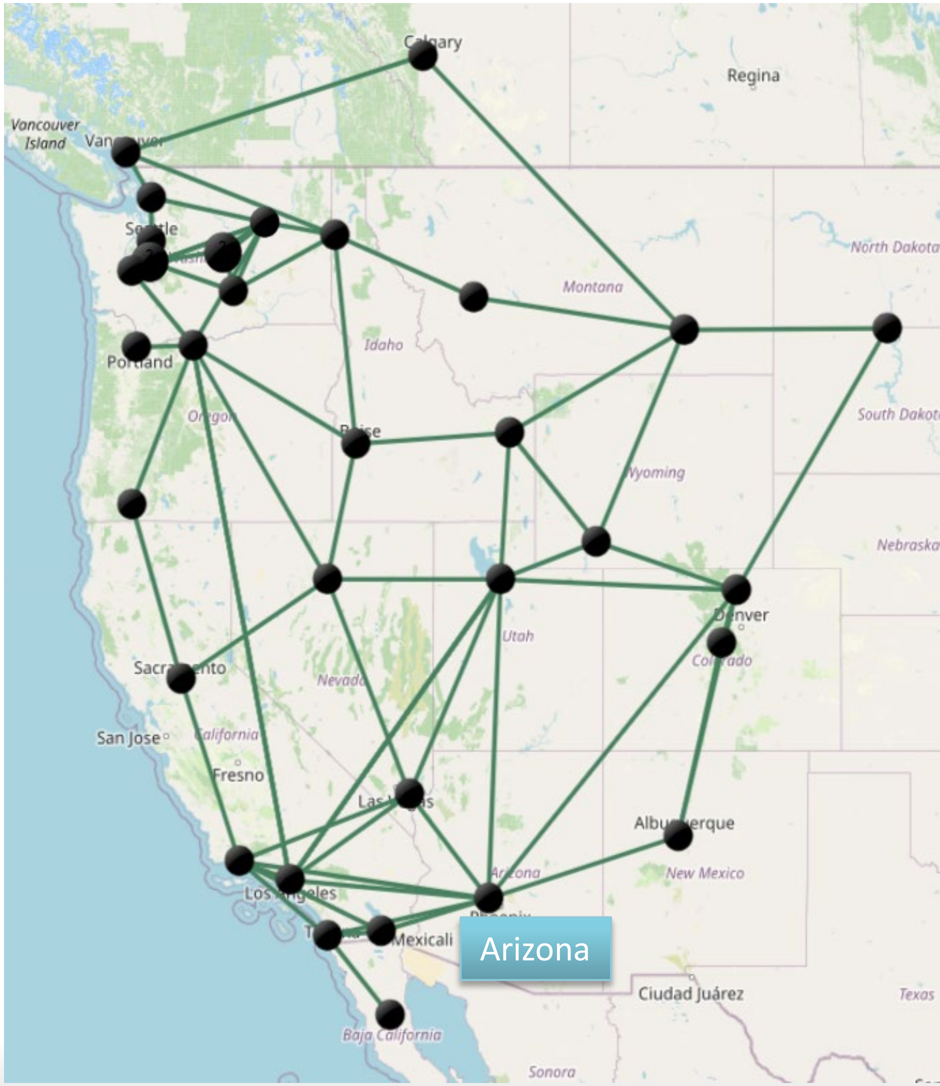
- Reference resource strategy
  included for the PNW



Pipeline Freeze-off

i. Loss of 5,000 MW natural gas from Arizona

ii. November – February



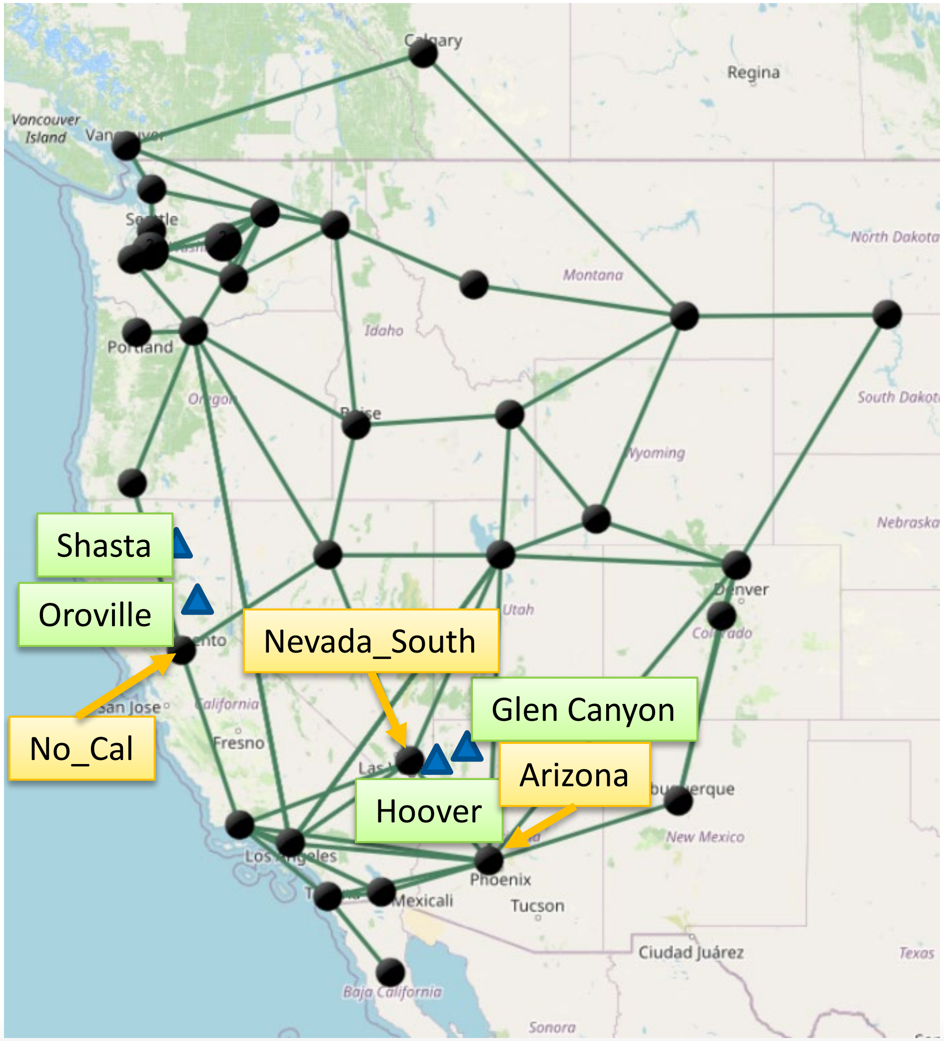
SW Drought

i. Glen Canyon
   i. Removal of **923** MW (Arizona)

ii. Hoover
   i. Removal of **730** MW (Arizona)
   ii. Removal of **316** MW (Nevada South)

iii. Lake Oroville
   i. Removal of **542** MW (No_Cal)

iv. see Lake Shasta
   i. Removal of **315** MW (No_Cal)



On Average, 2,826 MW of SW hydro is removed

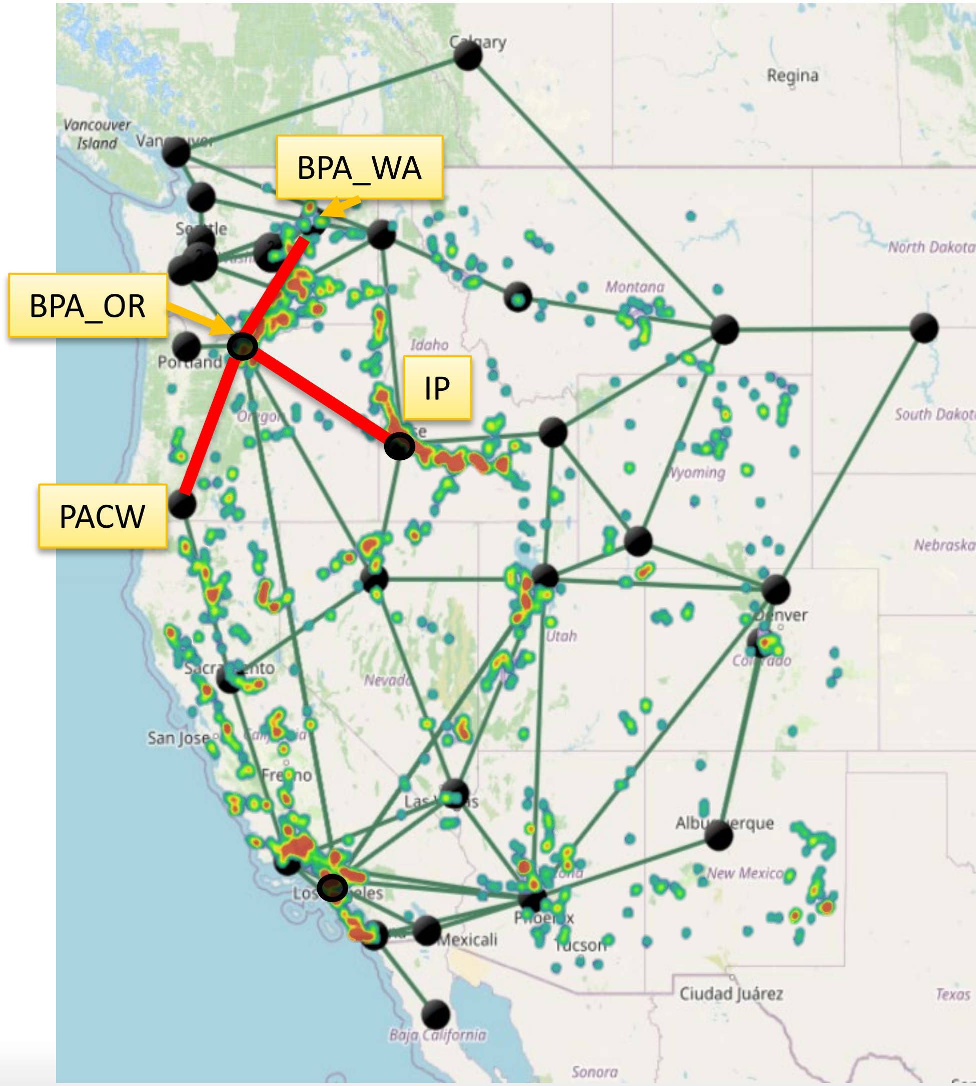
Wildfire

i. BPA_OR **<->** PACW: **5,800 MW**

ii. BPA_OR **<->** IP: **2,000 MW**

iii. BPA_OR **<->** BPA_WA: **7,500 MW**

iv. Wildfire dates:
   i. July 16-23
   ii. Derating:
      i. 50-90% of lines



Key Takeaways

- System is adequate with the plan resource strategy but is not adequate if we do nothing.
  - In the high demand world, we need to do more, as described in the strategy
  - When retiring existing resources early, we need to do more, as indicated in plan analysis
- Strategy effective at eliminating summer shortfalls and mitigating winter events
- Market reliance limit is serving us well for now, but market dynamics do pose some risks to monitor

System is Adequate in 2027 Under Plan Strategy

- System is adequate with the plan resource strategy
- The system is not adequate if we do nothing.
- High WECC demand (caused by, say, a faster pace of electrification) is a risk requiring more resources as outlined in the plan strategy
- Plan analysis showed and this study confirmed that early coal retirement is a risk requiring more resources to maintain adequacy

Results Overview

Adequate with resources tested

Not adequate with resources tested

Borderline with resources tested

Provisional Limit	<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

Strategy Most Effective at Addressing Certain Types of Shortfalls

The strategy…

- Eliminates summer shortfalls
- Mitigates winter shortfalls
- Limits remaining shortfalls to ramp hours
- Protects against long duration shortfalls

Heatmap of Maximum Capacity Shortfall by Month-Hour

Elimination of summer shortfalls

Mitigation of winter shortfalls

Ramp hours

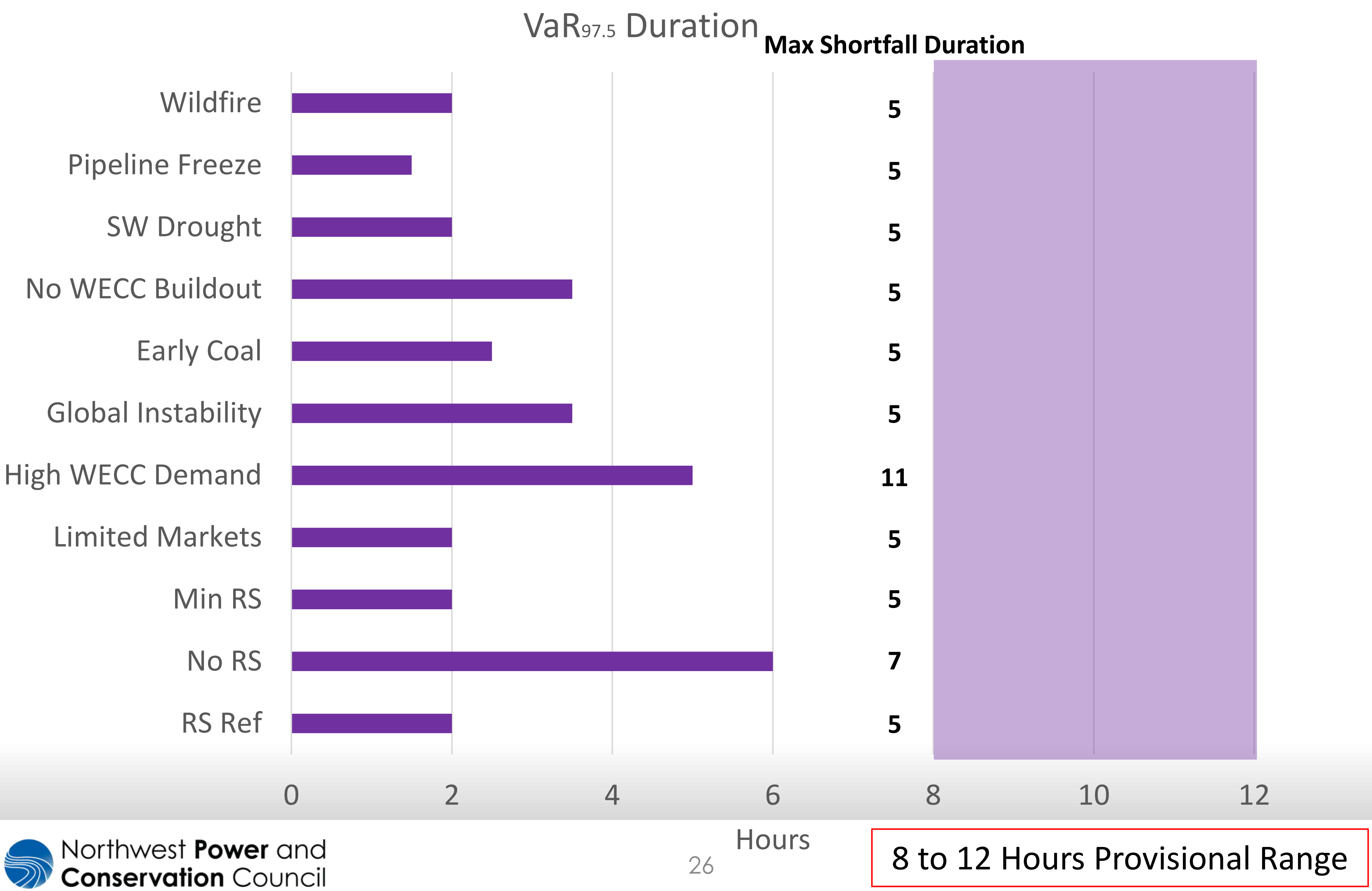
Reference with Resource Strategy (*RS Ref*)

Month / Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1						1300	3203	2856	1915	792														
2							402	443																
3																								
4																								
5																								
6																								
7													9											
8																								
9																								
10																								
11																								
12							173										1942	2160						

Reference without Resource Strategy (*No RS*)

Month / Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1						3149	5222	4964	4398	3699	496													
2					334	2560	3010	3357	2011	1844														
3																								
4																								
5																								
6									676	1780	1154		248	1189	1526	1174	979	1089	587	29				
7												625	285	384	749	370	398	355						
8														303	767	1153	888	697						
9																								
10																								
11							782	780	94															
12							746	191	467							1323	4275	4496	1732					

Protection Against Long Duration Shortfalls



Current Market Reliance Limit Offers Effective Risk Mitigation

- Out-of-region market supply uncertainties have a minimal effect on regional adequacy, assuming the Council's current market reliance limits:
  - Drought
  - Gas supply issues
  - Wildfire

- However, under certain future scenarios results show regional adequacy levels to become borderline or unacceptable:
  - High gas prices coupled with continued supply chain challenges
  - Lower than expected west-wide renewable generation acquisition
  - Increased WECC demand

Results Overview

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Borderline with resources tested

Provisional Limit	<5%	0.1-0.2 Event-year	8-12 Hours	2,000-3,000 MW	4,000-8,000 MWh
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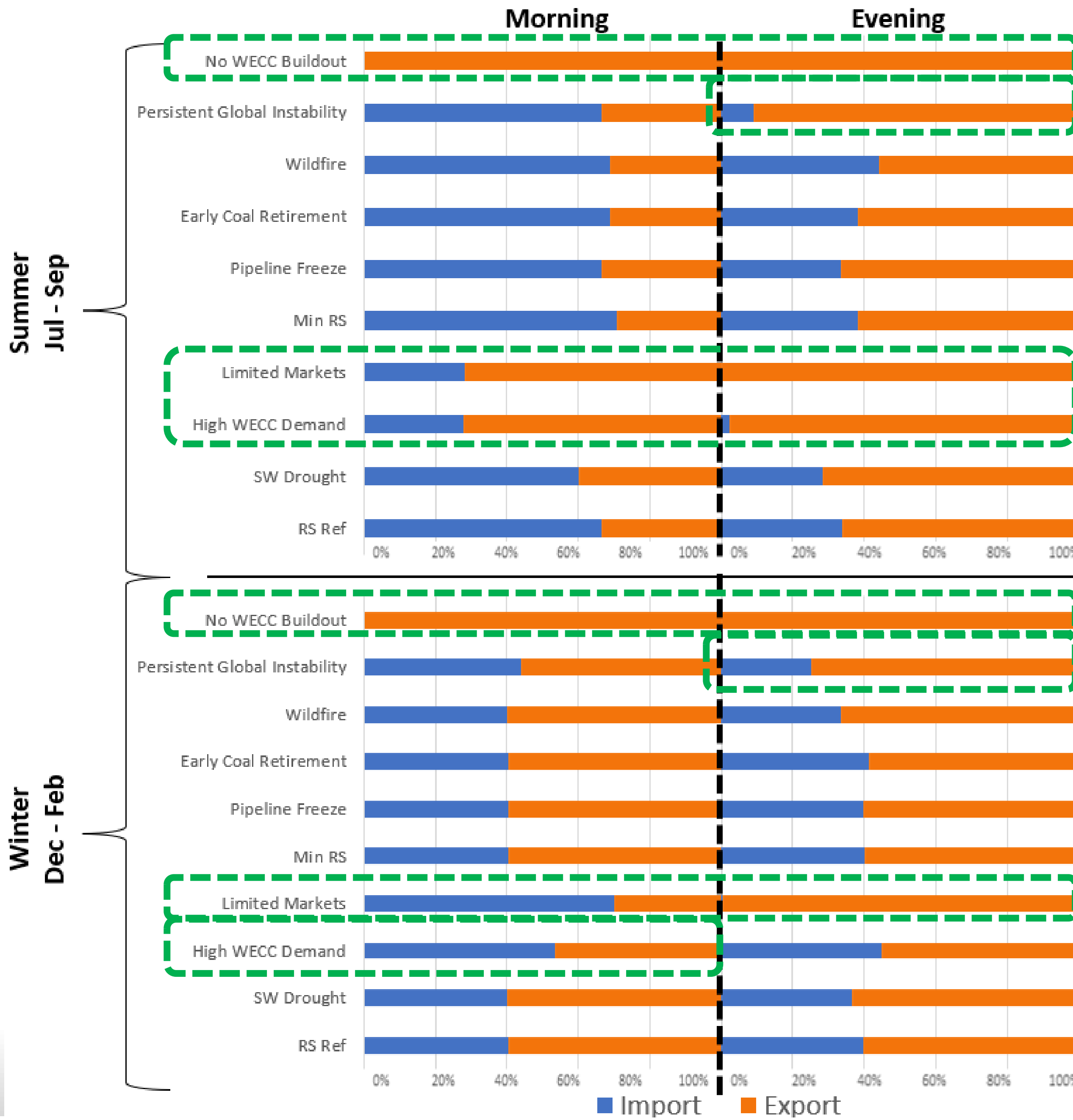
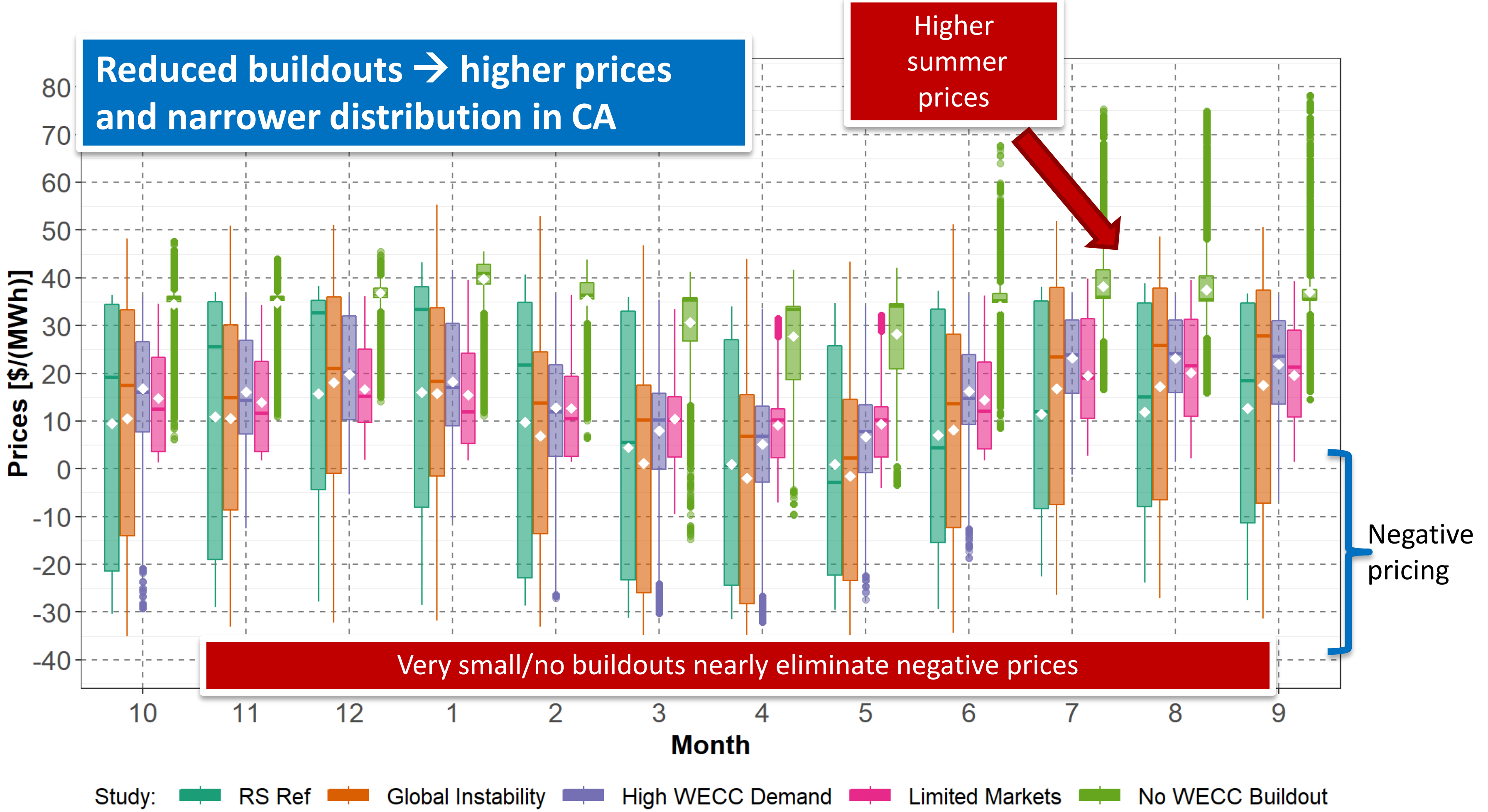
Future WECC Buildouts May Pose Market Dynamic Risks

- Projected renewable resource acquisition driven by clean policies is expected to change market supply and demand dynamics
  - Hourly pattern of renewable generation does not always coincide with the hourly pattern of greatest energy need.
  - Certain periods of the day may have very inexpensive market supply due to renewable surplus (mostly solar).
- Under conditions of increased supply and lower prices, the Northwest is expected to consistently import more power than it has in the past.
- However, there also will be times within the same day, often during morning and evening ramps, when available market supply is less and more expensive.
  - This provides an opportunity for the Northwest to export to other regions in the west but also means that those are the times of most market risk for the Northwest.
- The ability of the Northwest hydroelectric and thermal systems to ramp up and down to respond to those changing market dynamics requires appropriate market signals, either from a regional reserve pooling effort or from an enhanced market structure.

CA Import/Export During Summer and Winter Ramp Hours



Comparison of California Prices



Revisiting Key Takeaways

- System is adequate with the plan resource strategy but is not adequate if we do nothing.
  - In the high demand world, we need to do more, as described in the strategy
  - When retiring existing resources early, we need to do more, as indicated in plan analysis
- Strategy effective at eliminating summer shortfalls and mitigating winter events
- Market reliance limit is serving us well for now, but market dynamics do pose some risks to monitor

Seeking Council Direction

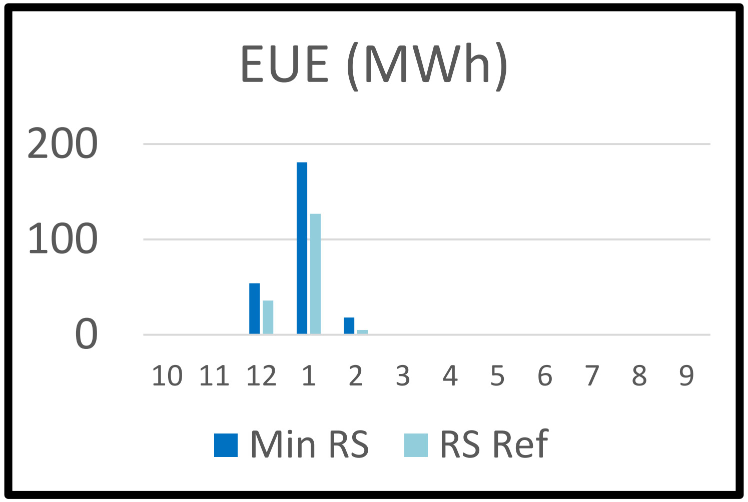
- Are you comfortable releasing the 2027 Resource Adequacy Assessment publicly after an editorial review by staff?

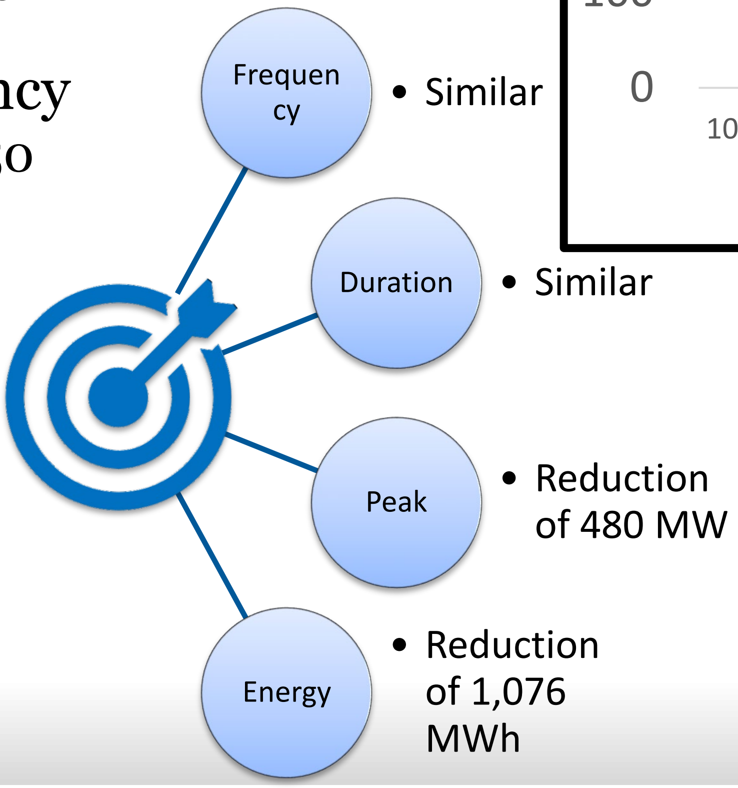
- Do you agree that staff should continue to develop the multi-metric approach as a more robust approach for assessing adequacy?

Appendix

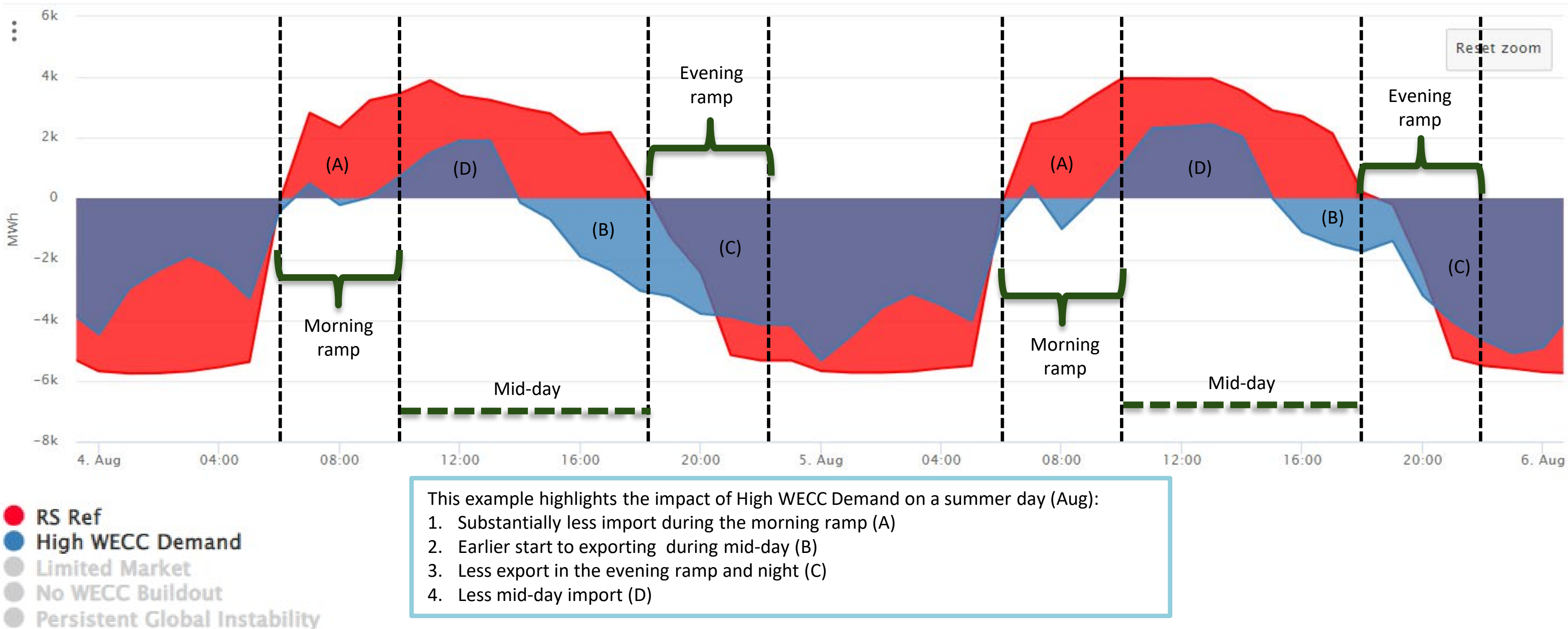
Comparison of Reference to Minimum?

- Recap on difference:
  - Renewables:
    - Additional 2,500 MW
  - Energy Efficiency
    - Additional 250 aMW
- Main Impact:
  - Reduction of shortfall magnitudes (decreased reliance on emergency resources)





Example of Daily California Summer Import/Export Behavior



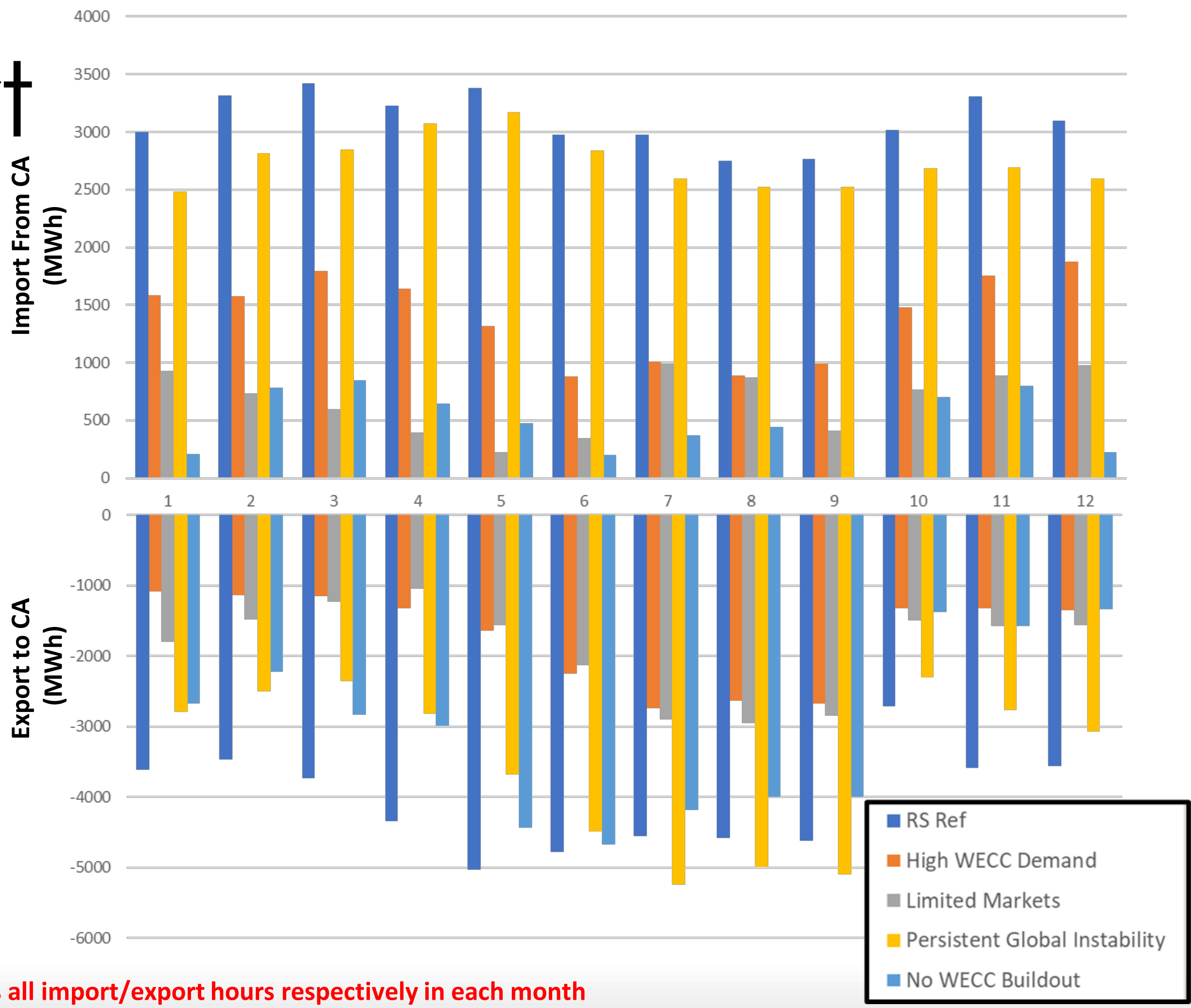
This example highlights the impact of High WECC Demand on a summer day (Aug):

1. Substantially less import during the morning ramp (A)
2. Earlier start to exporting during mid-day (B)
3. Less export in the evening ramp and night (C)
4. Less mid-day import (D)

Positive = PNW import from California | Negative = PNW export to California

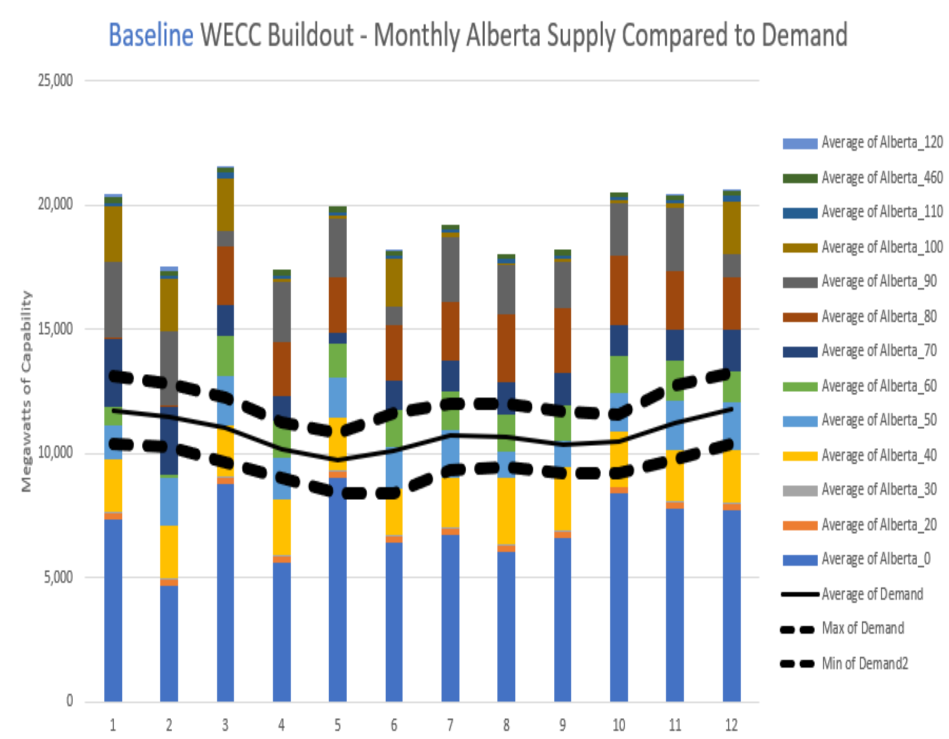
Average* California Import/Export

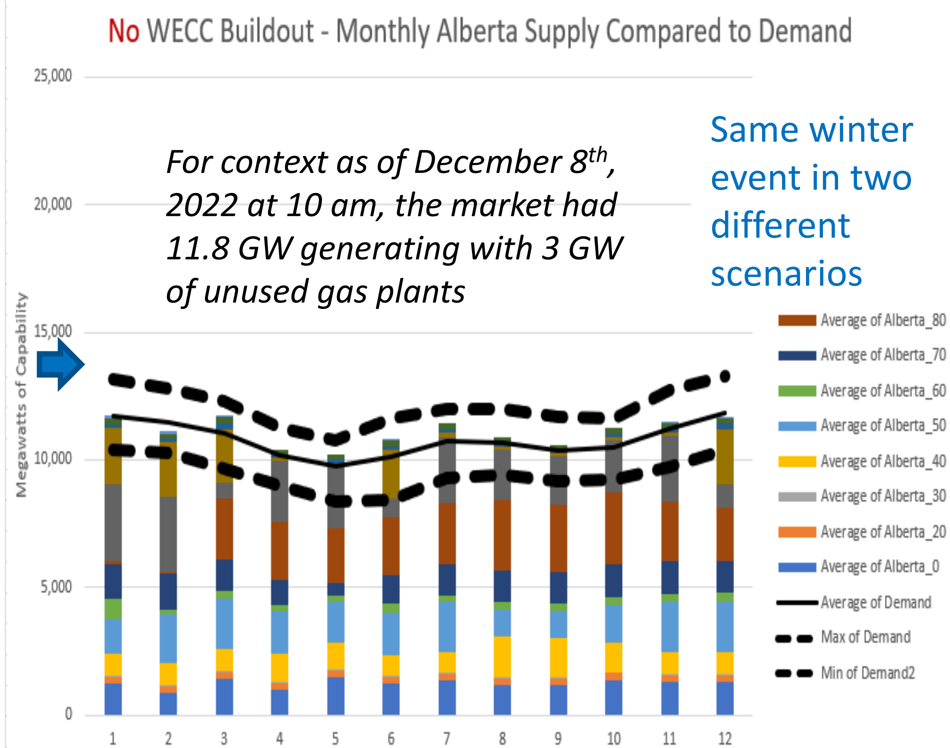
- Substantial reduction in average imports (MWh) under **High WECC Demand**, **Limited Markets** and **No WECC Buildout**
  - **Persistent Global Instability** shows a smaller impact on imports
- For exports, reduction across scenarios is observed, especially **High WECC Demand**
  - **Persistent Global Instability** is the only scenario suggesting higher exports during the summer months



*Average across all import/export hours respectively in each month

Note on Canadian imports: Alberta relies on imports from BC and region for adequacy and economics in the recent past, but this has already changed to primarily economic exchanges.





For context as of December 8th, 2022 at 10 am, the market had 11.8 GW generating with 3 GW of unused gas plants

Same winter event in two different scenarios

The Alberta_XX represents the supply capability near the price, XX $/MWh