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

November 9, 2021

MEMORANDUM

TO: **Power Committee**

FROM: **Ben Kujala**

SUBJECT: **Resource Adequacy in the Draft 2021 Power Plan**

BACKGROUND:

Presenter: John Ollis, Ben Kujala

Summary: The Council has already gotten public comment regarding concerns with how the draft plan represents resource adequacy. While these comments are being carefully considered, it also seems that there is potentially some confusion about what the plan considers an adequate power system. Staff has prepared a draft overview of resource adequacy in the 2021 Power Plan. This draft is an early effort to be responsive to the concerns raised and will be brought to the committee for feedback. With further refinement this draft may be useful in augmenting the supporting material for the final version of the plan.

Relevance: The comment period for the draft 2021 Power Plan concludes on Friday, November 19.

2021 Power Plan Resource Adequacy Overview

As provided under the Northwest Power Act, the Council is responsible for planning for a power system that is adequate. However, the Act does not define what an adequate power system is. Yet, it's clear from our history as an organization as well as the history of the region, that there are concerns about overestimating and underestimating what it means for the system to be adequate. Overestimating the amount of resources needed leads to an expensive supply of electricity, but underestimating leads to different but just as substantial expenses for the region. So, for our planning, adequacy is balancing the potential for stressful system events with the cost of mitigating those events. Thus, to assure the region of an adequate power supply, it is necessary, and our responsibility, to estimate the appropriate amount of resources, including conservation, needed to sufficiently meet the region's demand for electricity but not so robust that it never faces the possibility of an outage. Throughout the history of the Council, our estimation of resources needed for an adequate regional power supply is captured and put forward in our resource development plan. Thus, the system in our estimation is inadequate if fewer resources are developed than what is detailed in our resource development plan.

The Council has used well-established adequacy metrics and planning approaches in formulating its resource development plan, including Loss-of-load Probability (LOLP). Once the plan is issued, however, we evaluate whether the regional power system is adequate not based on a model or metric, but rather based on whether the region implements our resource development plan. As such, for the 2021 Plan we expect the region will be inadequate in 2027 if it has not added 750 to 1000 average megawatts of energy efficiency and at least 3500 megawatts of renewable resource while also pursuing all low-cost and frequently deployable demand response. Of course, the future is uncertain so through our mid-term assessment we will continue to evaluate if this recommended resource development plan is a sufficiently balanced strategy.

The Council used a wide range of modeling assumptions and analyses to develop its resource development plan and its assessment of what it takes for the system to be adequate.

Resource Strategy Assessment

The resource strategy assessment takes the needs assessment, defined further below, which considers a single future load and expands that assessment to cover a wide range of potential future loads. For example, while the needs assessment for the early coal retirement scenario showed minimal energy needs in the first year of the study for the medium load, the resource strategy assessment showed summer needs ranging from no additional need for low loads, up to 1000 average megawatts for high loads. Around 2027, the potential summer energy need grows to a maximum of 3000 average megawatts. While we can estimate the Loss-of-Load Probability from the needs assessment, the resource strategy assessment covers 300 different circumstances for each operating year that could potentially yield 300 different LOLP results for each year of the study, just for this one scenario.

The best summations of the requirements to maintain an adequate power system are the expected resource buildouts in the resource strategy, which shows resources needed to meet a wide range of forecasted future demands. Other summary statistics run the hazard of over or underrepresenting

what is needed to maintain an adequate system. This is particularly true because of the Associated System Capacity Contribution approach to representing the aggregate system capacity for different combinations of resources.

The adequacy and needs assessments should not be seen as a proxy for determining the Council's estimate of future resource needs. They help in structuring the question of how much resource is needed, but they are not in themselves sufficient to fully answer the question.

Adequacy and Needs Assessment

During the 2021 Power Plan development, it became clear that there was some confusion about the role of the studies the Council uses to both assess the adequacy of the strategy laid out by the 7th Power Plan and to determine a new resource strategy for the 2021 Power Plan. This coupled with the challenge of incorporating resources with different characteristics than traditional baseload resources raised the question of whether the adequacy metric currently used is still appropriate for assessing shortfall risk. Another factor which appears to be obfuscating the role adequacy has played in the 2021 Power Plan is the broad range of adequacy results associated with the different policy scenarios that were tested. Finally, an additional consideration that seemed to concern stakeholders was the inclusion of the fundamentals and changing policies of the western grid and how that impacted the thinking about the availability of the market outside the region as a viable mitigation measure against regional adequacy issues.

The overarching goal of the Council's regional power plan is to develop a resource strategy that will ensure an adequate, efficient, economic, and reliable power supply. While the terms "adequate" and "reliable" are related, they have specific and distinct meanings for power system planning. A power system is defined to be reliable if it is both adequate and secure, where adequacy generally refers to having sufficient generating capability and security generally refers to having a robust transmission system.

Resource adequacy plays an essential role in both the development and implementation of the Council's power plan. First, the needs assessment is a vital consideration in the analysis of resource investments made by the Regional Portfolio Model (RPM, Council's capital expansion model), which aids in the development of the resource strategy in the power plan. Second, the annual adequacy assessment provides an early warning of potential near-term (three-to-five year) supply shortfalls and gives utilities time to implement appropriate measures outlined in the plan or to take other mitigating actions.

Thus, consideration of adequacy in these two processes is for two different but related purposes: determining regional adequacy needs to design a resource strategy in a power plan and assessing adequacy during the implementation of the plan as a check of the current resource strategy of the plan updated with any resources that have been built since the previous plan was developed.

The purpose of the ***needs assessment*** is to estimate the gap between the existing resource capability and the resource capability needed to maintain adequacy. A needs assessment looks at specific years throughout the plan's 20-year horizon and is used to calculate adequacy reserve margins (ARMs), which (like planning reserve margins) set the minimum surplus (or deficit) energy and capacity thresholds required to maintain an adequate system. This methodology of using ARMs

for energy and capacity was designed specifically to send the current version of the RPM information that would ensure that it considered only adequate resource strategies[1]. The RPM acquires resources if they are expected to be profitable, if they are required by clean-air laws and policies or if they are needed to meet the ARM thresholds. Lower cost resource strategies often contain resources that fulfill multiple purposes simultaneously.[2]

An ***adequacy assessment***, which generally only looks five years ahead, includes rate-based generating resources, planned resources that are sited and licensed, a limited amount of imported and within-region market supply and expected future energy efficiency savings. The primary difference between an adequacy assessment and a needs assessment is that the adequacy assessment includes expected energy efficiency savings laid out by the current power plan while the needs assessment does not. The needs assessment is used in conjunction with other analyses to help determine the appropriate amount of energy efficiency to include in the power plan.

The current metric used to measure resource adequacy is the annual loss-of-load probability (LOLP). The LOLP is currently assessed by simulating the operation of a future year's power system with many different combinations of natural river flows, temperatures, wind and solar generation, and generator forced outages. All hours when electrical demand cannot be served by non-emergency measures are recorded. The LOLP is the number of simulations in which one or more shortfalls occur divided by the total number of simulations. Historically, the Council has deemed the power supply to be adequate when the LOLP is five percent or less, that is, when the likelihood of a future year experiencing one or more shortfalls is not greater than five percent. Unfortunately, annual LOLP provides no indication of shortfall frequency, magnitude, duration, or seasonality and, therefore, should be considered only as a broad measure of adequacy.

When most of the regional system power was produced by resources (hydro, coal and gas) that for the most part had the necessary fuel required when needed, the biggest risks to the system were during periods of poor regional hydro runoff. Since so much of the regional load is served by the hydropower system, poor runoff conditions sometimes would result in the region's supply having insufficient energy, especially during peak demand periods. The LOLP standard was a simple measure that allowed planners to explore the risk of poor hydro conditions when coupled with other less significant risk factors. There are now, and proposed to be in the future, significantly larger amounts of resources (wind, solar) that do not have on-call fuel. This means there is uncertainty about availability on an hour-by-hour basis, but in general there is more diversity in the regional system. The work in the 2021 Power Plan seems to indicate that in the near term the system often

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[1] Note that no one metric can guarantee an adequate resource strategy in the RPM, which is why all candidate resource strategies are checked in the same hourly operations model used to assess adequacy and calculate the ARMs, GENESYS.

[2] For example, in the current plan, energy efficiency reduces the clean/RPS requirements necessary to fill, reduces emissions and helps bolster the adequacy of the system by reducing load on average and during peak times. That being said, it tends to not compete well against the predicted future market. The first tranche of wind and solar tends to help energy and peak adequacy issues, but additional renewables tend to drag on adequacy even though they compete well against market resources, reduces emissions and helps meet clean/RPS policies.

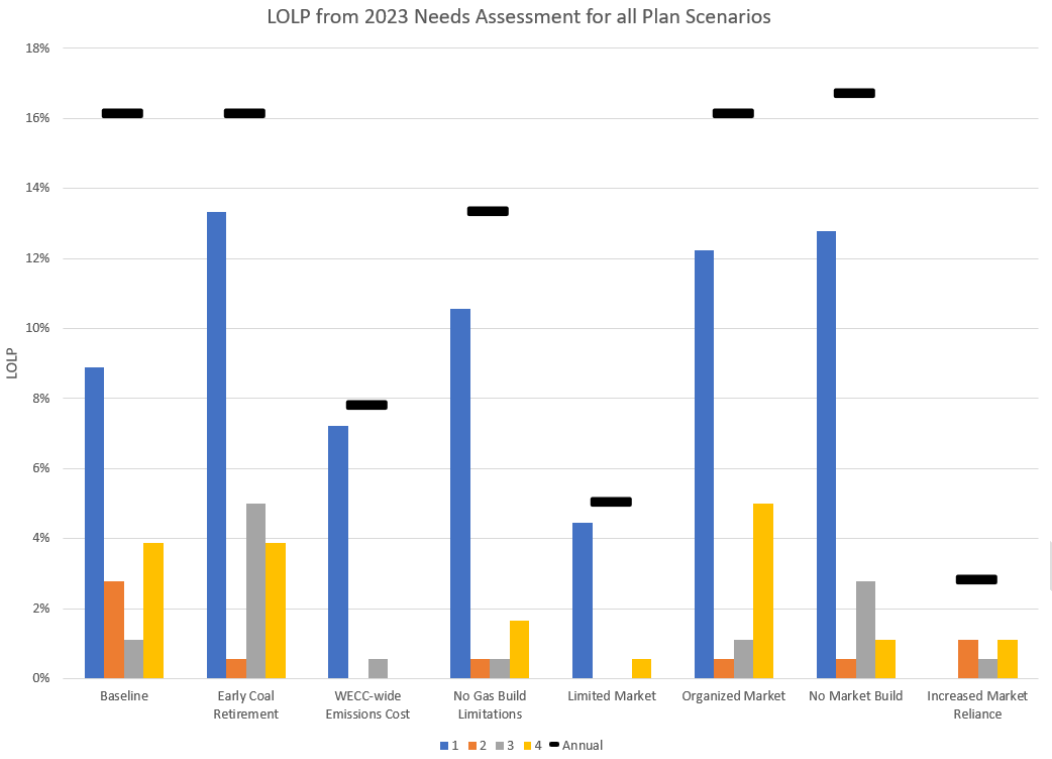
has enough energy during most hours, even in adverse hydro conditions, but sometimes has challenges with operational flexibility. These flexibility challenges occur in different ways (frequency, magnitude and duration of shortfalls) in different seasons. While the discussion of adequacy metrics is not always mentioned directly in comments, stakeholder concerns seem to be centered on relying too much on these resources without on-call fuel (wind and solar) to maintain an adequate system, which requires a better understanding of frequency, magnitude, duration and seasonality. The Council has been researching these issues for a number of years[3] and initiated an effort to amend its current adequacy standard to include measures of shortfall frequency, duration, magnitude, and seasonality[4].

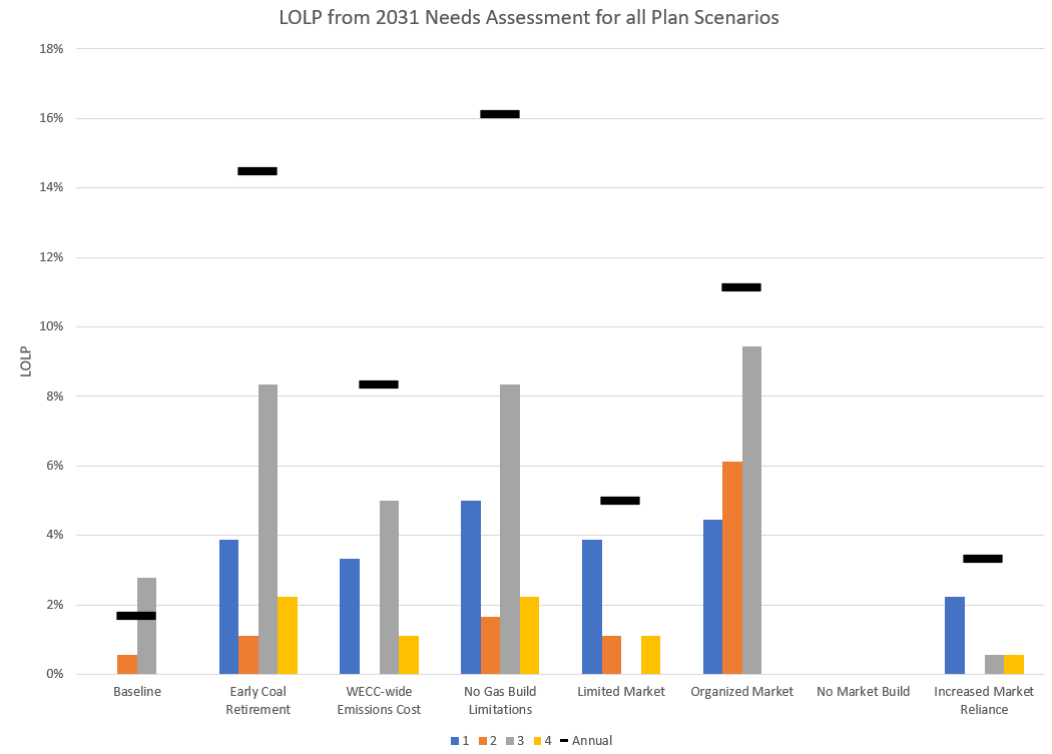
Needs assessment studies for the 2023, 2027, and 2031 operating years show changing levels of inadequacy that are primarily due to market fundamentals responding to the policies being tested. However, it is true that in all the policy scenarios, the set of clean policies based on annual energy targets over time cause the WECC power supply to be significantly and consistently more surplus in certain hours of the day and certain seasons. In almost all scenarios examined this translated into a reduction of additional regional energy needs, but a more complex story related to seasonal peaking needs. Additionally, the climate change projections show three major phenomena affecting adequacy; 1) increased winter inflows and decreased summer inflows to the hydro system, 2) higher temperatures in winter and summer causing generally decreasing winter loads and increasing summer loads, and 3) more volatile temperature events driving higher load peaks in both winter and summer. This means the seasonality and timing of the adequacy events combined with the advent of the changing timing associated with market fundamentals driven by the clean policies throughout the WECC changes the risks from likelihood of energy shortages to likelihood of operational issues and mitigation of high magnitude events we may not be able to predict. These problems can sometimes be solved by a different toolbox of solutions (i.e., building more renewables for energy and utilizing the hydro system more for flexibility) and may be different than adequacy issues we have seen in the past (i.e. critical hydro years and high thermal forced outages), but are inherently are still issues that need to be addressed to maintain an adequate system.

Furthermore, the different market fundamentals examined in the different policy scenarios, while showing the consistent messages highlighted above, showed a wide range in adequacy results. For example, in 2023, the range of LOLP was from 2.8% when we allowed for a higher market reliance level to over 16% when coal plants were retired early throughout the west, as can be seen in the first figure below. Seasonally, the problems also changed over time in the scenarios but not necessarily consistently as can be seen in the two figures below. The pace of resource additions external to the region definitely effected which seasons posed adequacy challenges within the region. Since what we were really measuring was the market position of the northwest region within the WECC, some

[3] Council staff John Fazio and Dan Hua wrote a paper addressing this issue published in September 2019 in Electric Power System Research journal, entitled "Three probabilistic metrics for adequacy assessment of the Pacific Northwest power system" Additionally, other entities throughout the world have identified similar issues with historical methods of defining adequacy. An article outlining these is "Quantifying Risk in an Uncertain Future", *IEE Power and Energy*, pp 29 – 36.
[4] A sample of metrics for the needs assessment results is in the spreadsheet.

of the changing needs depended heavily on the assumptions on market structure and level of reliance which meant that we saw a wide range of adequacy results.



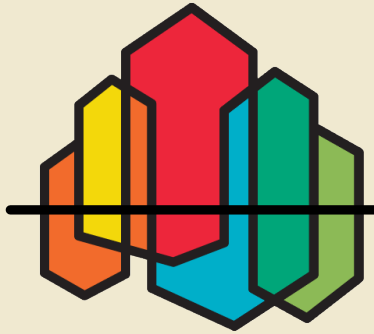


Needs assessment analyses for the 2021 power plan indicate that by as early as 2023, persistent low overall market prices could potentially create adequacy issues by leaving many regional generators idle (i.e., uncommitted), thus making them unavailable should unforeseen conditions arise. Unless a resource is needed to meet firm obligations or to carry reserves, it is only committed for service when forecasted prices indicate that it would be profitable. Thus, when forecasted prices are too low, plants are not committed, and fuel is not allocated for their operation leaving them unprepared during potential shortfall events. In the baseline modeling for the 2023 operating year, for example, the needs assessment resulted in an over 16 percent LOLP with a corresponding winter[5] capacity need of nearly 1,600 megawatts. By 2027, without the addition of any new resources in the region, but 86 GW of new renewables[6] and 3 GW of new gas resources[7] outside the region, the needs assessment showed an LOLP of .6 percent. This somewhat counter intuitive result is most likely due to evening and early morning market prices rising sufficiently high (due to combination of load growth and daily availability of market renewable generation) to prompt more regional thermal units to commit. Thus, even with the announced retirements of almost 4000 MW of coal plants by the end of 2023, studies show the 2027 power supply to be adequate in the baseline scenario.

Conversely, in a scenario (called the *Limited Markets* scenario) testing concerns that extra regional entities might not achieve stated planning reserve margins, significantly different results were seen. The needs assessment for this run in 2023 showed a 5% LOLP with a 253 MW need in late fall,[8] with no winter needs. The resources built external to the region were less than half of what was seen in the baseline conditions, and the renewable build was more than 5 times smaller. The lower LOLP with a smaller external market buildout is likely due to prices being sufficiently high to enable more regional thermal units to commit and thus making them available during unexpected shortfall events. This scenario seems to represent an overall WECC build smaller than what is already being planned, hence why the market supply/fundamentals uncertainty was one of the main risk factors examined in the scenario work for the plan.

[5] Defined as Q1: January, February and March
[6] Primarily for meeting state clean/RPS policies and goals, planning reserve margins, and comprised of over 80% stand-alone solar or solar hybrid.
[7] Primarily for meeting outside the region planning reserve margins
[8] Defined as Q4: October, November, December

2021 Power Plan Resource Adequacy Overview



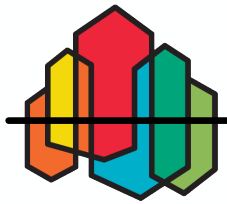
THE 2021
NORTHWEST
POWER PLAN
FOR A SECURE & AFFORDABLE
ENERGY FUTURE

To Assure the Region of an Adequate Power Supply

The Power Act directs the Council to adopt a plan

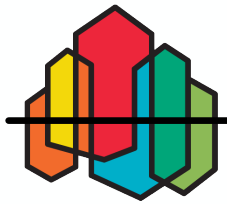
- "to assure the Pacific Northwest of an adequate, efficient, economical, and reliable power supply"
- "[that shall include] an analysis of reserve and reliability requirements"

The draft plan does not indicate the system is adequate - our estimation of resources needed for an adequate regional power supply is captured and put forward in our resource development plan



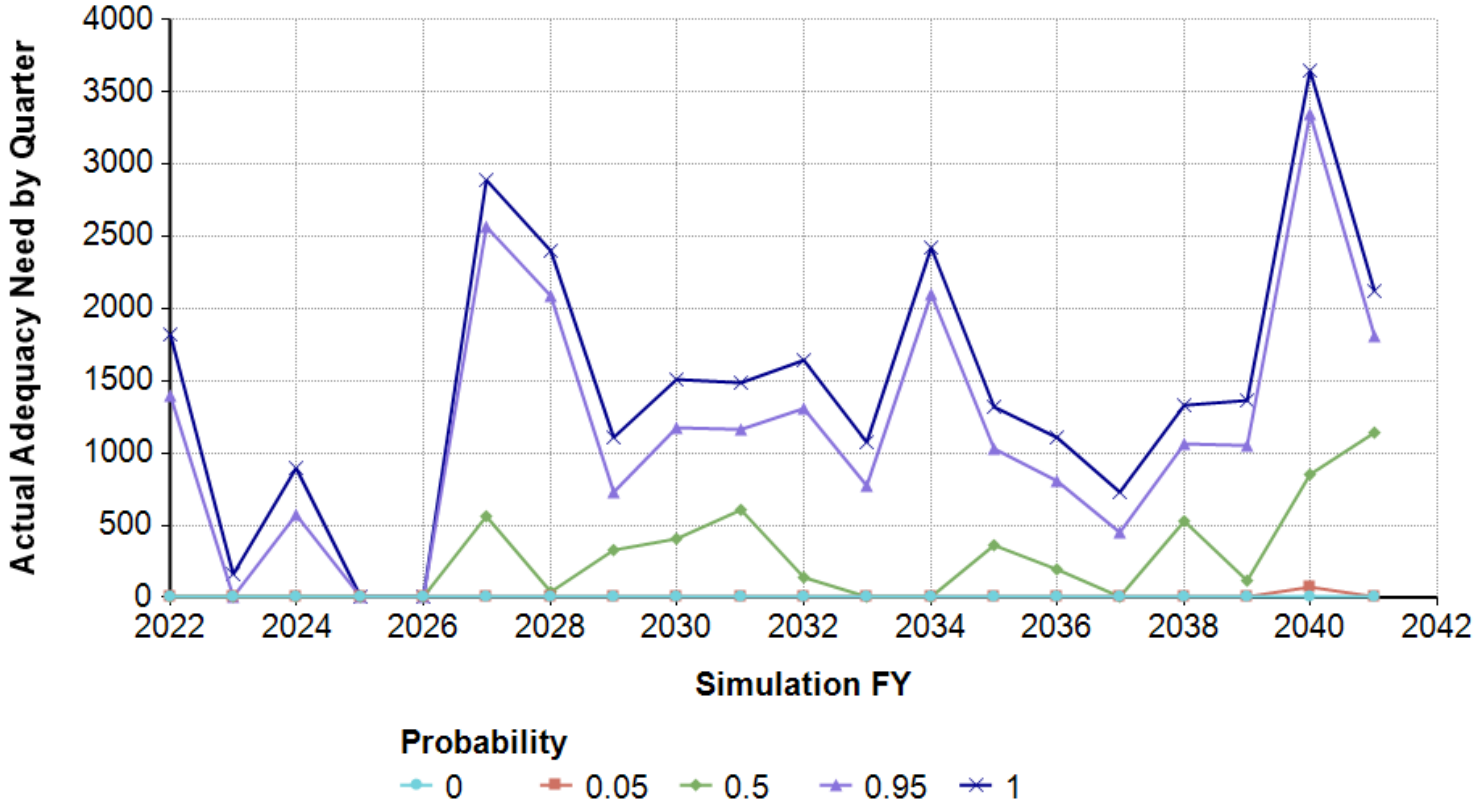
Resource Strategy Assessment

- Done for all 7 scenarios with multiple sensitivities explored
- Looks at the next 20 years for potential needs
- Includes 300 different potential future load conditions
- A much broader evaluation of what it takes for the regional system to be adequate than the adequacy assessment or the needs assessment
  - E.g. while the needs assessment for the early coal retirement scenario showed minimal energy needs in the first year of the study for the medium load, the resource strategy assessment showed summer needs ranging from no additional need for low loads, up to 1000 average megawatts for high loads. Around 2027, the potential summer energy need grows to a maximum of 3000 average megawatts.



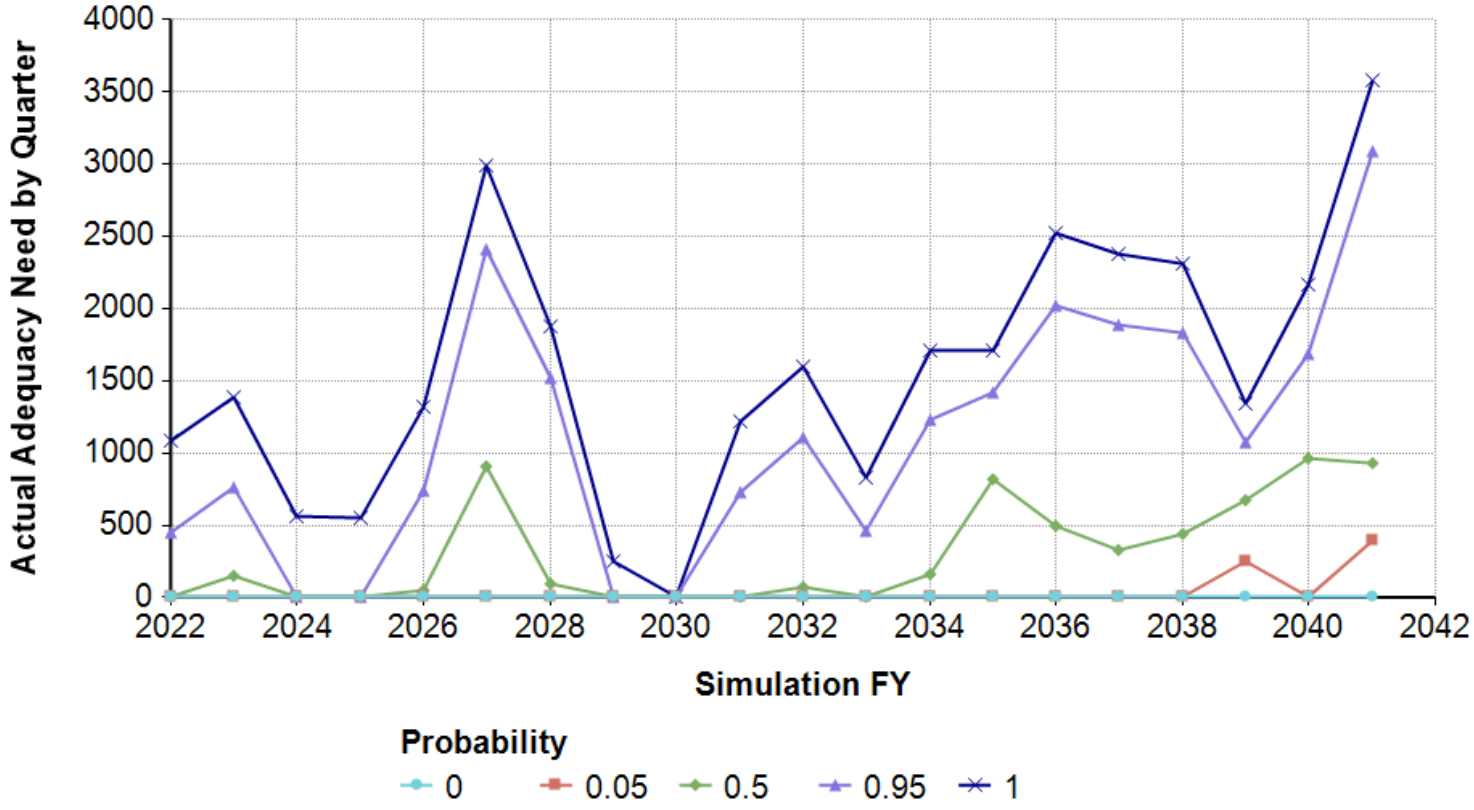
Early Coal Retirement – Winter Energy Needs

Assuming no additional resource builds



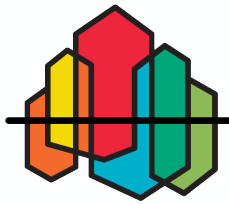
Early Coal Retirement – Summer Energy Needs

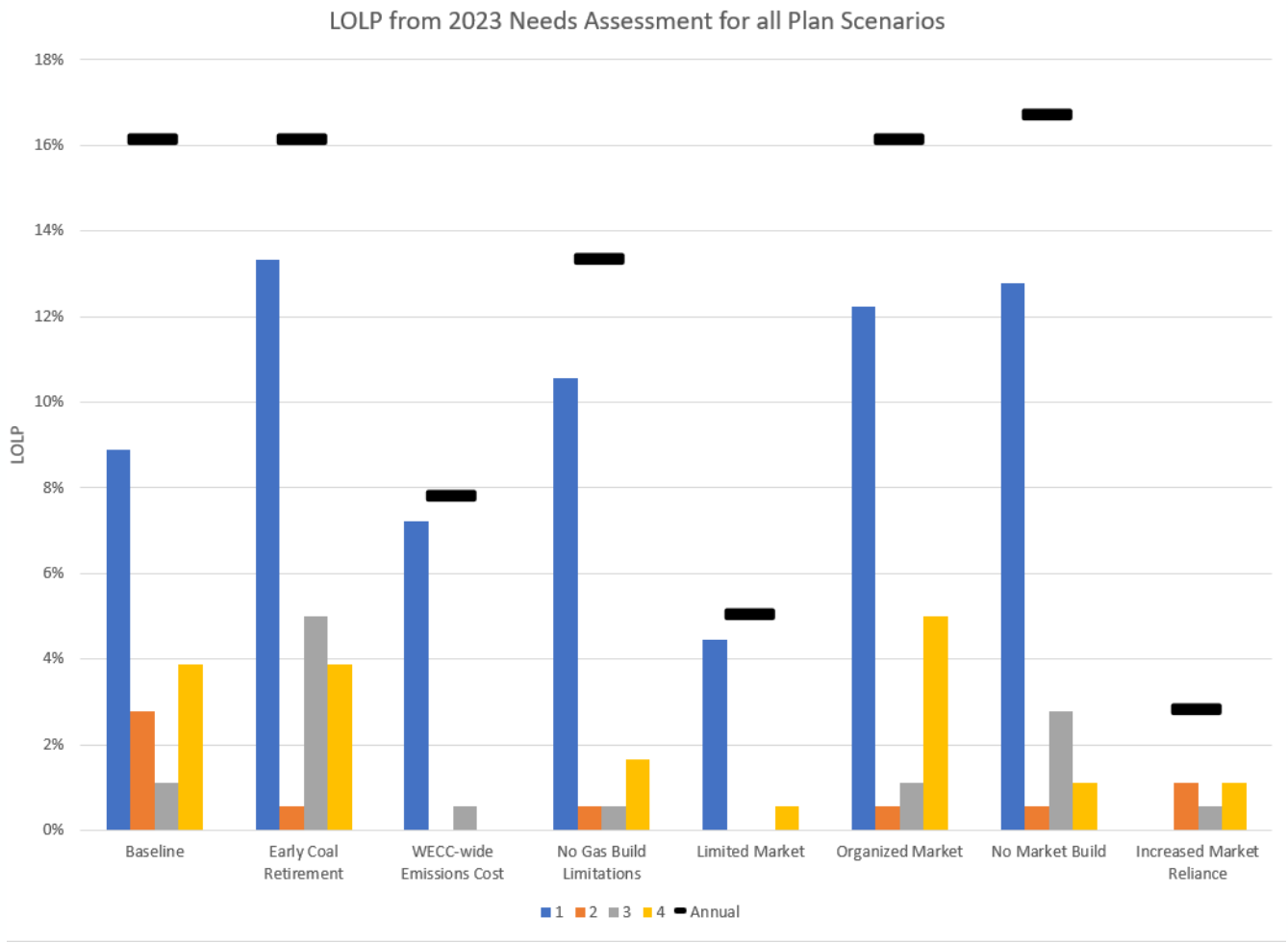
Assuming no additional resource builds

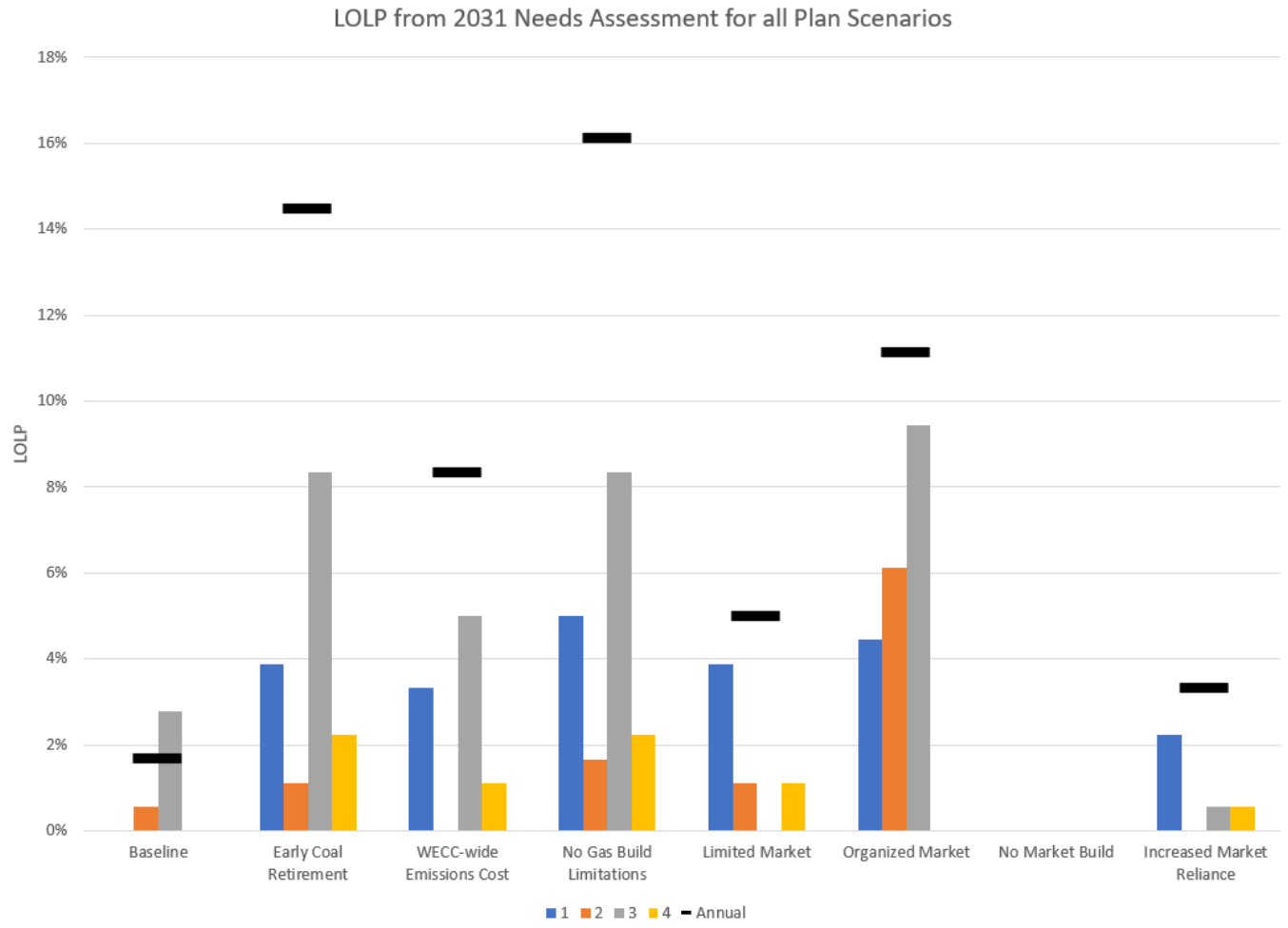


Needs Assessment

- Estimate the gap between the existing resource capability and the resource capability needed to maintain adequacy for pre-determined load condition
- Used to create the Adequacy Reserve Margin
- Loss-Of-Load Probability from either the needs assessment run or the adequacy assessment is a conditional probability of curtailment given the load forecast, existing system, etc. – not a measure of the likelihood of curtailment over all future load conditions for all potential retirements
- Includes
  - All existing regional resources
  - planned resources that are sited and licensed
  - a limited amount of imported and within-region market supply
- Excludes additional energy efficiency

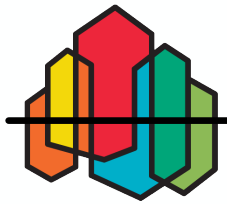



LOLP from 2023 Needs Assessment for all Plan Scenarios
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
LOLP
Baseline
Early Coal Retirement
WECC-wide Emissions Cost
No Gas Build Limitations
Limited Market
Organized Market
No Market Build
Increased Market Reliance
1
2
3
4
Annual


LOLP from 2031 Needs Assessment for all Plan Scenarios
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
LOLP
Baseline
Early Coal Retirement
WECC-wide Emissions Cost
No Gas Build Limitations
Limited Market
Organized Market
No Market Build
Increased Market Reliance
1 2 3 4 Annual

Adequacy Assessment

- Assess the adequacy of the existing system with expected loads and energy efficiency five years ahead
- Includes
  - Rate-based generating resources
  - Planned resources that are sited and licensed
  - A limited amount of imported and within-region market supply
  - Expected future energy efficiency savings




Further Questions?