Western Assessment of Resource Adequacy

Analytical Approach

The Western Assessment of Resource Adequacy (Western Assessment) examines resource adequacy through an energy-based probabilistic approach, looking broadly across the entire Western Interconnection and more specifically within each of five subregions over the next ten years. This analysis complements other analyses by entities like the Western Power Pool, California Independent System Operator, and others, by providing a high-level look at resource adequacy risks that can help stakeholders target areas for deeper examination and mitigation.[1]

This document explains the current capacity-based approach used by other entities and outlines WECC's energy-based approach.

Current Approach: Using Capacity to Calculate PRMs

Current approaches to calculating PRMs are typically based on resource capacity: a comparison of expected demand (in megawatts) to nameplate capacity (in megawatts). There are many ways to adjust these numbers, e.g., discounting nameplate capacity using capacity value to more accurately reflect the capacity that can be relied on from a given resource. However, regardless of how the numbers are altered, the calculation is based on capacity.

A resource-capacity-based approach starts with expected peak demand and then applies a reference margin using various assumptions to create buffers for reliability to ensure the peak hour is resource adequate (See Figure 1). Then the PRM is calculated based on the current portfolio. If the PRM is greater than the reference margin for a given hour, that hour is considered "resource adequate."

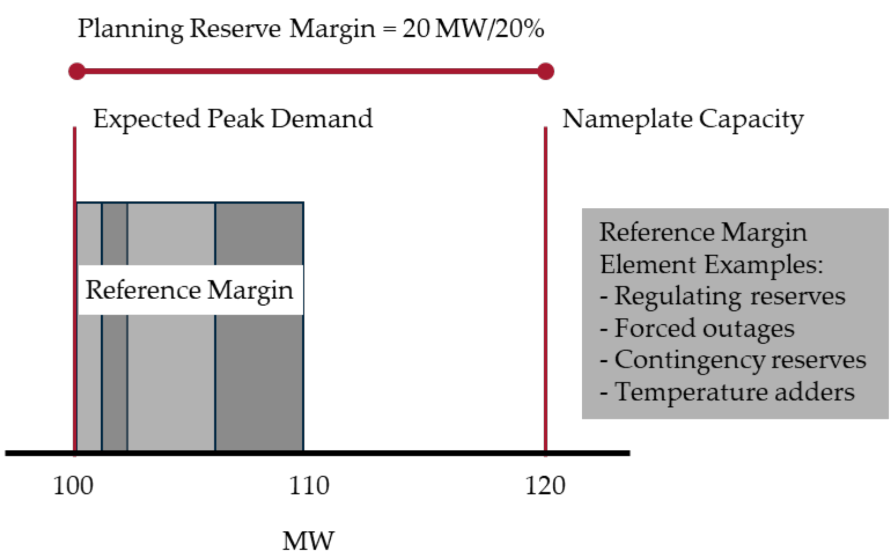


Figure 1: Planning Reserve Margin with a Capacity-Based Approach

[1] Examples of other entities include Energy and Environmental Economics (https://www.ethree.com/e3-webinar-resource-adequacy-in-the-desert-southwest/ and https://www.ethree.com/wp-content/uploads/2019/03/E3_Resource_Adequacy_in_the_Pacific-Northwest_March_2019.pdf), and the Northwest Power and Conservation Council (https://www.nwcouncil.org/energy/energy-topics/resource-adequacy/).

This method has worked in the past because resource portfolios were predictable and consistently ran relatively close to nameplate capacity. They consisted of hydro and various baseload resources like coal, nuclear, and natural gas. The output of baseload resources is controllable and fairly constant. Hydro resources can be variable, but years of data and operational experience have increased the ability to forecast them. Under traditional portfolios, the greatest source of variability was unforeseen or forced outages, which were adequately covered by the reference margin.

When variable energy resources (VER) like solar and wind were first added to resource portfolios, there were so few of them that their variability had little to no effect on the resource adequacy of the system. In other words, when a VER did not produce as expected, due to a change in weather, for example, there was enough headroom on the system to cover the missing energy from the VER. As VER penetration slowly grew, planners started accounting for the variability of VERs by discounting the nameplate capacity using methods such as capacity values (See Figure 2). This approach allowed planners to continue calculating PRMs using capacity while accounting for the low level of variability in energy output from VERs.

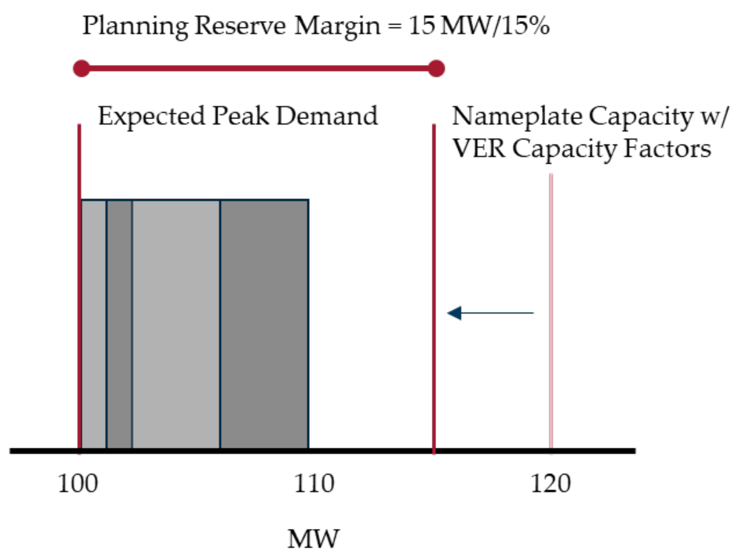


Figure 2: Capacity-Based Approach with Capacity Factors

As the resource mix has further changed, baseload resources like coal and nuclear have been retired and VERs have increased. This has increased the overall variability of the aggregate resource mix. Before the addition of large amounts of VERs, the probability curve for the energy output of the resource mix was fairly narrow; meaning actual output would not vary greatly from the expected or forecast output (See Figure 3). The reference

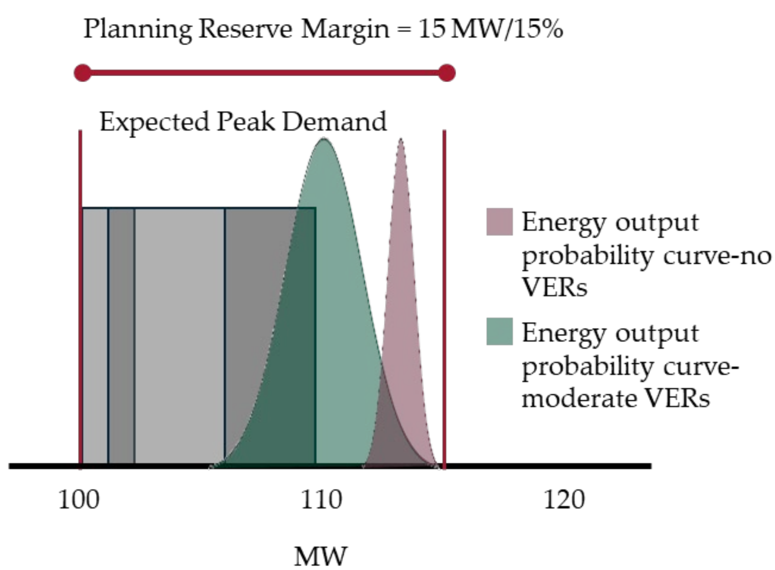


Figure 3: Capacity-Based Approach with Probability Curves

margin was established to cover the probability of forced outages (among other things). Therefore, if the energy output varied due to forced or unplanned outage, the reference margin would cover it. However, as VERs are added and variability increases, the energy output probability curve expands. Once enough VERs are added, the curve expands far enough that the energy output of the resource portfolio may fall short. This could result in the reference margin not alleviating the variability, making the system "resource inadequate." The resulting situation is a system considered resource adequate in terms of capacity, but resource inadequate in terms of actual energy produced. In practical terms, this means, once the amount of VERs on a system reaches a certain level, the system could be viewed as having *adequate capacity* to serve demand—even under extreme conditions—but the system may not be able to *produce enough energy* during an extreme event.

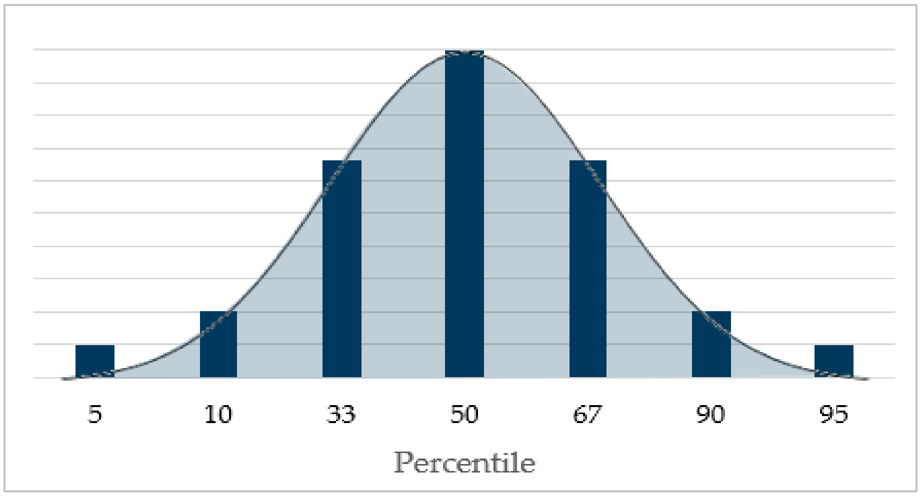
In addition to increased system variability, demand variability has also increased due to drivers like customer choice, climate change, and extreme weather. This combination of increased generation and demand variability requires the West to evaluate resource adequacy in terms of energy availability, instead of viewing resource adequacy solely in terms of capacity. This will allow planners to understand where and when potential energy shortfalls might occur.

WECC's Energy-Based Probabilistic Approach

To evaluate and account for increasing variability, WECC uses an energy-based probabilistic approach.

Energy-Based Probabilistic Analysis

An energy-based probabilistic analysis—like the analysis used in this assessment—looks at the probability that demand and resource availability will occur at the expected energy value. This can be plotted on a probability curve (See Figure 4). The curve shows the probability of potential levels of demand or resource availability based on the expected value WECC receives from Balancing Authorities. For example, the expected number provided by Balancing Authorities represents the 1-in-2 (also 50/50, 50%, or 50th percentile) probability. Examples of the other common probabilities referenced in this report can be found in the table.



Probability	Percentile	Likelihood of Occurrence
1-in-20	5th	5%
1-in-10	10th	10%
1-in-3	33rd	33%
1-in-2	50th	50% (expected)
1-in-3	67th	33%
1-in-10	90th	10%
1-in-20	95th	5%

Figure 4: Example Probability Curve and Table of Common Probabilities

The probabilistic analysis used in this report evaluates the probability curves of demand and resource availability together (See Figure 5). The area in which these curves overlap represents the possibility that there will not be enough resources available to serve the demand. This is called demand at risk. The overlap is the only place where the resource availability number could be less than the demand number. The greater the overlap of the two curves, the greater the likelihood that this will be the case. Consequently, the goal is to keep the two curves far enough apart so the overlap—or probability that demand will exceed resource availability—is kept below a certain threshold. This threshold is determined by the planning entity's risk tolerance. For this analysis, WECC has set the risk tolerance threshold to the one-day-in-ten-year (ODITY) level, meaning 99.98% of the demand for each hour is covered by available resources; i.e., the area of overlap is equal to no more than .02% of the total area of the demand curve for any given hour.

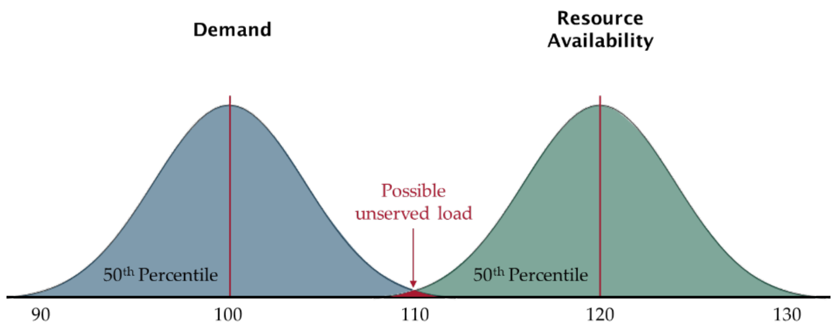


Figure 5: Example Demand and Resource Availability Curves

The overlap—the demand at risk—can increase when one or both of the curves move. This happens when the expected demand increases or the expected resource availability decreases, or both. In any of these cases, the curves maintain their original shape but move closer together, increasing the overlap (See Figure 6). An example of this occurrence is when a Balancing Authority updates the expected demand forecast to a higher level without changing the portfolio.

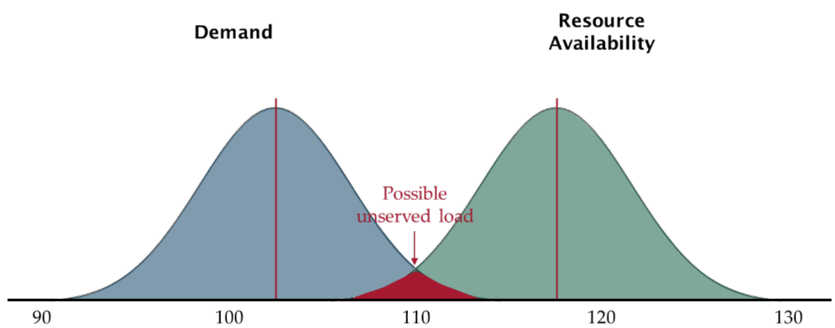


Figure 6: Demand and Resource Availability Curves with Increased Overlap

Another way that the overlap is increased is through variability. When rare events occur more regularly than predicted, the probability curve changes shape. For example, heat wave events like those that occurred in the West in 2020 and 2021 were once rare events. The August 2020 Heat Wave was a 1-in-30 event, but when evaluated considering climate change, this type of event now becomes more likely, with a 1-in-20 chance of occurring. Roughly two weeks after the August heat wave, there was another extreme heat event that had a 1-in-70 chance of occurrence, which, after accounting for climate change, has a 1-in-40 chance of occurring again. The June 2021 Heat Wave in the Pacific Northwest was a 1-in-1000-year event, which, when calculated to account for climate change, is now 150 times more likely to occur again. As these extreme events become more common, the probability that they will occur increases. When a rare event like a 1-in-30 event becomes more common, the probability curve around it changes shape (See Figure 7). When one or both of the curves change shape, and nothing else changes, the overlap of the two curves can increase, boosting the likelihood that demand will exceed resource availability (See Figure 8).

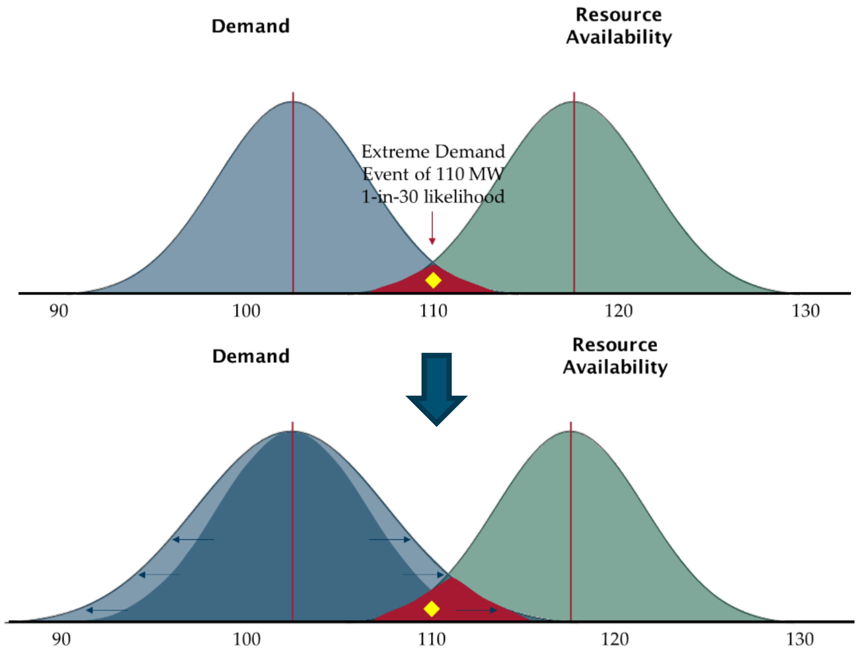


Figure 7: Demand and Resource Availability Curves with Expanded Demand Curve

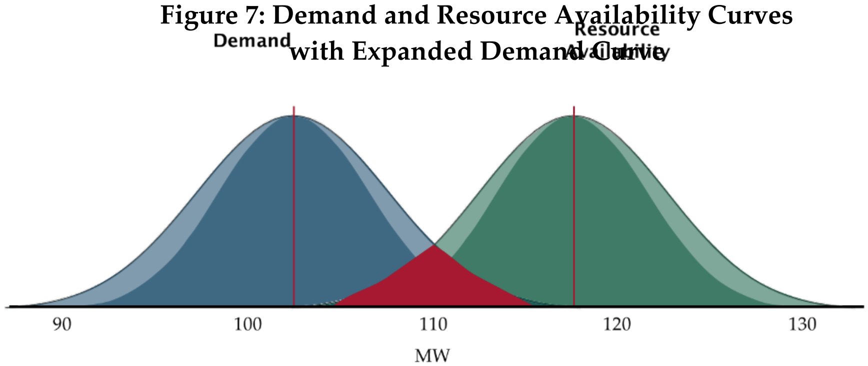


Figure 8: Demand and Resource Availability Curves Expanded Due to Variability

Calculating the Planning Reserve Margin

This assessment generates PRMs that produce an overlap in demand and resource availability probabilities that represent no more than a .02% chance that demand will exceed available resources—making the grid 99.98% resource adequate. In Figure 9, with an expected 1-in-2 chance that demand is 100 MW and resource availability is 120 MW, a 20-MW—or 20%—planning reserve margin is needed to remain 99.98% resource adequate. This is based on the shapes of the demand and resource availability curves.

If a planning entity expects to have only 115 MW of resources available, the planning reserve margin shrinks to 15 MW, or 15% of expected demand (See Figure 10). This increases the likelihood that demand will exceed available resources. In this example, Figure 10 shows that the resource curve moved to the left by 5 MW, moving the curves closer together and increasing the overlap.

When demand and resource variability are added, shown by the expanding curves in Figure 11, the 15-MW PRM becomes even less effective. The expected demand has remained the same (100 MW), increasing the overlap. If the 15-MW PRM is used, the system is not 99.98% resource adequate.

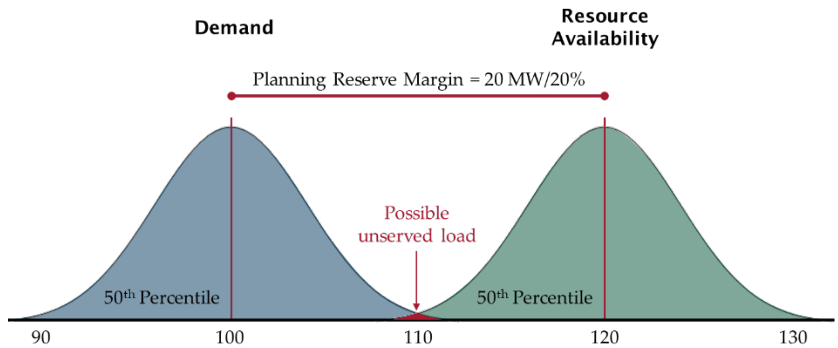


Figure 10: Example Demand and Resource Curves with 20% PRM

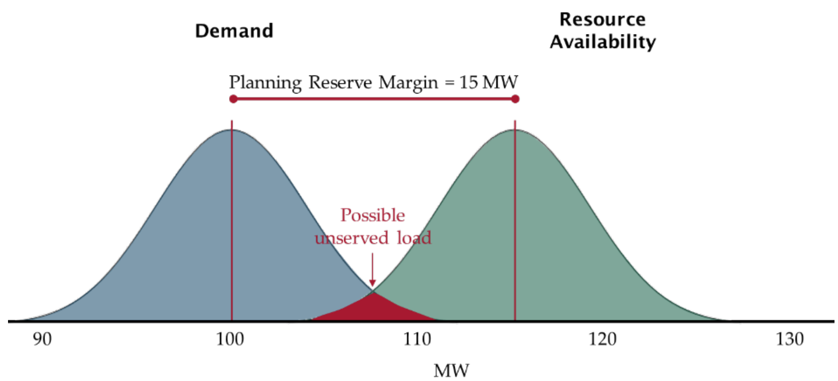


Figure 9: Example Demand and Resource Curves with 15% PRM

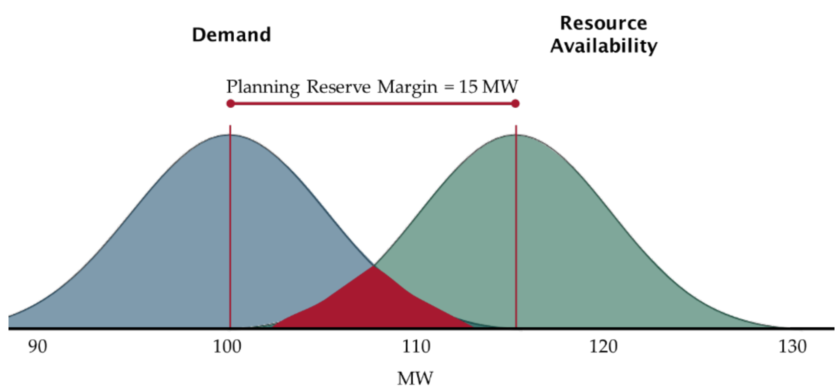


Figure 11: Expanded Demand and Resource Curves with Large Overlap

To return to 99.98% reliability, the PRM would need to increase to 22 MW (22%) to account for the changes in demand and resource availability (See Figure 12).

This example assumes that entities use the PRM to cover the increased variability, i.e., as variability increases, entities must increase their PRMs to remain 99.98% resource adequate. In reality, there are additional ways to separate and shrink the curves.

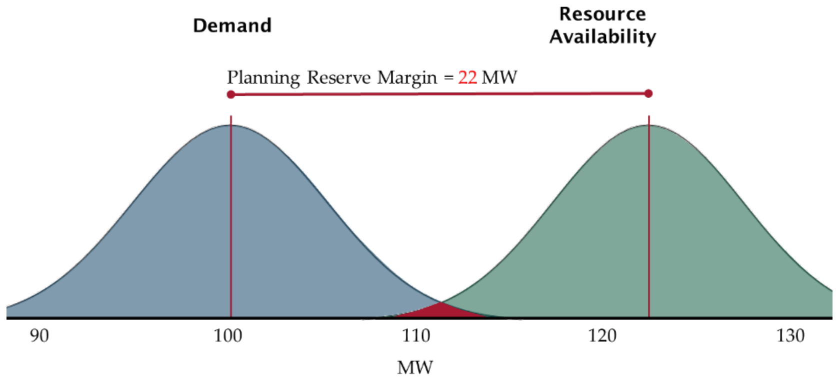


Figure 12: Example Demand and Resource Curves with 22% PRM