April 27, 2021

MEMORANDUM

TO: **Council Members**

FROM: **John Fazio**

SUBJECT: **2021 Power Plan Resource Adequacy Assessment**

BACKGROUND:

Presenter: John Fazio, Senior Systems Analyst

Summary: Staff will brief the Council on the resource adequacy assessment to be included in the 2021 Power Plan. Analysis from the Council's redeveloped GENESYS model projects an adequacy need over the next few years, followed by minimal resource needs throughout the planning period horizon. To maintain adequacy, an estimated 1,600 MW of added capacity is needed by 2023. After 2023, and despite additional coal plant retirements, adequacy can be maintained throughout the study horizon primarily due to the high level of expected renewable resource buildout across the West and the opportunity to optimize the utilization of the existing hydro and gas-fired resource fleet. However, because of the inherent uncertainty in future West-wide resource expansion and because of the potential for high electricity demand growth due to electrification, the Council could choose to propose a higher level of resource development in its resource strategy to offset these risks.

Workplan: Action item Res-8: Adaptive Management: To track Seventh Power Plan implementation and adapt as needed, the Council, in cooperation with regional stakeholders, will provide an annual resource adequacy assessment.

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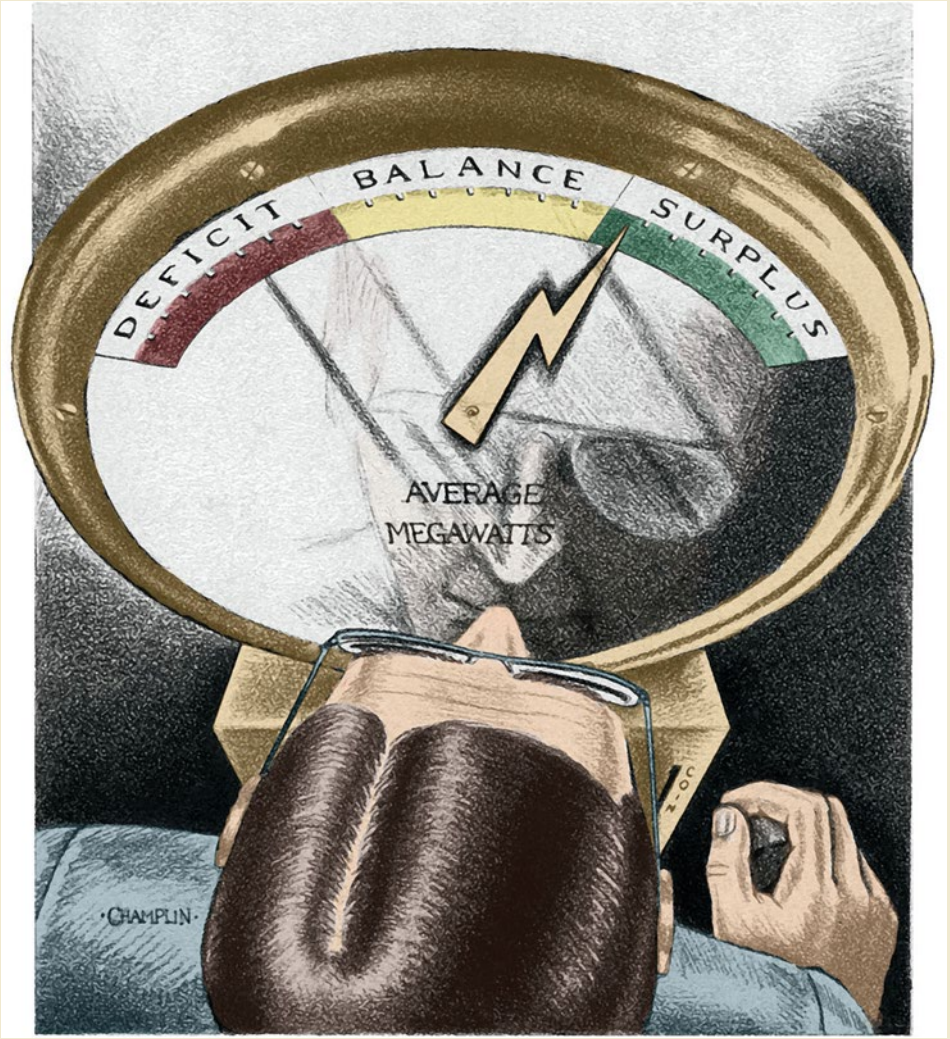
Background: The Council assesses the adequacy of the regional power supply annually as an early warning to gauge whether new resource development is keeping pace with load growth and with resource retirements. This year the resource adequacy assessment will be a part of the Council's 2021 power plan. This year's assessment differs from past assessments in three significant ways. First, primarily due to state clear air laws and policies across the West, acquisition of renewable resources has increased rapidly, which has affected market prices and has put more pressure on system operators to maintain reliable service. Secondly, because the region is now more likely to experience short-term capacity deficiencies, the Council chose to redevelop its adequacy model (GENESYS) to simulate hourly operations more realistically. Finally, the Council chose to use forward-looking projections for temperature and stream flows based on general circulation model analyses of climate change instead of the historical data used for previous assessments. Because of this new approach, the Council has had to take more time with stakeholders to vet the new model and climate change data and to interpret model results.

Power Plan Resource Adequacy Assessment



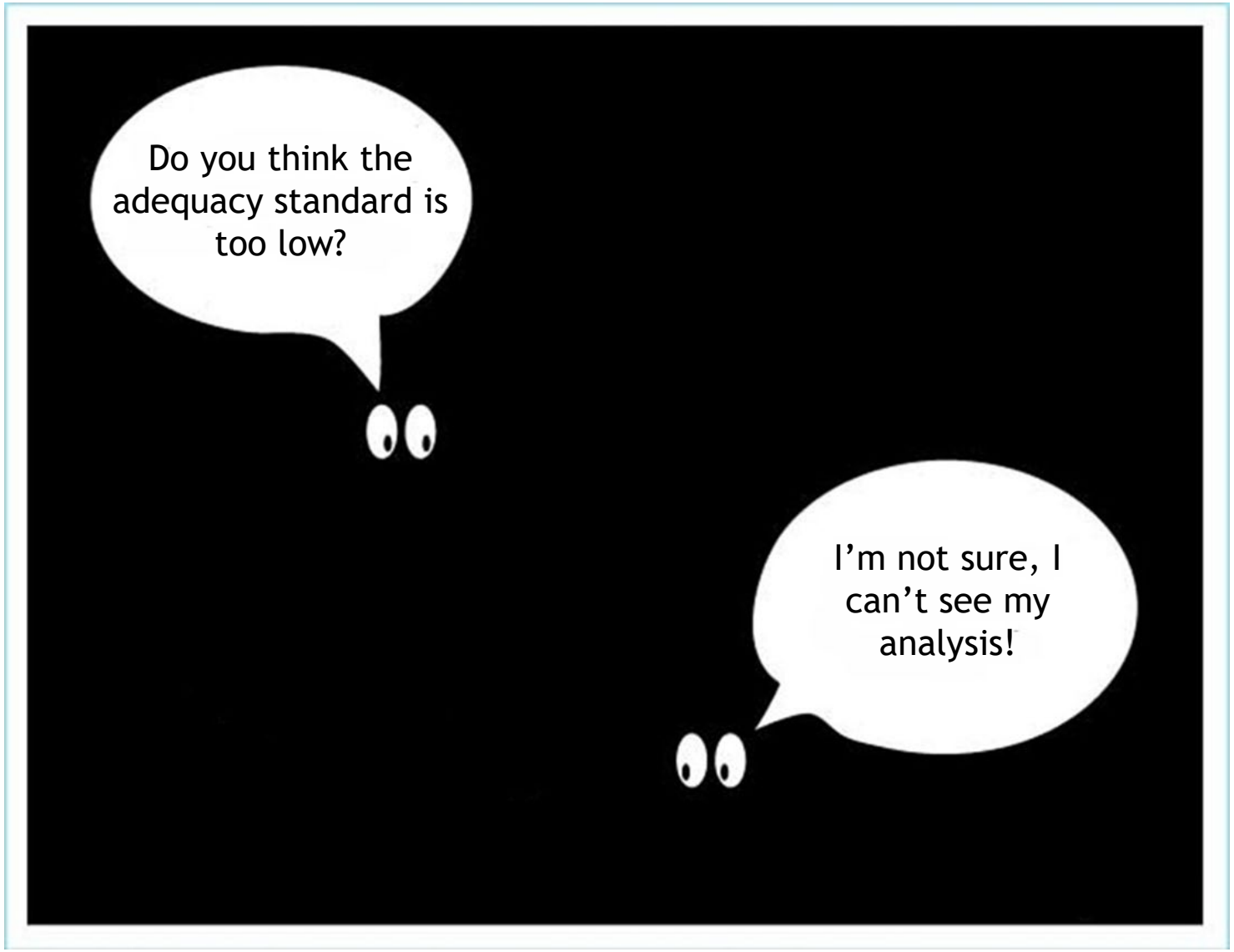
Council Meeting

May 5, 2021

John Fazio

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

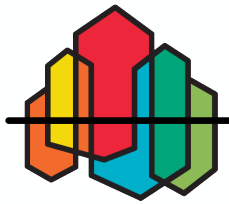
A Bit of Dark Humor!



Power Supply Adequacy and Reliability

- Adequate Power Supply
  Having sufficient generating capability to serve all demand, accounting for a reasonable range of uncertainties
  - Generator breakdown
  - Lack of wind and solar generation
  - Droughts
  - Extreme temperatures

- Reliable Power Supply
  Ability to *generate* and *deliver* power to all customers, accounting for a reasonable range of uncertainties
  - Requires an adequate supply
  - Requires an ample and available transmission system

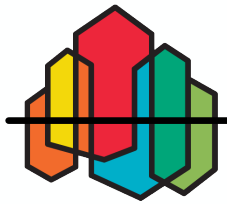


Council's Resource Adequacy Standard

- Only assesses whether generating capability is sufficient
- ***Does not*** account for the sufficiency or availability of transmission

- Adequacy Standard
  The power supply is deemed to be adequate if, in any year, the likelihood of having to take emergency actions to keep the lights on is less than or equal to 5%

- Loss of load probability (LOLP) must be less than or equal to 5%
  (Even though "loss of load" is in the name it does not equate to blackouts)



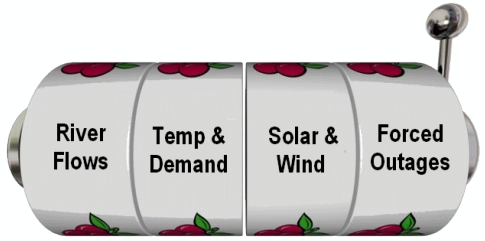
Adequacy Standard and the Power Plan

- Early Warning
  Every year the Council assesses the adequacy of the power supply 3 to 5 years out as an early warning to gauge whether new resources and demand-side measures are needed and whether utility plans address those needs.

- Power Planning
  The amount of required surplus generating capability above expected demand (based on the 5% LOLP standard) is used as a minimum threshold to develop the plan's resource strategy.

Assessing Resource Adequacy

- Simulate the power supply's operation
  - Chronological hourly simulation of all resources for one year
  - Run thousands of simulations with different futures
  - Record all hours when load is not served



- Calculate the probability of load not being served
  - Count number of years with at least one shortfall
  - Annual LOLP is the probability a future year will have at least one shortfall
  - LOLP = Number of years with a shortfall divided by number of simulations

- Set a limit on the probability of not serving load
  - Council's adequacy standard limits LOLP to 5 percent
  - Power supply is adequate if the likelihood of one or more shortfalls in a year is less than or equal to 5 percent

What does LOLP really Mean?

	Resource	Description
Modeled in GENESYS	Generating Resources	Resources dedicated to serving PNW load, whether inside or outside the region
	Conservation Programs	Cost effective energy efficiency measures, appliance and housing codes and standards
	Market Supplies	In-region and out-of-region wholesale short-term market supplies
	Standby Resources	Small (usually expensive) generators or demand buy-back agreements
Not Modeled	Emergency Actions 1	More expensive non-declared resources or demand cut-back provisions
	Emergency Actions 2	Utility or governor's calls for energy conservation
	Emergency Actions 3	Rolling black outs or brown outs

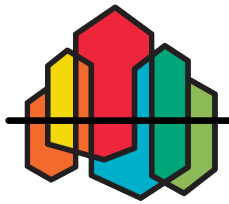
LOLP = Likelihood of taking emergency actions, not necessarily curtailment

Why is the adequacy assessment different now?

- Climate change
  - Forward looking temperature and river flow projections instead of historical
  - Better representation of expected future conditions
  - Captures seasonal shifts in load and hydro generation, which affect adequacy

- WECC-wide resource buildout
  - State clean air laws and policies are driving high acquisition of renewable resources
  - Increases market supply with daily periods of inexpensive energy
  - Affects PNW resource dispatch and can reduce resources needed for adequacy

- New (and improved) adequacy model
  - 17 BA areas, WECC resources & loads, unit commitment, fuel accounting, dynamic reserves
  - Individual hydro project hourly simulation, more accurate representation of flexibility
  - Dynamic representation market supply and price

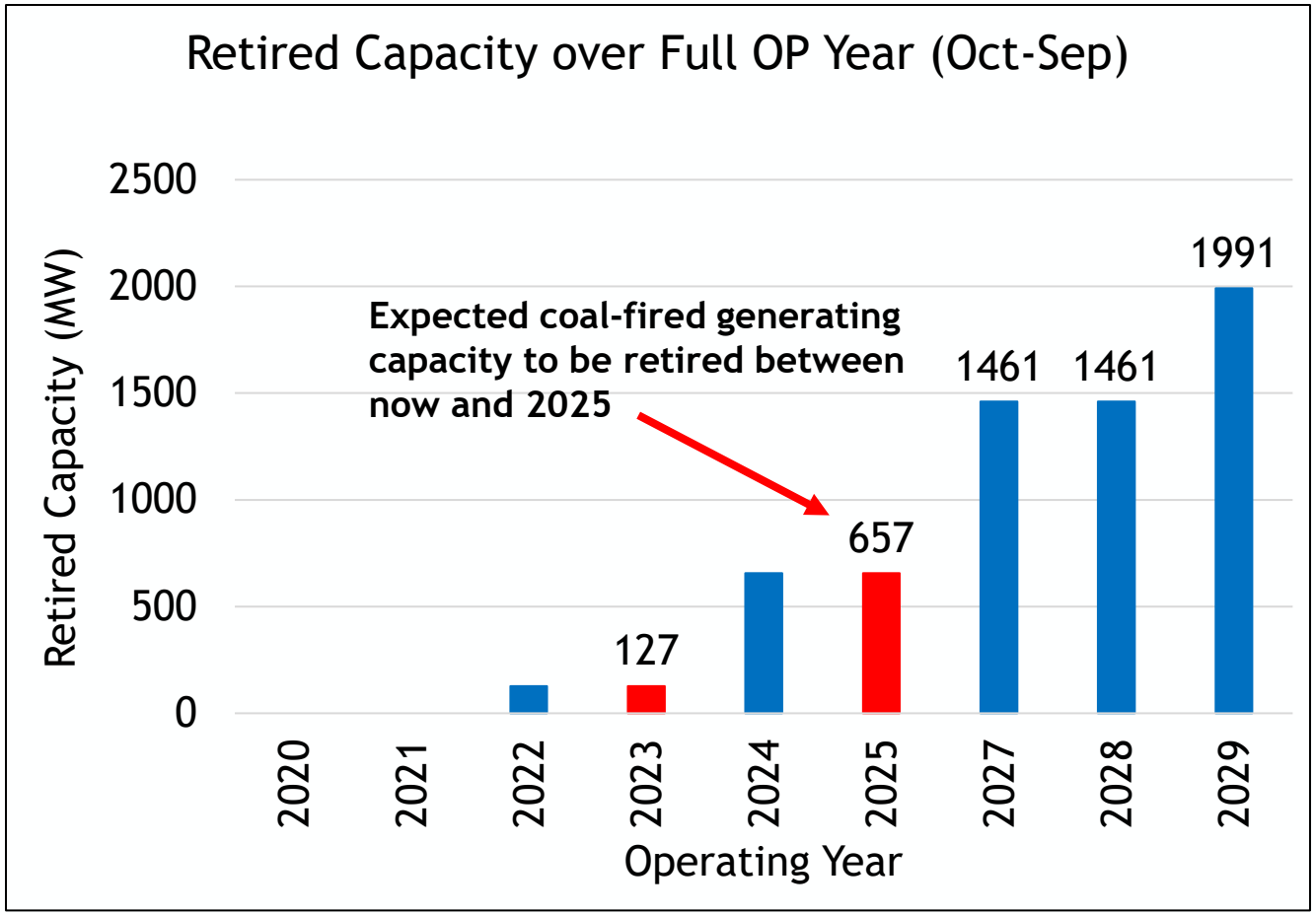


Announced Coal Plant Retirements by 2025

Coal Plant Retirement Schedule

Coal Plant	Capacity (MW)	Retire Date (EOY)	Total MW Retired
N Valmy 1	127	2021	127
Bridger 1	530	2023	657
N Valmy 2	134	2025	
Centralia 2	670	2025	1461
Bridger 2	530	2028	1991
Total	**1,991**		**1,991**

Cumulative MW of Retired Nameplate Capacity

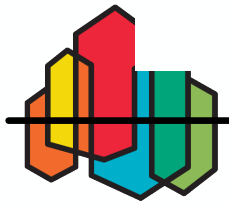


Resource Adequacy Assessment

Annual LOLP (percent)	2023	2025
Redeveloped GENESYS (baseline WECC buildout, 0 aMW EE 2023, 400 aMW 2025)	32.0%	1.7%
With additional reserves (but no new resources)	9.0%	

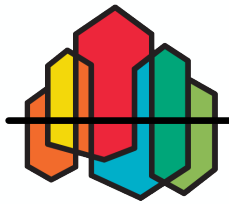
Key Findings

- The existing power supply is not adequate
- Utilities are aware of the imminent risk and are planning accordingly
- Region may need as much as 1,600 MW of capacity by 2023 (winter need)
- Increasing reserve requirements may be a cost-effective way to temporarily reduce the need
- Need drops off significantly by 2025 primarily because increasing market prices support greater amounts of thermal unit commitment



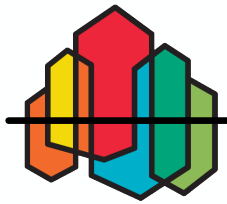
Why Increasing Reserves Helps

- Increasing reserve requirements forces more thermal resource to commit
- If market prices are too low, thermal resources may not be committed and are thus unavailable to provide reserves or to help with other contingencies
- However, increasing reserve requirements comes at a cost because resources may be operated “out of the money” a high amount of time
- This issue already occurs in California



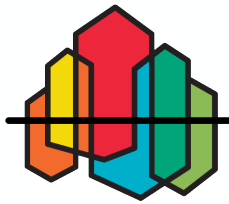
RAAC Questions and Comments

1. Why is resource need so much lower than retired capacity
2. Can adequacy be maintained without conventional thermal resources
3. Large WECC buildout seems unrealistic
4. How much can reutilization of thermal resources really help (e.g., more reserves and unit commitment)
5. Are we overestimating the flexibility of the hydro system, and can we ensure that all non-power hydro constraints are being met
6. Why are the classic GENESYS model LOLP results so different



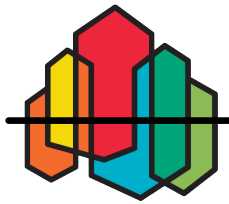
1. Resource need vs. Retired Capacity

- Retired capacity (2019-25) is 2,276 MW yet resource need is only 1,600 MW.
- Power supply was adequate in 2019 (i.e., LOLP < 5%) and thus likely had surplus capability that would lessen the amount of needed resource.
- Expected increasing and inexpensive WECC market supply can help. Even though hourly imports are capped, imports can occur over more hours.
- Better utilization of the hydro system (within its operating constraints) can defer new resource acquisition.
- Better utilization of thermal resources (e.g., unit commitment and reserves) can also defer new resources.



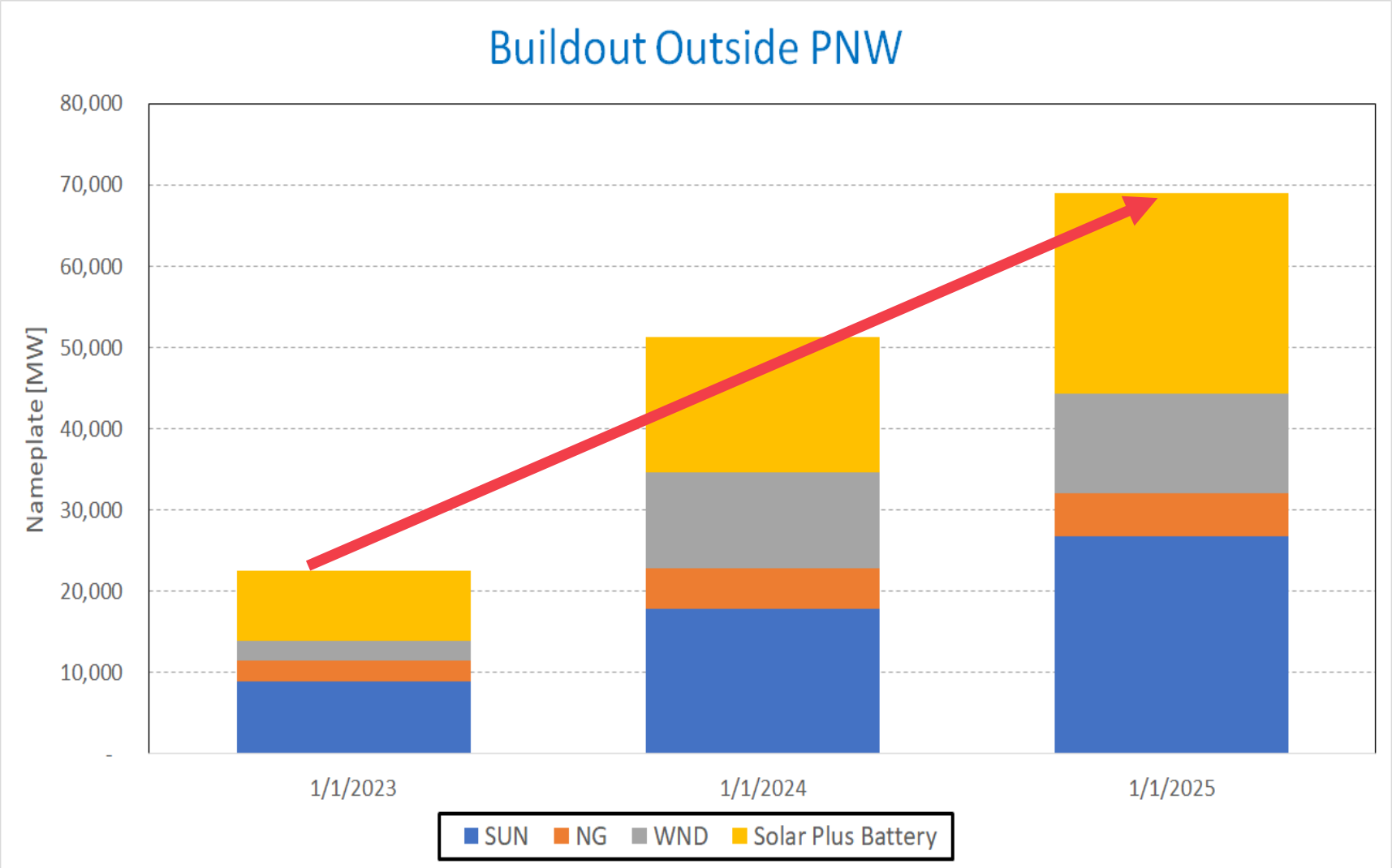
2. Are conventional thermal resources needed

- Concern that acquiring only renewable resources will lead to problems since they cannot be dispatched
- Increasing market supply and better utilization of existing resources can lessen the amount of needed resource
- While acquiring renewable resources does increase the need for additional balancing reserves, simulations show that for now the existing system can provide them
- It is likely that batteries will be a part of the resource strategy
- Retirements are scheduled over a long period (16 years), which should provide sufficient time to develop better batteries, pumped storage and perhaps other technologies



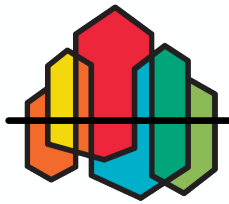
3. Large WECC buildout

- Baseline has 70 GW of non-PNW buildout by 2025
- Buildouts were extensively reviewed by the SAAC
- Even with lower buildout, midday cheap market supply should increase
- GENESYS substantially limits market import
- With no WECC buildout the 2025 LOLP only increases to 2.2%



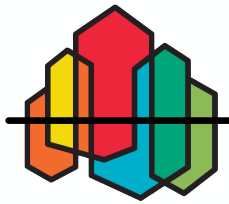
4. Thermal Resource Utilization

- Can the reutilization of the existing thermal resource fleet defer some of the need for new resources
- Unit commitment is modeled explicitly in the new GENESYS
- Unit commitment is based on market prices and, when prices are low, some resources are not committed, thus making them unavailable during potential shortfall events
- As market prices rise, more units are committed, and model results show that adequacy improves
- The new GENESYS dynamically assigns the declared level of reserves to both hydro and thermal resources
- Requiring a higher level of reserves means that more thermal resources will be committed and, thus could be available during potential shortfall events



5. Hydroelectric System Flexibility

- Is the model overestimating the flexibility of the hydro system and are non-power constraints being met
- The redeveloped GENESYS model simulates the hourly operation of individual hydro projects
- It implements monthly and hourly operating constraints provided by BPA and others
- Fine tuning the parameters to achieve a realistic hourly operation has been difficult and required extensive review by stakeholders
- While perhaps not perfect, the current simulation has met with stakeholder approval
- The model does its best to meet all non-power operating constraints, but it should be noted that even in real life, not all constraints can be met at all times
- The model may show more hydro flexibility than the classic version because it modeled more projects as reservoirs



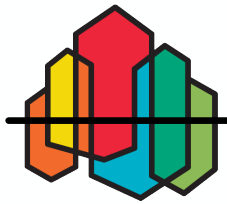
6. Redeveloped vs. Classic GENESYS

Annual LOLP (percent)	2023	2025
Redeveloped GENESYS (baseline WECC buildout, 0 EE 2023, 400 aMW 2025)	32.0%	1.7%
Classic GENESYS (200 aMW EE 2023, 400 aMW 2025)	15.7%	22.6%
Redeveloped GENESYS resource need	1600 MW	0 MW
Classic GENESYS resource need	1250 MW	850 MW

- LOLP is the likelihood of having to take emergency actions
- Hard to compare LOLP directly because the new GENESYS simulates more aspects of system operation in more detail
- New GENESYS enhancements include 17 BA areas (instead of 2), hourly simulation of individual hydro projects (instead of in aggregate), unit commitment, dynamic assignment of both hydro and thermal reserves (instead of just hydro), dynamic WECC-wide market and price assessment
- While still problematic, a comparison of resource needs may be better than comparing LOLP

Sensitivity Studies

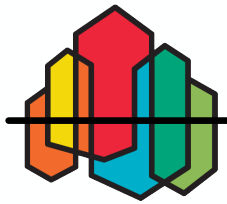
- Effects of increasing hours of import in the classic model
- Effects of increasing hydro flexibility in the classic model
- Effects of increasing reserves in the new model
- Effects of assuming no WECC-wide buildout in the new model



Key Elements of the new GENESYS that affect LOLP

- Better representation of a limited market supply
  - ***Max hourly market imports are the same in both old and new models***
  - Old model has fixed number of import hours and high market prices
  - New model uses dynamic pricing to determine hours of import and prices can be much lower than regional resource operating costs
  - Net effect is a greater amount of imported energy and a potential shift in the order and timing of dispatch for regional resources

- Better representation of hydro operations and reserves
  - Old model simulates the aggregate hydro system on an hourly basis
  - New model simulates individual hydro projects on an hourly basis
  - Net effect is a better utilization of hydro storage



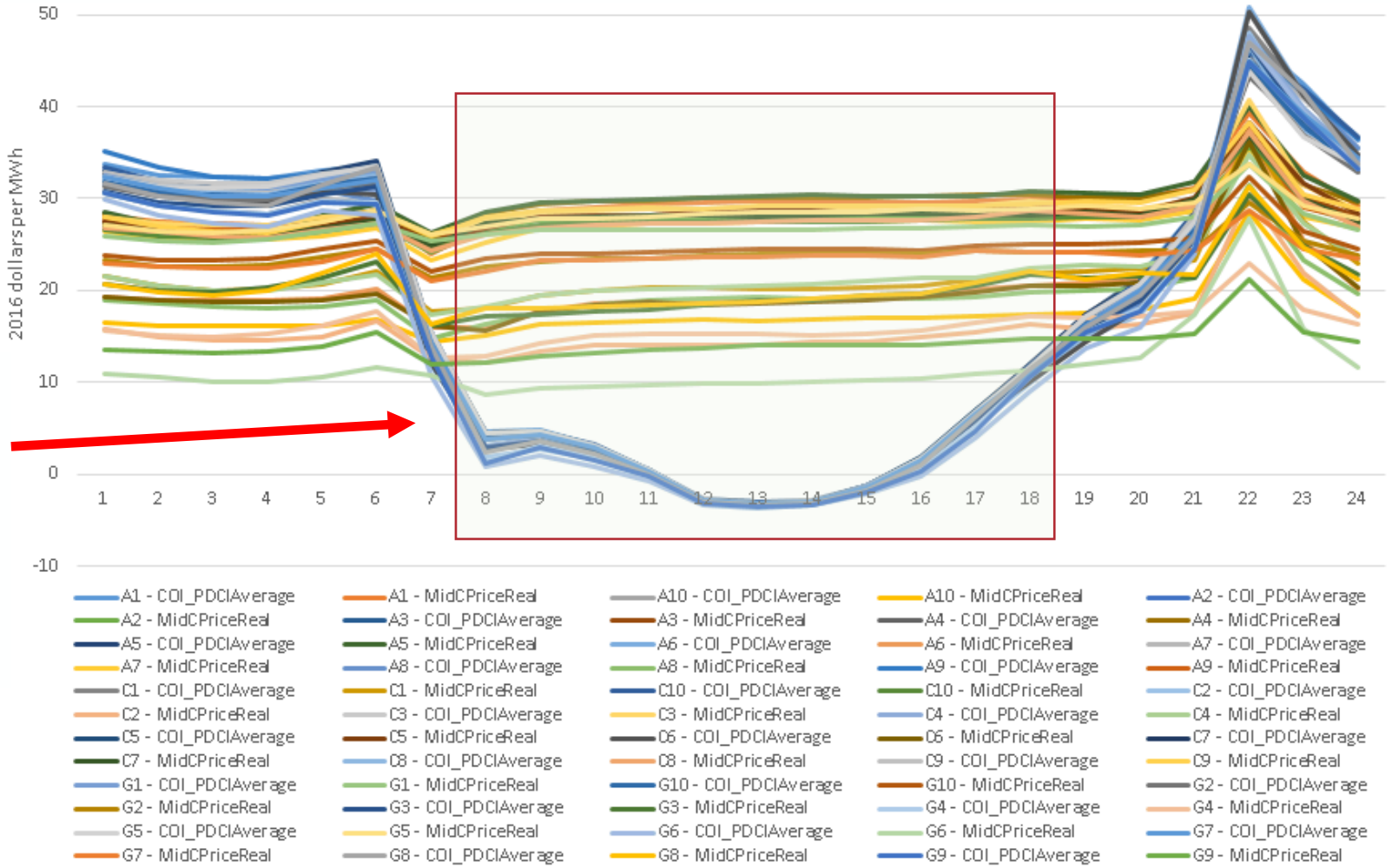
Market Assumptions

Resource	Classic GENESYS	Redeveloped GENESYS
Min intertie cap (to all regions)	11,000 MW	Same
Winter SW spot market	2,500 MW any hour	2,500 MW any hour (no spot or purchase ahead)
Winter SW purchase ahead	3,000 MW 8 hours (10pm to 6am)	
Winter IPP[1] availability	Full availability (2,400 MW)	Same
Total winter hourly max import	3,400 MW	2,500 MW net
Summer SW spot market	1,250 MW 5 hours (9am to 2pm)	1,250 MW any hour (no spot or purchase ahead)
Summer SW purchase ahead	None	
Total summer hourly max import	1,250 MW	Same
Summer IPP availability	Full 10 hours (8am to 6pm)	Any hour

[1]IPP = Independent power producers = PNW market supply

Expected Summer Market Prices

Daily period when the market supply from California is cheaper than mid-C prices



Summer Market Expected Daily Shape for 30 CC Hydro Conditions

Redeveloped GENESYS Hours of Import

Year	Month	0%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	100%
2024	10	0	1	3	7	8	9	10	11	12	13	14	16	24
2024	11	0	4	6	8	8	9	10	11	12	13	17	21	24
2024	12	0	5	6	7	8	9	11	11	12	13	16	20	24
2025	1	0	3	4	6	7	8	9	10	11	13	16	23	24
2025	2	0	1	2	5	6	7	8	9	10	11	13	16	24
2025	3	0	0	1	4	5	7	8	9	10	11	12	13	24
2025	4	0	6	8	9	10	10	11	12	13	13	14	14	20
2025	5	2	6	7	8	9	10	10	11	12	13	14	15	24
2025	6	0	5	6	8	9	9	10	11	12	13	15	17	23
2025	7	0	5	6	9	10	11	12	13	13	14	16	18	24
2025	8	0	2	4	7	9	10	11	12	14	15	15	18	24
2025	9	0	3	5	7	9	10	12	13	13	14	17	21	24

Effect of longer hours of import in Classic

LOLP	2023	2025
Classic GENESYS	15.7%	22.6%
New GENESYS	32.0%	1.7%
Classic with 10 hours market availability		21.5%
Classic with 15 hours market		15.2%
Classic with 18 hours market		7.6%

Effect of added hydro “flexibility” in Classic

LOLP	2023	2025
Classic GENESYS	15.7%	22.6%
New GENESYS	32.0%	1.7%
Classic with 10 hours market availability		21.5%
Classic with 15 hours market		15.2%
Classic with 18 hours market		7.6%
Classic with 15 hours market + additional 1K hydro “flexibility”		6.0%
Classic with 15 hours market + additional 2K hydro “flexibility”		1.2%

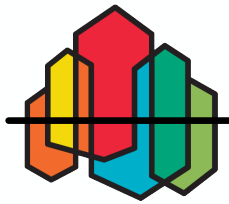
Effect of added reserves and WECC buildout

LOLP	2023	2025
Classic GENESYS	15.7%	22.6%
New GENESYS	32.0%	1.7%
Classic with 10 hours market availability		21.5%
Classic with 15 hours market		15.2%
Classic with 18 hours market		7.6%
Classic with 15 hours market + additional 1K hydro “flexibility”		6.0%
Classic with 15 hours market + additional 2K hydro “flexibility”		1.2%
New model with no WECC buildout		2.2%
New model with higher reserves	9%	

Interpreting Sensitivity Study Results

The objective is not to get model results to match. Rather, it is to identify and more thoroughly review parameters that can significantly affect LOLP.

- Import Hours
  - Even though both models have the same hourly import limits, the new model imports over more hours, thus supplying more market energy
  - Increasing the number of import hours in the classic model can make imported energy more equitable between the models
- Hydro Flexibility
  - The redeveloped GENESYS does a better job of optimizing hydro storage
  - Allow the classic model to temporarily draft below the critical rule curve as a surrogate for increasing flexibility
- No WECC buildout and Increased reserves
  - Eliminating the WECC-wide buildout seems to have little effect on the LOLP
  - Increasing reserve requirements has a big effect, likely because more thermal units must be committed in order to provide the reserves



Resource Adequacy Assessment Summary

- **The region has an adequacy need in the first few years, followed by minimal resource needs throughout the planning period horizon.**
- To maintain the Councils adequacy standard, an estimated 1,600 MW of added capacity or some combination of increased reserves and a more moderate capacity addition is needed by 2023.
- After 2023, and despite additional coal plant retirements, adequacy can be maintained throughout the study horizon primarily due to the high level of expected renewable resource buildout across the West and the opportunity to optimize the utilization of the existing hydro and gas-fired resource fleet.
- While these findings are robust across many scenarios, there is risk that the analyses do not fully capture the inherent uncertainty in the projected WECC buildout and the possibility of accelerated loads due to electrification programs. Thus, additional resources could be acquired to offset this risk.