March 2, 2021

MEMORANDUM

TO: **Power Committee Members**

FROM: **John Ollis, Manager of Planning and Analysis**

SUBJECT: **Update on Power Plan Needs Assessment (ASCC)**

BACKGROUND:

Presenter: John Ollis

Summary: To ensure that the resource strategy in the 2021 power plan will lead to an adequate supply, the Council's adequacy standard is incorporated directly into the Regional Portfolio Model (via Adequacy Reserve Margin, or ARM) as is the associated system capacity contribution (ASCC) of new resources to address that need. Said another way, the ASCC represents the amount of peaking capability of a particular portfolio of new resources within the context of meeting the regional adequacy requirement. The ASCC for all resource combinations considered are calculated using the Council's GENESYS adequacy model.

At the August and September 2020 power committee meetings, Council members were briefed on preliminary ARM and ASCC values based on analyses done with the classic GENESYS model. For the 2021 power plan, however, the Council will use ARM and ASCC values based on its newly redeveloped version of the GENESYS model, which (among other enhancements) provides a more detailed representation of hydroelectric operations. To ensure that the model's simulated operation appropriately represents real-life operation, an extensive vetting process was undertaken. While staff is comfortable with the current setup of the model, discussions with stakeholders continue about model parameters for

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scenarios and future enhancements, as they do with all of Council's power system models, on how to improve the model representation of the regional system.

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Relevance: Through its power plan, the Council is mandated to ensure an adequate, efficient, economic and reliable power supply. Toward that end, the Council adopted a regional adequacy standard in 2011. By using the ARM targets and the ASCC estimates in its planning models, the Council can ensure that future resource acquisitions will be adequate (i.e., will not lead to costly overbuilt systems nor to inadequate underbuilt systems).

Workplan: A.5.2 Related to power supply adequacy assessments

Background: The Adequacy Reserve Margin is the amount of surplus generating capability above the expected load required to maintain an adequate power supply. The ARM thresholds are derived from resource and load data taken from GENESYS studies that produce precisely adequate systems (i.e., they exactly meet the Council's 5% LOLP adequacy standard). The theory is that acquiring sufficient new resource capability to meet the ARM threshold will result in a power system that, when analyzed, will yield a 5% LOLP.

The Associated System Capacity Contribution is a measure of how much reliable capacity a resource provides when added to a power supply. A resource's ASCC is assessed by analyzing how much a potential peak-hour shortfall is reduced by adding an incremental amount of new resource. However, because of the dynamic interaction among all resources in a power supply, the ASCC for a specific resource can change as the resource mix changes. To accommodate for this dynamic interaction, aggregate ASCC values are assessed for many different combinations of new resources and are stored in an ASCC array (or table). When resources are needed to meet the ARM threshold, the composite ASCC value for the entire package of new resources can be interpolated from the ASCC array.

Update on Power Plan Needs Assessment: *Revised Baseline ARMs and Capacity Contribution Studies*

Power Committee

3/9/2021

John Ollis

THE 2021
NORTHWEST
POWER PLAN
FOR A SECURE & AFFORDABLE
ENERGY FUTURE

Baseline Needs Assessment Summary

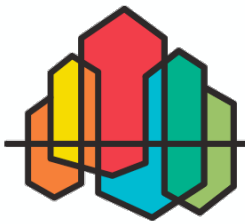
- Region has significant needs in the action plan time frame with the most needs in the winter.
- The market has low priced power in every season in the middle of the day and NW hydro system is effective at utilizing it to meet needs.
- Conservation continues to work in tandem with the hydro system well to address adequacy issues, however many other resources do as well

Agenda

1. **Review the Role of the Needs Assessment in Picking a Resource Strategy**

2. **Determine Regional Needs**
   - Assumptions for 2023, 2027 and 2031
   - Adequacy Reserve Margin results

3. **Determine How Different Resources Meet Those Needs**
   - Assumptions for 2031 studies
   - Associated System Capacity Contribution results



Needs Assessment Role in Power Plan

How do these simulations guide our result in the plan?

Get A Strategy

AURORA Buildout

Long term capital expansion for the WECC ensures that price simulations in AURORA are informed by an ***adequate system*** that ***meets policies***

AURORA Price Runs

Hourly market capability is needed for GENESYS to provide ***a good adequacy signal for the NW*** informed by changing market fundamentals

Hourly WECC-wide price simulations inform ***market prices*** and ***associated emissions*** in the RPM, both can significantly impact ***regional resource strategy economics***

YOU ARE HERE

GENESYS

RPM

YOU ARE HERE

Hourly analysis in GENESYS creates quarterly ARMs and ASCCs, which the RPM uses ***to select an adequate resource strategy***

Check A Strategy

AURORA Buildout

Long term capital expansion for the WECC ensures that a check in AURORA is informed by an ***adequate system*** that ***meets policies***

AURORA Check

Candidate ***regional resource strategy*** may be checked within the context of the WECC to ensure we are ***consistent with policies*** and ***operational feasibility*** within a WECC-wide context.

RPM

GENESYS Check

Candidate ***regional resource strategy*** is checked in GENESYS to ensure the ***system is adequate*** and ***operationally feasible***.

What Changes Between Scenarios?

- **Adequacy Reserve Margins**
  - Will likely change in many of the scenarios where the following is true:
  1. Market price, composition, structure or reliance levels change significantly
  2. Existing resources are retired on a different schedule than baseline
  3. Existing and new resources dispatch based on a emissions price
- **Associated System Capacity Contribution Array**
  - Will likely not change in most scenarios.
  - Is designed to work with multiple scenarios.

Assumptions and Methodology Review

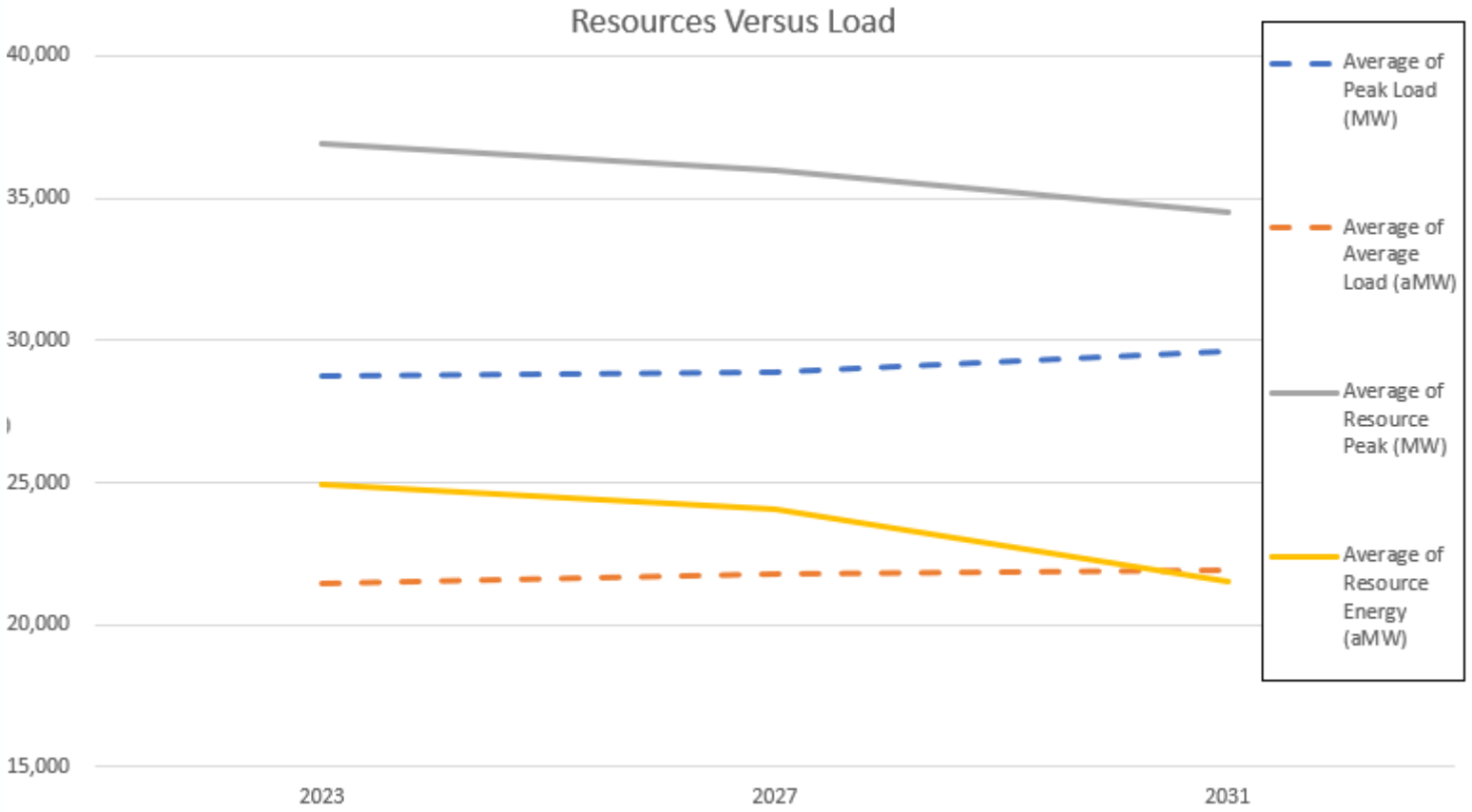
Existing resources, market availability and size, reserves

Review: Existing Resources

For the Baseline Needs Assessment for the plan:

- Inside the region: No additional generating resources or EE, coal retirements as currently announced.
  - Jim Bridger 1 out after 2023
  - Centralia 2 and North Valmy 2 out after 2025
  - Jim Bridger 2 out after 2028
- Outside the region: The long term AURORA buildout
  - Represented as extra-regional load forecasts as in AURORA and market supply price bins reflecting retirements and additions per the AURORA forecast
- Transmission limitations: Similar to AURORA

Review: Regional Portfolio Capability is Decreasing and Loads are Growing



Review: Market Reliance Assumptions in the Classic and Redeveloped GENESYS

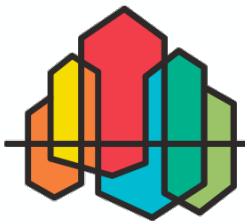
Resource	Redeveloped GENESYS Assumptions	Classic GENESYS Proposed Assumptions
Winter SW spot market	2,500 MW total all hours	2,500 MW all hours
Winter SW purchase ahead market	2,500 MW total all hours*	3,000 MW off peak hours
Winter IPP availability	Full (2,403 MW)	Full (2,403 MW)
Summer SW spot market	1,250 MW total all hours	1,250 MW 9am to 2pm
Summer SW purchase ahead	1,250 MW total all hours	No purchase ahead market
Summer IPP availability	Full (2,403 MW) all hours	Full (2,403 MW) 8am to 6pm
MT and WY wind	1,461 MW included	1,461 MW included

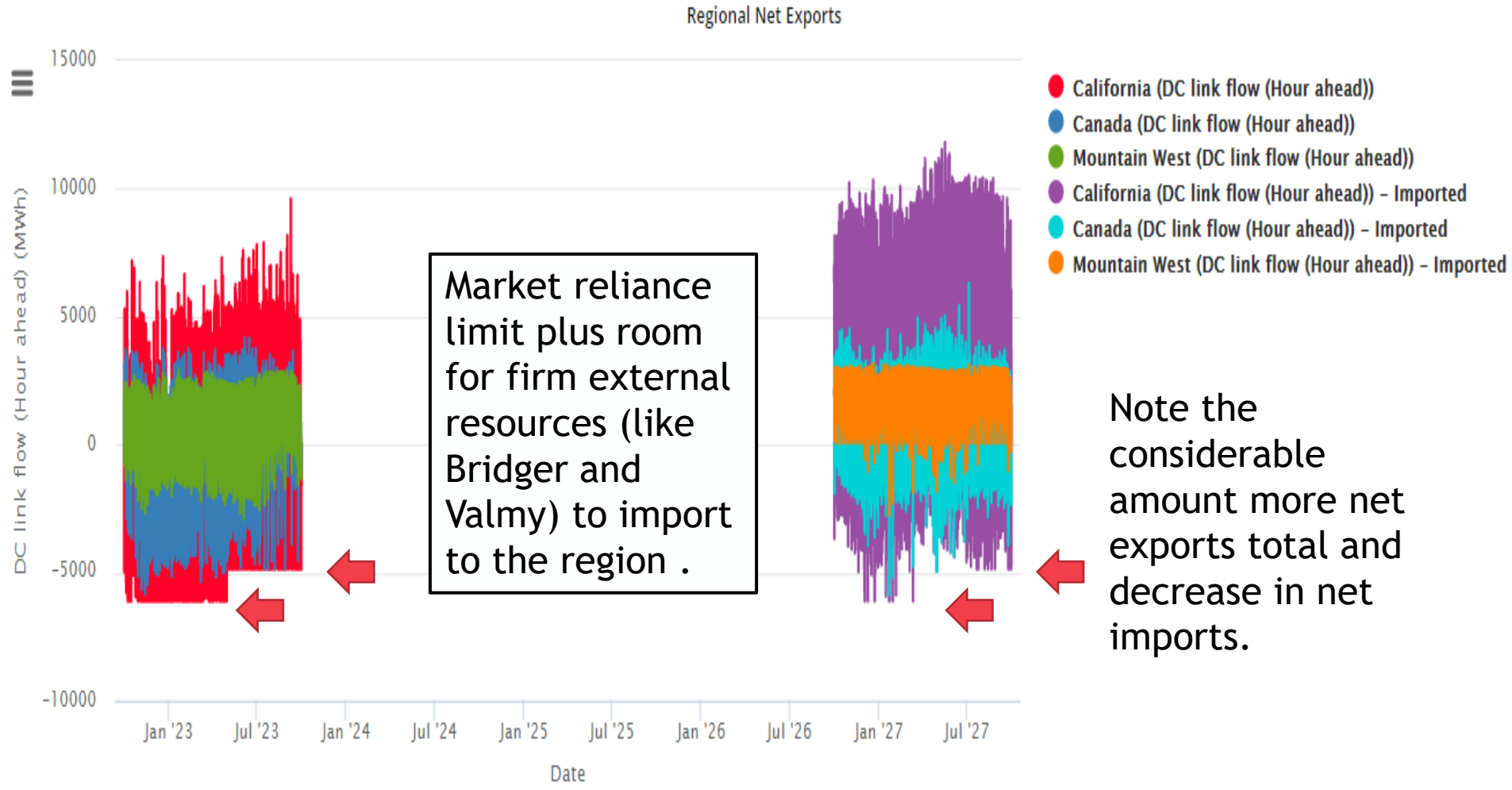
* See next slide (depends on market fundamentals)

Review: Incorporating Market Supplies

- Classic GENESYS – User provided fixed inputs
  - SW Spot Market – 2500 MW winter, 1250 MW summer (limited to 5 hours/day)
  - SW Purchase ahead – 3000 MW winter limited to off-peak hours, none in summer
  - Max 3400 MW total import (spot + purchase ahead)
  - SW market priced higher than any NW resource
  - NW IPP market resources – fully available (limited to 10 hours/day in summer)

- New GENESYS – Dynamic assessment of supply, user provided limitations
  - Simulates dispatch of out-of-region resources & loads
  - User can limit imports into the PNW by season (after accounting for regional resources that are physically outside our region)
  - No option to control hour-of-day market availability
  - NW IPP market resources available to all markets (not just the PNW)
  - Market exchanges (for all regions) based on price dynamics

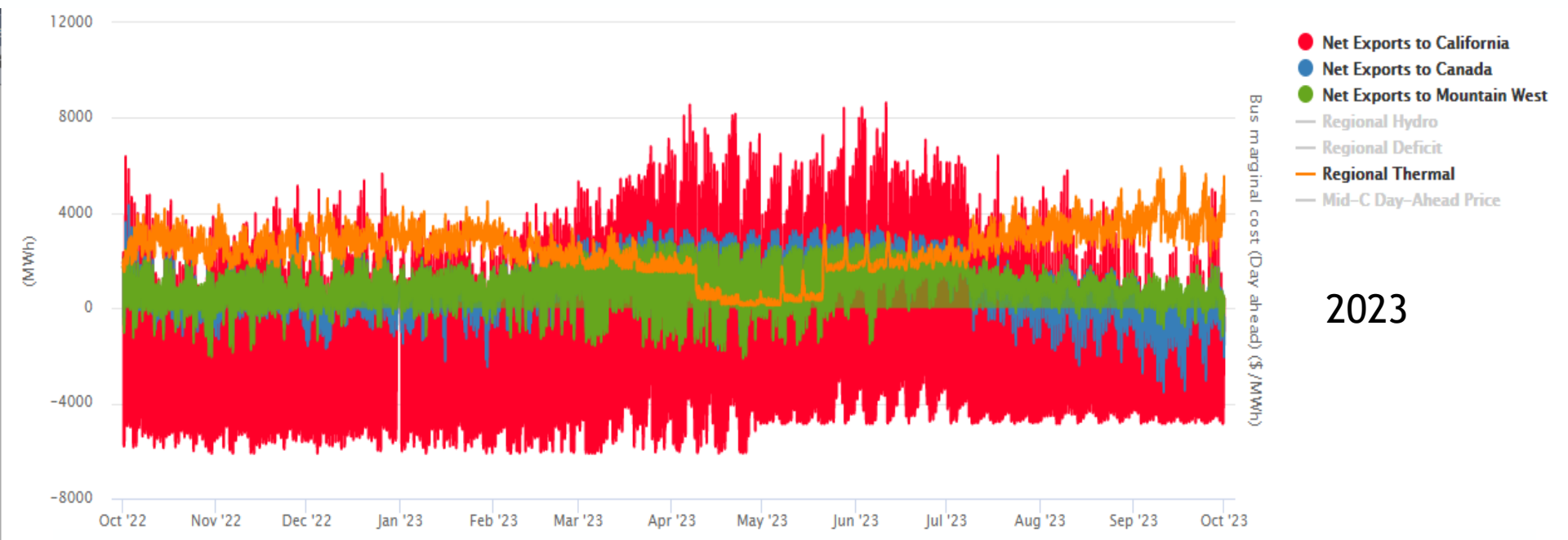




Market reliance limit plus room for firm external resources (like Bridger and Valmy) to import to the region .

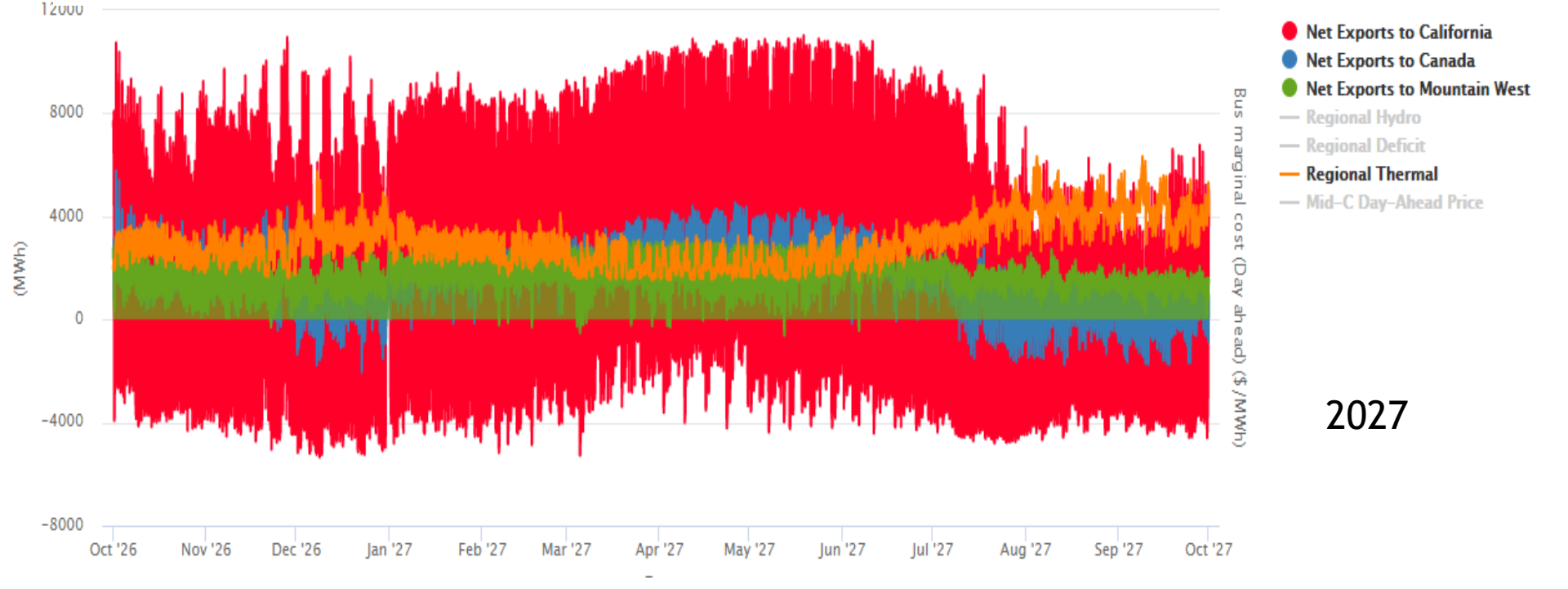
Note the considerable amount more net exports total and decrease in net imports.

Comparison between 2023 and 2027 net market position by net export region.

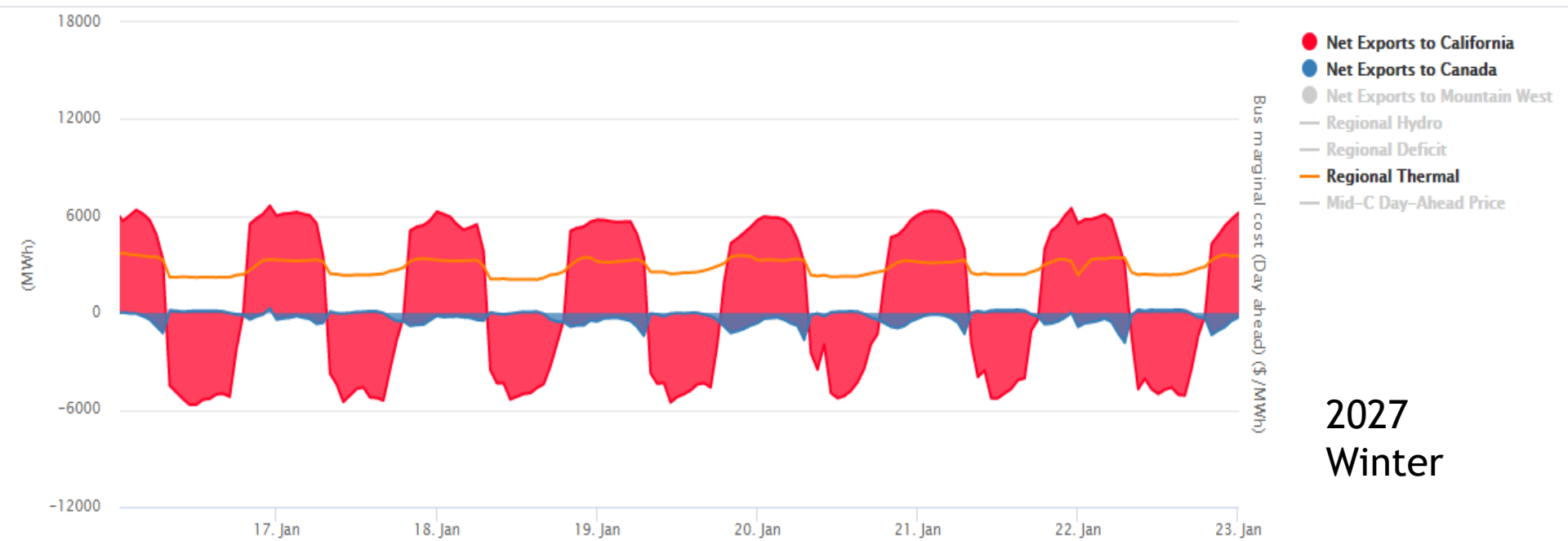


2023

Out of region supply creates dramatic day/night import export dynamic.

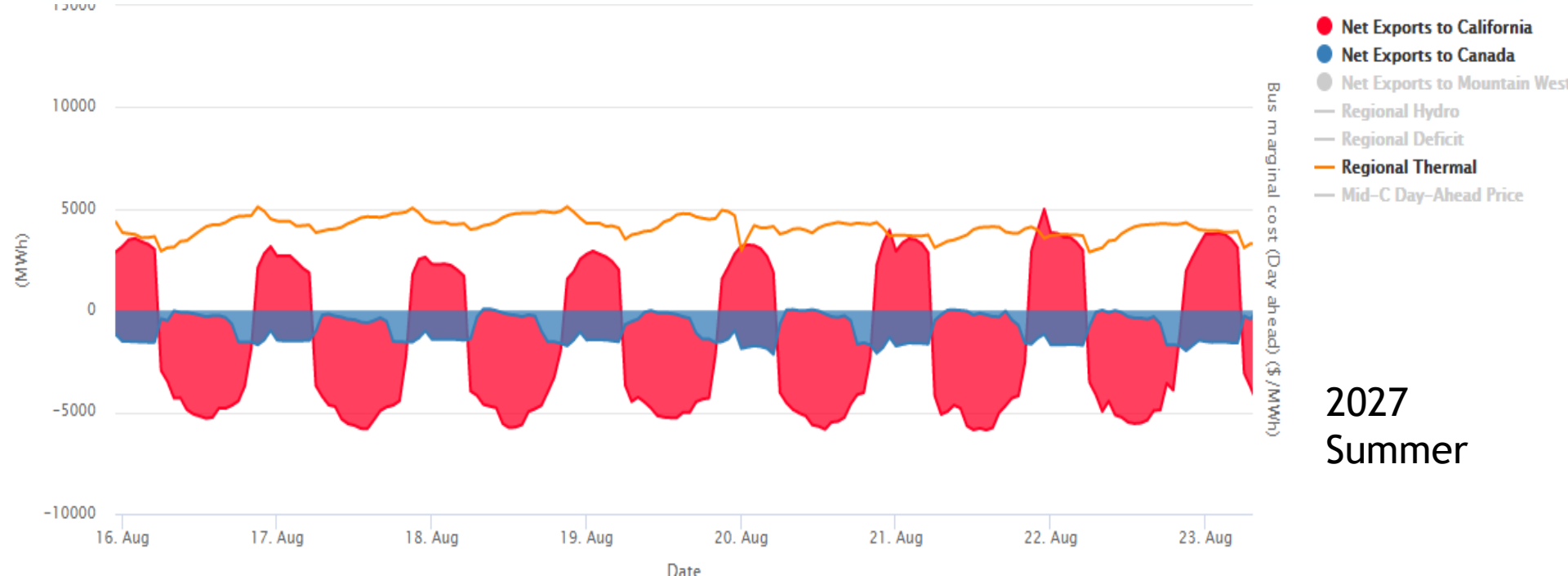


2027



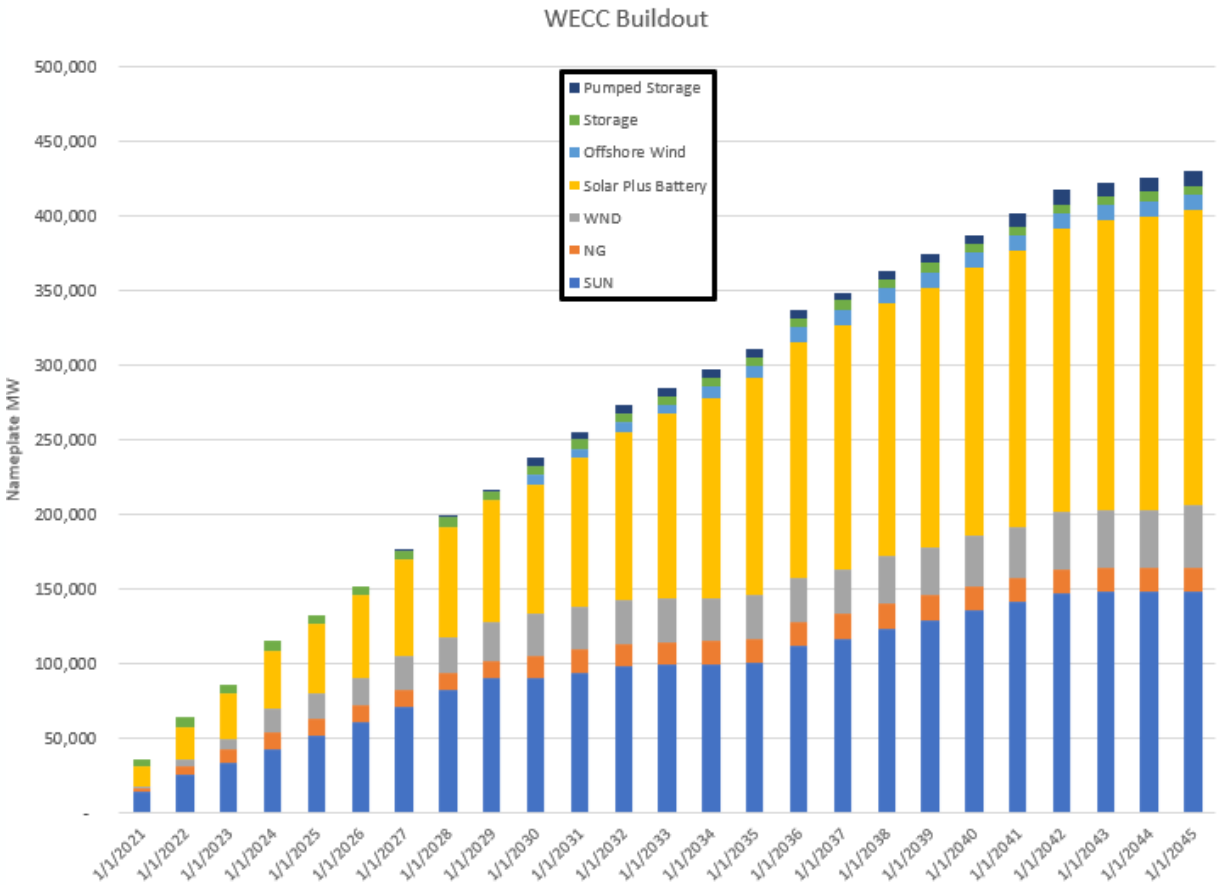
2027
Winter

In summer, BC has more supply available to export in the evening…

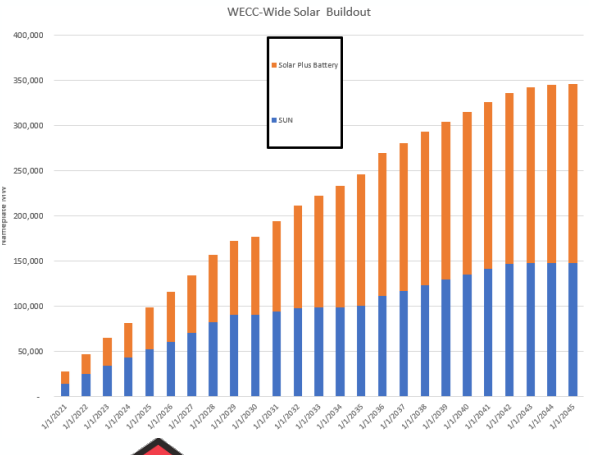


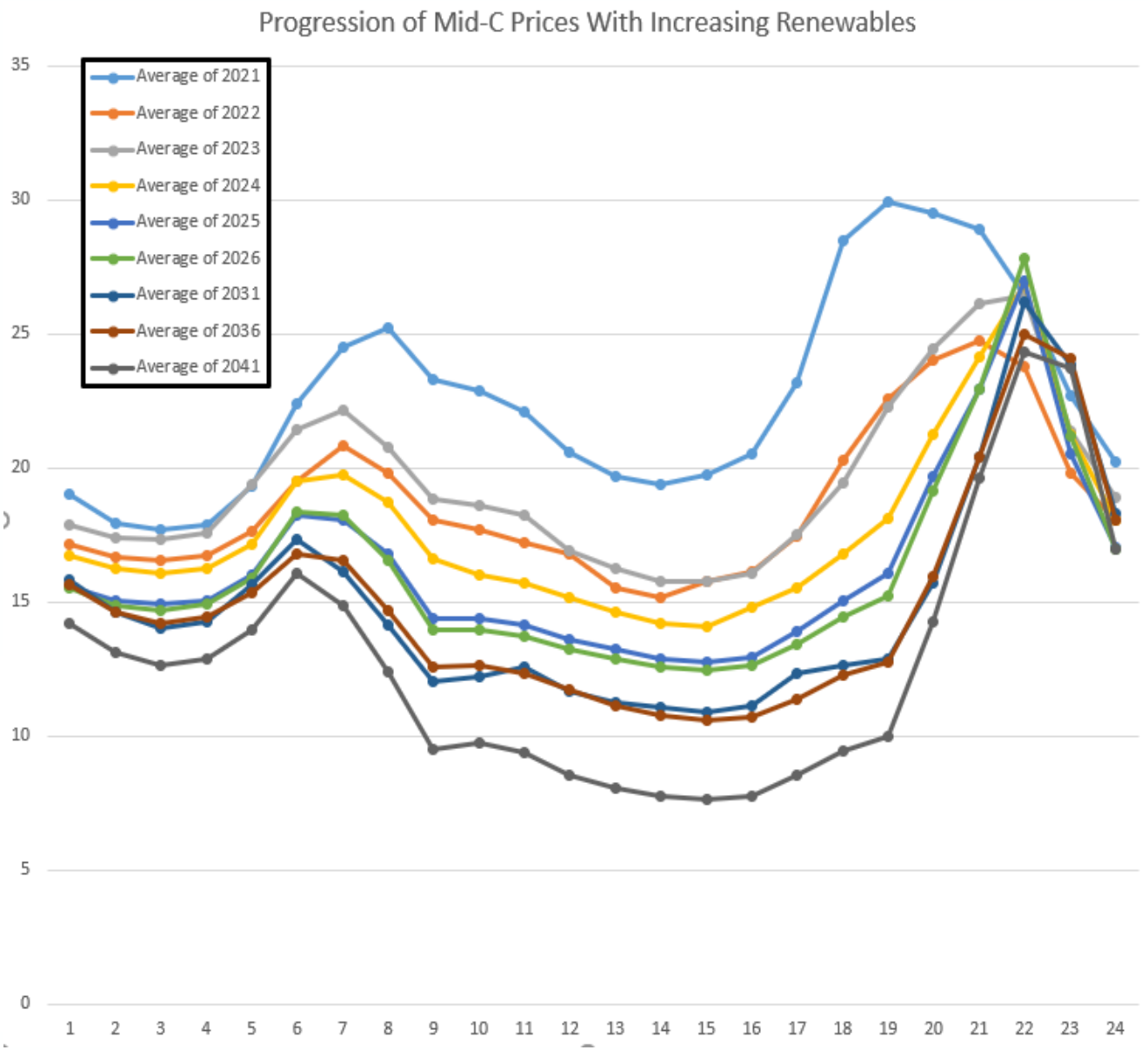
2027
Summer

Even though **net** market reliance is limited the large external buildout still effects market supply fundamentals



Daily shape changes with more WECC-wide solar



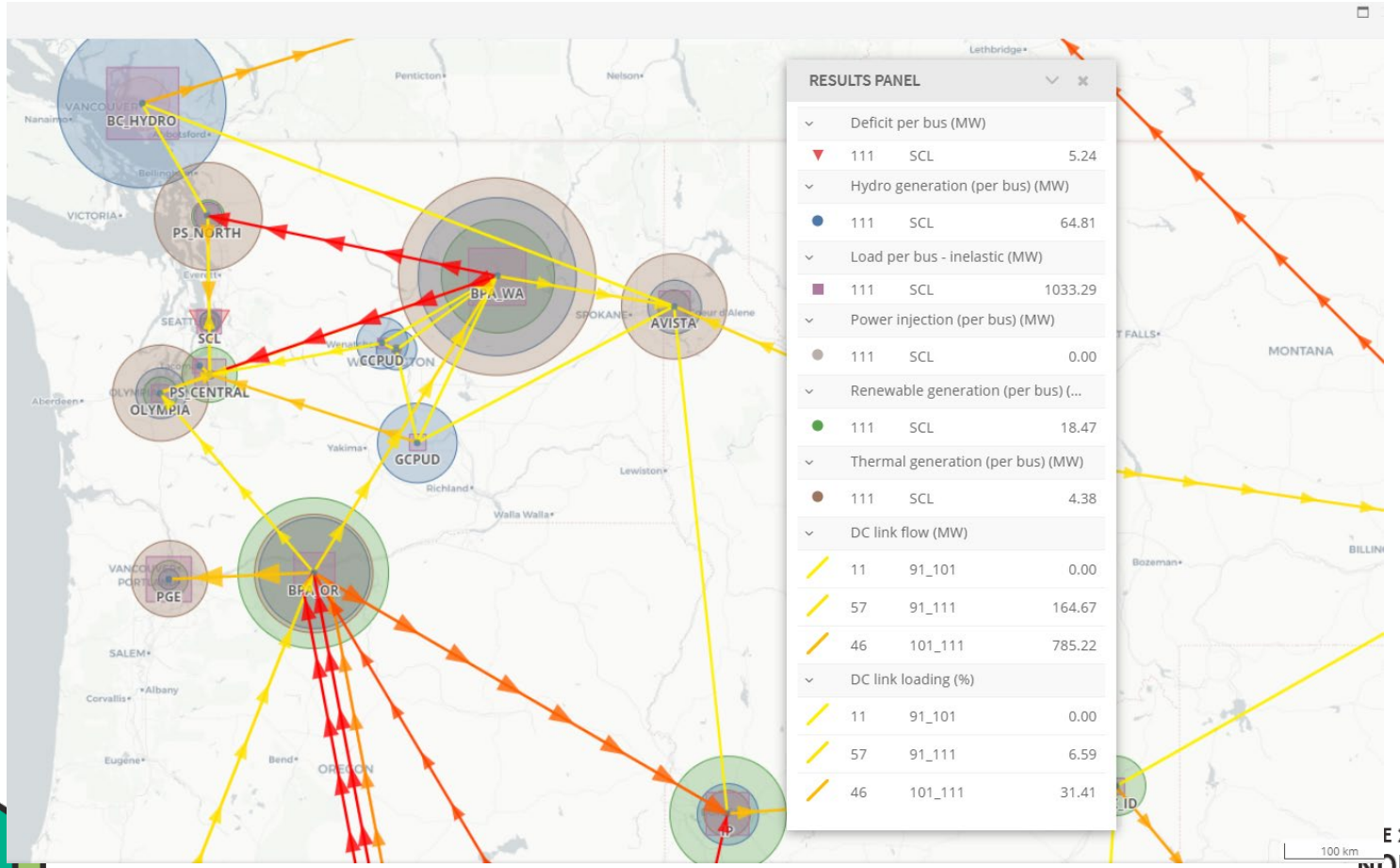


Review: Balancing Reserve Assumptions

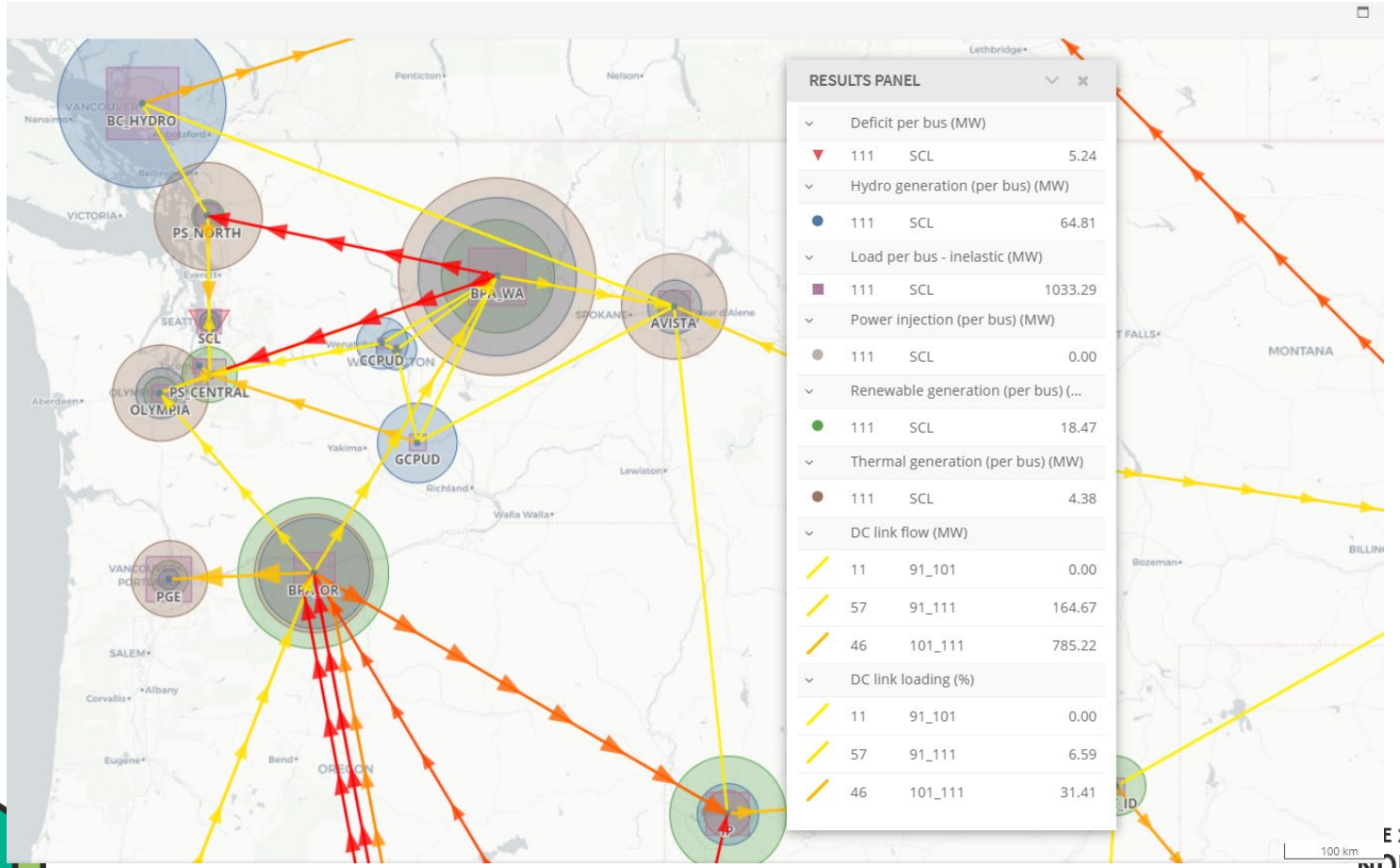
Per Northwest Power Pool EIM Study (public data)

1. **Each BA has to hold and provide balancing reserves specified in the study on existing (or new) resources**
   - Consistent with assumptions for AURORA
   - Fidelity on a monthly basis for hour of day
2. **No balancing reserve sharing between BAs**
   - Very conservative considering all entities would be in EIM and holding all the reserves from the NWPP EIM study should ensure sufficiency
   - Since the model does not currently reserve transmission for reserves there was some congestion/reserve provision adequacy issues for utilities with remote resources (SCL, PGE, PSE, PAC) that would not happen in operations (per modern transmission scheduling practices).

Example: On Sept 2nd, at 8 am, there is a small deficit in Seattle. The region is long in aggregate and could have covered the deficit with contingency reserves but this is still considered an adequacy event for planning purposes. Why?



While theoretically this could still be an issue, in the model this is happening because firm transmission is not scheduled for reserve provision. In practice, the transmission likely would have been scheduled…



Fuel Accounting for All Resources

Reserve Provision

1. **All resources must have fuel available to provide reserves**
   - Energy limited resources (Hydro, demand response, batteries and pumped storage)
   - Variable availability fuel resources (Wind, solar and hydro)
   - On call fuel resources with limits (most gas resources)
   - On call fuel resources with no limits (some gas and coal resources)
2. **Future value of stored fuel**
   - Hydro (also pumped storage and batteries to an extent)
3. **Conservative assumption on gas fueling flexibility**
   - Draft and pack limits at 3% with exception of plants with access to storage (eastside gas likely has more flexibility)
   - One nomination assumed per day (5 nomination windows)

SAAC and Stakeholder Feedback

- Concern about market effects on adequacy
  - Market reliance limits are effectively mitigating much of these concerns and are definitely responsible for more adequacy events in the simulations
  - Testing of different market conditions is a planned part of scenario work especially the scenario focused on market reliance and organized markets
- Some forecast error based events are reasonable, should there be so many?
  - Staff implemented two changes since that time that significantly reduced the forecast error related outages
    - Allow balancing reserve sharing (as is current practice in the EIM) to address transmission reserve issue
    - Allow eastside gas plants to vary more significantly off gas nomination schedule

Changes in Methodology per Staff Observations and SAAC Feedback

Increase fuel flexibility of eastside gas units (existing and new)

- Change from ± 3% to ± 50% the daily nomination schedule for all units with access to eastside gas
- Fix issue related to units with gas limitations inability to provide reserves.

Work around transmission reservation issue for reserves held on remote resources to reduce forecast error related deficits

- Let regional reserves to be the sum of the maximum balancing reserves held by each BA (maintain sufficiency)
- Allow reserves to be shared within the region in the true up stage (allow for sharing of reserves

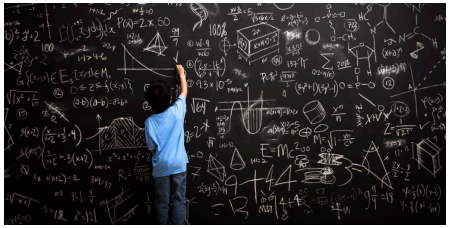
Reduce negative capacity contributions

- Start with a less adequate system (maybe a different base year, maybe more retirements…)

1. **Increased load to similar magnitude highest load future in RPM**
2. **Retired all coal in region by 2031**

Adequacy Reserve Margin Results

Review: Calculation of Adequacy Reserve Margins



- $ARM_C = \frac{(Existing\ Resource\ Peak\ Capability + \boldsymbol{X_C} - Peak\ Load)}{Peak\ Load}$

- $\boldsymbol{X_C}$ is the amount pure capacity in a quarter that would eliminate all peak shortages in 95% of the simulations

- $ARM_E = \frac{(Existing\ Resource\ Average\ Energy + \boldsymbol{X_E} - Average\ Load)}{Average\ Load}$
- $\boldsymbol{X_E}$ is the amount energy in a quarter that would eliminate all energy shortages in 95% of the simulations

Note that these calculations allow the 5% adequacy criteria to be translated into something like a "planning reserve margin."

Effects of New Features on LOLP: Redeveloped GENESYS versus Classic GENESYS

1. Out-of-region market supply **Decrease**
   if supply is limited to classic GENESYS assumptions (due to dynamic vs. prescribed hourly availability)
2. Plant specific hourly hydro simulation: **Increase**
   New model has more hourly operating constraints, but classic model sustained peaking may be conservative
3. Multiple NW nodes: **Increase**
   Classic GENESYS only models 2 NW nodes
4. Unit commitment: **Increase**
   Classic GENESYS has very limited unit commitment logic
5. Dynamic balancing reserves: **Increase**
   Classic GENESYS only includes a fixed allocation of hydro reserves and no thermal reserves
6. Forecast error: **Increase**
   Classic GENESYS does not model forecasting error
7. Optimization: **Decrease**
   All else being equal, this should lower LOLP in order to reduce curtailment costs

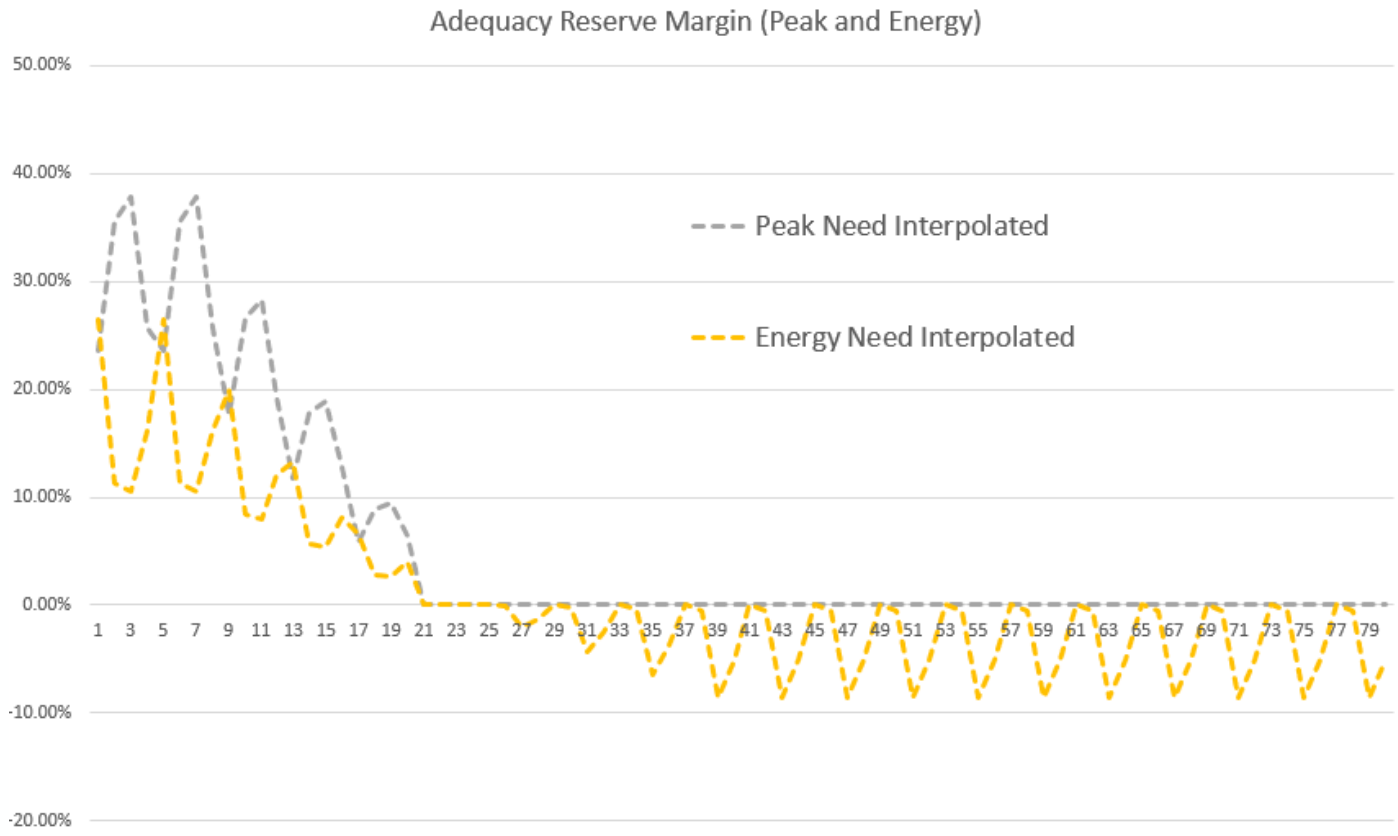
2023 LOLP	2025 LOLP	2027 LOLP	2031 LOLP
32%	27%	1%	3%

Classic GENESYS result

Forecast error and unit commitment are still associated with deficit issues in around 40% of the games in 2023 but far fewer events within the games.

Summary of Adequacy Reserve Margin Results

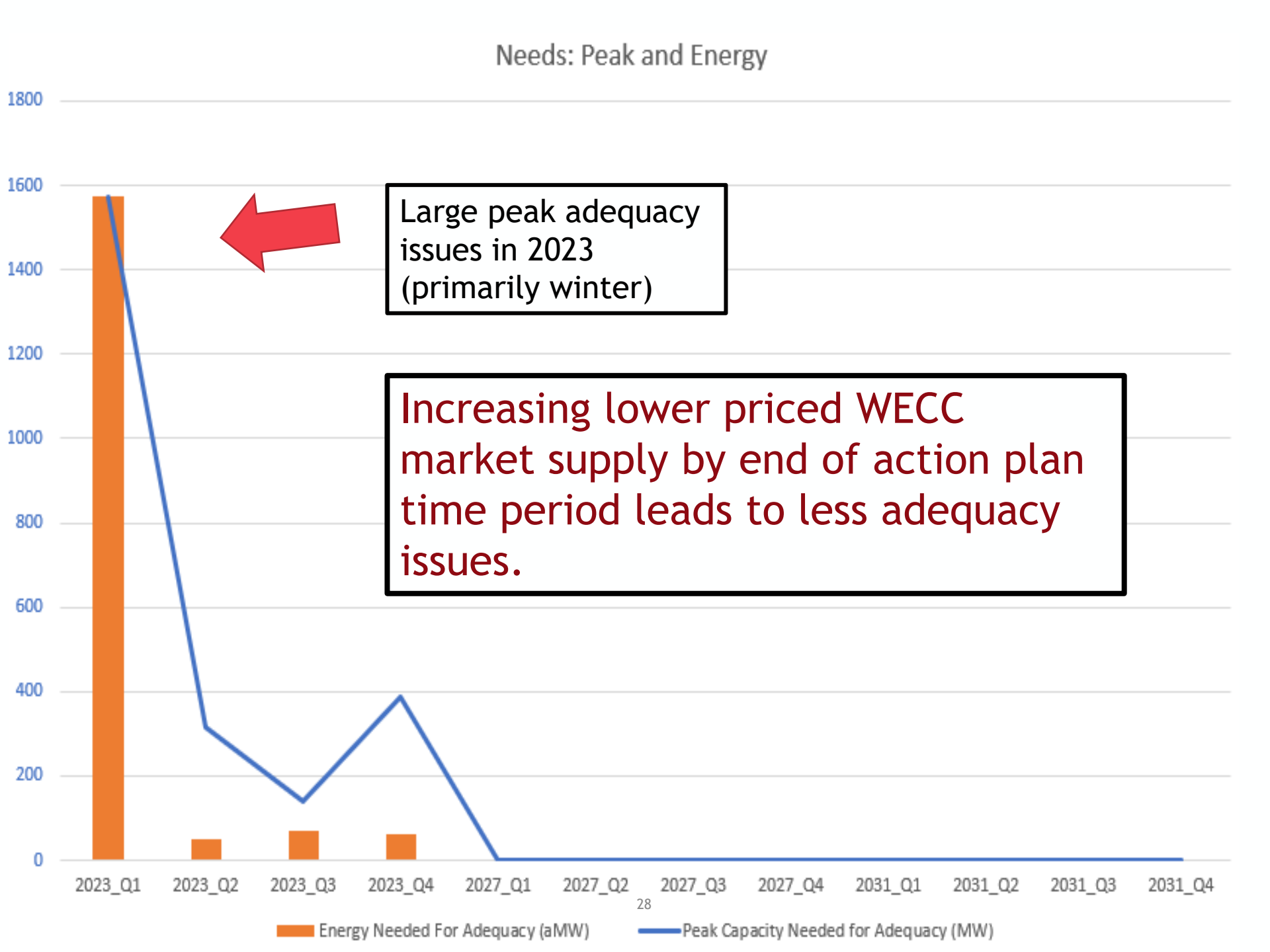
- Required reserve margin to meet a 5% LOLP standard decreases over time on a peak and energy basis.



Observation:
System is becoming more adequate without adding resources!

Why?
Many low variable cost renewables built in WECC to meet policies and replace retired resources.

Even with limited market reliance, NW hydro is well positioned to utilize available surplus to relieve adequacy issues


Needs: Peak and Energy
1800
1600
1400
1200
1000
800
600
400
200
0
Large peak adequacy issues in 2023 (primarily winter)
Increasing lower priced WECC market supply by end of action plan time period leads to less adequacy issues.
2023_Q1
2023_Q2
2023_Q3
2023_Q4
2027_Q1
2027_Q2
2027_Q3
2027_Q4
2031_Q1
2031_Q2
2031_Q3
2031_Q4
Energy Needed For Adequacy (aMW)
Peak Capacity Needed for Adequacy (MW)

ARM Results Summary

High Level Purpose

The RPM uses the ARM results to translate the Council's adequacy requirement of 5% into peak capacity and energy needs the regional portfolio must meet to be adequate.

Observations

- Significant adequacy issues due to forecast error, unit commitment issues and more detailed operational considerations.
- Adequacy issues decrease over time due to increase in inexpensive external market supply even though *net* market reliance limit is held constant.

Capacity Contribution Results

After a bunch of caveats…

Associated System Capacity Contribution (ASCC) Purpose

- **Is not** a "capacity factor"
- **Is not** a "effective load carrying capability"
- **Is** the capacity contribution associated with adding a particular portfolio of new resources in context of the existing system.
  - Like the ARM is just a way to turn the 5% LOLP adequacy criteria into a quarterly need
  - The ASCC is just a way to get a portfolio of resources expected capacity contribution in terms of how many of those quarterly needs it can address specific to how the RPM considers peak adequacy.
  - The ASCC is specific to the regional footprint and portfolio

These numbers only mean something in context of the RPM

Pup Quiz!

Should I use the Council's ASCC numbers as a proxy for capacity factor or ELCC for my own portfolio?

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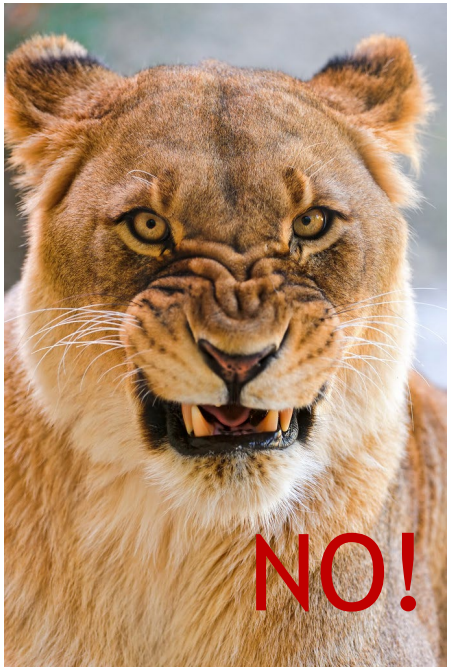

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Associated System Capacity Contribution is designed **specifically** for use in the RPM tuned to the regional or BPA footprint

Associated System Capacity Contribution – *A Project Management Tool*

- Without lots of iterative hourly studies we can take complicated operational aspects of a set of resources or resource types and convert those into a simple peak capacity contribution indexed by the amount of resource added.
  - Even so, it took over 100 hours of staff/contractor time and significant cloud computing budget just to execute and process the results from 11,610 simulations.
- Allows RPM to be focused on testing policy scenarios over many futures and not take weeks to complete one run.
- A few notes:
  1. It would be calculated differently if we did not use LOLP as our adequacy metric
  2. It is calculated differently per the assumptions in the model used to estimate it.
     - Market economics and reliance key assumptions, but market reliance limits significantly limit effect of market economics.

Assumptions

This run is designed to be representative of the capacity contribution and work with as many scenarios as possible.

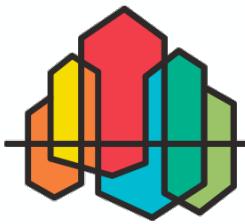
- Similar to 2031 ARM simulation (with two exceptions)
  1. All regional coal units retired
  2. Regional load increased by 8%, which is similar in magnitude to the highest 2031 load future in the RPM
  3. Examine 30 different hydro conditions and temperature years with 3 different associated wind conditions.
- Recall both the ARM and ASCC are really just metrics we use to pass information to the RPM to ensure that when we check a resource strategy that it meets the Council adequacy standard of 5% LOLP.

Resource Types and Amounts Tested in the ASCC Array

- Staff ran all 128 combinations of these resource type amounts. Each combination has 4 quarterly ASCC values.
  1. **0 MW** and **2750 MW Thermal**
     - modeled as 2 CCCT and 4 SCCT on the east side of the region (also modeling proxy for existing coal)
  2. **0 MW** and **3000 MW Short Duration Energy Limited Resources**
     - modeled as 300 MW, 4 hour batteries in 10 different BAs
  3. **0 MW** and **2000 MW Long Duration Energy Limited Resources**
     - modeled as three 8 hour pumped storage plants (one 1200 MW and two 400 MW)
  4. **300 aMW** and **3500 aMW EE**
     - modeled as a proportional reduction in load in every BA in the region with hourly shapes appropriate to the first few and almost all the bins of EE, respectively
  5. **0 MW** and **5000 MW Solar**
     - modeled as five 1000 MW east side solar plants
  6. **0 MW** and **6000 MW Montana and SE WA Wind –**
     - modeled as a one ASCC resource type and two 1500 MW plants.
  7. **0 MW** and **1900 MW Gorge Wind**

Use of the ASCC Array in the RPM

- The 128 different discrete combinations of resource portfolios are entered into the RPM.
- A multilinear interpolation is used to allow the RPM approximate the capacity contribution of any new resource build in the RPM.
- Thus, no matter what resource strategy is in the RPM, the RPM uses the ASCC array to see how much it reduces peak needs.



Modified ASCC Methodology – Using two sets of GENESYS simulations

1. Base run maximum deficits by game g and quarter q

$$Max(Deficits^{Base})_{g,q}$$

2. Run with capacity added maximum deficits by game g and quarter q

$$Max(Deficits^{ResourceAdd})_{g,q}$$

3. Calculate difference by game g and quarter q

$$\Delta_{g,q} = Max(Deficits^{Base})_{g,q} - Max(Deficits^{ResourceAdd})_{g,q}$$

4. Take the expected value of those differences over all the games and divide by size of resource, R, gets selected in RPM*

$$E(\Delta_{g,q}) \,/_{R}$$

*Nameplate MWs for all but EE which is selected by aMW

Peak needs **before** adding resources

Peak needs **after** adding resources

Peak needs **reduction by** adding resources

Expected peak needs contribution by adding resources

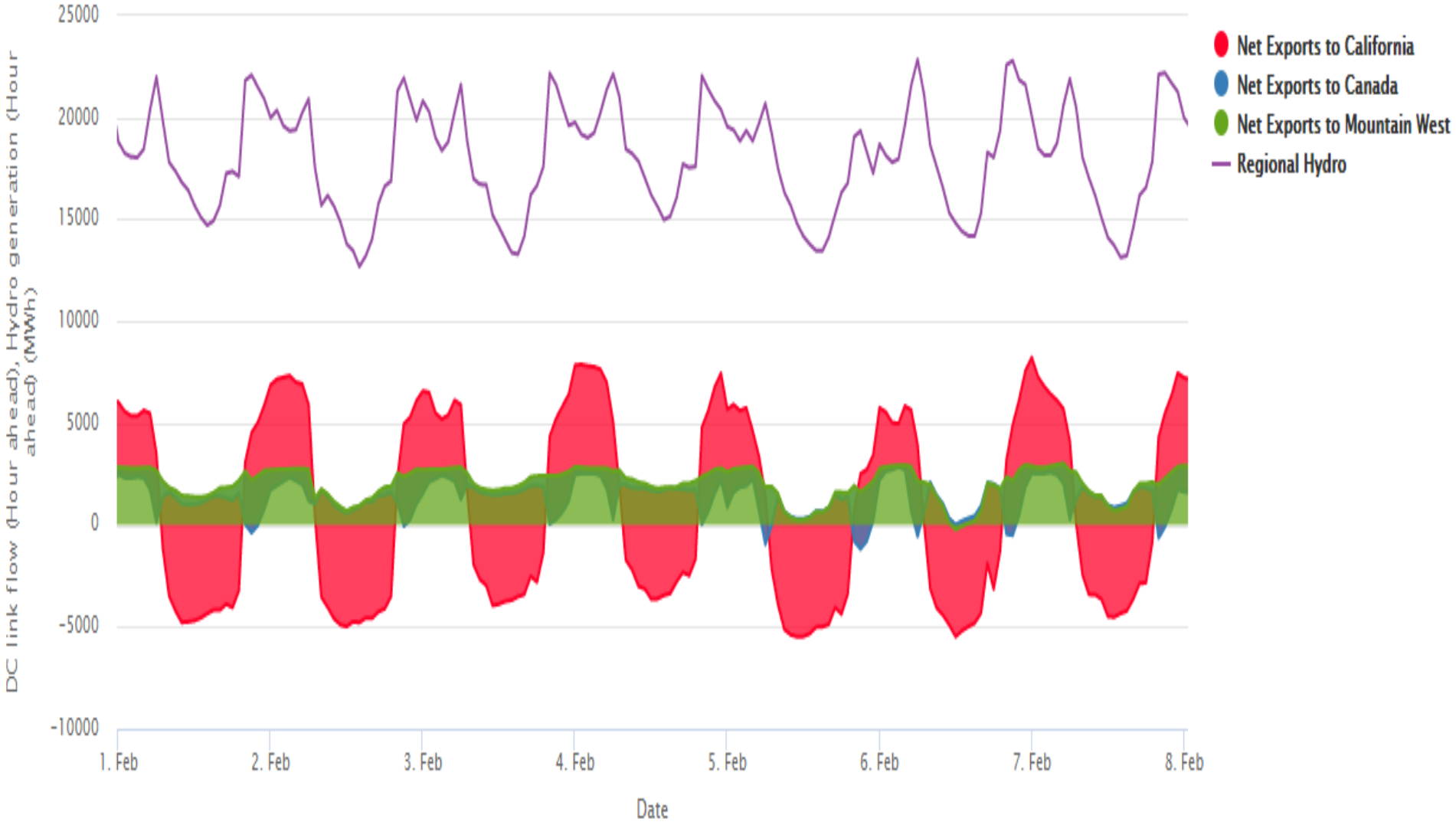
Examples of Capacity Contribution Results

This implies 300 aMW of EE reduces 965 MW of winter need.

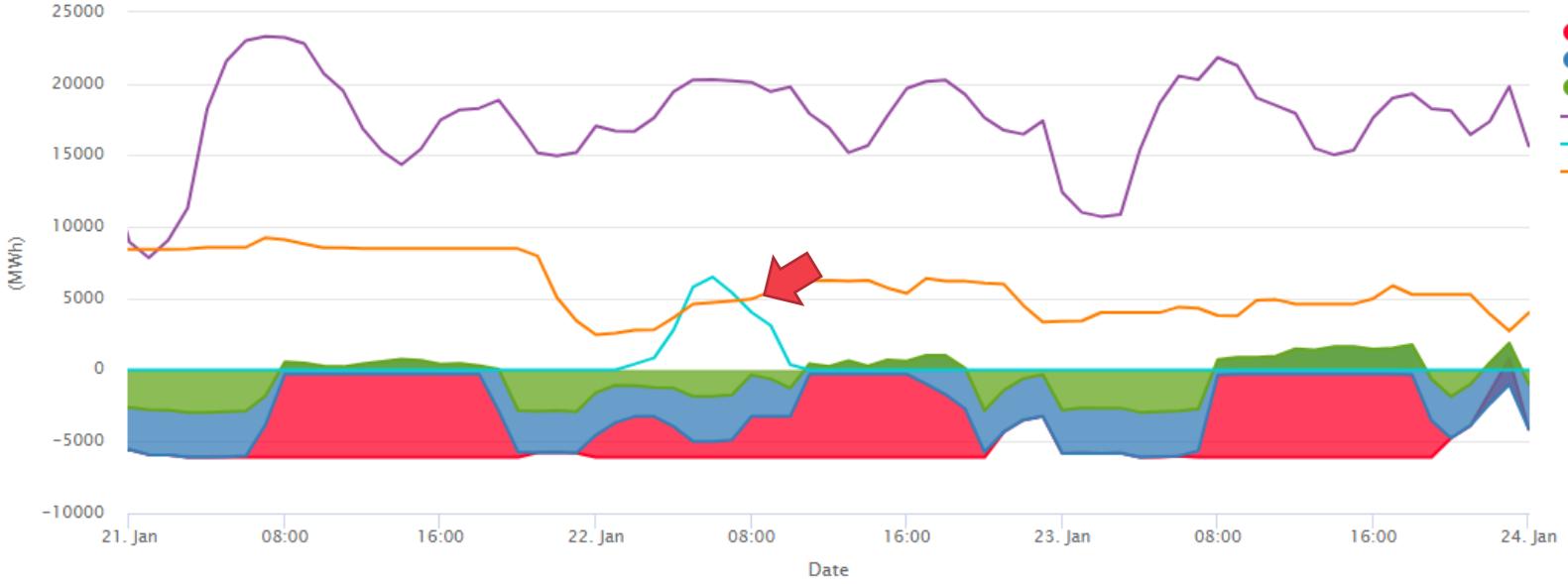
Quarter	300 aMW EE	Peak needs reduction after adding 300 aMW		300 aMW EE and 5000 MW of solar	Peak needs reduction after adding 300 aMW and 5000 MW of solar
1	3.21	965 MW		1.14	6016 MW
2	0	0 MW		0.02	125 MW
3	0.17	51 MW		0.06	332 MW
4	0.10	29 MW		0.16	844 MW

Different Resource Combinations Reduce Needs More Efficiently

Resource Combination	Total Resource Add	Q1 Peak Needs Met	Q2 Peak Needs Met	Q3 Peak Needs Met	Q4 Peak Needs Met
300 aMW EE	300	965	0	51	29
300 aMW EE and 5000 MW Solar	5300	6016	125	332	844
300 aMW EE and 3000 MW Montana and SE WA Wind	3300	3337	0	209	1570
300 aMW EE and 1900 MW Gorge Wind	3300	8361	0	254	1276
300 aMW EE and 2000 MW Long Duration Energy Limited	2300	8361	125	228	1251
300 aMW EE and 3000 MW Short Duration Energy Limited	3300	8361	125	367	1963
300 aMW EE and 2550 MW Thermal	2850	8361	125	287	1263

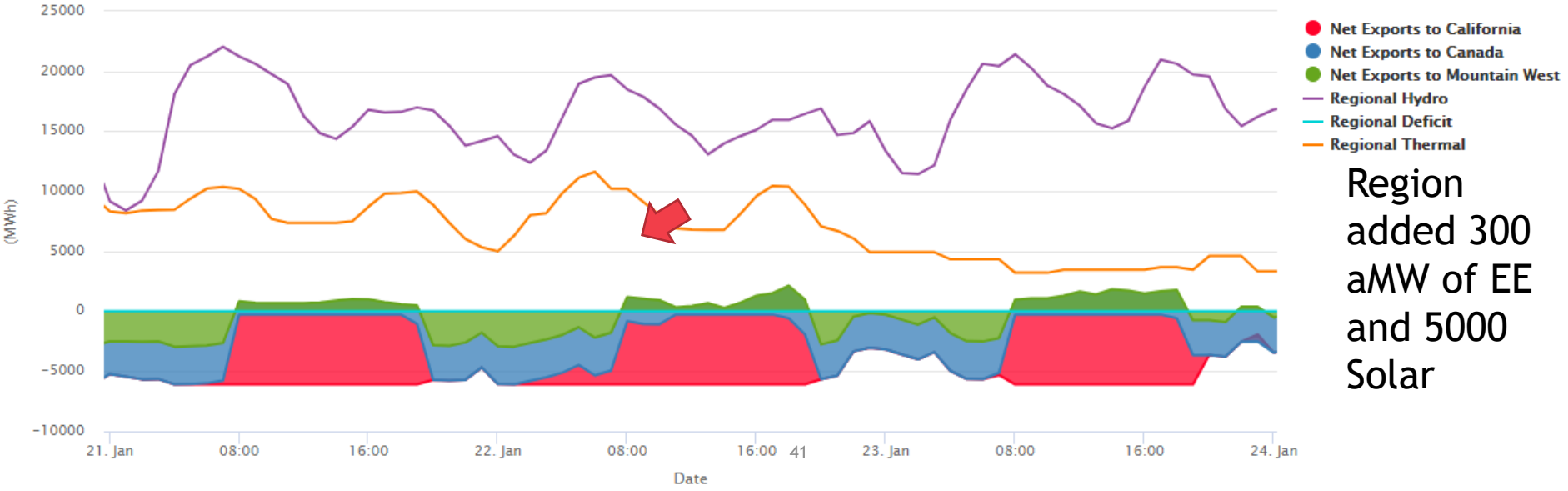


In most days of all seasons and scenarios, NW and BC import excess power from the SW during the day and export during the night, but when there are adequacy issues the dynamics can look different



ASCC Base

When there is an adequacy event, the hydro system may have the capacity but not the fuel to meet regional needs. In this case, almost an 9000 MW deficit is negated by adding 300 aMW and 5000 nameplate solar.



Region added 300 aMW of EE and 5000 Solar

ASCC Results Summary

High-Level Purpose:

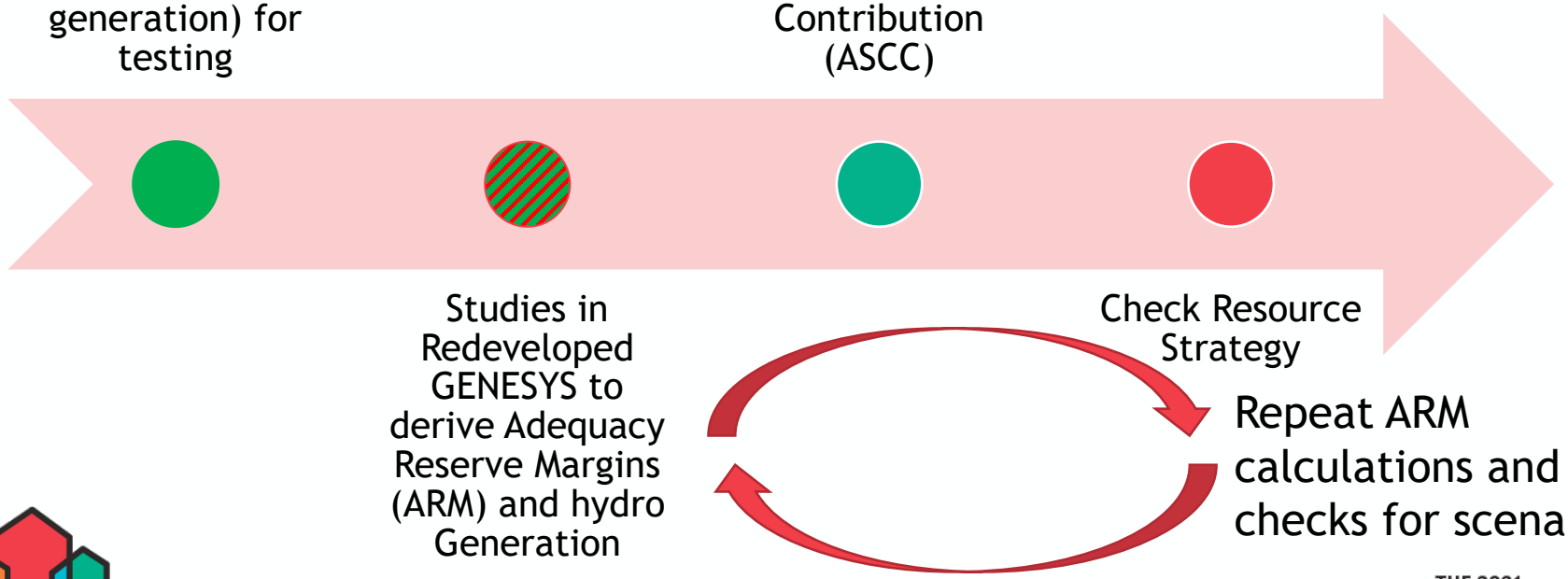
- Use ASCC array to pass information on how different resource combinations can be expected to reduce peak needs as established by the ARM.

Observations:

Staff is still analyzing the results, but so far…

- EE is very effective at eliminating needs.
- Winter Needs: (Traditional capacity and energy issues)
  All resources are effective at addressing.
- Spring Needs: (Flexibility issues)
  Tend to be more difficult to eliminate, but energy limited resources and thermals tend to be most effective.
- Summer Needs: (Many forecast error and ramping issues)
  Tend to be more difficult to eliminate, but energy limited resources, EE and Gorge wind seem most effective.
- Fall Needs: (Less hydro to absorb solar)
  All non-solar resources address fairly effectively.

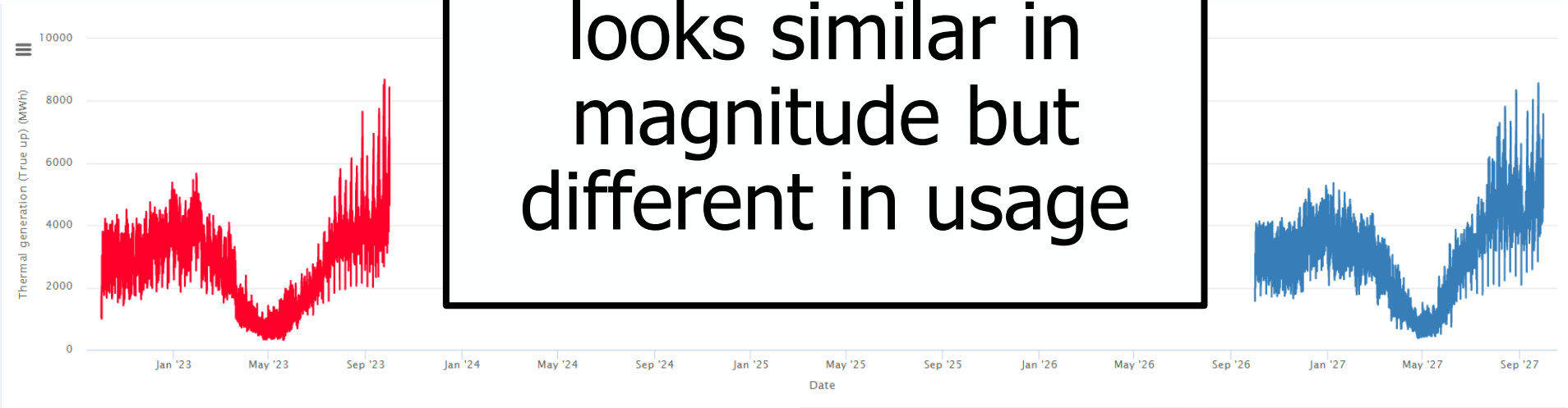
Next Steps: Ensuring a Resource Strategy is Adequate



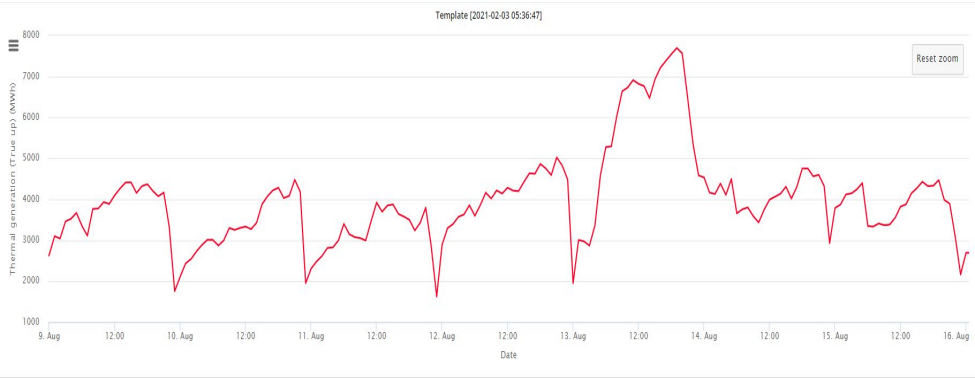
Questions

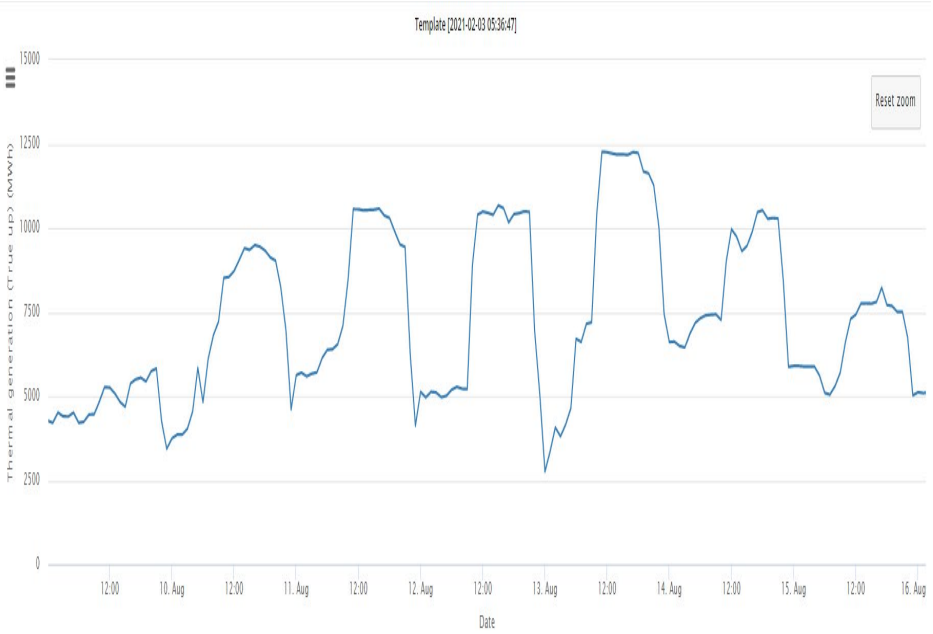
jollis@nwcouncil.org – John Ollis

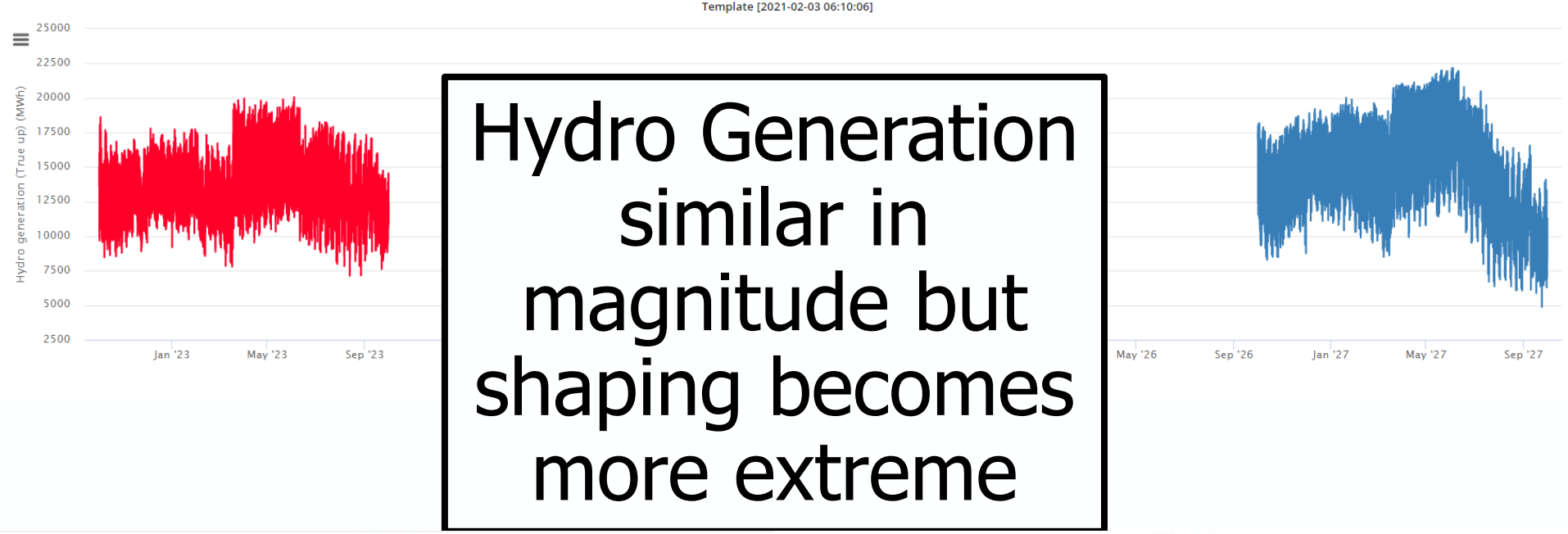
Thermal Generation looks similar in magnitude but different in usage



More cheap solar available midday, even in summer shifts thermal use for capacity and adequacy purposes







Hydro Generation similar in magnitude but shaping becomes more extreme