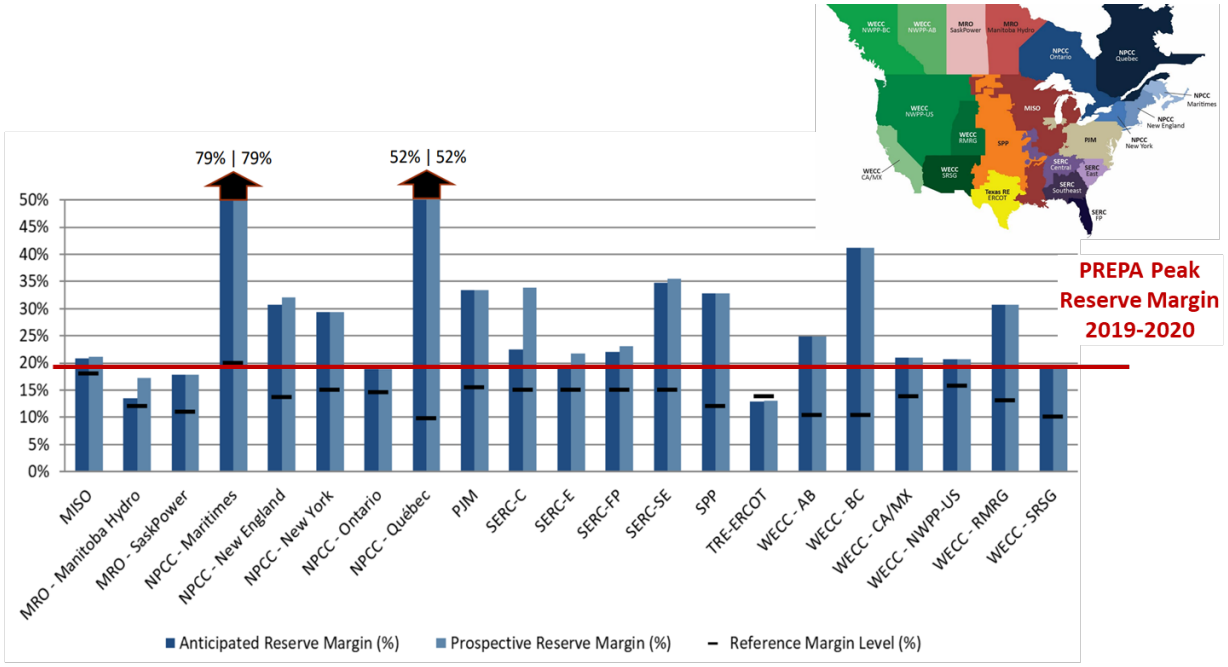
# Resource Adequacy

Resource Adequacy (RA) is a utility planning standard that has become increasingly relevant for utility planning since the California Electricity Crisis of 2000-2001. Specific standards for RA have been established for several states and territories depending on local ISO rules and requirements established by State Legislatures.

As a general statement, RA requirements require the utility to sign contracts with enough generating capacity to meet its peak demand plus some level of Planning Reserve Margin (PRM). Since the PRM is a capacity-based metric, it does not always provide a full indication of performance, for example, in energy limited systems such regions with significant hydro nameplate capacity, but where water resources may be limited during some periods. In a similar manner, an island-based utility such as PREPA might have higher RA requirements since it is not interconnected to neighboring utilities that could help meet peak demands via Transmission interconnects. For this reason and others, certain regions relay more heavily on a defined RA level than others, and the actual targeted reserve margin may vary from utility to utility. But it is a standard metric for the viability of a grid to meet its load.

NERC evaluates reserves for all North American utilities for every summer and winter planning period, and RA and other metrics are monitored closely. As seen in the chart below, which focuses on the impact of the COVID-19-related demand reductions in most of the country,




**PREPA Peak Reserve Margin 2019-2020**

***Source: NERC 2020 Summer Reliability Assessment***

## Resource Adequacy

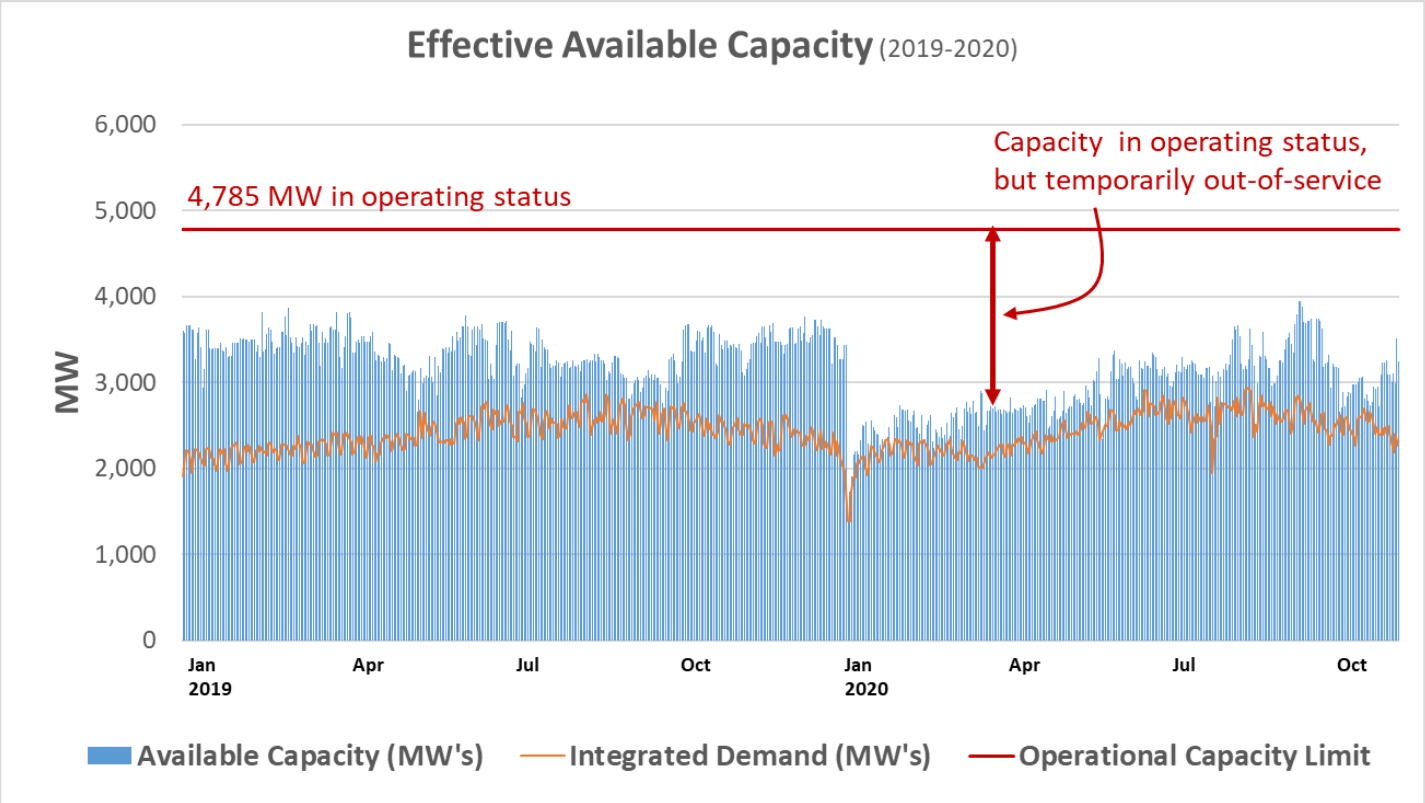
The Anticipated Reserve Margin, which is based on available resource capacity, is a metric used to evaluate resource adequacy by comparing the projected capability of anticipated resources to serve forecasted peak demand.[4] Large year-to-year changes in anticipated resources or forecasted peak demand (net internal demand) can greatly impact Planning Reserve Margin calculations. Other than in ERCOT, all assessment areas have sufficient Anticipated Reserve Margins to meet or exceed their Reference Margin Level for Summer 2020 as shown in the Figure 1.

Although the pandemic introduces significant uncertainty into demand and some risk to generation resource availability, as discussed in the following section, the projections below provide indication that adequate resources are available to meet peak demand.

adequate reserves typically exist in most regions although currently, ERCOT and MRO show reduced levels due to local situations at each.

However, as in most topics related to electric utility planning, an annual or seasonal perspective provides some useful insight, but it is also necessary to consider more finite time horizons to understand the adequacy of resources to meet load and the probabilities of customer interruption. The chart below shows the average daily reserve margin (expressed as total available capacity divided by peak demand for each day). What becomes clear is that while an average annual reserve margin of ~20% might at first seem to be adequate, on a daily basis, PREPA experiences many, many days where available reserves fall below prudent utility planning practices. The chart also illustrates how daily peak demand and reserves fluctuate significantly through the year due to summer and winter fluctuations and fell sharply in 2020 following the January earthquake and loss of Costa Sur Units 5&6.

The chart below also highlights perhaps the most prominent characteristic of PREPA's System Operations sector, which is the extreme unreliability of PREPA's generation assets. While precise data has still proven difficult to obtain despite several data requests, there are currently approximately of 6,173 MW of nameplate rated capacity listed in PREPA, but 1,388 MW of this is effectively out-of-service even though it might not have been officially designated as such. This out-of-service capacity includes units that have not operated in several years and others such as Palo Seco 2, which are designated as structurally unsafe to walk on, much less operate. Taking a realistic viewpoint that these out-of-service units cannot provide reliable reserves leaves 4,785 MW in operating status. PREPA has also had an average of 1,620 MW per day of this total capacity unavailable during the past two-year period, so in effect, their available capacity averaged approximately 3,166 MW between 2019-2020. This unavailable capacity is reflected in the solid white section between the horizontal red line and the solid blue bars in the figure below.




Source: LUMA analysis of Daily System Loads and Availabilities 2019-2020

In almost every operating utility in North America, hourly data is available to meaningfully evaluate Resource Adequacy. In fact, sub-5 minute time intervals are becoming the more typically used time-interval, because this level of time granularity is required to accurately model renewable generation. PREPA was unable to provide reliable hourly data for a retrospective assessment of their situation [1], so LUMA relied upon daily data which they did provide and recorded the peak demand and the available generation data for each day between 2019 and 2020. This daily data can provide additional perspective on how utility planners must manage their planning function and was used by LUMA to provide some insight on the daily volatility in available reserves and probability of failures.

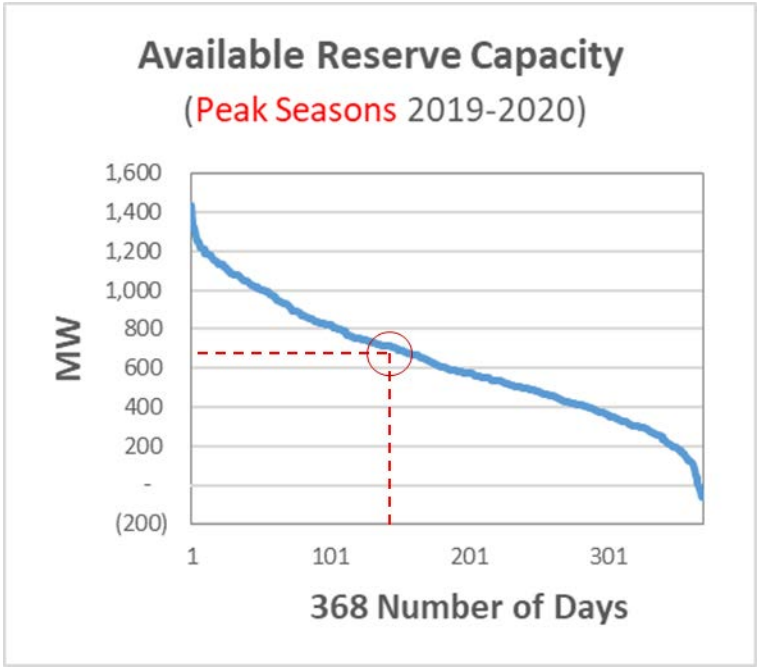
Even a daily perspective does not convey the true condition of PREPA's fleet. For example, even if the there might be adequate reserves for one particular day in our reported data, that does not mean that there were not several hours during that day where there was not adequate reserves and as a result, load shedding events could have occurred. However, the

[1] PREPA has subsequently provided this hourly data since the Resource Adequacy analysis was completed, and LUMA will soon update this analysis with the improved data.

daily data does allow an approximate load duration curve to be developed, which is the proper tool for system planners to evaluate reserves.

A load duration curve shows the frequency of how many time intervals (in our case, days) of the year did certain load or reserve amounts exist. In other words, a utility planner can select a point moving along the axis to determine what the corresponding value on the other axis should be. We have assumed a planning reserve of 750MW as a reasonable target, which represents approximately 1.5 time the capacity of the largest unit on the system. This is based upon NERC guidelines and we have used Ecoelectica in this example.

If we use 750 MW as the targeted reserve requirement for a system such as PREPA on the left hand vertical axis and read across to where it intersects the load duration curve, it tells us that on 287 of the 368 days in our peak season sample period, PREPA had less than 750 MW reserve margin (as measured by daily peaks). In other words, *78% of the days during peak season, PREPA was not within NERC planning guidelines*.




As a result of the unreliable generating fleet, and the sub-standard level of Resource Adequacy, PREPA is forced to make many operational decisions which would otherwise be seen as sub-optimal. They are forced to run their thermal units at lower loads in order to rely upon them to provide ramping ability or spinning reserve. This causes these plants to consume more fuel, which increases costs and environmental emissions. In addition, because they have so little flexibility, they have almost no available options to achieve economic dispatch of existing assets or to reduce load shedding as their alternative to operational issues. The Systems Operations group is knowledgeable and aware of their dilemma, but they can't change it.

The most viable solution to increase Resource Adequacy and to provide some reserve margin is to invest money for necessary repairs into existing generation assets to improve output and reliability. Even though these plants are all retirement candidates, and it might seem questionable to invest in them, PREPA has gotten itself into a situation with very limited alternatives.