Resource Adequacy Enhancements

Second Revised Straw Proposal

October 3, 2019

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1. Executive Summary

The California Independent System Operator (CAISO) is performing a comprehensive review of the CAISO's Resource Adequacy (RA) provisions and proposing enhancements that ensure effective procurement of capacity to reliably operate the grid all hours of the year. This comprehensive review has identified potential modifications to the CAISO provisions for System, Local, and Flexible RA.

The CAISO's second revised straw proposal considers enhancements to RA counting rules and assessments. This includes considering forced outage rates for system, local, and flexible RA requirements. It is common practice among other ISOs to include an assessment of unforced capacity value that relies on the probability a resource will experience a forced outage at some point when it has been procured for RA capacity. The CAISO proposes to develop a methodology for calculating unforced capacity values and an assessment to ensure the shown RA capacity is collectively adequate to meet the CAISO's system operational needs in all hours. The proposal also considers the inclusion of a portfolio assessment process to ensure that reliability needs can be met by the shown RA portfolio during all hours. The CAISO believes this proposed portfolio assessment is necessary to address the growing integration of use- and availability-limited resources into the RA fleet.

Regarding provisions for RA must offer obligations and bid insertion, the CAISO is proposing modifications to ensure coordination with the Day Ahead Market Enhancements and Extended EIM initiatives. This coordination is key to ensure all three proposals work without creating any conflicting outcomes. RA resources must offer obligations will be set at the amount of NQC shown for RA, not the amount of UCAP shown. To align with the CAISO's Day-Ahead Market Enhancements initiative, RA resources will have a 24 by 7 must offer obligation into the day-ahead market unless explicitly provided an exemption to this requirement through the proposed modifications. The CAISO also proposes that non-use-limited resources and use-limited resources with an opportunity cost will receive bid insertion, unless exempted.

The CAISO is proposing several changes to the existing planned outage provisions and planned outage process. Several changes are intended to ensure planned outages can be taken by 45 days prior to the month in response to stakeholder feedback. The CAISO has removed the previously proposed requirement for providing comparable capacity for planned outages. The proposal also attempts to remove obligations for outage replacement to the greatest extent possible. The CAISO proposes to redesign the planned outage process to reflect system UCAP targets rather than traditional NQC targets. This proposed change will better align with the counting rules and RA assessments proposal to incorporate forced outage rates in capacity valuation and assess resource adequacy on a UCAP basis.

The CAISO proposes modifications to the RA import provisions, including adoption of certain existing California Public Utilities Commission (CPUC) rules to ensure RA imports are backed by a forward commitment of physical capacity with firm transmission delivery and sufficient operating reserves to back obligations. LSEs will be required to submit supporting documentation that any non-specified RA import resource shown on annual and monthly RA and Supply plans represent physical capacity and firm transmission. The CAISO will include

these requirements in the tariff to ensure similar treatment among all LSEs. The CAISO also proposes to require that non-specified RA imports provide the source BA that will provide the capacity to ensure that RA imports are not double counted for EIM entities' resource sufficiency tests or otherwise relied upon by the host BA to serve native load. The CAISO has also removed consideration of Maximum Import Capability provisions from the scope of this initiative and plans to initiate as standalone stakeholder initiative to fast track resolution of MIC related modifications.

The CAISO is proposing a new flexible RA framework that more deliberately captures the CAISO's operational needs for unpredictable ramping needs between day-ahead and real-time markets. Proposed changes to the flexible capacity product and flexible capacity needs determination are intended to closely align with CAISO's actual operational needs for various market runs (*i.e.*, day-ahead market and fifteen-minute market). The proposal also incorporates Effective Flexible Capacity (EFC) counting rules and allowing imports to qualify to meet flexible RA requirements. CAISO also proposes rules for allocation of identified flexible RA needs, updated showings and assessments rules, and updated Must Offer Obligations for flexible RA capacity.

The CAISO also includes proposed modifications to its backstop capacity procurement provisions to align backstop authority with the resource adequacy counting rules and adequacy assessments outlined above. These proposed modifications include additional procurement authority to use the capacity procurement mechanism as an option to fulfill load serving entities' unforced capacity deficiencies and system deficiencies as determined through a resource adequacy portfolio showing analysis.

The CAISO is proposing modifying its tariff authority to address local capacity needs that are met with availability limited resources, and will seek authority to procure additional resources through the capacity procurement mechanism in response to planned outages that reduce capacity below requirements if no substitute capacity is provided. These local RA related issues have been developed and spun off in a separate draft final proposal and thus, the CAISO has removed these sections from this RA enhancements proposal.

2. Introduction and Background

The rapid transformation to a cleaner, yet more variable and energy limited resource fleet, and the migration of load to smaller and more diverse load serving entities requires re-examining all aspects of the CAISO's Resource Adequacy program. In 2006, at the onset of the RA program in California, the predominant energy production technology types were gas fired, nuclear, and hydroelectric resources. While some of these resources were subject to use-limitations because of environmental regulations, start limits, or air permits, they were generally available to produce energy when and where needed given they all had fairly dependable fuel sources. However, as the fleet transitions to achieve the objectives of SB 100,[1] the CAISO must rely on a

[1] The objective of SB 100 is "that eligible renewable energy resources and zero-carbon resources supply 100% of retail sales of electricity to California end-use customers and 100% of electricity procured to

very different resource portfolio to reliably operate the grid. In this stakeholder initiative, the CAISO, in collaboration with the California Public Utilities Commission (CPUC) and stakeholders, will explore reforms needed to the CAISO's resource adequacy rules, requirements, and processes to ensure continued reliability and operability under the transforming grid.

The CAISO has identified certain aspects within the CAISO's current RA tariff authority that, among other things, require refinement to ensure effective procurement, help simplify overly complex rules, and ensure resources are available when and where needed all hours of the year. The following issues are of growing concern to the CAISO:

- The current RA counting rules do not adequately reflect resource availability, and instead rely on complicated substitution and availability incentive mechanism rules;
- Flexible capacity counting rules may not sufficiently align with operational needs;
- The provisions for import resources may need clarification to ensure physical capacity and firm delivery from RA imports;
- Current system and flexible RA showings assessments do not consider the overall effectiveness of the RA portfolio to meet the CAISO's operational needs; and
- The growing reliance on availability-limited resources where these resources may not have sufficient run hours or dispatches to maintain and serve the energy needs in local capacity areas and sub-areas.

The CAISO is conducting a holistic review of its existing RA tariff provisions to make necessary changes to ensure CAISO's RA tariff authority adequately supports reliable grid operations into the future. The second revised straw proposal specifically presents the CAISO's proposals for changes to system RA regarding the following topics; system RA requirements, showings and sufficiency testing, RA capacity counting rules, Must Offer Obligations and bid insertion, the planned outage process, and RA imports and Maximum Import Capability.

The CAISO also provides updates to its proposal for flexible RA capacity. The CAISO's proposal addresses identifying flexible RA capacity needs and products, setting flexible RA requirements and counting rules for EFC values, as well as flexible RA allocation, showings, and sufficiency tests and flexible RA Must Offer Obligation modifications.

Regarding local RA modifications, the CAISO will examine incorporating forced outage rates into the local RA process. The CAISO proposed changes to local capacity assessments to address availability limited resources, and meeting local capacity needs with slow demand response. The CAISO also presents its proposal to modify aspects of its backstop capacity procurement, including certain enhancements to the Capacity Procurement Mechanism.

The remaining stakeholder initiative schedule is detailed below.

serve all state agencies by December 31, 2045."
https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100

3. Stakeholder Engagement Plan

Table 1 outlines the schedule for this stakeholder initiative below. CAISO plans to seek CAISO board approval of the elements in this RA enhancements initiatives in the second quarter of 2020.

Table 1: Stakeholder Engagement Plan

Date	Milestone
Oct 3	Second revised straw proposal
Oct 9	Stakeholder meeting on second revised straw proposal
Oct 23	Stakeholder comments on second revised straw proposal due
Dec 17	Third revised straw proposal
Jan 7-8	Stakeholder meeting on third revised straw proposal
Jan 22	Stakeholder comments on third revised straw proposal
Feb 26	Draft final proposal
March 3-4	Stakeholder meeting on draft final proposal
March 25	Stakeholder comments on draft final proposal due
Q2 2020	**Present proposal to CAISO Board**

4. Resource Adequacy Enhancements: Principles and Objectives

Principles

The resource adequacy framework must reflect the evolving needs of the grid

As the fleet transitions to a decarbonized system where fuel backed resources are replaced with clean, variable, and/or energy-limited resources, traditional measures of resource adequacy must be revisited to include more than simply having sufficient capacity to meet peak demand. The RA products procured and the means to assess resource adequacy must be re-examined and refreshed to remain relevant. Any proposed changes must assure that RA accounting methods effectively evaluate the RA fleet's ability to meet the CAISO's operational and reliability needs all hours of the year. The evolving fleet is altering the CAISO's operational needs. As more variable supply and demand interconnects to the system, the CAISO requires resources that are more flexible and can quickly and flexibly respond to greater levels of supply and demand uncertainty. RA requirements and assessments must reflect the evolving needs of the grid and the RA framework must properly evaluate and value resources that can meet these evolving needs.

RA counting rules should promote procurement of the most dependable, reliable, and effective resources

Both RA and non-RA resources should be recognized and rewarded for being dependable and effective at supporting system reliability. If a non-RA resource has a higher availability and is more effective at relieving local constraints relative to other similar RA resources, then such information should be publicly available to enable load-serving entities (LSEs) to compare and contrast the best, most effective resources to meet their procurement needs. Having this information publicly available to load-serving entities will improve opportunities for the most dependable and effective resources to sell their capacity. Thus, in principle, RA counting rules should incentivize and ensure procurement of the most dependable, reliable, and effective resources.

The RA program should incentivize showing all RA resources

Modifications to the existing RA structure should encourage showing as much contracted RA capacity as possible and not create disincentives or barriers to showing excess RA capacity. Although it may be appropriate to apply additional incentive mechanisms for availability, CAISO must balance the impact that such incentives may have on an LSE's willingness to show all of its contracted RA capacity.

LSE's RA resources must be capable of meeting its load requirements all hours of the year

RA targets should be clear, easily understood and based on reasonably stable criteria applied uniformly across all LSEs. For example, to date, the CAISO has relied on a planning reserve margin that is met through a simple summation of the shown RA resources' Net Qualifying Capacity (NQC) values. Most Local Regulatory Authorities (LRAs) set a planning reserve margin at fifteen percent above forecasted monthly peak demand. However, some LRAs have

set lower planning reserve margins. It is not possible to determine if those LSEs with lower planning reserve margins impair the CAISO system without comparing the attributes of the underlying resources in LSE's portfolios, relative to resources' attributes in other portfolios. In other words, the simple summation of NQC values in a LSE's portfolio does not does not guarantee there will be adequate resources and does not assure an LSE can satisfy its load requirements all hours of the year. As California Public Utilities Code section 380 states, "Each load-serving entity shall maintain physical generating capacity and electrical demand response adequate to meet its load requirements, including, but not limited to, peak demand and planning and operating reserves" (emphasis added).[2] In other words, resource adequacy also encompasses LSEs meeting their load requirements all hours of the year, not just meeting peak demand.

Objectives

In evaluating RA enhancements, CAISO is reviewing NQC rules, forced outage rules, adequacy assessments, and availability obligations and incentive provisions. These existing rules are inextricably linked and require a holistic review and discussion. This review includes considering assessing the reliability and dependability of resources based on forced outage rates. Incorporating forced outages into the CAISO's RA assessment will help inform which resources are most effective and reliable at helping California decarbonize its grid.

Based on the CAISO's review of best practices and the diverse stakeholder support for further exploration of these matters, CAISO is proposing a new resource adequacy framework to assess the forced outage rates for resources and conduct RA adequacy assessments based on both the unforced capacity of resources and the RA portfolio's ability to ensure CAISO can serve load and meet reliability standards.

The CAISO's proposal seeks to remain aligned with the CPUC process. However, CAISO notes that solely relying on an installed-capacity-based PRM as the basis for resource adequacy, as is the case today, is not sustainable into the future given the transforming grid and the new resource mix and its operational characteristics.

CAISO must consider the express intent of the original legislated RA mandate: to ensure each load-serving entity maintains physical generating capacity and electrical demand response adequate to meet its load requirements. This is essential as California transitions to greater reliance on more variable, less predictable, and energy limited resources that may have sufficient capacity to meet a planning reserve margin, but may not have sufficient energy to meet reliability needs and load requirements all hours of the year. Given this growing concern, CAISO is proposing to develop a new resource adequacy test that will ensure there is sufficient capacity to not only meet peak load needs, but, just as importantly, to ensure sufficient energy is available within the RA fleet to meet load requirements all hours of the year.

[2] California Public Utilities Code Section 380: http://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=PUC&division=1.&title=&part=1.&chapter=2.3.&article=6.

As noted above, the current RA practices rely heavily on the existing NQC counting rules. CAISO believes that resources' NQC values will continue to be an important aspect of the RA program in the future. CAISO envisions Must Offer Obligations being tied to NQC values. However, CAISO is also considering how to incorporate resource forced outage rates into local RA assessments. Similar to the current provisions of other ISOs, CAISO proposes calculating and publishing both installed capacity (NQC) and unforced capacity (UCAP) values and utilizing both figures in the CAISO's RA processes.

5. RA Enhancements Second Revised Straw Proposal

The following sections detail the CAISO's proposed modifications and provide the CAISO's rationale and supporting justification. The CAISO has organized the Second Revised Straw Proposal into sections covering System, Flexible, and Local RA and related sub topics, and a section covering proposed modifications to the CAISO's backstop procurement provisions. The CAISO has separated two local RA topics from previous versions into a separate draft final proposal.[3]

The RA Enhancements Second Revised Straw Proposal covers the following topics:

- System Resource Adequacy
    - Determining System RA Requirements
    - Forced Outage Rates and RA Capacity Counting
    - System RA Showings and Sufficiency Testing
    - Must Offer Obligation and Bid Insertion Modifications
    - Planned Outage Process Enhancements
    - RA Import Provisions
- Flexible Resource Adequacy
    - Identifying Flexible Capacity Needs and Requirements
    - Identifying Flexible RA Requirements
    - Setting Flexible RA Requirements
    - Establishing Flexible RA Counting Rules: Effective Flexible Capacity Values and Eligibility
    - Flexible RA Allocations, Showings, and Sufficiency Tests
    - Flexible RA Must Offer Obligation
- Local Resource Adequacy
    - Forced Outage Rates and RA Capacity Counting
- Backstop Capacity Procurement Provisions
    - Capacity Procurement Mechanism Modifications
    - Reliability Must-Run Modifications
    - UCAP Deficiency Tool

[3] Draft Final Proposal for Local Assessments with Availability Limited Resources and Meeting Local Needs with Slow Demand Response can be found on the RA Enhancements Webpage: http://www.caiso.com/informed/Pages/StakeholderProcesses/ResourceAdequacyEnhancements.aspx

5.1. System Resource Adequacy

Resource deliverability under stressed system conditions remains an essential and important part of a resource's ability to support reliable grid operations, and the CAISO intends to preserve the current NQC calculations for resources, *i.e.*, the CAISO will continue to perform NQC calculations exactly as it does today, and will continue to derate Qualifying Capacity values (QC) based on deliverability.

For all resources with NQC values, the CAISO proposes to establish UCAP values to identify the unforced capacity value (discounted for units' forced outage rates) for use in system, local, and flexible RA showings and assessments.[4] The UCAP value speaks to the quality and dependability of the resources procured to meet RA requirements. The CAISO also proposes to establish system RA requirements and associated sufficiency tests that account for unit forced outage rates. In other words, a resource's RA value would be measured in terms of its UCAP value, and individual LSE sufficiency tests would be measured based on meeting UCAP requirements each month. The following section provides the CAISO's proposed modifications to incorporate these changes into CAISO RA processes and tariff.

5.1.1. Determining System RA Requirements

The CAISO proposes that RA accounting should reflect both NQC and UCAP values. The CAISO will coordinate with the CPUC and LRAs to ensure alignment with individual LRA requirements.

System UCAP Requirement

From a planning perspective, it is reasonable to expect that the amount of UCAP made available should be sufficient to serve forecasted peak load and ancillary services requirements given the forced outage rate of resources is embedded in the UCAP value. After removing forced outages from the planning reserve margin, what remains is forecast error and ancillary services. When the RA program was originally developed, the estimated forced outage rate for RA resources was approximately 4% to 6% of the 15% planning reserve margin. Unfortunately, as noted in greater detail below, the CAISO observes forced outage rates far exceeding these values at critical times. The inference drawn from this is that the current PRM, after accounting for such high forced outages rates, is insufficient to cover load forecast error and operating reserves during key times, jeopardizing reliability and not meeting a "good utility practice" standard.

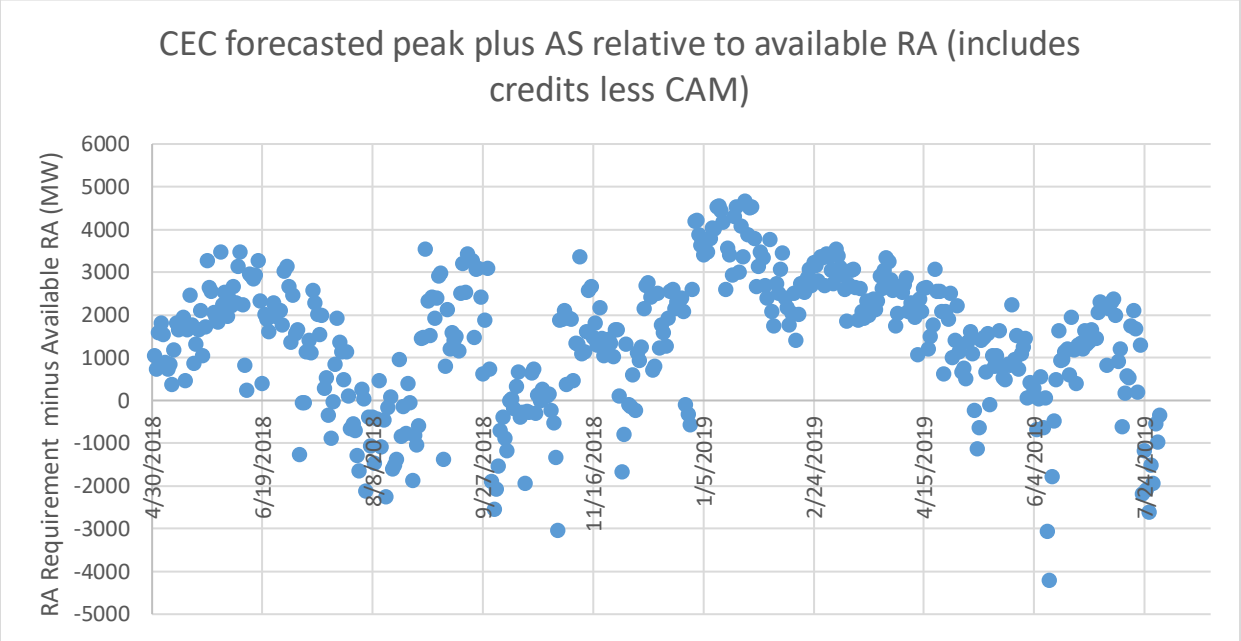
To address these concerns, the CAISO is proposing a system UCAP requirement to more directly account for forced outages. To ensure resource adequacy, the CAISO must carry operating reserves for three percent of load and three percent of generation, or cover the Most Severe Single Contingency according to BAL-002-WECC-2a,[5] and must have sufficient RA capacity to provide regulation and the flexible ramping product. Therefore, CAISO proposes to

[4] Resources without an NQC are not eligible to provide system or local RA capacity.
[5] BAL-002-WECC-2a found here: https://www.nerc.com/_layouts/15/PrintStandard.aspx?standardnumber=BAL-002-WECC-2a&title=Contingency%20Reserve&jurisdiction=United%20States

develop a minimum system UCAP requirement that all LSEs must meet and show as RA under the CAISO tariff.

The current system RA structure is designed to cover peak forecasted load, operating reserves, forced outages, and demand forecast error. It is reasonable to assess how well the current program achieves those objectives. CAISO analyzed data from its Customer Interface for Resources Adequacy (CIRA) system. The goal of this analysis was to assess how well the RA requirements would meet peak forecasted load, operating reserves, and forced outages. Forecast error was excluded from the assessment. CAISO used the RA requirements for May 2018 through July 2019 based on the CEC 1-in-2 peak load forecast. CAISO added six percent to that number to account for required operating reserves. Then, the CAISO compared that value to the available RA capacity. Available RA capacity is defined as shown RA capacity plus credits[6] minus forced outages. This analysis was conducted at a daily granularity.[7] As Figure 1 shows, there are several days that the CAISO would have been unable to cover forecasted peak demand plus operating reserves. This is shown by observation below zero on the vertical axis. More specifically, on just over 17.5 percent of the days, CAISO would not have adequate RA capacity to meet its planning targets. Further, this assumes that 100 percent of all RA credits are available at the fully credited level, including over 1000 MW of credited demand response in all but one month (which was 950 MW). If, for example, 500 MW of credited capacity is not available or responsive for any reason, the percent of days the CAISO would be deficient increases to 25 percent.

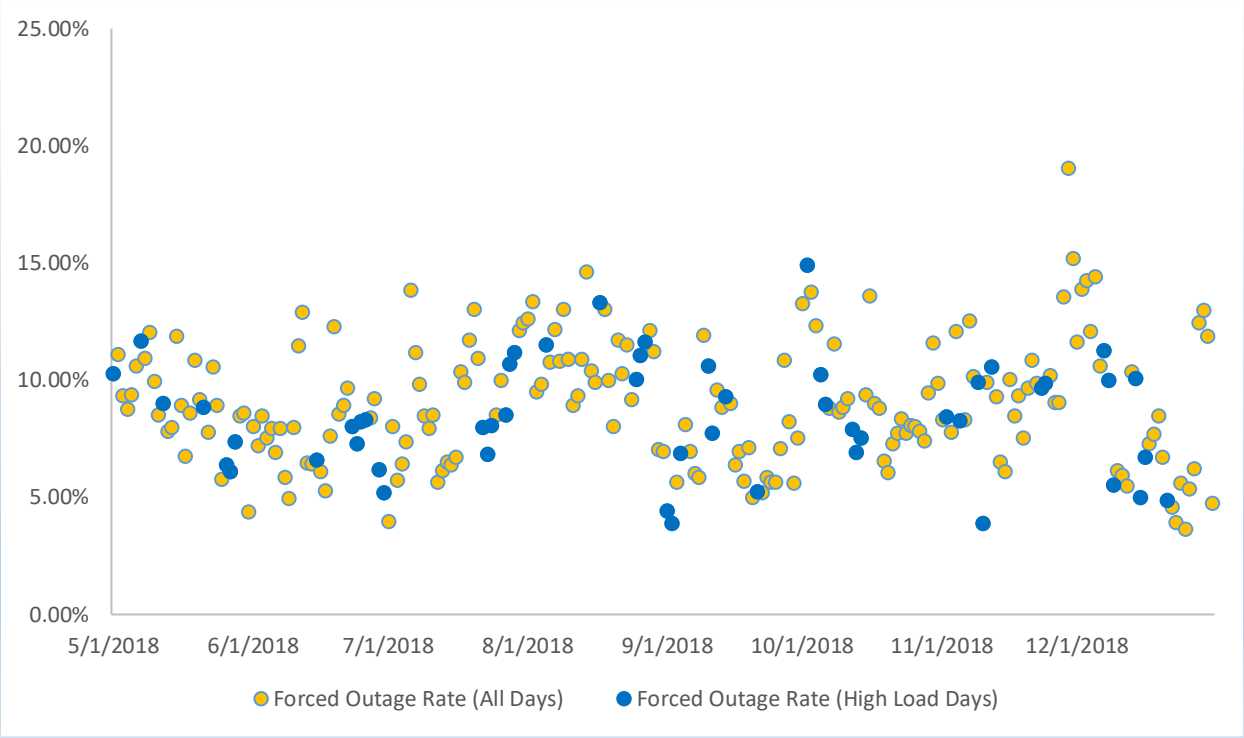
Figure 1: Available Capacity relative to forecasted need



[6] CAM credits were excluded from this analysis to avoid double counting.
[7] CIRA only captures when a forced outage flag has been inserted for a day. Hourly granularity is not available in CIRA.

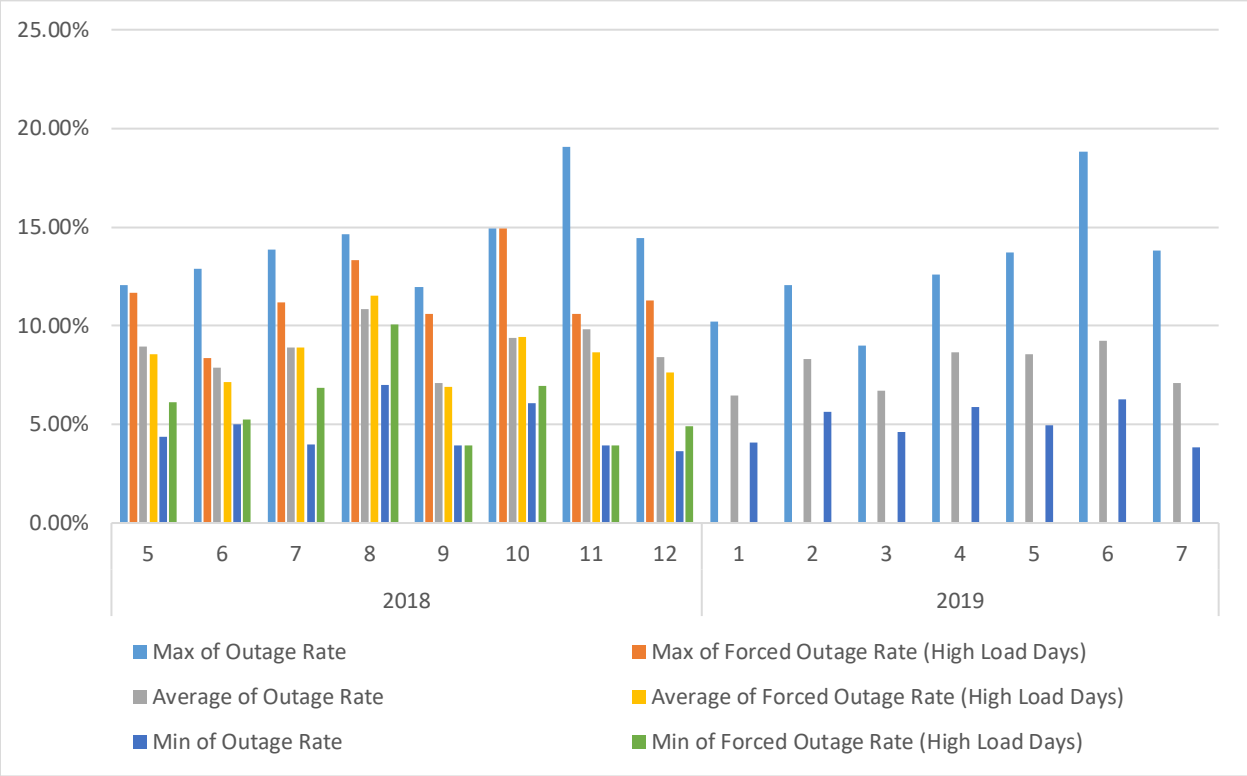
Additionally, the CAISO looked at the coincidence of forced outages rates with high load days. The CAISO wanted to see if forced outages rates differed based on actual load. Figure 2 shows the forced rates from May 1, 2018 through December 31, 2018. Additionally, the highest load days in each month have been isolated as well. This figure shows there is a very slight reduction in the forced outage rates on high load days meaning there is very little difference between forced outage rates based on load. Put another way, a planning reserve margin should assume forced outage rates are the same regardless of load. Figure 2 shows forced outage rates regularly in excess of ten percent, and even exceeding 15 percent on multiple occasions, including higher load days. This means that any LRA setting a planning reserve margin that accurately and thoroughly accounts for forced outages should include at least a 10-15 percent range on top of the forecasted peak demand. This is further demonstrated by the distributions shown in Figure 3, which shows the maximum, minimum, and average forced outage rates for each month.[8]

Figure 2: Forced Outages relative to monthly high load days (2018 only)



[8] Additional assessments regarding the RAAIM and its effectiveness at incentivizing forced outage replacement capacity is provided in section 5.1.2. If RAAIM is working effectively, it would likely reduce the overall need for UCAP values. However, as shown below, it has not been very effective at incentivizing replacement capacity.

Figure 3: Distributions of Forced Outage Rates



CAISO has examined two options to establish the minimum amount of UCAP required to maintain reliable grid operations: Top-down and bottom-up. The top down assumes all units in a given tech type will have the same average forced outage rate while the bottom up examines each unit individually.

The top-down approach relies on assumptions about average forced outage rates across various technology types to conduct a LOLE study to derive an assumed UCAP requirement. The top-down approach relies heavily on the assumption that forced outage rates are homogenous within a technology type. As shown in section 5.1.2, this assumption may not hold in California under greater scrutiny. Large variances in the forced outage rates within a technology type can lead to inefficient capacity procurement. Further, this type of study has not been applied to a system as reliant on variable and energy-limited resources as is the CAISO's.

The bottom-up approach is built on the foundation of forecasted peak demand. From there, ancillary services are added. However, unlike the top down approach, the bottom-up approach does not rely on any assumptions about average forced outage rates for various technology types. Only individual resource outage rates are needed and then only for procurement and showing purposes. Therefore average forced outage rates are not used since this information is embedded in the UCAP values.

On balance, the CAISO believes the bottom-up approach is best to establish a minimum system RA requirement based on UCAP because it helps ensure minimum resource adequacy requirements are achieved to maintain reliability given the growing number of LRAs and the

potential variance in the LRAs' PRM targets. A RA requirement based on UCAP should also help mitigate the potential for capacity leaning among LSEs.

In comments, the CPUC staff suggested using either a higher planning reserve margin or a more conservative load forecast (*i.e.*, 1-in-5 instead of 1-in-2) as an alternative solution to UCAP. As noted in CAISO's testimony in the CPUC's RA proceeding, the CAISO supports using the more conservative 1-in-5 load forecast, particularly for the shoulder months where the CAISO observes greater variability in the monthly peaks.[9] Utilizing higher load forecast would ensure more diverse load profiles can be addressed by RA procurement. However, such a change does not address the fundamental and underlying issue of forced outages.[10] Based on the data reviewed by the CAISO, to avoid deficiencies caused by forced outages, all LRAs must provide ancillary services to ensure six percent operating reserves based on forecasted peak demand, plus an additional 10-15 percent to reasonably address forced outages. The results of CAISO's analysis show that a planning reserve margin of 120 percent is needed to address peak demand, forced outages, and operating reserves. This excludes forecast error, which, at least in part, can be addressed by using a 1-in-5 peak load forecast. However, this may not provide adequate RA capacity in many years. For example, using a 1-in-10 year forecast for planning purposes should cover all reasonably foreseeable procurement needs, avoiding the need to include forecast error in a planning reserve margin. Alternatively, using a 1-in-2 forecast would require that virtually all under-forecasting error be included in the planning reserve margin. Therefore, the CAISO recognizes that efforts to establish a minimum UCAP requirement needs additional collaboration with LRAs to determine the most appropriate means of addressing under-forecasting risks. However, at this time, CAISO believes that UCAP requirement should be set at a minimum of 106 percent of forecasted peak (which is forecast load plus reserves), plus any additional capacity needed to account for forecast error. The CAISO seeks stakeholder input regarding how to best account for forecast error in setting a UCAP requirement.

The CAISO has received stakeholder feedback indicating a need for the CAISO to consider how to coordinate these important system RA modifications with the CPUC's RA program and with other LRAs. The CAISO agrees this is an important consideration. For a detailed discussion on matters related to coordination of the proposed UCAP concepts with the CPUC's programs, please see section 5.1.2.

5.1.2. Forced Outage Rates and RA Capacity Counting

The CAISO is proposing new RA counting rules that account for the probability of forced outages, eliminating the need for complicated replacement capacity rules. Many of the U.S. Independent System Operators (ISOs) and Regional Transmission Operators (RTOs) with Centralized Capacity Markets operate using an Installed Capacity (ICAP) or UCAP market. ICAP values generally account for impacts to resources caused by ambient weather conditions and represents physical generating capacity. UCAP is a percent of the ICAP available once

[9] http://www.caiso.com/Documents/Jul10_2018_RAProceedingTrack2Testimony-Chapter4-SystemRADemandForecasts_ProposalNo3_R17-09-020.pdf

[10] These tools may provide more capacity to the CAISO, they do not ensure the quality and reliability of that capacity.

outages are taken into consideration. NYISO, PJM, and MISO incorporate forced outages when calculating each resource's qualifying capacity and measure capacity using UCAP in their respective markets. In contrast, ISO-NE relies on an ICAP value that incorporates historical forced outage data when establishing its Installed Capacity Requirement.

The methodological assumptions for calculating UCAP values vary somewhat among system operators and the criteria inputs are unique for each resource type. Generally, UCAP incorporates the availability of a resource using a derating factor. There are several key advantages to integrating forced outages into a generator's calculated RA qualifying capacity value. Recognizing a unit's contribution to reliability enables one to compare its reliability to other resources. Greater resource accountability should produce market signals that promote procurement of better performing resources with improved operational reliability and availability. The accessibility of information on the forced outage rates of resources can help buyers avoid risks and make better informed decisions when making bilateral trades or procuring replacement RA capacity.

To date, neither the CAISO nor the CPUC account for system-wide resources on forced outage beyond the margins included in the established planning reserve margin requirement. Instead, the CAISO relies on substitution rules and the Resource Adequacy Availability Incentive Mechanism (RAAIM). RAAIM calculates incentive payments and resource non-availability charges based on a resource's bidding behavior and is intended to incentivize compliance with bidding and must-offer obligations and ensure adequate availability of RA resources.

Calculating NQC, UCAP, and EFC values

The CAISO proposes to calculate and publish monthly NQC and UCAP values for all resources annually (*i.e.*, once per year a unit will get a distinct NQC and UCAP value for each month of the upcoming year). This calculation will limit UCAP at a resource's NQC value and will only consider forced outages in determining a resources UCAP value. The UCAP value will not be affected by CAISO approved planned outages.

The CAISO will calculate UCAP values for all resource types that do not rely on the CPUC's Effective Load Carrying Capability (ELCC) methodology for determining QC values. For resource's with ELCC values calculated using the CPUC's ELCC methodology, CAISO will use the ELCC value as the UCAP value. The CAISO provides more discussion regarding the basis for this treatment below.

As a starting point, CAISO proposes to adopt the standard UCAP calculation similar to PJM's approach. Specifically, the CAISO proposes to calculate UCAP as:

UCAP = (NQC) * (1 - EFOR)

Although the CAISO is proposing the above UCAP calculation, it is doing so as an initial concept simply because it is a generally accepted methodology. CAISO is still examining alternative variations of this calculation, such as the approaches used by MISO and NYISO.

The CAISO is also assessing the benefits of calculating units' forced outage rates seasonally as the NYISO and MISO do. The forced outage rate could, for example, measure January through

April and October through December as one season (winter or off-peak), and May through September as another season (summer or on-peak). Once calculated, the forced outage rate would be set for each season for the upcoming RA year. Although seasonal calculations may add some complexity, they likely better reflect resources' availability during peak and off-peak seasons. The CAISO proposes to utilize three years of historic data to determine these calculations for unit forced outage rates. In other words, each forced outage will impact a resource's seasonal forced outage rate and its UCAP value for the next three years.

The CAISO is considering incorporating a weighting method that places more weight on the most recent year's performance and less weight on more historic periods in determining a resource's UCAP values. An initial proposal for stakeholder consideration on this issue is to place the following weights on the proposed calculation; 50% weight for the most recent annual forced outage rate, 30% weight on the second annual forced outage rate period, and 20% weight on the third annual forced outage rate period (most historical observation included in the proposed three year calculation).

Several stakeholders have asked the CAISO to allow for a UCAP adjustment after an outage has occurred and repairs have been made to the resource. The CAISO does not propose to make such an allowance for two reasons. First, part of the goal of UCAP is to incentive the maintenance upfront to avoid the forced outage in the first instance. Allowing for an adjustment for maintenance after the fact would eliminate this incentive. Second, although the CAISO's proposed weighting method would reflect the forced outage in the subsequent year, it also provides two supplemental benefits. Specifically, by weighting more recent years more heavily, it ensures that the repairs are durable and not simply quick fixes that may not be durable. If the repairs are not durable, and the resource continues to go on forced outages, then those would be reflected promptly in the next RA year. The second benefit of the proposed weighting methodology is that it allows resources that have made durable repairs to recover from the UCAP reduction fairly quickly because the outage will impact the UCAP value less in only two years. Therefore, the CAISO proposes to not adjust UCAP values based on performed maintenance.

ELCC will establish UCAP values for wind and solar resources

The CAISO will rely on the CPUC's ELCC methodology when applicable. Currently, the CPUC only applies this methodology to wind and solar resources, but could expand it to cover other variable energy resources such as weather sensitive or variable output DR and storage technologies. The reason for the CAISO's reliance on the ELCC calculation is two-fold. First, as noted in Table 4 in the Appendix, other ISOs equate wind and solar UCAP values with a statistical assessment of resources' output. Second, the ELCC already takes into account the probability of forced outages for wind and solar resources.[11] Therefore, these technologies already have their QCs derated for expected forced outages.

The CPUC's ELCC calculation has two challenges as applied for this purpose. First, the CPUC calculates the average ELCC for the wind and solar fleet. This means that some resources will

[11] Forced outages are accounted for by using actual production data to inform the wind and solar production profiles in the ELCC modeling.

perform better than average, while others will perform worse. If all wind and solar resources are shown for RA, then there is no problem. However, if only a subset of solar and/or wind resources are shown as RA, then the average ELCC value of the RA wind and solar fleet may differ from the average ELCC value of the entire fleet.

A second, but related issue, is the CPUC calculates a diversity benefit that relies on the portfolios of wind and solar resources. If the showings have a different ratio of wind and solar resources, then the diversity benefit may not be reflected in the RA fleet. Either of these issues can result in over or under-procurement depending on what resources are shown as RA.

The CAISO notes that there are additional resource types for which CAISO is still assessing the applicability of the above proposed forced outage accounting and what other methods may need to be applied to develop UCAP values. The CAISO continues to explore options for DR, hydro, QFs, and new resources and seeks additional stakeholder feedback regarding how to develop UCAP methodologies for these resource types.

Through the Energy Storage and Distributed Energy Resources initiative, the CAISO is developing an ELCC methodology for DR resources.[12] The CAISO will use this methodology to inform local regulatory authorities of a QC counting methodology that considers the variable and availability-limited nature of certain DR resources. Similar to the ELCC methodology for wind and solar, an ELCC methodology for DR would consider resource availability when determining the capacity value of DR. If LRAs adopt an ELCC methodology for DR resources, as the CAISO suggests, the CAISO could rely on the ELCC methodology to establish UCAP values for DR.

Removing Forced Outage Replacement and RAAIM application to forced outage periods

The RAAIM provisions rely on different AAHs for determining the hours of greatest need for each capacity product, which adds significant complexity. The AAHs for generic capacity are the five peak load hours on non-holiday weekdays. The AAHs for flexible capacity differ in both hours and duration. Category 1 flexible capacity has a 17 hour assessment interval for all days designed to cover both the morning and evening ramps. Flexible capacity categories 2 and 3 have 5 hour assessment windows designed to cover the maximum net load ramp. Flexible capacity category 2 assessment hours covers all days and category 3 covers only non-holiday weekdays. The AAHs can change annually for both generic and flexible capacity.

The RA program is designed to ensure the CAISO has sufficient capacity available to serve load reliably. Any resource providing RA capacity to the CAISO has an obligation to offer that capacity into CAISO's markets. The Must Offer Obligations (MOO) for various RA and technology types are listed in the CAISO's Reliability Requirements BPM.[13] CAISO also relies on outage reporting to track whether resources are available at any given time. If there is sufficient notice given and capacity available, the CAISO can grant outages without requiring

[12] ESDER 4 Stakeholder Initiative Webpage: http://www.caiso.com/informed/Pages/StakeholderProcesses/EnergyStorage_DistributedEnergyResources.aspx

[13] See the Reliability Requirements BPM, pp. 77-82 for System and Local RA obligations and pp. 93-96 for flexible RA obligations.

replacement capacity. However, not all outages occur under those conditions, and the CAISO developed RAAIM to address these particular instances.

RAAIM is designed to provide an incentive for resources on outage to minimize the duration of the outage or to provide substitute capacity. Additionally, RAAIM provides an additional incentive payment to generation that is available over a predetermined measurement. RAAIM does not apply to all hours; it only applies during the Availability Assessment Hours. These hours and days differ depending on the RA product the resource is providing to CAISO. Although RAAIM provides an incentive to provide substitute capacity, it also provides an incentive to only show the bare minimum RA capacity needed for each capacity type, because showing additional capacity exposes that capacity to RAAIM non-availability charges – without providing any corresponding benefit to the LSE to which that resource is contracted.

The CAISO reviewed the effectiveness of RAAIM to incentivize resources to provide replacement during forced outages. As a starting point, CAISO reviewed data from the CIRA, system. Data was pulled from May 1, 2018 through July 31, 2019. CAISO compared the quantity of shown RA MW for a given day, the reported MWs of capacity on forced outage, and the MWs of forced outage substitute capacity provided. The CAISO did not differentiate the cause of the forced outage, including whether or not the outage was exempt from RAAIM. At the core, the effectiveness of RAAIM should not be measured simply by how much of capacity is replaced for certain outage types, but by how well it ensures there is adequate capacity available to CAISO. Even if the vast majority of outages are RAAIM exempt, CAISO may be left with insufficient capacity. Figure 4 shows that, overall, very little substitute capacity is being provided to the CAISO in response to forced outages. Additionally, the CAISO understands that there may be limited capacity available in some local areas to provide substitute capacity. The CAISO conducted a similar assessment of system level capacity and found, with very limited exceptions, similar results. These results are shown in Figure 5.

Figure 4: Forced Outages vs Replacement Capacity (All)

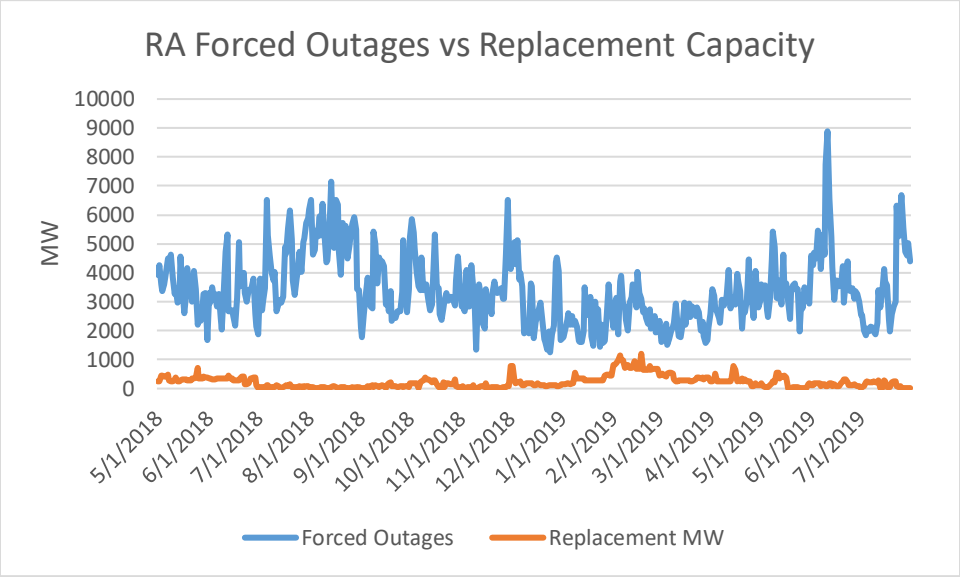
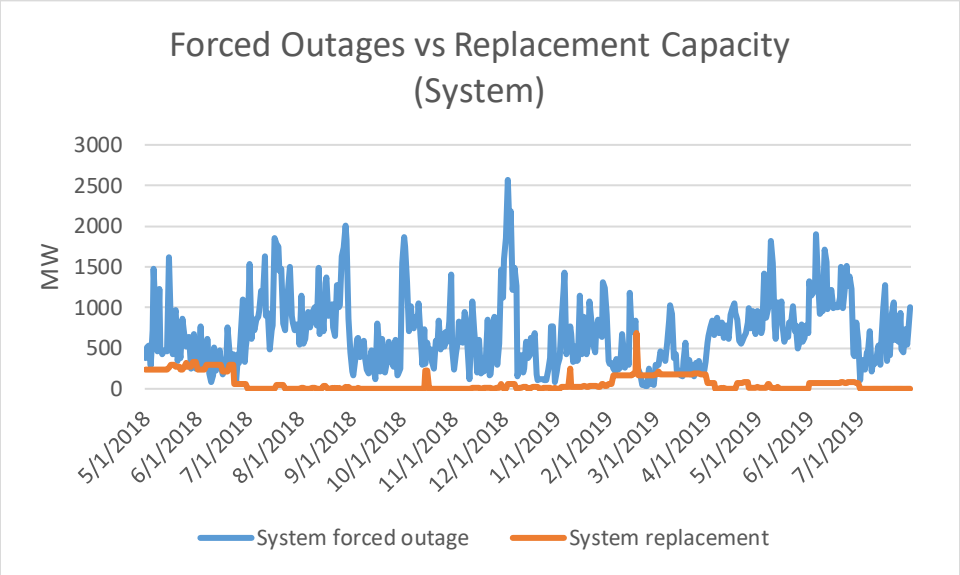


Figure 5: Forced Outage vs Replacement Capacity (System Only)



The CAISO concludes that RAAIM is not providing adequate incentive to provide substitute capacity for forced outages. The CAISO cannot ascertain whether the cause is due to the risk of RAAIM charges already being incorporated into capacity pricing, insufficient RAAIM charges/revenues (*i.e*. price is not high enough or benefits spread too broadly), excessive exclusions/exemptions, the dead band applying for the first outages, or some other reason. Ultimately, CAISO's analysis shows that reliance on RAAIM to ensure adequate capacity may not provide sufficient incentives and that it is reasonable to eliminate RAAIM. Additionally, a capacity counting tool that provides no dead band and provides more limited exempt outages provides greater assurance that CAISO will have adequate capacity. CAISO believes a superior approach is to establish incentives to conduct resource maintenance to avoid outages and to procure capacity that is more reliable in the first instance. UCAP provides the proper incentives, while still allowing LSEs to procure the most cost effective capacity needed to meet their procurement obligation. The relationship between MOOs, RA substitution rules, and RAAIM creates a complex system of processes that differ vastly from other ISOs/RTOs. However, in light of above data and CAISO's UCAP proposal, it is possible to eliminate these complex relationships for a process that relies on upfront accounting for forced outages.

Finally, as stated above, a fundamental component of the CAISO's proposal is to account for forced outages in upfront capacity valuation and assessments. The CAISO proposes to assess forced outages against resources' UCAP values and will no longer include forced outage replacement as an option for addressing forced outages. This change will align the process with the new proposed paradigm of assessing resources' forced outage rates to provide transparency into the reliability and dependability of individual resources.

Forced Outage Rate Data

The first and primary input needed to calculate a resource's UCAP value is an accurate and appropriate forced outage rate. The specific forced outage rate for a resource is the key information necessary to calculate the expected value (in terms of MWs) of a capacity

resource's unforced capacity. To determine these forced outage rates, CAISO considered two potential data sources, the CAISO's Outage Management System, and the NERC Generation Availability Data System (GADS).[14]

NERC's GADS compiles resource outage data for resources across the country. Although fleet wide averages across NERC regions are readily and publically available, resource specific information is more difficult to access and compile. Additionally, GADS reporting is mandatory only for resources 20 MW and above. As the number of small distributed resources increases over time, GADS may miss a large number of resources and/or resource types that can provide RA capacity. The CAISO could propose to establish tariff requirements for reporting of NERC GADS data to aid data development for the CAISO's proposed UCAP concept. However, this could be problematic due to the limitations on size and resource types requiring potential exclusions or caveats. Furthermore, the CAISO is concerned that more universal outage reporting for GADS purposes may not always align with the potential CAISO forced outage nature of work cards. The CAISO believes a good area to focus on for this stakeholder process is defining the type/nature of outages that will be assessed against resource's forced outage rates. It is a vital issue to establish an accurate and fair forced outage rate definition.

Currently, the CAISO has established numerous outage cards in the CAISO Outage Management System (OMS) that are designed to describe the nature of work for resource outages. The CAISO also uses these outage cards to determine whether a resource must provide substitute capacity to avoid RAAIM charges, or if the outage is beyond the resource's control and therefore RAAIM exempt. However, the CAISO has encountered challenges utilizing the OMS as currently configured. More specifically, the OMS data is not currently designed to be easily convertible for purposes of generating a forced outage rate.

As a result of these challenges, the CAISO is exploring additional options for collecting data to calculate forced outages. The CAISO efforts can be broken down into two objectives: Transitioning to UCAP and longer term outage collection and reporting. These efforts continue to look at both GADS and OMS data while also considering potential for new outage reporting. Ultimately, the CAISO seeks a solution that a) aligns the outage reporting in CAISO systems and GADS and b) provides incentive for individual resources to minimize forced outage rates, instead of leaning on technology type class averages. The remainder of this subsection provides additional details regarding the CAISO's efforts to both transition to UCAP and then ensure accurate long term outage reporting.

To transition to UCAP, and address the challenges with using the existing OMS data, the CAISO is considering numerous other options. Given the outage reporting differences between GADS and OMS, the CAISO believes a perfect estimate of UCAP in year one is unlikely. Therefore, the CAISO is trying to develop a transitional approach that creates a reasonable estimate of resources' forced outage rates while a long term system is implemented. As such, the CAISO will look to balance precision with complexity and cost. First the CAISO is exploring an option proposed in comments submitted by Middle River Power. More specifically, the CAISO would, initially rely and GADS data to generate UCAP values. Although Middle River

[14] https://www.nerc.com/pa/RAPA/gads/Pages/GeneratingAvailabilityDataSystem-(GADS).aspx

Power specifically suggested using fleet averages, the CAISO is also considering requiring all resources seeking a UCAP value to submit to the CAISO either three years of GADS data or as many years of data as the resource has been operational. The CAISO would then use these values to generate resource specific UCAP values. Finally, the CAISO continues to work with the existing OMS data to determine if it can be reconfigured to generate initial UCAP values. The CAISO seeks stakeholder input on these transitional options as well as any other suggestion they might have.

Long term, the CAISO seeks to have a system that more closely tracks to NERC reporting requirements. At the same time, the CAISO believes individual resource accountability is paramount. Therefore, the CAISO is not considering GADS fleet averages for anything more than as a transitional tool. Long-term, the CAISO is considering numerous options. For example, similar to the transitional option, the CAISO is considering an option that requires all resources to submit GADS data in order to calculate UCAP values. Alternatively, the CAISO is considering revisions to OMS to align the outage reporting and categories with these in the NERC standards. This would require the CAISO to make significant changes to the OMS system and nature of work outage cards.

However, in considering this option, the CAISO acknowledges that although there is a growing number of small resources active in the CAISO's markets, it is still a relatively small number of MW. The CAISO must assess the cost and benefits associated with potentially creating a new system to calculate forced outage rates if it only for a small portion of the fleet[15] especially if the CAISO has GADS data for much of the fleet. However, the CAISO remains concerned that a growing number of resources will fall below the 20 MW GADS reporting requirement and the misalignment between NERC and OMS outage reporting. Therefore and is hesitant to rely strictly on GADS data as a long term solution. Alternatively, the CAISO is also considering assessing UCAP using resource specific outage rates. As noted, accessing this data from NERC is not feasible. Therefore, The CAISO is seeking stakeholder input to assess which of these is a preferred approach.

Finally, The CAISO continues to assess the existing Nature-of-Work cards to determine how best to leverage them for UCAP outage calculations The CAISO seeks stakeholder feedback on this initial classification of outage nature of work cards to define the outages that it will include in calculating resource specific forced outage rates. Further, given the continued (and even increased) importance on outage reporting, the distinctions between forced and planned outages, and how to differentiate among the different outage natures of work, the CAISO also seeks stakeholder feedback on what additional tariff and BPM clarifications in the area of outage reporting may be appropriate.

[15] Transitioning to a new OMS system or creating a new outage reporting system requires the CAISO to determine if there are any necessary modifications to the forced outage cards nature of work definitions. The CAISO also needs to modify the requirements for what information is provided through the CAISO OMS to provide the correct information to make accurate assessments of resource specific forced outage rates. Additionally, OMS will likely require some level of system modifications to accurately and automatically track resource outage data on a comparable basis.

Proposed Forced Outage Rate Assessment Interval

The CAISO proposes to apply a 16-hour window between 5:00 AM and 9:00 PM as the assessment window for assessing resource specific forced outage rates. This interval covers the period when resources are in highest demand to meet CAISO needs. This is consistent with the CAISO's proposal in the revised straw proposal.

The CAISO also considered a 24-hour forced outage assessment interval. However, using all hours reduces the impact of forced outages during peak needs by increasing the relative impact denominator in the forced outage calculation.[16] The CAISO's proposed 16-hour assessment interval focuses on the hours of greatest need and, as discussed below, mirrors the convergence between the hours of system, local, and flexible capacity needs. Further, as noted below, using the same assessment intervals allows the CAISO to calculate and utilize the same forced outage rate for both generic and flexible capacity. Although the CAISO's proposal focuses most specifically on peak demand hours, forced hours in the off-peak hours may still result in diminished reliability. The CAISO seeks stakeholder input regarding what, if any, additional protections should be put in place to cover these off-peak hours.

Calculating Unit Forced Outage Rates

Forced Outage Rate Background

Conceptually, a forced outage rate performance index evaluates the total hours of full and partial forced outages for estimating a unit's availability. IEEE has established a standard methodology to calculate the generating unit's availability using GADS historical event and performance data (see standard equation below).[17]

The defined methods are commonly adjusted by system operators to accommodate for unique reliability needs, but generally the metric accounts for those hours and months of greatest demand and excludes planned or maintenance outages. Similarly, some RTOs and ISOs use the standard EFORd metric, but others such as MISO, use an adjusted calculation (referred to as XEFORd) which adjusts the EFORd metric to remove outages outside of management control. NYISO, PJM, and ISO-NE all use the net dependable capacity in lieu of the net maximum capacity. The standard EFORd availability metric formula is:

$$EFORd = \frac{FOHd + EFDGd}{FOHd + SH} \times 100\%$$

- EFORd = Equivalent demand forced outage rate: A measure of the probability that a generating unit will not be available due to forced outages or forced deratings when there is demand on the unit to generate.

[16] Both the numerators and denominator increase, but the *relative impact* of an outage is greater under the 16 hour window than a 24 hour window (*i.e.* 1/16>1/24). Using 24 hours implies that a forced outage in any hour is equal to a forced outage in any other hour.
[17] IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity, available at: https://www.nerc.com/docs/pc/gadstf/ieee762tf/762-2006.pdf

- FOH = Forced outage hours: The phrase forced outage hours represents the number of hours a unit was in an unplanned outage state.
- EFDH = Equivalent forced derated hours: EFDH is the forced derated hours converted to equivalent hours. [18]
- SH = Service hours: The phrase service hours represents the number of hours a unit was in the in-service state.

CAISO's proposed Forced Outage Rate formulation

The CAISO proposes using the standard IEEE formula as the basis for its proposed forced outage rate calculation. As noted above, the standard methodology to calculate the generating unit's availability uses GADS historical event and performance data to determine unit specific equivalent demand forced outage rates. However, it is challenging to determine when a resource is "in demand" when it is on a forced outage. If the resource has not reported the forced outage and simply does not respond to a dispatch, it can be determined to have been on outage when it was in demand. The CAISO needs resources to report forced outages as soon as possible to make feasible and reliable dispatch awards. Resources on forced outage are removed from the market, and therefore, it is not feasible to determine if they are in demand. Thus, applying an EFORd is not a viable option. Further, because the CAISO is proposing to assess forced outage rates during a 16-hour assessment window, the proposed approach is based upon a simplified Effective Forced Outage Rate or (EFOR). The formula proposed is a starting point to develop an EFOR determination for each unit with a NQC as follows:

$$EFOR = \frac{FOH + EFDG}{FOH + SH} \times 100\%$$

The CAISO proposes to apply this standard formulation to determine unit level EFOR rates as a starting point for including forced outages in RA capacity valuation and assessments. As noted above, other RTO/ISO regions that have incorporated these unit availability measures into their RA processes have made various adjustments and necessary accommodations to apply this general formula to their particular market and region's needs and differences. Similarly, the CAISO proposes to further develop this more general measure of forced outage rates into a CAISO specific approach.

Another key consideration is excluding outages considered "outside of management control", or OMC, from resources forced outage rates. OMC outage periods are commonly excluded in other ISO/RTO regions and cover outage periods that are outside of a resource owner's direct control. For example, a transmission induced outage or a force majeure event such as a wildfire or flooding event that forces a unit out of service should be considered outside of management control. The CAISO proposes to incorporate a similar concept in its final EFOR formulation. CAISO seeks stakeholder feedback on this concept and any input on the various types of

[18] The phrase equivalent hours represents the number of hours a unit was in a time category involving unit derating, expressed as equivalent hours of full outage at maximum capacity. Both unit derating and maximum capacity shall be expressed on a consistent basis, gross or net.

modification or enhancements that should to the initial IEEE standard availability metric calculation included in this proposal.

Unit Outage Rate Analysis Examples

The CAISO received feedback requesting analysis supporting the proposed inclusion of a unit's forced outage rates for capacity valuation and conducted some preliminary analysis to assess the proposal's potential impacts. However, at this time, the CAISO has not identified a generally applicable method for converting OMS data into forced outage rates. As a result, the CAISO has not conducted a fleet-wide forced outage analysis for the purposes of this proposal. However, NERC GADS data for WECC shows a WECC-wide average forced outage rate for all resource types providing outage data of approximately 8%. As an alternative, the CAISO has analyzed a subset of unit outage data and provides some examples of the resulting analysis in the following figures.

The CAISO made the assumptions and utilized the formulas below for determining the following example outage analyses.

Assumptions:

- For any Forced Outages lasting over 7 days, change to planned outage
- For overlapping forced outages, sum of all outages are accounted for in calculations

Calculation formulas:

$$Forced\ Outage\ Rate = \frac{\sum_{area} Pmax\ - \sum_{area} Forced\ Avail\ MW}{\sum_{area} Pmax}$$

$$Planned\ Outage\ Rate = \frac{\sum_{area} Pmax\ - \sum_{area} Planned\ Avail\ MW}{\sum_{area} Pmax}$$

$$Total\ Outage\ Rate = \frac{\sum_{area} Pmax\ - \sum_{area} Total\ Avail\ MW}{\sum_{area} Pmax}$$

Example Outage Analysis Results

The following figures provide the results of the CAISO's outage analysis for two example resources. It illustrates the magnitude of outages these example resources had over the 2018 annual and summer periods. The CAISO's analysis shows that resource availability related to forced outages varies over seasons and between resources. Significant variance in resource forced outage rates is precisely the issue the CAISO's proposed UCAP modifications are intended to capture.

Figure 6: Example Unit #1 – Seasonal outage rate analysis: summer 2018

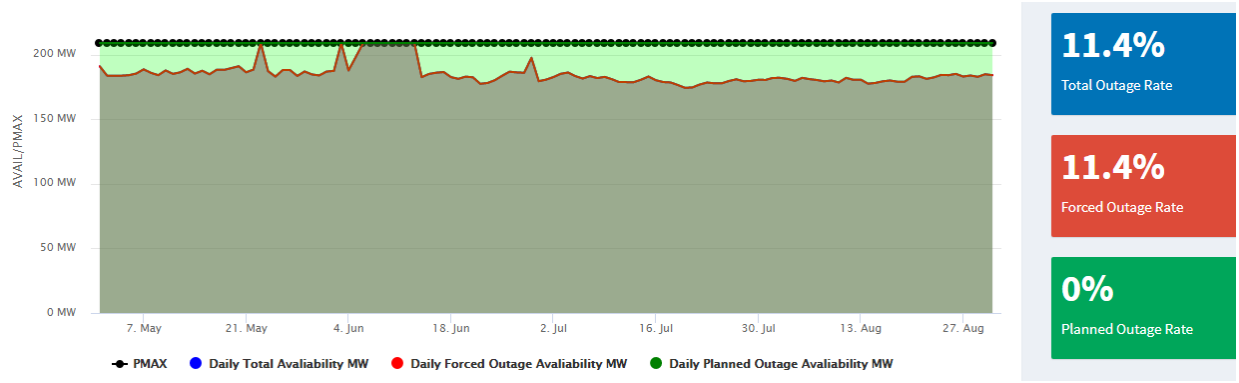


Figure 7: Example Unit #1 – Annual outage rate analysis: 2018

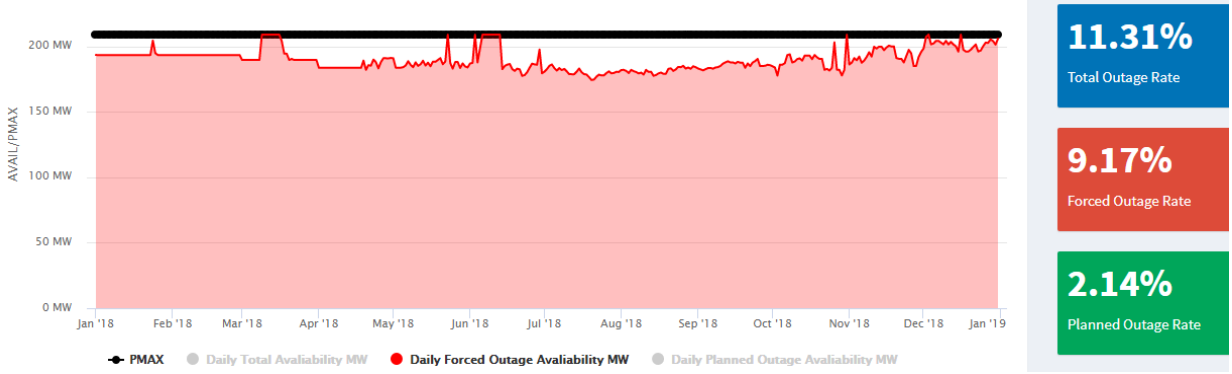


Figure 8: Example Unit #2 – Seasonal outage rate analysis: summer 2018

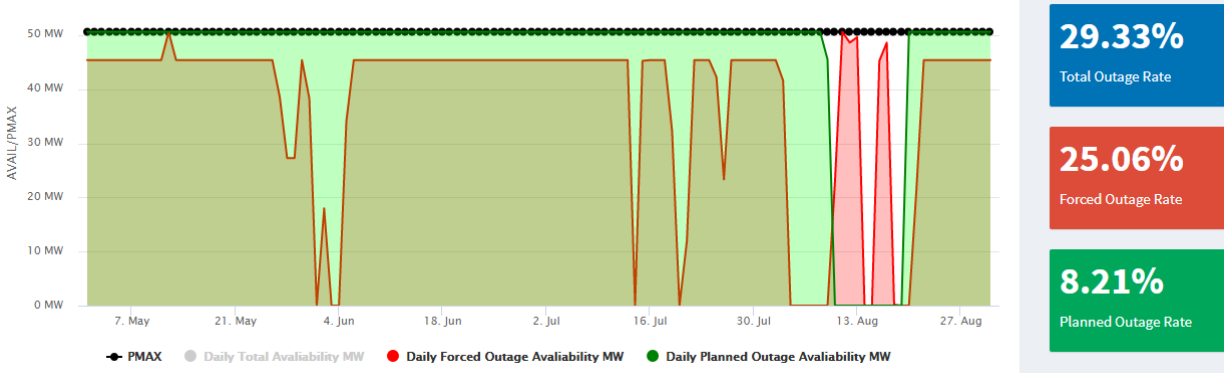
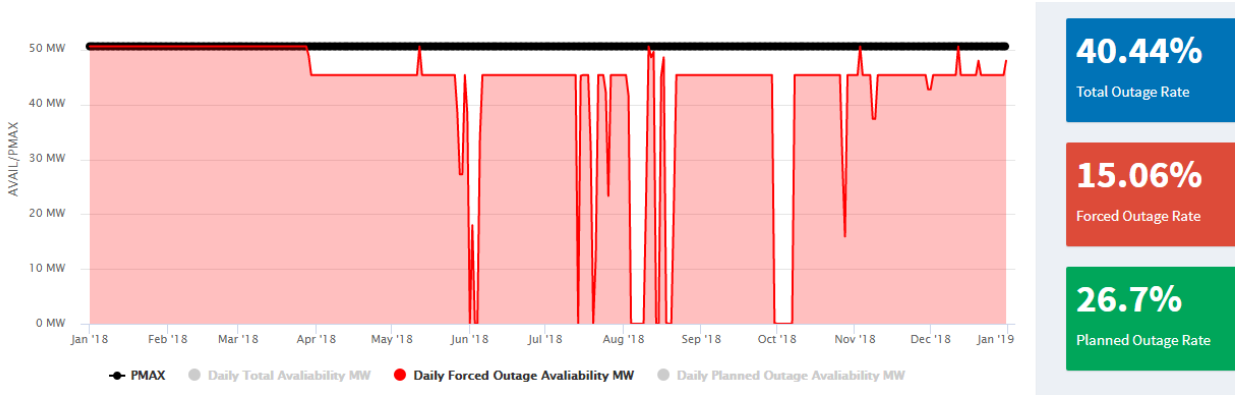


Figure 9: Example Unit #2 – Annual outage rate analysis: 2018



The example resource forced outage analysis is for illustrative purposes only and any final proposal will provide detailed calculation parameters and inputs. The CAISO intends to further develop these aspects of the proposed forced outage rate calculations with stakeholder input.

Coordination of Proposed UCAP Concept with CPUC RA Program

The CAISO received stakeholder feedback that it must closely consider how its proposed UCAP concept will be coordinated with the current CPUC RA program. Certain parties expressed concern that the CAISO proposal could create conflicting RA requirements, or otherwise undermine the System RA Planning Reserve Margin (PRM) established by LRAs. CAISO understands these concerns and commits to the coordination necessary to align with LRAs' RA programs. Ideally, LRAs would adopt similar counting rules and requirements to minimize administrative complexity. However, system RA requirements and PRMs based on installed capacity are not necessarily inconsistent with CAISO's proposal. Regardless, CAISO will work with LRAs to align RA programs with the current proposal. For instance, this collaborative effort includes proposing similar counting rules in the upcoming CPUC RA proceeding.

The CAISO's proposal provides improved transparency over resource forced outage rates, which will help improve procurement and retirement decisions. Existing installed capacity measures reflect an expected fleet average outage rate, which can result in efficient resource procurement on the low end of the forced outage distribution and more overall procurement than might be seen using UCAP values. The UCAP requirement will provide an appropriate target to guide forward procurement of resources with better forced outage rates and better reliability. The CAISO seeks stakeholder input to identify any additional CPUC/LRA RA program issues or UCAP related concepts that should be included for consideration and coordination.

5.1.3. System RA Showings and Sufficiency Testing

The CAISO will conduct two sufficiency tests for system capacity: an individual deficiency test and a portfolio deficiency test. These tests are designed to ensure there is both adequate UCAP to maintain reliability for peak load and that the portfolio of resources, when combined, work together to provide reliable operations during all hours. The CAISO will also conduct tests for flexible and local capacity needs; those assessments are discussed in Sections 5.2 and 5.3 respectively.

Individual Deficiency Assessments

The CAISO will assess LSE RA showings and resource supply plans to ensure there is sufficient UCAP shown to meet the identified reliability need described above. Because the CAISO will be assessing system capacity showings based on UCAP values, the CAISO proposes that, LSEs and resource SCs need only submit and show resources' UCAP. Once shown, the CAISO will consider each resource's UCAP value to conduct its UCAP assessment.

Additionally, LSEs will not be permitted to procure only the "good part" of a resource (*i.e.*, LSEs cannot simply procure only the unforced capacity portion of a resource, and any amount shown for RA will be assessed considering the resource's forced outage rate). For example, an LSE could not claim to buy 90 MW of both NQC and UCAP from a 100 MW resource with a 10 percent forced outage rate. In comments to the straw proposal – part 2, several parties requested CAISO allow resources to sell and show only the UCAP value of the resource. There are two reasons CAISO cannot allow this. First, the UCAP accounting method relies on the probability that some resources will be out at various times. Allowing some resources to do so would likely require CAISO to maintain the same complicated substitution rules it is seeking to eliminate to maintain the desired level of reliability. Second, in CAISO's review of best practices in other ISO's such practices are not permitted.

Partial RA resources (shown for RA for only a portion of its capacity) will receive a proportional UCAP value reflecting the proportion shown for RA purposes (*i.e.*, A 100 MW resource with a 10 percent forced outage rate shown for 50 MW of NQC will be assessed as being shown for 45 MW of UCAP RA).

LSEs that fail to meet the UCAP requirement will be notified of the deficiency and provided an opportunity to cure. LSEs that fail to cure may be subject to backstop procurement cost allocation. Specific backstop procurement authority for this deficiency and cost allocation are discussed in greater detail in Section 5.4.

Individual RA Showing Incentive

The CAISO also proposes to develop an individual LSE RA showing incentive. The CAISO proposes to develop a new tool called the UCAP deficiency tool, which is intended to discourage LSEs from failing to show RA at least equal to their UCAP requirement and incentivize LSEs to show above their UCAP obligations and . The concept of the UCAP deficiency tool is to apply a penalty to LSEs that show less than (below) their UCAP requirement, and distribute those collected penalties to LSEs showing over (above) their UCAP requirements. This proposed tool and incentive is described in Section 5.4, below. Examples and further discussion of this proposed concept are also provided in Section 5.4.3.

Portfolio Assessment

The CAISO will also conduct a portfolio deficiency test of the resources shown for RA to determine if the portfolio is adequate to serve load under various load and net load conditions during all hours of the day. The portfolio deficiency test will use only the shown RA fleet in a production simulation to determine if CAISO is likely to serve forecasted gross and net-load peaks, and maintain adequate reserves and load following. The need for this assessment is

similar in concept to the collective deficiency test CAISO conducts for local RA. However, the CAISO will only conduct this assessment for monthly RA showings, which are the only showings that have 100 percent of the system, local, and flexible RA capacity requirements. The increased number of energy and availability-limited resources on the system and the reliance on these resources to meet RA needs means that some resource mixes provided to meet RA requirements may not ensure reliable operation of the grid during all hours of the day across the entire month. Similar to the local assessments, the CAISO is looking to maintain a consistent definition for capacity to facilitate transacting a homogeneous product. However, the CAISO must assess how the shown RA fleet works collectively to meet system needs.

The objective of a portfolio analysis is to assess if the CAISO can serve load with the shown RA fleet. Because year ahead system RA showing requirements are currently only 90 percent for the five summer months for CPUC jurisdictional entities, the CAISO will only conduct this assessment for monthly RA showings.

The CAISO has considered three general approaches to conducting this model. These options are included in the following table.

Table 2: Portfolio Assessment Modeling Options

Modeling Approach Option	Iteration[19]	Load	Wind/solar	Other Generators
Net Load Deterministic	One	Known	Known	a) A generator forced outage schedule determined randomly prior to the assessment, or b) Model all resources at UCAP value
Generator Stochastic	One or several	Known	Randomly determined for each iteration with fixed installed capacity	A generator forced outage schedule determined randomly prior to each iteration
Full stochastic	Several	Random draws	Randomly determined for each iteration with fixed installed capacity	A generator forced outage schedule determined randomly prior to each iteration

There are pros and cons regarding each of the above testing options. For example, the net load deterministic model can run relatively quickly when compared with the other options. However,

[19] One iteration is defined a predetermined interval. This is interval can be a single day, a week, or a full month.

this speed comes at the expense of performing numerous draws and the robust statistical results that can be derived from a full stochastic production simulation. The net load deterministic and the full stochastic models basically have inverse pros and cons (*i.e.*, one runs fast but does not provide the same volume of information, the other takes longer but produces more information), while the generator stochastic model falls somewhere in between.

Additionally, the CAISO must determine the best platform for conducting this test. Any platform used to conduct this assessment should reasonably reflect that actual CAISO system. Therefore, the CAISO explored three primary platforms:

- Market Optimization based model – An offline version of the CAISO market optimization software
- Integrated Optimal Outage Coordination (IOOC) tool – A tool under development by the CAISO's Operations Engineering group to test planned transmission and generation outages, similar to the market optimization tool in terms of resource commitment and optimization
- Summer Assessment Plexos model – A Plexos model used to conduct CAISO summer assessment, which models many constraints, but not all.

All of the above options are complex, time-consuming simulations. The Summer Assessment model is capable of running more quickly than the other two, but lacks the detail offered by the other two.

In balance, having assessed the time constraints, complexity, and data output, the CAISO favors the net load deterministic model using the IOOC at this time. The CAISO must conduct this assessment and provide feedback to market participants within 10 days of receiving RA showings; therefore, processing time is critical. The CAISO will be the first ISO or RTO to conduct such an assessment, regardless of turnaround time, making it reasonable to start with the less complicated option and "learn to walk before we run." Additionally, although the Summer Assessment Plexos model runs faster, it does not model all CAISO constraints and warrants relying on one of the other two models. Given the IOOC offers the ability to include planned outages, the CAISO believes it will yield the most reliable results.

Finally, the CAISO must establish the proper metric to determine the adequacy of the portfolio. Each of the above approaches may provide different metrics. These different metrics can be interpreted differently in evaluating whether the RA portfolio meets the CAISO's operational needs. The CAISO has explored two primary metrics for the portfolio deficiency test: serving load and loss-of-load expectation. Given the CAISO will initially conduct a production simulation that is largely deterministic, there is insufficient information to generate a meaningful LOLE. Therefore, the CAISO proposes to use the portfolio's ability to serve forecasted load for the upcoming month. The portfolio must ensure the CAISO can maintain load, Ancillary Services, and load following [20] requirements for all days and all hours in the portfolio deficiency test. If any of these requirements is not met, the CAISO will identify a portfolio deficiency.

[20] Load following is needed because the production simulation is run at an hourly granularity and does not fully capture intra-hour ramping needs.

The CAISO will model only RA resources in this portfolio analysis. Any additional energy provided in the CAISO's day-ahead or real-time markets represents energy substitutes in those markets, but are not needed in the portfolio assessment to determine if the RA fleet is adequate. Additionally, the CAISO must establish baseline inputs into the portfolio assessment. The CAISO will rely on CEC 1-in-2 hourly load forecast. Because the analysis is run on hourly blocks, the CAISO will also include load following requirements. The wind and solar production profiles will be generated prior to running the production simulation. These profiles represent maximum potential output from these resources. These profiles will not be considered must take capacity and actual use of wind and solar resources in the production simulation may be lower than the profile. Generator availability will be determined through Monte Carlo draw using resource forced outage rates.

If the portfolio is adequate, no additional actions will be taken. If the portfolio is unable to serve load under given load or net load conditions, then the CAISO will declare a collective deficiency, provide a cure period, and conduct backstop procurement using the CPM competitive solicitation process to find the least cost solutions to resolve the deficiency if left uncured. The specific details regarding CPM designations and cost allocation is provided in Section 5.4.1.

The CAISO considered additional assessments of individual RA showings, however, it is not feasible to adequately develop individual LSE load profiles and determine a specific LSE's RA portfolio contributed to the collective deficiency and, therefore, is subject to LSE specific cost allocation.

5.1.4. Must Offer Obligation and Bid Insertion Modifications

The RA program is designed to ensure the CAISO has sufficient capacity available to serve load reliably all hours of the year. Any resource providing RA capacity to the CAISO is obligated to offer that capacity into the CAISO market. This ensures the market has sufficient bids available to dispatch resources to serve system load reliably. Currently, the CAISO tariff contains provisions regarding must offer obligations, bidding, and bid insertion rules. Resource Adequacy resources will continue to have a must offer obligation under RA Enhancements. CAISO proposes the following must offer obligation and bid insertion modifications in this initiative:

- Must offer obligations must be set at the amount of NQC shown for RA, not the amount of UCAP shown;
- Resources have a 24 by 7 must offer obligation into the day-ahead market unless exempt, and;
- Non-use-limited resources and use-limited resources with an opportunity cost will receive bid insertion, unless exempt.

Storage resources, particularly those with limited energy storage capabilities, pose additional challenges compared to traditional generation when connected to the grid. Not only do these resources need to bid into the market, they also have to be sufficiently charged to ensure that energy delivery is possible. The appendix of this proposal discusses potential solutions for management of storage resources and integration into the must offer obligations and existing market frameworks.

Stakeholder Comments

In the previous proposal, the CAISO proposed setting the must offer obligation at the amount of NQC shown for RA. Most stakeholders, including NRG, MRP, and Wellhead support this proposal. NCPA does not support this aspect of the proposal and believes instead, must offer obligations should be set at the UCAP. As described in more detail below, must offer obligations must be set at the NQC rather than the UCAP to ensure the UCAP requirement is met while eliminating complex forced outage substitution rules.

The CAISO also proposed a 24 by 7 must offer obligation and bid insertion for all non-use-limited resources and use-limited resources with modeled opportunity costs. Within their comments, stakeholders offered a variety of responses to these aspects of the proposal.

For example, PG&E opposes the 24 by 7 must offer obligation proposal, suggesting it is unrealistic and unnecessary. Instead, PG&E urges the CAISO to define must offer obligation and bid insertion requirements that reflect operational capabilities and changing load requirements. The CAISO has modified its proposal to align with proposals in the Day-Ahead Market Enhancements initiative and believes this approach will provide greater flexibility for resources providing RA relative to the current must offer obligations. This approach will ensure must offer obligations are aligned with operational needs and remove must offer obligations through real-time if a resource is not awarded in day-ahead. Removing the blanket 24 by 7 must offer obligation into real-time addresses concerns that the must offer obligations are not aligned with operational needs.

Boston Energy expressed concerns with the proposed modifications for the must offer obligation for NGR. They state requiring NGRs to bid their charge and discharge capabilities would introduce a disconnect between the way the NQC and the must offer obligation is defined because the NQC is set on the discharge capabilities only. As described below, the CAISO must have visibility of the resource's charge and discharge capability through its bids into the day ahead market in order to ensure fuel sufficiency of the resource when its RA capacity is needed.

The Six Cities preferred the CAISO's proposal to apply bid insertion to all non-use-limited resources and use-limited resources with opportunity costs instead of an alternative approach to treat intervals without bids and forced outages for the purposes of the UCAP calculation. PG&E opposes the proposal to apply bid insertion to use-limited resources with opportunity costs, particularly until conditionally available resources (CARs) are defined more clearly. The CAISO has published a policy paper clarifying the definition of CARs and their treatment in the market

going forward.[21] Consistent with these clarifications, this RA Enhancements proposal does not exempt CARs, as they can use outage cards to manage their use.

CDWR suggests the 24 by 7 must offer obligation and bid insertion should not apply to an integrated hydro system due to the complex and uncertain nature of pumping demand and generation. The CAISO believes that if a hydro unit has qualifying use limits, their use can be managed by the opportunity costs provided by Commitment Costs Enhancements Phase 3. The CAISO recognizes not all hydro resources' use-limitations can be modeled by opportunity costs, and allows for hydro units to request CAR status to manage their use through outage cards.

NCPA asks the CAISO to clarify that load following-metered subsystems will continue to be exempt from the must offer obligation. The CAISO is not proposing changes to how load-following metered subsystems are treated under the existing tariff.

CLECA and SCE oppose bid insertion for RDRR. However, CLECA suggests that, if bid insertion must be applied, bids should be inserted at the cap so emergency resources are not dispatched before economic resources. Because RDRR is only used when the CAISO declares a warning or emergency, it is important to ensure bids are available for use during these stressed grid conditions. As such, the CAISO has maintained the bid insertion proposal for RDRR. The CAISO agrees with CLECA that bids inserted for RDRR should be submitted at 100% of the bid cap so that RDRR is used after resources with bids below the cap.

Must Offer Obligations Proposal

Must offer obligations must align with NQC value

The CAISO proposes that a resource's must offer obligation be consistent with the resource's shown NQC value. This is consistent with the practice in other ISO/RTOs.[22] More specifically, if a 100 MW resource with a 20 percent forced outage rate is shown for 80 MW of UCAP, then it has shown its full 100 MW of NQC. It must then bid 100 MW of capacity into CAISO's markets.[23] This bidding rule is required to ensure sufficient capacity is available to the system at all times by accounting for the fact that some resources will be on forced outage. Absent this requirement, units must be available 100 percent of the time to their UCAP values or provide substitute capacity, otherwise the CAISO would be short of available RA capacity. Assuming resources are available 100% of the time is an unreasonable expectation and requiring replacement capacity defeats the goal of simplifying RA rules.

If units maintained their historic forced outage rates, the CAISO would be consistently short of UCAP unless RA resources had a MOO up to their NQC. For example, assume a unit shown for

[21] Commitment Cost Enhancements Policy Clarification: http://www.caiso.com/Documents/WhitePaper-CommitmentCostEnhancements-TariffClarification.pdf

[22] See https://www.aeso.ca/assets/Uploads/CRA-AESO-Capacity-Market-Design-Report-03302017-P1.pdf at p. 22. "In all the reviewed markets except California and ISO-NE, the capacity of these facilities is procured and settled as UCAP. In California and ISO-NE, the capacity obligation is denominated as installed capacity (ICAP). Notwithstanding that, in most markets, capacity is procured and settled as UCAP, the resulting performance obligation on conventional controllable generation is to offer all of the ICAP except on recognized outages."

[23] If a resource only shows a portion of its NQC as RA, the must offer obligation is set at the portion of the NQC that is shown for RA, not the full amount.

100 MW of NQC had a UCAP value of 80 MW, reflecting that it is available 80% of the time. If that unit were only required to bid its UCAP value of 80 MW, and it performed at its average historic availability level, the CAISO would only receive 64 MWs of dependable capacity from that unit. Setting must offer obligations at the UCAP would thus require substitute capacity for all forced outages to ensure reliability. Alternatively, and as proposed here, setting the must offer obligation at the shown NQC value allows CAISO to eliminate forced outage substitution and its complexities. By establishing a UCAP-based RA construct with an associated must offer obligation at the NQC value, the RA fleet effectively provides its substitute capacity upfront, eliminating the need for complex resource substitution rules. For this reason, CAISO proposes to eliminate the existing RA forced outage substitution rules in favor of UCAP-based resource RA counting and NQC-based resource bidding. This concept is addressed in greater detail in Section 5.1.2 above.

Resource Adequacy resources will have a day-ahead must offer obligation

As the RA Enhancements and Day-Ahead Market Enhancements stakeholder processes evolve, the CAISO continues to assess whether there is a need for a real-time RA must offer obligation. Sufficient commitments and capacity reservations made in the day-ahead market would obviate the need for a real-time RA must offer obligation. The CAISO is proposing a new capacity product in the Day-Ahead Market Enhancements initiative called imbalance reserves. Imbalance reserves will help the CAISO commit and position resources during the day-ahead timeframe to provide upward and downward ramp capability in the real-time market. After reviewing developments in both initiatives, the CAISO has determined, with limited exceptions, a day-ahead must offer obligation for resource adequacy resources is sufficient to commit resources and reserve capacity for use in real-time. This is because all resources awarded in the day-ahead, including resources awarded imbalance reserves, will have a real-time must offer obligation up to their day-ahead award. As such, the CAISO proposes must offer obligations for RA resources into the day-ahead market only. As discussed in greater detail below, a limited set of RA resources, due to program design or forecasting challenges, will continue to have real-time must offer obligations, regardless of day-ahead awards.

This solution is more efficient than the current 24 by 7 resource adequacy must offer obligation into both day-ahead and real-time. Under this proposal, the resource adequacy program will ensure sufficient supply is bid into the day-ahead market. The day-ahead market will then commit resources to meet the energy, imbalance reserve, and ancillary service needs for the following trade day. Resources committed in the day-ahead, including resources with imbalance reserve awards will have a must-offer obligation into the real-time market. Any resource with an imbalance reserve award will be required to reserve capacity in the day-ahead timeframe to ensure ramping and uncertainty needs between the day-ahead and real-time markets can be efficiently met. The real-time must offer obligation based on commitments made in the day-ahead will provide the CAISO with adequate capacity for use in real-time, while relieving capacity not committed in day-ahead of their real-time must offer obligation.

Although RA resources would not have a real-time must offer obligation if they are not awarded in the day-ahead, resources must still be available for exceptional dispatch after the day-ahead market. If resources receive an exceptional dispatch, they will still be required to provide that

energy real-time. As described below, RDRR and certain resources with variable capability will continue to have a real-time must offer obligation due to the characteristics of the resources.

Under the Day-Ahead Market Enhancements and RA Enhancements proposals, resource adequacy resources will have a 24 by 7 must offer obligation in the day-ahead market only. Their must offer obligation will be extended into real-time only if the resource is scheduled in day-ahead for energy, ancillary services, or imbalance reserves. While flexible RA resources will be required to bid for imbalance reserves, it is optional for system or local resources to bid for imbalance reserves. Must offer obligations for flexible resources are described in section 5.2.5. This approach will better align the must offer obligations to the operational needs because the day-ahead market will position resources prior to the real-time market to meet energy and imbalance needs. By committing these resources in the day-ahead, it should be unnecessary for all RA resources to have a 24 by 7 must offer obligation in the real-time market.

Standard must offer obligation

The CAISO performed a comprehensive review of must offer obligations for all resource types in the tariff and Reliability Requirements BPM and believes the current must offer obligations can be simplified to provide market participants more clarity when determining the must offer obligations for different resources. To simplify the must offer obligations, the CAISO proposes a standard day-ahead must offer obligation into the day-ahead market that would apply to all resources unless specified by CAISO under an exemption by resource type.

Standard day-ahead must offer obligation: Economic bids or self-schedules for all RA capacity for all hours of the month a resource is not on outage. [24]

Bid Insertion Proposal

As part of this RA Enhancements initiative, the CAISO is proposing revisions to the bid insertion rules. Although the CAISO currently requires RA resources to economically bid or self-schedule into the market, it also supplements those bidding obligations with bid insertion provisions for non-use limited resources. The CAISO has considered two potential options for revising bid insertion rules:

1. Apply bid insertion to all non-use-limited resources and resources registered as use-limited under Commitment Cost Enhancements – Phase 3 (CCE3) policy, or;
2. No bid insertion for any resource, but either apply RAAIM to RA resources or treat all intervals without bids as forced outages for the purposes of the UCAP calculation.

The CAISO proposes adopting option 1. The CAISO recently implemented the CCE3 policy that allows resources with certain use limitations to include approved opportunity costs in their market bids. The policy is designed to ensure the more effective and efficient use of resources

[24] Outage refers to both planned and forced. If a resource is on outage, whether it is planned or forced, it should not be bidding that capacity into the market because it would not be able to deliver it.

in the market and to facilitate regular and consistent market participation from resources with certain use limitations.

Applying bid-insertion to non-use-limited resources and resources registered as use-limited under CCE3 policy will ensure that resources have bids in the market and would need to report outages to avoid the market dispatching the resource, enhancing the CAISO's ability to identify forced outages. Additionally, option 2 creates a greater disincentive to show RA capacity.

Exemptions to Standard Must Offer Obligation

The CAISO recognizes that not all resource types are physically capable of adhering to the proposed standard must offer obligation, and therefore proposes a list of exemptions to the standard must offer obligation outlined in Table 3. Exempt resource types will still be subject to must offer obligations, but they will be defined by CAISO based on the characteristics of the resource type.

The CAISO also recognizes the need to define specifically the bid insertion rules for resources that fall outside the categories of non-use-limited or registered use-limited. For example, it may not be appropriate to apply bid insertion to resources with variable output. Therefore, the CAISO also includes bid insertion exemptions listed in Table 3. If a resource is exempt from bid insertion, the CAISO would not insert bids into the day-ahead market for these resources in the event that required amounts of RA capacity are not offered into the day-ahead market. This table summarizes day-ahead market must offer obligations only.

The CAISO initially proposes to generally define the following exemptions for must offer obligations and bid insertion into the day-ahead market based on resources type and seeks stakeholder feedback on this list, including modifications or additions.

Table 3: Exemptions to Standard Must Offer Obligation and Bid Insertion Proposal

Exemption Type	DA MOO	DA Bid Insertion
Eligible Intermittent Resource	May, but not required to, submit Bids in the Day-Ahead Market	No
NGR (Non-REM)[25]	Standard DA MOO plus MOO should reflect charge and discharge capabilities	No
Non-Dynamic, Non-Resource Specific Imports	Economic Bids or Self-Schedules are to be submitted for all RA Capacity. Block bids or self-schedules should be no longer than one hour for imports providing resource adequacy	Yes

[25] Additional detail on potential solutions for market participation of storage resources is included in the Appendix 9.2.

PDR[26]	Refer to Energy Storage Distributed Energy Resources Phase 4 initiative for developments on bidding obligations for PDR [27]	No
Pumping load	Economic Bids or Self-Schedules are to be submitted for all available energy up to RA Capacity quantity	No
RDRR	May, but not required to, submit Bids in the Day-Ahead Market	No
Regulatory Must Take (RMT)	Must be available consistent with the resource's availability plan for all RA capacity up to the RMT amount, standard DA MOO for any RA capacity above the RMT amount	No
Run-of-River Hydro	May, but not required to submit bids in day-ahead market	No

Modifications to Current Exemptions

This proposal includes several modifications to the current must offer and bid insertion exemptions for the day-ahead must offer obligations.

The CAISO proposes that for resources participating under the NGR, the must offer obligation should reflect both the charge and discharge capabilities of the resource so the CAISO can fully optimize the resource. To do so, the CAISO must have bids available for the unit's full capability. Bidding full charge and discharge capability will allow CAISO to ensure fuel sufficiency for the resource. At this time, the proposal would also apply for battery storage resources participating under the NGR model regardless of the point of interconnection (*i.e.* transmission or distribution), and the CAISO is considering how it would apply to other technology types that may participate under NGR in the future.

The CAISO proposes that for Regulatory Must-Take (RMT) resources, the must offer obligation for the portion of the resource that is RMT should be consistent with availability. The CAISO initially proposes that RMT resources submit an availability plan 45 days prior to the RA month for the portion of the resource that is RMT. The corresponding must offer obligation would be for the MW amount specified on the availability plan. If a portion of the resource is not RMT and provides RA, that portion of the resource would fall under the standard must offer obligation.

[26] CAISO is considering potential modifications to must offer obligations for variable-output DR in the ESDER 4 stakeholder process, including bidding requirements and submission of forecasted capability. ESDER Stakeholder Initiative Webpage: http://www.caiso.com/informed/Pages/StakeholderProcesses/EnergyStorage_DistributedEnergyResources.aspx

[27] PDR bidding requirements are specified in CAISO tariff Section 30.6.1 – Bidding and Scheduling of PDRs

Currently, RA imports may submit multi-hour block bids or self-schedules. As outlined in Section 5.2, the CAISO is proposing to adopt requirements for the flexible RA program that focus on meeting uncertainty needs between day-ahead and real-time, rather than predictable ramps over the course of the day. However, the CAISO still needs to be able to shape day-ahead market awards to meet predictable ramping needs over the course the day. The system RA fleet must, therefore, be capable of being shaped hour by hour. Multi-hour block schedules negatively impact the CAISO's ability to avoid renewable curtailment and ramping constraints. Therefore, going forward, the CAISO proposes that system RA resources may not submit block bids or self-schedules greater than one hour.

A few resources will continue to have a real-time must offer obligation for RA capacity, including RDRRs and resources with intra-hour variability. The CAISO must maintain the real-time must offer obligation for RDRR resources, unlike other RA resources because RDRR is not required to participate in day-ahead and is only available in real-time if the CAISO declares a warning or emergency. Therefore, the CAISO must ensure RDRR resources continue to have a real-time must offer obligation to ensure they are available in real-time if needed. Additionally, the CAISO proposes to apply bid insertion for RDRR resources in the real-time. The CAISO proposes to insert bids at 100% of the bid cap so RDRR resources, which are reserved for emergencies, are not used before resources that offer below the cap.

The CAISO must also maintain the real-time must offer obligation for resources with intra-hour variability, such as eligible intermittent resources and run-of-river hydro. Run-of-river hydro resources have similar operating characteristics to wind and solar because they have limited ability to control output from one interval to the next. It is optional for eligible intermittent resources to bid into the day-ahead market. In real-time, they are scheduled based on a forecast provided by the CAISO. This ensures feasible real-time dispatches that reflect intra-hour variability. The CAISO does not receive forecast data for run of river hydro. Therefore, run-of-river hydro cannot be treated as a VER due to lack of data availability. However, they can be treated similarly for the purposes of the must offer obligation. The CAISO proposes run-of-river hydro submit their own day-ahead forecast of resource output, and updated forecasts in real-time. Eligible intermittent resources and run-of-river hydro would, therefore, not have a day-ahead must offer obligation, and would have a real-time must offer obligation up to their forecasted amount.

The CAISO is also proposing changes to bidding rules and must offer obligations for variable-output demand response resources in the Energy Storage and Distributed Energy Resources (ESDER) initiative. These changes would allow resources to submit forecasted capability and satisfy their must offer obligation by bidding this capability. Additional details on the bidding requirements for variable output demand response will be developed within the ESDER initiative.

For resources providing their own forecast, such as run-of-river and variable-output DR, the CAISO is considering potential provisions that limit opportunities to submit inaccurate forecasts for strategic purposes. Additionally, as resource types requiring treatment based on a forecast increases, the CAISO may also consider the need to allocate commitment costs made due to forecasting uncertainty.

The CAISO believes the proposed must offer obligations and bidding rules provide clearer requirements for market participants to follow when determining when they must bid into the CAISO market. The CAISO welcomes stakeholder feedback on the proposals for the standard must offer obligations and list of exemptions.

Additionally, the CAISO has limited NGR eligibility for system RA to resources under the non-regulation energy management (non-REM) option. The CAISO cannot maintain system reliability over-relying on resources limited to providing regulation only. REM management resources are neither required, nor capable, of providing energy needed to meet the energy needs of system. Therefore, the CAISO has limited the system RA eligibility of NGRs to NGRs with the non-REM option.

5.1.5. Planned Outage Process Enhancements

The CAISO considered modifying its planned outage provisions to correspond with the proposed modifications to its RA counting rules and assessments. The CAISO describes its proposed changes to its planned outage provisions in the following section and some relevant background on the current provisions.

Background

The CAISO currently uses the Planned Outage Substitution Process Obligation (POSO) for planned outages. The POSO provisions are provided in CAISO tariff at sections 9.3.1.3 and 40.9.3.6 and the Outage Management BPM. RA resources currently enter planned outages into CAISO Outage Management System (OMS). The CAISO's Customer Interface for Resource Adequacy (CIRA) system runs a daily POSO report with determination for a planned outage need for substitution. The POSO process is currently conducted on a first-in-last-out basis,[28] therefore resources submitting planned outages earliest will have the greatest likelihood of being approved to take their planned outages without substitution requirements. The POSO process compares the total amount of operational RA capacity to the total system RA requirement.

As noted previously, LRAs establish system RA requirements based upon CEC monthly peak forecasts and are updated 60 days prior to the start of each delivery month. If, after removing all planned outages, available capacity is less than the RA requirement, the CAISO assigns substitution obligations for resources seeking to take planned outages during those short timeframes.

[28] CAISO will first request the resource providing RA Capacity with the most-recently-requested outage for that day to provide RA Substitute Capacity and then will continue to assign substitution opportunities until the ISO has sufficient operational RA Capacity to meet the system RA requirement for that particular day.

Objectives and Principles

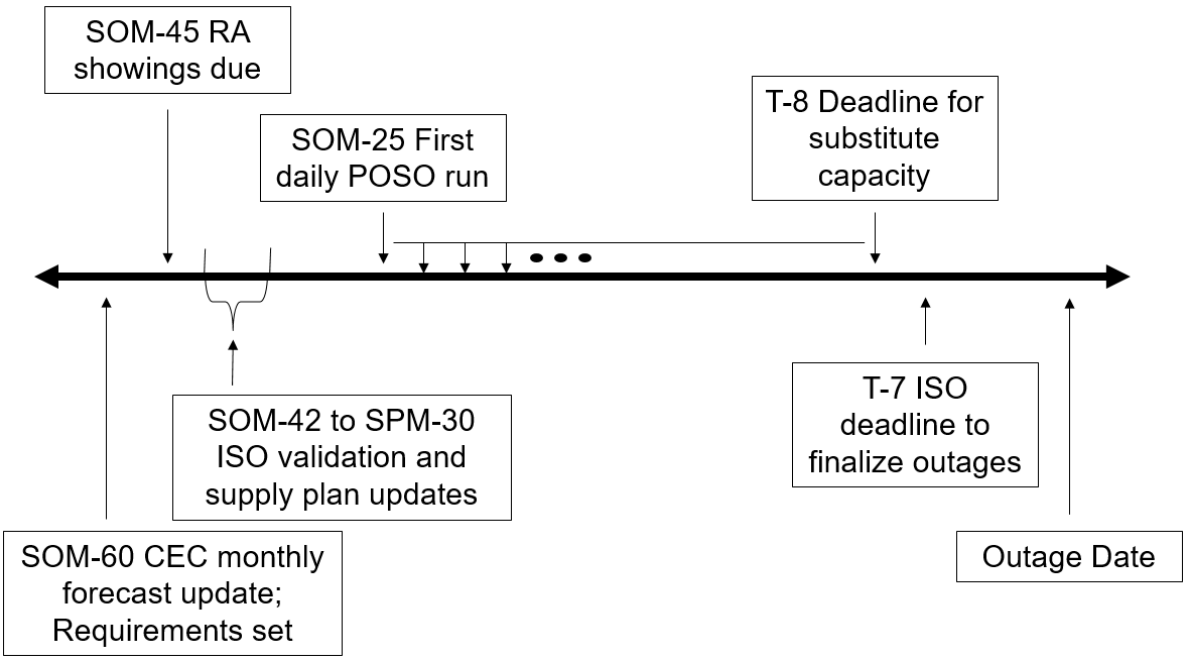
The CAISO provides the following objectives and principles to guide the development of modifications to the planned outage provisions. Modifications to the CAISO planned outage provisions should:

- Encourage resource owners to enter outages as early as possible,
- Avoid cancellation of any approved planned outages to the extent possible,
- Minimize the need to require substitute capacity to greatest extent possible
- Identify specific replacement requirements for resources requiring replacement,
- Allow owners to self-select, or self-provide, replacement capacity, and;
- Include development of a CAISO system for procuring replacement capacity.

Current Planned Outage Substitution Obligation Timeline

The current POSO timeline is provided in Figure 10 below. The current timeline provides the first POSO assessment at T-22, or 22 days prior to the start of the RA delivery month, for all outages submitted prior to T-25. This is the first instance when resource owners are provided with indication of any POSO replacement obligations. Resource owners are allowed to provide replacement capacity through the T-8 timeframe, and the CAISO finalizes replacements and outages at T-7.

Figure 10: Current POSO timeline



Proposed Modifications to the Planned Outage Process

The CAISO is proposing several changes to the existing planned outage provisions and planned outage process. Further, based on numerous stakeholder comments to the revised straw

proposal, the CAISO is proposing several changes to ensure planned outages can be taken by 45 days prior to the month. Additionally, numerous stakeholders noted the challenges with providing comparable capacity for planned outages. Therefore, the CAISO has removed this requirement. The CAISO also is attempting to remove obligations for outage replacement to the greatest extent possible. The CAISO proposes to redesign the planned outage process to reflect system UCAP targets rather than traditional NQC targets. This proposed change will better align with the counting rules and RA assessments proposal to incorporate forced outage rates in capacity valuation and assess resource adequacy on a UCAP basis, as detailed in Section 5.1. The proposed modifications include:

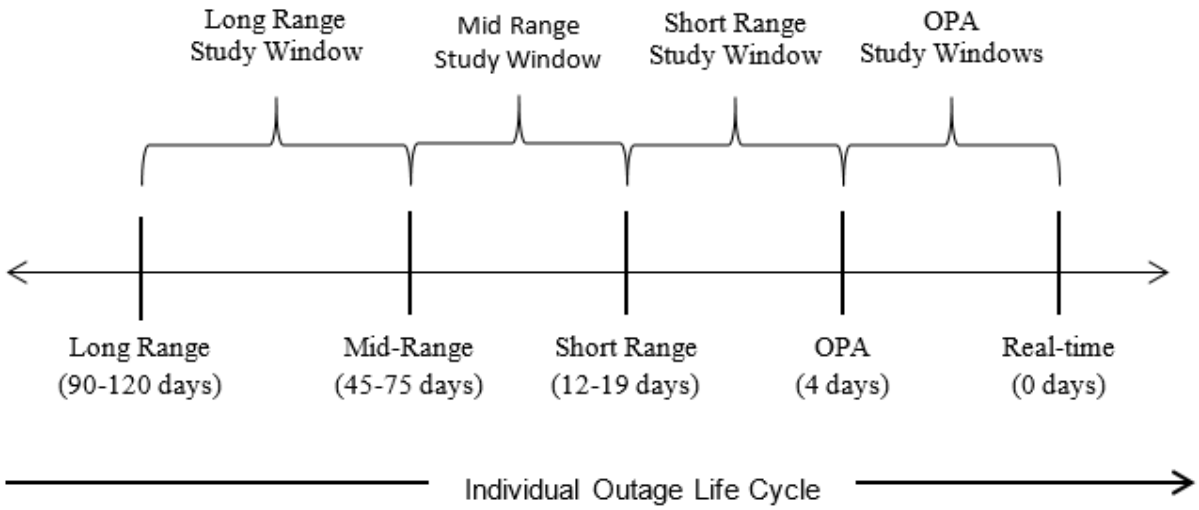
- Allow internal resources to be shown for subsets of months
- Include an RA adequacy test before approving some planned outages
- Development of a planned outage calendar
- Development of a substitute capacity bulletin board

These elements are described below and in greater detail with examples and justification in the subsequent sections.

Revised RA Planned Outage Process

The CAISO proposes to revise the RA planned outage process to align with the timeline provided in the Outage Management BPM. This timeline is provided in Figure 11, below.

Figure 11: Outage management timeline[29]



The CAISO proposes to modify the opportunities and definitions for planned outage opportunities. Specifically, the CAISO proposes three different types of planned outages:

1. Planned outages – outages submitted at least 45 days prior to the RA month

[29] For additional details, see the CAISO Outage Management BPM at https://bpmcm.caiso.com/BPM%20Document%20Library/Outage%20Management/Outage%20Management%20BPM%20Version%2021_clean.docx

2. Opportunity outages – outages submitted between 44 days and eight days prior to the outage
3. Forced outages – outages taken seven or fewer days prior to the outage

Each outage type will have different approval criteria and treatment on RA showings and supply plans. The following provides additional details regarding how the CAISO will consider each outage type.

Planned outages must be submitted at least 45 days prior to the month. This aligns with the timeline by which mid-range planned outages must be submitted as per the CAISO's Outage Management BPM. Because these showings are known so far in advance, the SC for the resource may not put them on a supply plan for the days the resource is on planned outage. To facilitate this, the CAISO will allow internal resources to be shown for RA for a subset of the whole month. However, this does not mean that CAISO will allow for daily RA deficiencies. Resources providing RA capacity during a month and taking planned outages are responsible for working with the LSE to provide any substitute capacity needed to ensure RA requirements are addressed. Because these resources essentially are not providing RA capacity on those days, the outage will be approved or denied based only on the existing CAISO reliability check. Additionally, because these are not on an RA showing, they will also be excluded from the CAISO's portfolio analysis. Additionally, resources taking planned outages cannot extend a planned outage after 45 days prior to the month. If an outage is expected to last beyond the initially submitted outage dates, then the CAISO will assess the extension request as an opportunity or as forced outage and apply the appropriate standard. If the CAISO does not approve an outage extension, any additional outage time will be considered forced and included in the resource's forced outage rate. If approved, these outages will not be included in forced outage calculations.

If a resource has submitted a request for a planned outage and the resource is still on an RA showing, then the CAISO will notify the resource of a discrepancy and give the resource the opportunity correct the discrepancy. If the discrepancy is not corrected, the CAISO has two options. First, the CAISO could cancel the planned outage. Given CAISO's objective not to cancel planned outages, this is not a preferred outcome. The other option is to account for the planned outages in the RA adequacy assessment. This option would put the burden for replacement capacity on the LSE. The CAISO seeks stakeholder feedback regarding which of these options is the preferred approach.

The CAISO recognizes planned outages may arise from opportunities after RA showings have been made. As such, the CAISO will allow for planned outages taken after RA showings have been made. Any outage submitted between 44 days prior to the month and 8 days prior to the outage will be considered opportunity outages. CAISO will approve these outages if two conditions are met;

1) There is sufficient RA capacity available so the CAISO is not deficient relative to the system RA requirement, and
2) The outage is approved through the CAISO reliability check.

These conditions will be assessed sequentially. If the requested outage will result in deficient RA capacity, the CAISO will reject the outage without running the reliability check. The resource requesting the outage may provide substitute capacity to resolve any RA deficiencies. If there are no RA deficiencies or all deficiencies are resolved, the CAISO will run the reliability check. The CAISO will run the reliability check, with the replacement capacity. If the CAISO approves the outage, then the new resource will take on the must-offer obligations for RA capacity. If the CAISO rejects the outage, then the replacement capacity's RA obligation is absolved, and the R are only for the duration approved by the CAISO. Any requested extensions must be made more than eight days prior to the last day of the approved outage window. If approved, these outages will not be included in forced outage calculations. Any extensions made after that date will be treated as planned as forced.

All outages requested seven days or less prior to the outage will be treated as forced. These outages will be included in the resource's forced outage rate. This treatment incentivizes a resource to either notify CAISO as soon as possible it is going on outage or to complete the planned outage within the CAISO-approved window. However, the CAISO runs the final reliability check eight days prior to the operating day. Outages after that time have already be considered with the RA UCAP requirements.

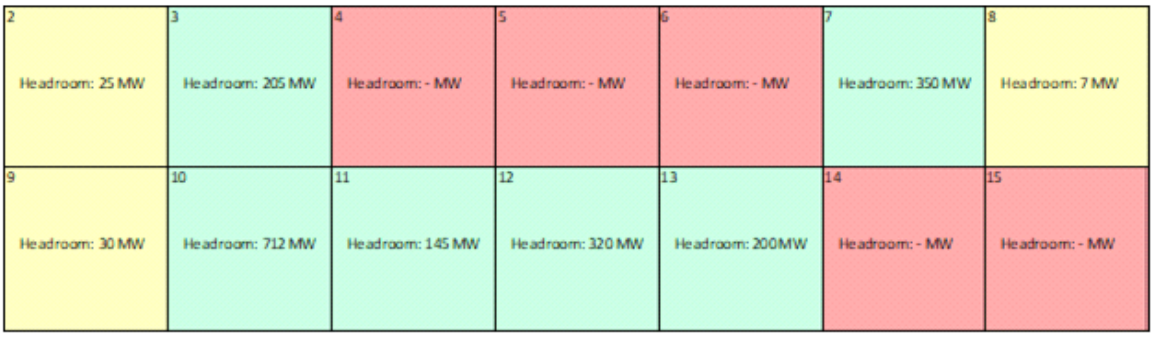
Planned Outage Outlook transparency

The CAISO proposes to offer greater visibility into how much resource adequacy capacity has been shown relative to the resource adequacy requirements. The goal is to provide resources greater transparency regarding available capacity well in advance of planning outages. Specifically, CAISO proposes to develop a calendar that shows in advance, on a daily basis, the potential availability of additional system RA headroom. This RA headroom should allow resources to identify potential calendar dates with RA headroom in advance of requesting planned outages, thus mitigating replacement obligations and helping the CAISO maintain adequate available capacity. If the calendar shows no available headroom, then any RA resource requesting a planned outage will be required to show substitute capacity.

Outages will to be approved and denied through the planned outage tool discussed above. Outages and substitute capacity will continue to be evaluated, accepted, the outage calendar adjusted on a first-in-last-out basis. Thus, resources submitting outage requests will be assessed first, making it less likely the CAISO will deny their outage or require them to provide substitute capacity compared to later requesting resources. The CAISO will continue to allow resources taking outages requiring replacement to self-provide substitute capacity for any outages requiring replacement.

Figure 12 demonstrates the conceptual planned outage outlook calendar. The CAISO proposes to publish this type of calendar including daily MW values for UCAP headroom in excess of system RA requirements.

Figure 12: Example substitution availability calendar



Additional issues related to planned outage provisions

Local constraints will continue to be enforced in the CAISO's outage planning, and the CAISO may deny outages if local reliability issues arise. Self-providing substitute resources (within the same local area) may reduce instances of the CAISO denying outages for local reliability issues.

The CAISO will retain its authority to deny any outage for reliability reasons, even those that have provided substitute capacity. The CAISO will also retain its ability to procure additional capacity through backstop tools for reliability after the planned outage timeframe, as necessary.

Planned Outage Substitution Capacity Bulletin Board

The CAISO proposes to develop a bulletin board for resources to match planned outages requiring substitution with substitute capacity resource sellers. This planned outage substitution bulletin board should make it easier for resources to connect with potential substitute supply. Resources not shown as RA resources or with additional available UCAP may voluntarily offer that capacity to provide substitute capacity. The resource SC will be able to list resources and a specified price for use of that substitute capacity. Resources looking for substitute capacity can use this bulletin board to find the comparable capacity needed to take the planned outage.

The CAISO will provide daily granularity. Resource owners looking for substitute capacity will have visibility into resources offering substitute capacity. Results will be filtered to only substitute capacity suitable for substitution (per replacement comparability requirements). Accepting capacity through this tool will automatically match resources on outage with substitute capacity.

5.1.6.RA Import Provisions

The CAISO has included the review of import RA rules and provisions in this initiative. The CAISO provides analysis and updates the proposed modifications to the RA imports provisions in the following section.

Background

LSEs can meet system RA requirements with a mix of RA resources, which can include imports from outside the CAISO balancing authority area. Import RA resources were used to meet an average of around 3,600 MW (or around 7 percent) of system RA requirements during the peak

summer hours of 2017. In the summer of 2018, this increased to an average of around 4,000 MW (or around 8 percent) of system resource adequacy requirements.[30] Thus, the quantities are significant and may affect the RA program and its ability to ensure reliability.

Today, RA import resources are not required to be resource specific or to specify that they represent supply from a specific balancing area. RA import resources are only required to be shown on RA and supply plans with associated maximum import capability (MIC), and make offers as shown at a specific intertie point into the CAISO's system. Import RA can be bid at any price below the offer cap and does not have any further obligation to bid into the real-time market if not scheduled in the day-ahead integrated forward market or residual unit commitment process.

Some stakeholders previously expressed concerns that current RA import provisions potentially undermine the integrity of the RA program and threaten system reliability. The CAISO's Department of Marking Monitoring (DMM) expressed similar concerns in their September 2018 DMM special report on import RA.[31] In that report, DMM explained the existing rules could allow for some portion of resource adequacy requirements to be met by import RA that have limited availability and value during critical system and market conditions. For example, Non-Resource Specific (NRS-RA) RA imports could satisfy their RA must offer obligation by routinely bidding significantly above projected prices in the day-ahead market so they do not clear the market, relieving them of any further offer obligations in real-time. This is possible because NRS-RA imports do not have bid cost recovery or bid cost verification and can determine the price at which they choose to bid import energy.

Potential concerns and issues under review

The CAISO is focused on reviewing the current RA import provisions to determine if they cause reliability concerns and identifying how any potential issues can be mitigated. The CAISO has previously identified two areas of concern with the current RA import provisions as explained below.

Potential concerns regarding current RA import provisions:

1. **Double counting of RA import resources**:

The CAISO's RA import provisions should ensure the CAISO can certify that import resources shown for RA are not also being used by the resource's native BA to serve native load, sold to a third party, or being used to meet capacity needs of other areas in addition to CAISO load. The CAISO cannot be sure whether RA imports are being double counted under current provisions.

2. **Speculative RA import supply being used on RA showings**:

The CAISO believes that RA import provisions should foreclose (or at a minimum, discourage) speculative RA import supply. Speculative RA import supply occurs when RA imports shown on

[30] 2017 CAISO DMM Annual Report, p. 259: http://www.caiso.com/Documents/2017AnnualReportonMarketIssuesandPerformance.pdf
[31] DMM Special Report: Import Resource Adequacy, September 10, 2018: http://www.caiso.com/Documents/ImportResourceAdequacySpecialReport-Sept102018.pdf

RA supply plans have no physical resource backing the showing or no firm contractual delivery obligation secured at time of the showing.

The CAISO previously described speculative RA import supply and noted DMM's similar concerns above. Previously, the CAISO indicated this could present a significant reliability problem due to initial evidence of relatively high priced DA bidding by NRS-RA imports. This type of behavior can represent a potential bidding strategy used by speculative supply to avoid a subsequent RT MOO or actual RT energy award and resulting delivery obligation. The CAISO completed additional analysis efforts in attempt to better understand the issues related to NRS-RA import resource's reliability contributions, included in this section and in the proposal appendix.

Objectives

The CAISO identifies the following objectives to guide any potential RA import rule modifications.

- Modify RA import provisions to ensure that NRS-RA imports are backed by physical capacity and reserves with firm transmission delivery.
- Create more comparable treatment for RA imports to internal RA resources. The current provisions provide less rigorous requirements for RA imports.
- Coordinate import provisions with any related modifications being proposed through CAISO's extended EIM and DAME initiatives. Correlation between the RA Enhancements initiative, the Day-Ahead Market Enhancements (DAME) initiative, and the Extension of the Day-Ahead Market to the EIM (EDAM) is vital to ensure all of the interrelated aspects work together without unintended consequences.

RA import analysis

The CAISO analyzed the impact of NRS-RA imports on the RA program and CAISO markets. This section includes updated analysis that incorporates day ahead market participation. The CAISO also provides updated granularity of this analysis that breaks down some aspects by scheduling coordinator (SC) to provide transparency into the potential of speculative supply occurring. Stakeholders also requested additional analysis on these issues.

The CAISO conducted related imports analysis in the summer of 2018 as a part of the Intertie Deviation Settlement initiative.[32] The Intertie Deviation Settlement initiative investigated why awarded import resources are not delivered, the magnitude of non-delivery that occurs, and a proposal to mitigate non-delivery of import resources. The RA Enhancements effort leverages that analysis to determine if there is a problem with non-delivery of import RA when awarded in the CAISO real-time market.

To assess market awards and delivery patterns of RA imports, the CAISO analyzed three data sets: import RA showings; HASP schedule for import RA resources; and RA delivered quantities. This enabled the CAISO to identify if imports that were awarded in the real-time

[32] Information on the Intertie Deviation Settlement initiative can be found here: http://www.caiso.com/informed/Pages/StakeholderProcesses/IntertieDeviationSettlement.aspx

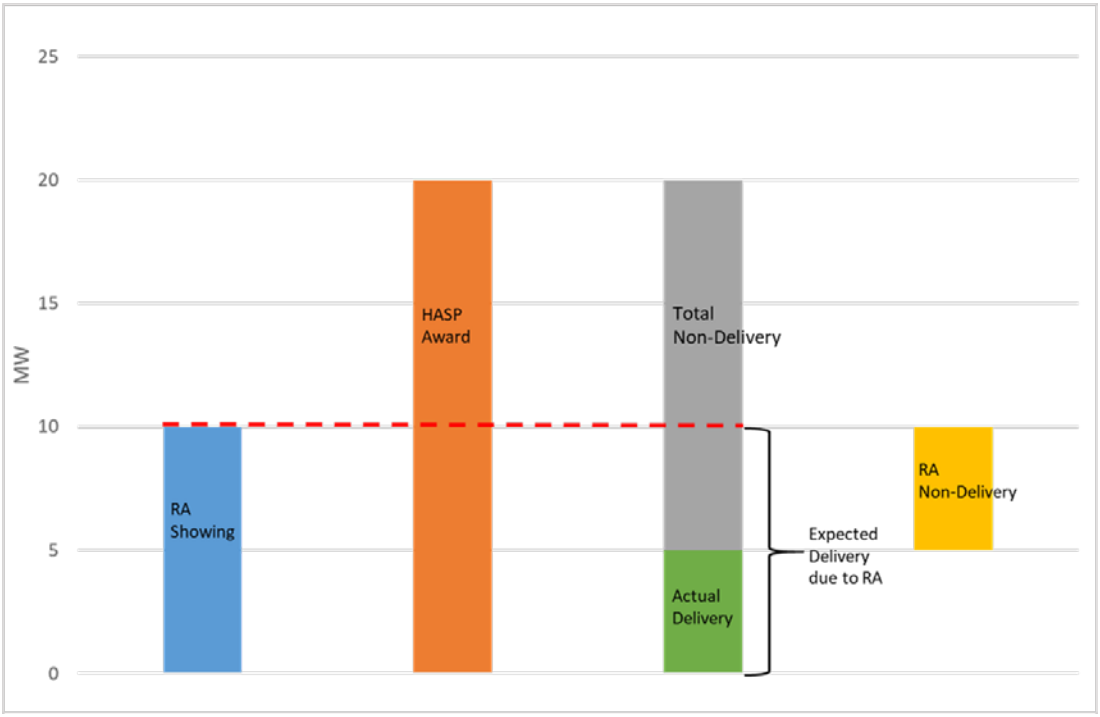
market but failed to deliver, did not deliver because the scheduling coordinator failed to bid, or actually delivered a MWh quantity greater than the RA showing.

The CAISO defines "non-delivery" as the MWh quantity that did not meet the real-time schedule. Because RA imports are scheduled hourly, the non-delivery quantity is determined by comparing the HASP schedule to the RA delivery quantity. It is important to compare these values to the RA showing. Specifically, an RA import's Resource ID is not limited to bidding only the amount of MWs that have been shown for RA, and the CAISO has observed many instances when bidding and awards for RA import Resource IDs exceed the amount of MWs shown for RA. The CAISO attempts to illustrate this issue with a hypothetical example below. Additional analysis to better quantify the potential for any reliability concerns related to RA import non-delivery is also included in the hypothetical example below.

As illustrated in Figure 13 below, 10 MW was shown for import RA and the HASP schedule was for 20 MW during a specific hour. When comparing the HASP schedule to the market dispatch, we determine that only 5 MW was delivered. Therefore, 15 MW can be classified as undelivered. This quantity is depicted in the grey colored bar.

To determine how much of this non-delivery can be attributed to import RA, the CAISO assumed the total amount of RA expected would be the same as the import RA showing. In this example, the non-delivery due to RA imports can be assumed to be 5 MW. Although the total amount of non-delivery can be considered a reliability concern, it is particularly concerning that 5 MW of RA was not delivered. This may indicate the potential of speculative RA. This 5 MW that is not delivered is a potential reliability concern.

Figure 13: Clarifying potential concerns related to RA import delivery

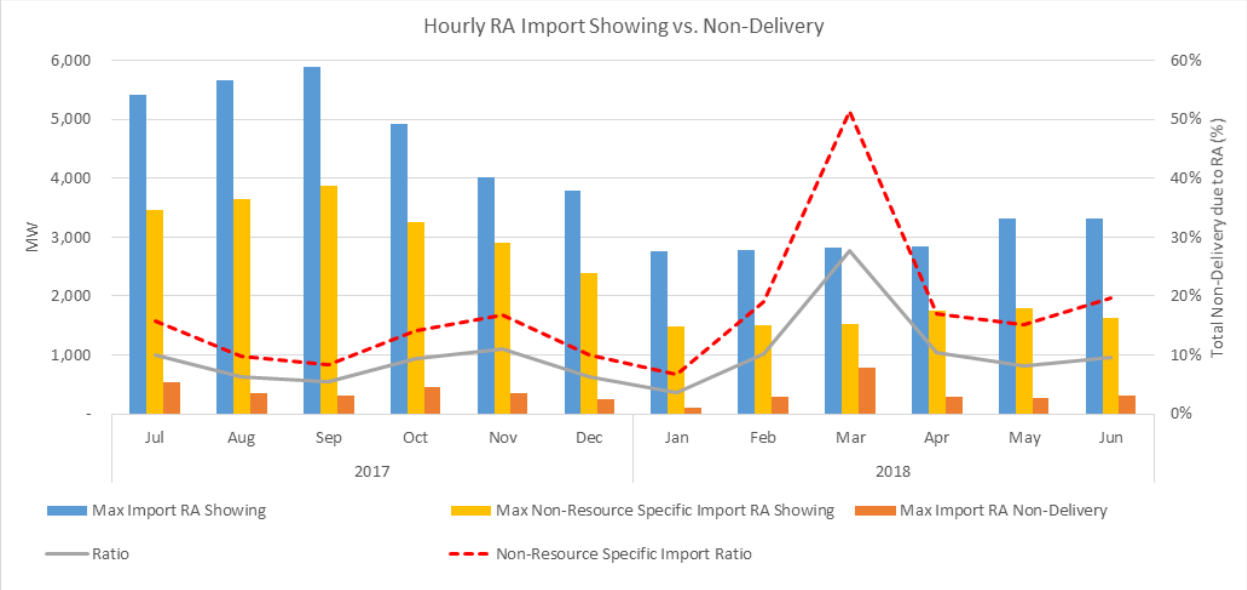


The CAISO applied the approach described in the hypothetical example to the initial RA enhancements analysis, previously presented in the CAISO straw proposal to ensure that the actual stated magnitude of non-delivery of RA imports provided through this analysis is accurate and appropriate.

The analysis shown in the figure below provides data from July 2017 to June 2018 for RA import non-deliveries. The CAISO noted in the revised straw proposal that actual non-delivery results, after considering the modification to its analysis described above, shows a maximum monthly non-delivery of RA imports of approximately 10% on average over the study period.[33] The CAISO has identified that some tie gen resources (pseudo-tied or dynamic scheduled) resources were also included in the sample previously analyzed.

The CAISO updated the analysis included in Figure 14 below. The updated analysis indicates the true maximum monthly non-delivery from NRS-RA imports resources was on average actually 17%, on average, during the study period. This change is due to the removal of the other tie gen capacity so the analysis now compares non-deliveries to only the NRS-RA imports.

Figure 14: Observed undelivered RA import resources (hourly average)



In addition to correcting the real-time non-delivery figure from the revised straw proposal, the CAISO provides analysis of day ahead and HASP bidding and awards for NRS-RA import resources. This analysis also includes SC level data, but values have been averaged over the year timeframe studied and the names of specific SCs have also been masked to prevent confidentiality issues or any anti-competitive information related concerns. The additional analysis provided in this proposal is included in part below, and additional charts and supporting tables are included in the proposal appendix at section 9.2.

Figure 15 provides the Day Ahead bidding and awards for the AAH hours (on average). Figure 16 provides the HASP bidding and awards for the AAH hours (on average). These charts

[33] See CAISO Revised Straw Proposal.

indicate non-delivery is relatively low, and generally consistent with expected forced outage rates of internal RA resources. Additionally, the analysis shows that RA import behavior is generally consistent with requirements and expected participation by NRS-RA import providers. The additional SC level analysis provided further below helps to differentiate the general statistics provided in these figures.

Figure 15: Day Ahead bids, awards, self-schedules, and actual non-delivery – average during AAH hours

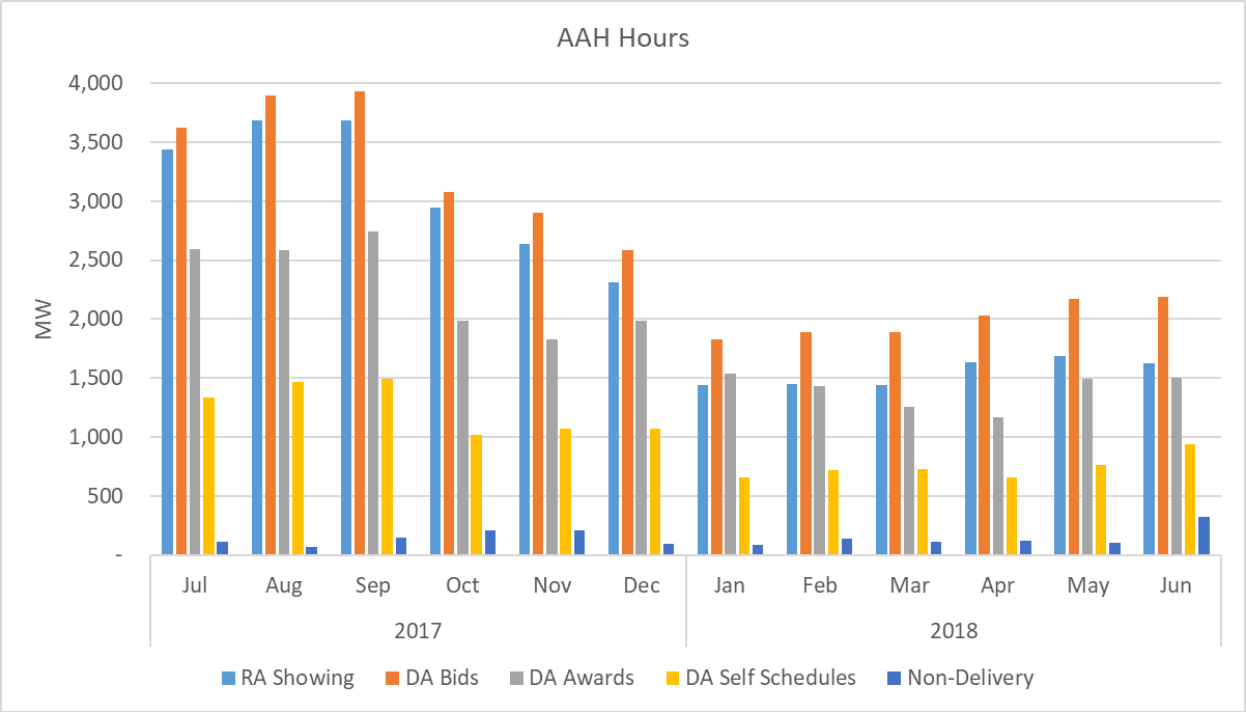
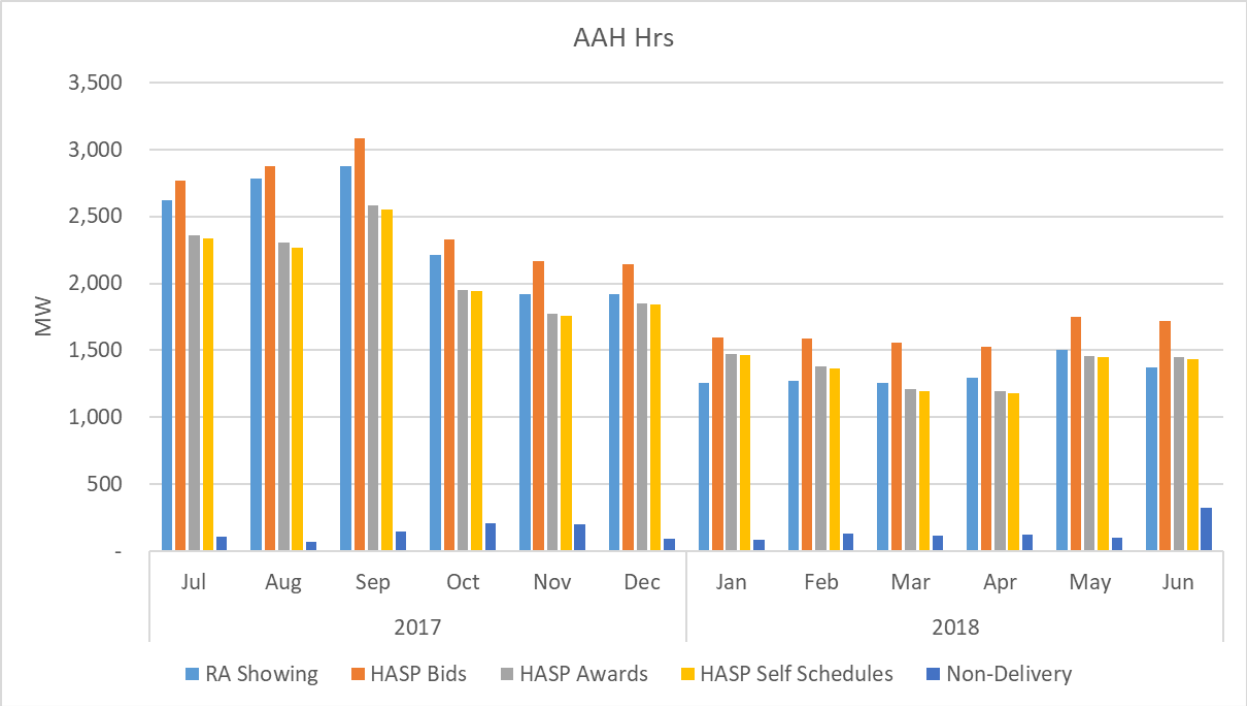
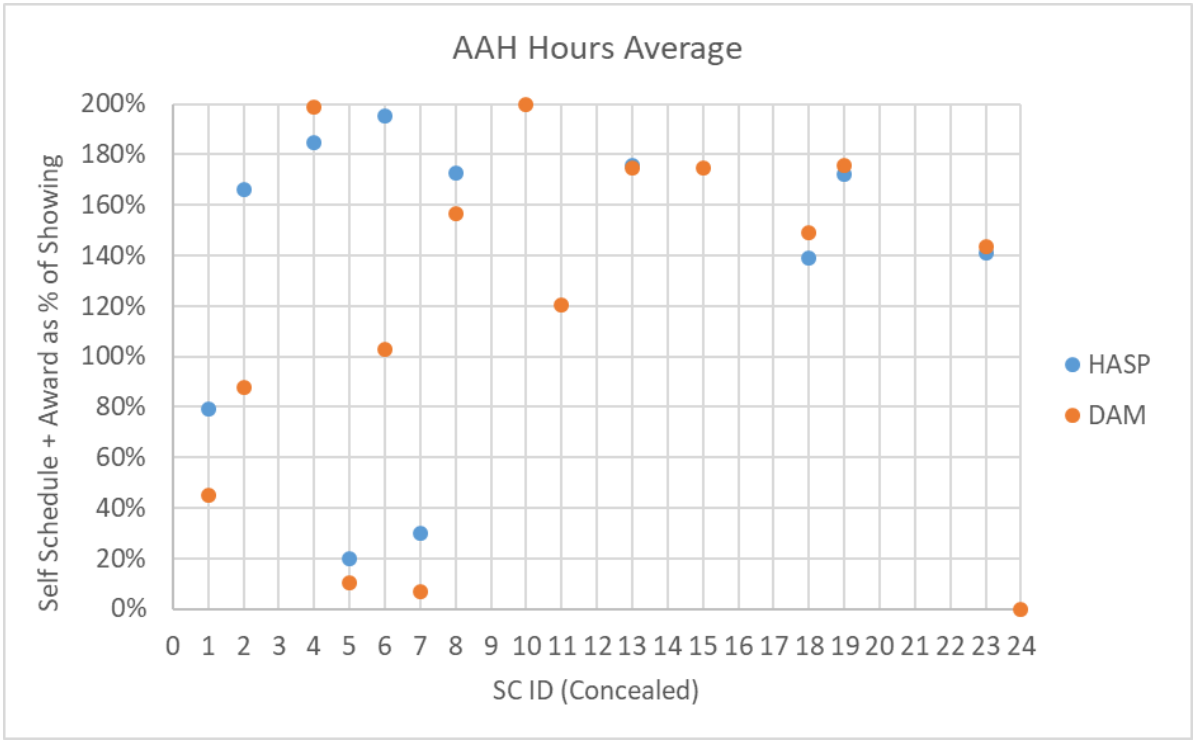


Figure 16: HASP bids, awards, self-schedules, and non-delivery – average in AAH hours



The CAISO also provides additional analysis of the 24 resource SCs that provided import RA over the studied time period. Figure 17 provides SC awards and self-schedules as a percent of RA showings for AAH hours (on average).

Figure 17: SC Awards and Self Scheduled as % of RA showings – Average in AAH hours



This additional analysis indicates that most SCs providing NRS-RA imports on RA showings are likely providing physical capacity that has been secured in advance with firm delivery capability and operating reserves. This is evidenced by the high ratio of awards and self-scheduled import RA to RA showings by most SCs providing NRS-RA imports.

The data also provides evidence that a select number of SCs may be providing NRS-RA imports that could represent speculative supply or not be backed by sufficient reserves or firm transmission necessary to support actual delivery of energy, should the CAISO markets actually call on these supplies to deliver the capacity that is shown. This is evidenced by the low ratio of awards and self-scheduled import RA to RA showings by select SCs providing NRS-RA imports. For example, 20 of the NRA-RA import SC's awards and self-schedules were all at or near 100% of their NRS-RA showing amounts, on average, over the year analyzed. In contrast, four of these SC's awards and self-schedules were far below their NRS-RA showing amounts, on average, over the year analyzed. Additionally, in the day-ahead timeframe, three SCs averaged under 10% awards and self-schedules compared their NRS-RA import showing MWs over the year. These results are not unexpected given the current RA import provisions, but CAISO believes that the proposed modifications should help ensure NRS-RA imports are backed by physical capacity with firm transmission.

The CAISO believes that the proposed modifications to the import provisions described below will help to mitigate the potential that NRS-RA imports will be provided without forward commitment of physical supply.

Proposed RA Import Rule Modifications

The CAISO proposes to require specification of the Source BA for any NRS-RA imports used on RA and Supply Plans for monthly showings. The CAISO also proposes to adopt provisions similar to current CPUC RA program rules and regulations for RA imports. This will ensure RA imports are backed by a forward commitment of physical capacity with firm transmission delivery and sufficient operating reserves to back obligations. Specifically, all LSEs must submit supporting documentation that any non-specified RA import resource shown on annual and monthly RA and Supply plans represent physical capacity and firm transmission. The CAISO will include these requirements in the tariff to ensure similar treatment among all LSEs. The CAISO also proposes to align any RA import bidding obligations with other interrelated aspects of this proposal and the Day Ahead Market Enhancements initiatives. These modifications are described in further detail below.

Specification of RA Import Resource Balancing Area Source

The CAISO's current RA provisions allow NRS-RA imports to provide System RA. As noted above, RA import resources are not required to be resource specific or to provide any greater certainty they represent physical supply from a specific Balancing Area. They are only required to be shown as sourced on a specific intertie into CAISO's system.

Because of tighter capacity supply in the West, the CAISO has expressed increasing concerns about the potential for Non-Resource Specific RA import resources to be double counted for reliability. Double counting of capacity may occur when a resource is shown to the CAISO as

RA while also being concurrently relied upon by other regions or Balancing Areas (BA) to meet capacity or energy needs. The CAISO proposes to require RA imports to specify the source Balancing Area to ensure all RA import resources are fully available and dedicated to the CAISO for reliability. This is increasingly important as the CAISO considers extending the day-ahead market to EIM entities, ensuring that resources outside of the CAISO's BA are not double counted for meeting resource sufficiency requirements.

With the potential extension of the day-ahead market to EIM entities, the CAISO believes that, at minimum, RA import resources must specify the source BA. The proposed modification would allow the CAISO to ensure that RA imports are not double counted for EIM entities' resource sufficiency tests. Without this rule, it would be possible for an EIM entity to count on capacity from a resource within its own BA to pass the EIM resource sufficiency evaluation, while also showing the resource as import RA to the CAISO. This is not a reasonable outcome because the resource is incapable of physical meeting both the BA's flexibility needs *and* the CAISO's RA needs. Requiring a designation of the source Balancing Area ("Source BA") will be sufficient to ensure RA imports are not being double counted for EIM resource sufficiency tests.

Incorporating CPUC RA program RA imports rules and regulations in CAISO's tariff

Under CPUC decisions, the CPUC's qualifying capacity rules require sufficient physical resources – both energy and operating reserves – supporting NRS-RA imports used to meet RA requirements. Specifically, D.04-10-035, adopted the following methodology:

> "The qualifying capacity for import contracts is the contract amount if the contract (1) is an Import Energy Product with operating reserves, (2) cannot be curtailed for economic reasons, and either (a) is delivered on transmission that cannot be curtailed in operating hours for economic reasons or bumped by higher priority transmission or (b) specifies firm delivery point (*i.e.*, is not seller's choice)." [34]

The CPUC's RA program allows for non-unit specific imports to qualify as RA capacity if they meet import deliverability requirements and have sufficient physical resources associated with them (*i.e.*, spinning reserve and firm energy delivery to a certain point).[35] To support compliance with these requirements, the CPUC requires LSEs provide documentation in their RA compliance filings reflecting that unspecified imports being shown as RA have firm energy delivery and operating reserves behind them. The CPUC has specified that this documentation can be in the form of contract language or an attestation from the import provider confirming the import is supported by firm energy and operating reserves.

The CAISO believes it is appropriate to incorporate similar provisions for RA imports in its tariff. Therefore, the CAISO proposes that all LSEs must submit supporting documentation that any non-specified RA import resource being shown on annual and monthly RA and Supply plans have firm energy delivery. Similar to the CPUC requirements, the supporting documentation

[34] See CPUC Decision D.04-10-035 Workshop Report at 21, available at http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/REPORT/37456.PDF
[35] See CPUC Decision: D.05-10-042 at 68.

that the CAISO will also require can be in the form of contract language or an attestation from the import provider that confirms the import is supported by firm energy and operating reserves.

Bidding Requirements for RA Imports

Currently, RA imports have a day-ahead must offer obligation, but only have a real-time must offer obligations if they receive a day-ahead award. The CAISO previously proposed to extend the must offer obligations for RA imports into the real-time markets, including all shown RA capacity, not only for resources/MWs scheduled in IFM or RUC. One reason for this proposal was to provide the CAISO access to RA imports for reliability through real-time and to further mitigate the potential for suppliers and LSEs to provide RA showings that may include speculative supply. However, after reviewing stakeholder feedback and considering the consequences of extending RA import bidding requirements into real-time, the CAISO does not believe it is appropriate to pursue a full real-time bidding requirement for all RA import MWs regardless of their day-ahead awards.

The CAISO also believes that extending the RA import bidding requirement into real-time might be misaligned with the current DA market enhancements (DAME) initiative proposal. This RA imports proposal also aligns with the other proposed must offer-related modifications herein that have been updated to coordinate better with the CAISO's DAME proposal. Therefore, consistent with other resources covered in section 5.1.4 and the Day-Ahead Market Enhancements the CAISO is proposing to maintain the current bidding rules for RA imports. Thus, only MWs that have received day-ahead awards will be required to bid in real-time.

The efficient utilization of the transmission system is important to consider. The proposed provisions also promote the most efficient utilization of transmission capability because when the non-resource specific imports do not clear the day-ahead market for some or all of their shown RA capacity, the associated transmission can be released for use in the real-time market for economic energy imports. Requiring a real-time bidding obligation for all non-resource specific RA imports could have a negative impact on the efficient utilization of the transmission, potentially increasing overall costs to serve load. This could occur if an RA import resource's bid in the real-time was priced at a level that would not clear the market, precluding the utilization of that reserved transmission capability. In this potential scenario, a lower cost energy import that may have cleared the real-time market could be precluded from being awarded, and overall costs to serve load could be increased in comparison. For these reasons, CAISO believes it is appropriate to maintain the current bidding rules for NRS-RA imports.

5.1.7. Maximum Import Capability Provisions

The CAISO has previously discussed Maximum Import Capability (MIC) provisions under this RA Enhancements initiative. Prior proposal iterations have provided the CAISO's review of the MIC provisions and proposed modifications to the MIC allocation process. The CAISO has identified a need to remove the discussion of MIC provisions from the scope of this initiative and plans to establish a stand-alone initiative to address changes to the MIC provisions.

This change in scope and process to address MIC provisions is necessary due to a number of important reasons. The primary reasons behind this change are the need to address the

recently identified 2021 RA year capacity shortfall and the potential adoption of a multi-year RA framework through a settlement process at the CPUC. The CAISO believes that these circumstances warrant removing this topic from the scope of RA Enhancements and establishing a fast track initiative to address any necessary modifications to the CAISO's MIC provisions on an expedited timeframe and implementation schedule.

5.2. Flexible Resource Adequacy

The CAISO seeks to close certain gaps by developing a new flexible RA framework that more deliberately captures the CAISO's operational needs and the predictability (or unpredictability) of ramping needs. Changes to the flexible capacity product and flexible capacity needs determination should closely align with CAISO's actual operational needs for various market runs (*i.e.*, day-ahead market and fifteen-minute market).

Background

In 2014, FERC approved tariff revisions to implement CAISO's FRACMOO proposal. The CAISO developed the original FRACMOO proposal and accompanying tariff provisions through an extensive stakeholder process in collaboration with the CPUC, municipal utilities, investor-owned utilities, generators, environmental groups, and other market participants. The FRACMOO proposal was a first step toward ensuring that load serving entities procured and offered resources to the CAISO that would ensure the CAISO had sufficient flexible capacity to reliably operate the transforming grid that was growing more reliant on distributed and variable energy resources. The tariff provisions resulting from that effort provided the CAISO with a flexible capacity framework. Specifically, the FRACMOO tariff provisions established:

- A study methodology for determining flexible capacity needs and allocating those needs to local regulatory authorities;
- Rules for assessing the system-wide adequacy of flexible capacity showings;
- Backstop procurement authority to address system-wide deficiencies of flexible capacity; and
- Must offer obligations to ensure CAISO has the authority to commit and dispatch flexible resources through its markets.

When the CAISO filed the tariff revisions to implement the FRACMOO proposal with FERC, it stated:

> This simplified initial approach provides a smooth transition to establishing durable flexible capacity requirements. CAISO has committed to re-evaluating the effectiveness of the flexible capacity requirements in 2016 to consider, among other matters, whether enhancements are needed to meet system flexibility needs or to allow resources that are dispatchable on a fifteen-minute basis to fulfill a portion of the flexible capacity needs.[36]

The original FRACMOO proposal was a first step toward ensuring that adequate flexible capacity was available to the CAISO to address the needs of a more dynamic and rapidly

[36] Transmittal letter at p. 19.

transforming grid. The FRACMOO proposal also represented the first ever flexible capacity obligation in any ISO market, recognizing that a resource adequacy program should include both the size (MW) of resource needs and the attributes of the resources providing them (*e.g.*, dispatchability and ramp rate). The CAISO anticipated enhancing the original FRACMOO tariff provisions once it had experience with a flexible capacity paradigm and better understood the system's flexible capacity needs, especially in light of the CAISO's operational needs and the transforming grid.

Subsequently, the CAISO initiated the FRACMOO2 stakeholder process. The objective of that initiative was to make changes to the existing flexible capacity framework to address fundamental gaps between the CAISO's markets and operational needs. Although the FRACMOO2 initiative was placed on hold, the objectives and work from that initiative have been integrated into the present initiative.[37]

5.2.1. Identifying Flexible Capacity Needs and Requirements

Flexible capacity needs

To define a flexible RA capacity requirement, the CAISO reviewed the drivers of flexibility on the system. This assessment sought to identify reasons the CAISO would need to move resources from a fixed schedule. The goal of this assessment was not to expand the requirement definitions for flexible RA, but to more clearly identify how the CAISO can access flexibility, then determine if an identified flexibility need required forward procurement to ensure adequate capacity is available to the CAISO. Although flexibility is required in all intervals to satisfy CAISO operational needs, not all types of flexibility are required in all hours. The CAISO identified multiple drivers of its need for flexibility, including:

- Forecasts (i.e. load, VER, BTMs) improve between market runs
- Timing granularity differs between market runs (1 hour, 15 min, 5 min)
- Deviations from dispatch
- Shaping around prescribed delivery of interties (Hourly blocks and industry ramp blocks)
- Net-load ramps are non-linear

The CAISO defines its flexible capacity needs into the following three categories based on dispatch, controllability, and the response required in certain time horizons:

- Primary – Frequency Response (Impacted by secondary and tertiary)
- Secondary – Regulation and AGC (Impacted by tertiary)
- Tertiary – Market flexibility needs

The CAISO requires all three types of flexibility, but not all must be procured through a resource adequacy construct. For example, primary flexibility is a requirement embedded in the resource interconnection process. Secondary flexibility needs ensure CAISO has sufficient regulation. At

[37] At this time, CAISO is closing the FRACMOO stakeholder process.

this time, CAISO has sufficient regulation capability incentivized and procured through the CAISO market to address this flexibility need.

Finally, tertiary flexibility, *i.e*. ensuring the market has sufficient flexibility reserved to address day-to-day operational needs provides numerous benefits that may not be fully realized absent express procurement in the forward planning horizon. Examples of benefits from forward planning for tertiary or market flexibility needs include:

- Realization of full EIM benefits
- Predictable and economic retirement of resources
- Facilitate state environmental policy at lowest cost
- Mitigate random price spikes
- Provide for lower cost, more reliable dispatches
- Ensures CAISO can maintain reliability during highly variable weather conditions

As a result, the CAISO's flexible capacity needs are to ensure:

- Markets have sufficient economic bid range to dispatch around load and resource variability (or inflexibility), manage significant net load ramps, address uncertainty and differences in market granularity (i.e. hourly vs. fifteen minute) between market runs,
- The CAISO always has sufficient flexible capacity to pass its own EIM ramp sufficiency tests
- Flexible resources have a path to economic viability relative to inflexible resources (*i.e*. leads to more rational retirement)

The CAISO reviewed the day-to-day operational system needs pertaining to flexible capacity. The CAISO observes the need for two categories of flexible capacity:

1) Predictable: known and/or reasonably forecastable ramping needs, and

2) Unpredictable: ramping needs caused by load following and forecast error.

These two types of flexible capacity needs — predictable and unpredictable — drive different forms of flexible requirements. Predictable and reasonably forecastable ramping needs require a set of resources available to the CAISO's day-ahead market to properly shape the day-ahead market to meet forecastable ramps. This allows the CAISO to create a feasible market dispatch in the day-ahead market. The current flexible RA needs determination is based on the largest forecasted three-hour net load plus 3.5 percent expected peak load.[38] The greatest net load ramps are largely driven by the sunset during the non-summer months. Numerous stakeholders questioned the need for a specific RA requirement predicated on ramps that are largely predictable. The CAISO agrees these ramps are largely forecastable on a day-to-day basis and

[38] The 3.5 percent portion of this equation was originally established to address overlap between flexible RA provisions and contingency reserves. However, the basis for determining the quantity of contingency reserves needed has since been revised.

can be addressed through day-ahead market awards. The day ahead market will set up a fleet of resources to meet day-ahead net load ramps.

A greater depth of economic bids allows the CAISO to shape day-ahead commitments and maximize the benefits to load. Specifically, a deeper pool of flexible resources that submit economic bids in in the day-ahead market and have sufficient ramping capabilities will improve the efficiency of CAISO dispatch and management of renewable resources. However, the CAISO relies on LSE resource procurement to address these ramps. This procurement should consider the trade-off between capacity costs, ramp speeds, and RPS obligations. Large quantities of slow or fixed output resources will likely result in renewable curtailment in the day-ahead time frame to ensure adequate capacity and ramping capabilities are available to CAISO to balance load and generation. Long-term, procurement of inflexible resources may put renewable energy goals at risk.

The CAISO's proposed flexible capacity framework is based on connecting forward procurement and market and operational needs into a single flexible RA product. The CAISO proposes to develop a flexible capacity product that will ensure it has sufficient flexible capacity to address uncertainty between the day-ahead and real-time markets. This product, including the requirements, flexible RA counting rules, and must-offer obligations will align directly with the Imbalance Reserve product. The CAISO's day-ahead market will provide commitments to address forecastable ramps. Additionally, the CAISO defers to LSE procurement to ensure RPS/GHG goals are achieved. Therefore, the CAISO proposes to eliminate the existing three-hour net load ramping requirement and will not, at this time, pursue flexible RA capacity to address predictable ramping needs.[39]

The remainder of this section describes CAISO's proposed flexible capacity product. With the continued increase in VERs and behind-the-meter solar photovoltaic systems, both load and generation output will continue to create greater uncertainty between the day-ahead and real-time markets. Under the current CAISO market rules, no additional long-start resources are committed after the day-ahead market closes and RUC awards are made. All remaining uncertainty, including both load following and forecast error, must be addressed by resources previously committed in the day-ahead market or by faster starting resources available for commitment in the real-time market.

The CAISO's first full market run is its day-ahead market. This market currently runs with hourly granularity using a forecast between 14 to 36 hours ahead of actual operations. To date, the CAISO has managed most resource commitments through the day-ahead market process. CAISO does not expect this to change. However, once the CAISO produces a day-ahead dispatch solution it must rely on real-time market dispatches to account for unpredictable ramps caused by uncertainty. Given the large time gap between the day-ahead market run and the 15 minute market, there can be significant differences between the two market iterations resulting from forecast error and time granularity. This is particularly true during sunrise and sunset.

[39] CAISO will continue to assess the market and operational needs to determine if large and/or steep net load ramps begin to create reliability concerns that require forward procurement.

As already noted in this proposal, to ensure the CAISO has adequate capacity available to the real-time markets to address uncertainty between the day-ahead and real-time markets, the CAISO is developing an Imbalance Reserve product in the Day-Ahead Market Enhancements initiative. The Imbalance Reserve product will ensure both upward and downward capacity is available to the real-time markets to address differences between the day-ahead and real-time markets caused by time granularity differences and forecast error. Additional details about the Day-Ahead Market Enhancements and the Imbalance Reserve product can be found at CAISO's webpage.[40]

The CAISO proposes to develop flexible resource adequacy capacity requirements to align with the proposed imbalance reserves to address uncertainty needs between the day-ahead and fifteen minute markets.

5.2.2. Identifying Flexible RA Requirements

The current flexible RA capacity requirements are divided into three categories, differentiated primarily by resource eligibility and the must-offer obligation for each category. Generally, eligible resources can provide flexible capacity for the amount of capacity it can produce over three hours. However, this structure fails to adequately differentiate and value the capability to move more quickly over shorter time intervals. Given the flexible capacity needs identified above, the CAISO will develop new flexible capacity requirements that incorporate shorter interval ramping capabilities. The CAISO will sunset the existing flexible capacity products once these new requirements are developed and implemented.

To address the above flexible capacity needs, the CAISO proposes a single flexible capacity requirement equal to the historic forecasted net load error between IFM and FMM plus a growth factor to account for additional growth in uncertainty.

As with the existing flexible capacity requirement, any new flexible RA capacity requirements should meet basic criteria. These criteria include:

- Easily procurable bilaterally
- Each requirement is clearly defined and quantified
- Resources' ability to meet each requirement is known and quantified
- Mitigates regulatory risks for procuring LSEs

The existing flexible RA capacity requirement met these objectives. However, the CAISO will modify the existing flexible capacity product to simplify counting, eligibility rules, and the must offer obligations to the greatest extent possible.

5.2.3. Setting Flexible RA Requirements

The flexible RA product will be designed to address differences between the IFM and FMM caused by both time granularity differences (*i.e.* hourly day-ahead schedules to fifteen minute FMM schedules) and forecast error. The CAISO proposes to use three years of historic data to

[40] Available at http://www.caiso.com/informed/Pages/StakeholderProcesses/Day-AheadMarketEnhancements.aspx

determine both the maximum difference between the day-ahead and fifteen-minute market forecasts and the rate that difference is changing (*i.e.* how much it increase year over year). The CAISO will combine the identified needs from the calculated flexible RA needs with expected changes in load, wind, and solar (including behind the meter solar) as submitted by LSEs in the CAISO's annual flexible capacity needs assessment survey and CEC load forecast. The CAISO will then use those data points to extrapolate the need for the uncertainty requirement for the upcoming RA year. Once there is sufficient data available from the imbalance reserves market, the CAISO can reexamine this practice and consider establishing this need based on imbalance reserves procurements. The CAISO seeks stakeholder input on this approach to determining the requirements for uncertainty.

5.2.4. Establishing Flexible RA Counting Rules: Effective Flexible Capacity Values and Eligibility

To ensure each LSE can demonstrate it has procured sufficient flexible RA capacity to meet its share of a flexible capacity requirement, the CAISO, as it does today, will publish a list annually showing all resources' EFC values. Each eligible resource will receive an EFC value for each month. The remainder of this section details the eligibility and counting rules meeting CAISO's proposed flexible RA for meeting the requirement. The CAISO notes that the eligibility and counting rules look to remain technology agnostic. The goal is to ensure any resource contributing to a given flexible capacity requirement, regardless of technology, provides comparable attributes to any other resource providing that same service.

Under the existing flexible capacity eligibility rule, section 40.10.3.2 of CAISO tariff, resources are required to meet various criteria to be eligible to provide flexible capacity. Many of these criteria are proving to be extremely difficult to validate. The CAISO is looking to simplify the eligibility criteria. At this time, CAISO is proposing a very basic set of eligibility criteria.

Eligibility criteria

Currently, flexible RA capacity can only come from resources internal to the CAISO BAA. Import resources are not eligible to provide flexible capacity. However, the CAISO has found that import capacity is capable of providing significant ramping capabilities. Therefore, the CAISO will allow imports to provide flexible RA capacity.

For any resource to be eligible to provide flexible RA the resource must meet all of the following criteria:

- Either be a non-use limited resource or a use-limited resource with a use limitation CAISO can model in its energy market or through an opportunity cost adder
- Not be a Conditionally Available Resource
- Be dispatchable in at least 15 minute increments (including imports)
- Not be a regulation energy management resource[41]

[41] As noted above, flexible capacity needs are defined by energy needs and the overlap with operating reserves. Regulation needs are not currently considered as part of the flexible RA capacity needs

The CAISO seeks stakeholder input regarding what additional eligibility criteria should be included.

Import resources may not be tied to a specific resources like internal flexible RA capacity.[42] As noted above, the CAISO will continue to allow non-resource specific imports to provide RA, but has provided additional clarity about the requirements for doing so. Further, any LSE using an import resource for flexible capacity must demonstrate it has sufficient MIC capacity to provide flexible RA capacity from an external resource. The MIC capacity is how LSEs demonstrate that the resource's output, and therefore flexibility, is deliverable to the CAISO. Although the MIC ensures the flexible capacity is deliverable, the CAISO must still ensure the flexible capacity is credited to the CAISO balancing area authority for purposes of the EIM sufficiency tests. Therefore, the resource must identify its BAA of origin and the interconnection point with CAISO system. The CAISO will then change all EIM sufficiency tests to credit CAISO with any flexible RA capacity from resources based in an EIM BAA shown as flexible RA capacity and remove the resources from any EIM entity's sufficiency tests.

Although these eligibility criteria provide much cleaner eligibility criteria than the existing flexible capacity eligibility criteria, they also leave two primary issues unresolved. The first is how the eligibility criteria account for energy limitations. At some level, the EFC counting rules ensure the resource is capable of producing energy for a given time period. However, these eligibility criteria do not address other concerns such as the resource's ability to have available energy when needed.[43] Similarly, there are no requirements for starts or ramping frequency. For example, the current Base Ramping flexible RA capacity product requires two starts or two ramps per day. The CAISO is not proposing minimum start or ramp requirements herein, but this issue requires further discussion.

The CAISO recognizes that with these two unresolved issues there is a risk resources can receive commitments that change from day-ahead to real-time, potentially rendering the resource unable to meet its day-ahead commitment. This can occur for resources with one start per day receiving a day-ahead award for an evening start and then being committed in the morning of the operating day. A similar scenario can exist for storage resources that are unable to recharge during the day. The CAISO is seeking stakeholder input about how, or if, flexible RA capacity eligibility criteria should address these concerns. Additionally, the CAISO seeks stakeholder feedback regarding the proposed eligibility rules and any additional criteria that should be considered.

EFC Counting Rules

The EFC for all resources will be assessed over a 15 minute interval. EFC values will only be calculated for resources that are eligible to meet the given requirement(s). The current EFC counting methodology includes an accounting for Pmin and a weighted average ramp rate for

[42] However, dynamic and pseudo-tied resources are connected to specific resources. Their counting rules will be the same as internal resources.
[43] The specific treatment of energy limitations is also being considered as part of the Day-Ahead Market Enhancements initiative.

the resource. The CAISO will no longer consider those elements. Instead, the CAISO will calculate the EFC using the largest range a resource can move over 15-minute interval capped at the resource's UCAP.[44] There is no planning reserve margin flexible RA. Capping EFC at UCAP provides the same forced outage benefits for flexible RA that UCAP offers for system RA. Exceptions to this rule are discussed below. This calculation will not include a minimum start time for Pmin to count towards the EFC. However, the Pmin of the resource cannot be split. This means that the Pmin for a resource is either completely included or excluded from a resource's EFC. The CAISO will calculate resources from warm start, and will consider the full range of the resource from its lowest operating limit to max output.

Imports do not have the same defined ramp rates or minimum operating levels as internal resources. Imports have no Pmin and high ramp rates in Masterfile. Given these parameters, the CAISO is unable to calculate an EFC for imports in the same way it does for internal resources. However, this simply means that the LSEs and resource owners must determine how much flexible capacity they wish to procure from imports. The CAISO will allow imports to provide EFC up to the UCAP of the resource.

At this time, the CAISO proposes to use the above counting rule for all technologies, with two exceptions: Solar and non-generator resources (NGR). Solar resources' NQCs are based on their ELCC values and may not reflect the resources' availability during all hours of the day. Additionally, they are limited in their ability to provide imbalance reserves outside of sun-up hours. As such, the CAISO in considering a couple options for solar resources including:

1. Limits on the amount of flexible RA that can be shown from solar resource
2. Creating a separate flexible RA product that would have a more limited availability

As such, the CAISO is not proposing an EFC counting rule solar at this time. Instead, the CAISO seeks stakeholder feedback on which of these options is preferred and how the CAISO should calculate EFC for solar given the preferred solution.

Consistent with current practices, the CAISO recognizes that NGR resources can help balance net load ramps by lifting the net-load in some intervals by charging and providing generation output during other intervals. Therefore, the CAISO proposes to count NGR resources' EFC based on the resource's ability to provide generation (positive and negative) over a fifteen minute period. This allows NGR resources to potentially receive EFC values that include their full charge and discharge ranges.

5.2.5. Flexible RA Allocations, Showings, and Sufficiency Tests

Each LSE must demonstrate it can meet its proportionate share of the requirement. The CAISO will provide each LRA its jurisdictional LSEs' contribution to the flexible capacity requirement. Each LRA can then determine its own allocation of the requirement to its LSEs. If the LRA does

[44] CAISO is currently exploring EFC deliverability studies as part of its transmission planning process. CAISO will also use this process to inform the current process in determining if resources can be EFC only resources (i.e. not require to have an NQC to receive an EFC).

not provide the CAISO with an allocation, then the CAISO will allocate to each LSE based on the CAISO's allocation methodology.[45]

The CAISO proposes to allocate the flexible RA capacity requirements to LRAs based on each LRAs' proportional share of peak load, and MWs of wind and solar. This allocation reflects that these factors, although not the only drivers, are the major drivers of uncertainty. However, the CAISO seeks stakeholder input on this option as well as any other options that should be considered.

Each LSE will be required to meet 100 percent of its flexible capacity requirement in both the year ahead and month ahead RA showings. Showings should be submitted in terms of EFC values. As is done today, the CAISO will assess the showings the requirement independently of system and local RA showings.

Once the CAISO receives flexible RA capacity showings, it will do two things. First, it will notify all LSEs whether they have provided adequate flexible capacity and will notify any LSE that is at risk of potential backstop procurement cost allocation. Second, the CAISO will assess the requirement at a system level. If the CAISO has received enough flexible RA at system level, it will not undertake any additional action regarding flexible RA capacity.[46] If the CAISO finds a deficiency the flexible RA capacity requirement, it will assess individual showings and notify LSEs of the system deficiency. LSEs will be provided an opportunity to cure the deficiency. This cure period will align with the cure period for other RA requirements. Once the cure period closes, the CAISO will proceed with the remaining validation processes. These process are provided in greater detail in Section 5.3, below.

5.2.6. Flexible RA Must Offer Obligation Modifications

The current flexible RA capacity products have different must offer obligations based on the category of flexible capacity a resource provides. These different offer obligations have created a significant amount of confusion for market participants. Therefore, the CAISO is looking to simplify the must offer obligations for flexible capacity. As noted in Section 5.1, the CAISO is clarifying must offer obligations for system and local RA capacity. More specifically, system and local RA capacity must offer obligation will typically run through the day-ahead market only.[47] Real-time must offer obligations will be derived from day-ahead market awards, including imbalance reserves. Further, as noted in the same section, the CAISO has proposed to assess resource forced outage rates over a 16-hour window between 5:00 AM and 9:00 PM. Lastly, CAISO data shows the uncertainty tends to be higher during the same 16 hour window.

As a starting point, the CAISO proposes that any resource providing any flexible capacity must submit economic bids for energy, ancillary services, and imbalance reserves to the CAISO's markets from 5:00 AM to 9:00 PM for all shown flexible RA capacity. The CAISO is still

[45] The CAISO is not looking for LRAs to provide an allocation methodology, instead, the LRA should provide the CAISO with each of its jurisdictional LSE's allocation.
[46] The CAISO may also develop locational flexible capacity requirements as part of this or a future stakeholder initiative.
[47] Exceptions to this rule are detailed in section 5.1.4, above.

assessing the appropriate must offer obligation for wind and solar resources and seeks stakeholder input about how those obligations should be designed.

This bidding requirement is consistent with allowing solar resources to provide EFC greater than their NQC and differs from the current practice of allowing solar resources to bid a proportionate amount of their EFC to NQC value. NGR resources must submit economic bids to cover both the charge and discharge range of their shown EFC.

5.3. Local Resource Adequacy

In previous proposals, the CAISO developed proposals for Local Assessments with Availability Limited Resources and Meeting Local Needs with Slow Demand Response. These proposals have been separated out from this document and finalized in a separate Draft Final Proposal. The Draft Final Proposal on these items is available at: http://www.caiso.com/informed/Pages/StakeholderProcesses/ResourceAdequacyEnhancements.aspx**.**

In the revised straw proposal, the CAISO proposed to leave the existing local RA studies and counting rules largely intact. However, numerous stakeholders commented that the CAISO should develop a proposal for local RA that would align with the proposed system UCAP rules. Given this feedback, the CAISO herein examines the potential for utilizing UCAP for local RA.

In order to utilize UCAP for local RA, one of two things must be done:

1) Run existing studies and convert local capacity requirements into a UCAP equivalent value, or
2) Determine the local capacity requirements using resources UCAP values in the study process.

The CAISO explores both of these options in greater detail, below.

In the first option, the CAISO would run the local capacity studies exactly as is done today. At the end of the study, the CAISO would publish the local capacity requirements in terms of NQC. Then, the CAISO would convert those values into a UCAP equivalent. To make this conversion, the CAISO will use a UCAP conversion factor. For example, the CAISO would multiply the Local Capacity Requirements times the average UCAP for all resources located in a local area. This has two immediate implications. First, it assumes that the UCAP value of the resources procured is at least greater than or equal to this average value. This becomes particularly important if the forced outage rates differ widely across technology types. If resources are procured that fall below the average capacity conversion factor, then the CAISO may identify deficiencies in local areas and may need to procure backstop capacity. Second, it is not immediately clear how such conversions will work across local areas and sub-areas. The primary benefit of this approach is that it builds off of other CAISO efforts such as the Transmission Planning Process (TPP). For example, when approving new transmission capacity, the CAISO will still assess the needs using installed capacity, not UCAP. The disconnect between the LCR and TPP study processes would only occur after the initial study results are completed and the conversion factor is applied to the LCR results.

In the second option, the CAISO would conduct the local capacity studies using the UCAP values for all generating resources. This means the local capacity requirements will come back slightly higher than they are today as the result of testing lower capacity values in the local area. It is worth noting that the current study methodology assumes all resources except the contingencies tested are in service. As the data in section 5.1.1 shows, this is unlikely. The reality is that UCAP values are affected most heavily by outages for shorter periods of time, not by partial de-rates of 10 to 15% across the whole year. Which resources are forced out would impact the results of the LCR study. However, it is not possible to test every outage scenario. Therefore, testing all resources at some outage level may yield more realistic results than assuming all resources are available. Another benefit of this approach is that it does not rely on any assumptions about what resources are procured to meet the local requirement. The requirement is set and addressed using UCAP values.

The major downside is that this option diverges from the methodology applied in the TPP. The TPP is done using established methodologies based on Pmax or qualifying capacity values for dispatchable resources and assumes that all resources except the contingencies being tested are in service.[48] Transmission planning standards are not based on UCAP values. The TPP study process would not necessarily support upgrades to address local capacity requirement deficiencies if it relied on UCAP values. The TPP is done using established methodologies based on installed capacity values. UCAP values are not readily convertible or meaningful in the TPP study process. Therefore, under this approach, the CAISO would be required to conduct the two studies under different assumptions. Ultimately, option 2 will result in slightly higher values of capacity.

At this time, the CAISO has determined that it is possible to conduct local studies using either methodology. However, given the divergence from other planning processes, the CAISO prefers option 1 at this time. However, the CAISO seeks additional stakeholder input on their preferred approach. Finally, the CAISO notes that the adopted methodology will only apply to the LCR study process and would not apply to any other planning studies.

5.4. Backstop Capacity Procurement Provisions

In this initiative the CAISO is: (1) proposing new authority to make CPM designations, (2) flagging potential changes to the RMR performance mechanism if changes to RAAIM are considered, and (3) proposing a new tool to encourage load to procure resources up to full UCAP requirements and dis-incentivizing entities from leaning on other LSEs.

The CAISO proposes new CPM authority to procure resources in the following three scenarios: (1) system UCAP deficiencies through the RA process; (2) inability to serve load in the portfolio deficiency test; and (3) an identified need to procure local RA after an area or sub-area fails to

[48] This is how forced and planned outages are accounted for in the transmission planning reliability standards.

meet the energy sufficiency test. These three needs are extensions to the existing CPM authority and are closely aligned with proposals outlined in this paper.

This proposal includes a new tool called the UCAP deficiency tool, which incentivizes entities to show at or above their UCAP requirements and will dis-incentivize leaning between entities during the RA showings. This tool will penalize entities that show UCAP below requirements and allocate these payments to entities that show above requirements.

5.4.1. Capacity Procurement Mechanism Modifications

The CPM is the tool that the CAISO uses to backstop the RA program. Specifically, when there is insufficient capacity shown in the RA process to reliably operate the grid, the CAISO may make CPM designations to procure resources that have not been shown in the RA process so that enough capacity is available to reliably operate the system. RA is shown on a year-ahead and a month-ahead basis and CPM can be used to backstop in either timeframe or in a more granular timeframe. Resource owners with additional capacity can participate in the competitive solicitation process (CSP) for their bids to be considered when and if the CAISO makes a CPM designation. Generally, in any timeframe the CAISO makes a designation, all options for procurement are reviewed and the least cost option that meets the reliability need is selected. Additionally, when the CAISO makes any CPM designation, it posts information about the designation and supporting documentation outlining why the CAISO needs the resource.

Authority to make CPM designations for capacity currently includes the following designation types:

1. System annual/monthly deficiency – Addresses insufficient system RA capacity in year-ahead or month-ahead RA showings;
2. Local annual/monthly deficiency – Addresses insufficient local RA capacity in year-ahead or month-ahead RA showings for one specific entity making showings;
3. Local collective deficiency – Addresses insufficient local RA capacity in year-ahead RA showings to meet the reliability needs for one specific local area;
4. Cumulative flexible annual/monthly deficiency – Addresses insufficient flexible RA capacity in the year-ahead or month-ahead showings for system needs;
5. A “Significant Event” occurs on the grid;
6. CAISO “Exceptional Dispatches” non-RA capacity; or
7. Capacity is at risk of retirement that is needed for reliability in a future year.[49]

[49] In the RMR-CPM enhancements initiative, the CAISO proposed to remove the capability to use CPM for capacity at risk of retirement, and to effectively transfer that capability to RMR authority. FERC issued a deficiency letter on these the package of changes requested in the RMR-CPM enhancements initiative in July, which the CAISO responded to. However, the CAISO is still awaiting a decision a final decision from FERC on the changes requested.
http://www.caiso.com/Documents/Apr22-2019-TariffAmendment-RMR-CPMEnhancements-ER19-1641.pdf.

The CAISO proposes modifications to its existing CPM authority to procure additional capacity in the following scenarios: (1) system UCAP deficiencies through the RA process; (2) inability to serve load in the portfolio analysis test; and (3) an identified need to procure local RA after an area or sub-area fails to meet the energy sufficiency test.

The CAISO will seek additional CPM authority to procure capacity based on system UCAP deficiencies. The CAISO will not make these designations merely because some LSEs are deficient, but instead will only make such designations when there are overall system deficiencies based on all RA showings. To make these designations, the CAISO will compare all UCAP reflected in RA showings to the total requirements for UCAP, and may make additional designations based on that difference. This authority will be similar to the CAISO's existing authority to procure for system deficiencies, which are based on total shown NQC values. This new authority will be based on shown UCAP and will apply in the year-ahead and month-ahead timeframes. Similar to existing authority, CAISO will alert entities with shortfalls and provide those entities with a chance to cure any shortfall. CAISO backstop procurement will only occur after this cure period closes.

The CAISO is not seeking authority to procure additional backstop capacity merely because an individual entity shows less capacity than its requirement. CAISO procurement based on individual LSE shortfalls could result in CAISO procuring more capacity than was necessary if other LSEs procure more capacity than required. By procuring only for system UCAP shortfalls, The CAISO will ensure that it receives enough UCAP to reliably operate the grid but will not procure excessive amounts. This approach is consistent with other categories of CPM procurement authority, where the CAISO only procures if there is a cumulative deficiency. However, procurement in this manner could result in entities '*leaning*' on other entities that show capacity in excess of their individual UCAP requirement. Because of these incentives, the CAISO also proposes to implement a UCAP incentive mechanism, discussed further below.

Section 5.1.3, above, provides details about the portfolio analysis the CAISO will conduct to determine if the resources procured through the RA process will be sufficient to meet the energy needs for an entire month, in addition to the peak needs during that period. If the CAISO determines it is unable to meet energy needs while performing this analysis, it can designate additional capacity using the CPM tool, to pass the analysis. The CAISO will use this authority at the same time it undertakes month-ahead designations for other CPM backstop designations. If the CAISO identifies an issue through the portfolio analysis, it will continue to allow a period for entities to cure the deficiency, before the CAISO makes any backstop designation. The CAISO also proposes additional CPM authority to procure capacity when it identifies a need identified from the portfolio analysis.

Finally, the CAISO proposes additional backstop authority to assure that procured local resources can meet energy needs in each local area and sub-area during the upcoming year. If CAISO identifies any capacity and/or energy shortfall, it will provide a cure period for entities to clear any deficiencies before exercising backstop procurement authority.

EXAMPLE: UCAP Deficiency

The CAISO provides the following brief example to explain a scenario where it could make a potential CPM designation for deficient UCAP procured in the RA process, after the cure period.

Assume in this example there are three load serving entities, each with a requirement to show 100 MW of UCAP. The first entity shows 125 MW, or 25 MW above the requirement, while the second and third entities show 80 MW and 75 MW respectively, or 20 MW and 25 MW below requirements, respectively. In aggregate, at the system level the RA process procures 280 MW and does not meet the 300 MW requirement for UCAP. This indicates a 20 MW shortfall at the system level, for which CAISO could undertake backstop procurement. If CAISO procures backstop capacity, it will allocate costs for that backstop to the entities that were deficient, in this case entities 2 and 3, per the LSE's share of the overall deficiency. In this case, entity 2 will be assigned 44% (20/45) of the costs and entity 3 will be assigned 56% (25/45) of the costs to procure the additional capacity for this designation. The CAISO provides additional discussion, below, about how LSE 1's showing can result in incentive payments for its 25 MW of excess capacity.

Figure 18: UCAP Deficiency CPM Backstop

LSE	Req. (MW)	Shown (MW)	Shortage (MW)
1	100	125	
2	100	80	20
3	100	75	25
TOTAL	300	280	45

Cost Allocation
20/45
25/45

↓

BACKSTOP: 20 MW

CPM Designation Order

Today if the CAISO makes multiple CPM designations for any single planning horizon, it first allocates costs and credits to individual entities that are deficient, then to all applicable LSEs that are collectively deficient. The CAISO will maintain the similar paradigm with the new authority. Going forward, the CAISO will first allocate the costs to system UCAP deficiencies, then to traditional NQC system deficiencies, then to local individual deficiencies, then to local collective deficiencies, and finally to portfolio deficiencies. This order is illustrated in Figure 19 below. As with current practice, if the CAISO were to consider multiple designations in one timeframe, it would make designations that meet all of the necessary reliability needs at the least cost. This figure may be used to determine cost and credit allocation, if the CAISO makes multiple CPM designations using different CPM authority.

Figure 19: CPM Designation Order

- System UCAP deficiencies
- System NQC deficiencies
- Local individual deficiencies
- Local collective deficiencies
- Portfolio analysis deficiencies

5.4.2. Reliability Must-Run Modifications

This initiative is considering whether to make changes to or eliminate RAAIM. RAAIM currently is the primary tool used to ensure that RA resources are bidding into the market, but any changes to RAAIM would not necessarily preclude using the RAAIM tool as the performance mechanism for RMR resources in the future. The approved RMR-CPM enhancements initiative approved the RAAIM to be used for the performance mechanism for RMR resources.

5.4.3. UCAP Deficiency Tool

As noted above, the CAISO is not proposing new CPM authority to make a designation when a specific entity shows less UCAP than individual requirements as long as the system as a whole is adequate. However, the CAISO is proposing a new tool, called the UCAP deficiency tool, which will impose deficiency charges on entities with deficient UCAP showings. This tool would be designed to prevent entities from leaning and to incentivize entities to show above individual UCAP requirements.

The concept of the UCAP deficiency tool is to apply a charge to resources that show less than their UCAP requirement, and distribute those collected charges to resources showing above their requirements. Without this tool, a situation could exist where one or more entities could choose to not procure their full UCAP requirement because they suspect that showings at the system level system will be sufficient to meet aggregate requirements or that the ISO will not make a backstop designation and no additional costs will be allocated. This concept is known as *leaning*.

Ideally, these proposed rules for the UCAP deficiency tool would result in a streamlined and straightforward mechanism, where any entity that shows less than their requirements would be charged for the amount of capacity the entity is short. This proposal includes specifications that the deficiency price will be set at the CPM competitive solicitation soft offer cap, which is currently $6.31/kW-year. All revenue collected will be distributed to entities that show above their UCAP, in proportion to the total amount shown above requirements for all entities.

The examples below include several scenarios that step through the details for how the UCAP deficiency tool could work in practice.

EXAMPLES: UCAP Deficiency Tool, with no CAISO backstop

This set of examples presents three scenarios where CAISO would use the UCAP deficiency tool, but not make any CPM designation. The first scenario shows procurement above the UCAP requirements and therefore no CPM designation. In this example LSEs 1 and entity 2 show 10 MW and 15 MW above their 100 MW month-ahead requirements, respectively, and entity 3 shows 10 MW below its 100 MW requirement. Because there is no system shortfall for capacity, the CAISO will not make a CPM designation, but because the showing from LSE 3 is below the requirement, the UCAP deficiency will trigger, and LSE 3 is assessed a charge for 10 MW * $6.31/kW-month, or $63,100. This charge is then allocated to LSE 1 and LSE 2, where entity 1 receives 10/25 = 40% or $25,240 and entity 2 receives 15/25 = 60% or $37,860.

Figure 20: UCAP Deficiency Tool, no Backstop

LSE	Req. (MW)	Shown (MW)	Shortage (MW)	Penalty	Payment
1	100	110			$25,240
2	100	115			$37,860
3	100	90	10	$63,100	
TOTAL	300	315	10	$63,100	$63,100

The second scenario shows a system shortfall, but CAISO does not issue a CPM designation. In this example LSE 1 and LSE 2 show UCAP below their 100 MW requirements, at 10 MW and 15 MW respectively, and LSE 3 shows 5 MW above their 100 MW requirement. In this scenario the CAISO could potentially procure backstop capacity to cure the 20 MW system UCAP deficiency, but does not make such a designation. In this case, the two LSEs that are short are assessed a charge for the capacity matching the UCAP deficiency. Because LSE 1 is 10 MW short it is assessed a charge of $63,100 and LSE 2 is assessed a charge of $94,650. Because LSE 3 is the only entity showing above the requirements, all of the collected charges are allocated back to that LSE, in this case the total amount allocated is $157,750.

Figure 21: UCAP Deficiency Tool, with Aggregate Shortfall

LSE	Req. (MW)	Shown (MW)	Shortage (MW)	Penalty	Payment
1	100	90	10	$63,100	
2	100	85	15	$94,650	
3	100	105			$157,750
TOTAL	300	280	25	$157,750	$157,750

In the third example LSE 2 and LSE 3 both show below their 100 MW month-ahead requirements, and LSE 1 shows exactly at its 100 MW requirement. In this scenario the aggregate amount of UCAP shown is below the aggregate amount of UCAP required for the

UCAP requirements. In this case, CAISO could potentially procure backstop capacity to cure the system UCAP deficiency. Irrespective of any CPM designation, CAISO will not charge any market participants for the shortfall, as there is no entity to allocate those charges back to.

Figure 22: UCAP Deficiency Tool, no Award Recipients

LSE	Req. (MW)	Shown (MW)	Shortage (MW)	Penalty	Payment
1	100	100			
2	100	80	20		
3	100	95	5		
TOTAL	300	275	25	$0	$0

EXAMPLE: UCAP Deficiency Tool with CAISO backstop

In this example LSE 1 and LSE 2 both show below their 100 MW month-ahead requirements, and LSE 3 shows above the 100 MW requirement. In this scenario LSE 1 is again short 10 MW and LSE 2 is short 15 MW. Additionally, because LSE 3 only procures 5 MW above its requirement, there is a shortage between the aggregate amount of UCAP shown and the aggregate requirement. This shortfall triggers a CAISO CPM designation, for the 20 MW deficiency. CAISO then allocates 8 MW of the CPM procurement to LSE 1 and 12 MW to LSE 2. The shortfall persists even with the adjustment for the CPM allocation, and the shortfall equals 5 MW or exactly the capacity that that LSE 1 showed above its requirement. Therefore, the remaining shortfall, inclusive of the CPM allocation, is 2 MW for LSEs 1 and 3 MW for LSE 2, which is then subject to the UCAP deficiency tool penalty. Penalties assessed are for $12,620 for LSE 1 and $18,930 for LSE 2. The $31,550 of the collected revenues are then credited to LSE 3.

Figure 23: UCAP Deficiency Tool, with Backstop

LSE	Req. (MW)	Shown (MW)	Shortage (MW)	CPM Alloc (MW)	Adj Short (MW)	Penalty	Payment
1	100	90	10	8	2	$12,620	
2	100	85	15	12	3	$18,930	
3	100	105					$31,550
TOTAL	300	280	25	20	5	$31,550	$31,550

↓

BACKSTOP: 20 MW

6. Implementation Plan

The CAISO originally targeted 2021 implementation for this initiative, meaning application to the 2022 RA compliance year. The CAISO understands this is a challenging and comprehensive initiative. Given this, the CAISO is planning a phased implementation in three parts:

Phase 1 (2020 for RA year 2021):

- MIC Enhancements (New initiative)
- Slow demand response

Phase 2 (2021 for RA year 2022):

- RA Import provisions
- Planned outage process enhancements
- Local studies with availability limited resources
- Must offer obligations and bid insertion rules
- Flexible resource adequacy

Phase 3 (2022 for RA year 2023):

- Capacity counting rules and forced outage assessments
- Portfolio analysis to ensure system sufficiency

CAISO seeks stakeholder feedback on the proposed phases, including the order these policies must roll out and the feasibility of the proposed implementation schedule.

7. EIM Governing Body Role

For this initiative, CAISO plans to seek approval from CAISO Board only. This initiative falls outside the scope of the EIM Governing Body's advisory role because the initiative does not propose changes to either real-time market rules or rules that govern all CAISO markets. This initiative is focused on CAISO RA planning, procurement, and performance obligations. This process applies only to LSEs serving load in CAISO BAA and the resources procured to serve that load, and does not apply to LSEs outside CAISO balancing authority area. CAISO did not receive any initial feedback from stakeholders regarding the initial proposed EIM classification for this initiative. CAISO continues to seek stakeholder feedback on this proposed decisional classification for the initiative.

8. Next Steps

CAISO will discuss this second revised straw proposal with stakeholders during a stakeholder meeting on October 9, 2019. Stakeholders are asked to submit written comments by October 23, 2019 to initiativecomments@caiso.com. A comment template will be posted on the CAISO's initiative webpage here: http://www.caiso.com/informed/Pages/StakeholderProcesses/ResourceAdequacyEnhancements.aspx

9. Appendix

9.1. Review of Counting Rules in other ISOs and RTOs

NYISO

NYISO is responsible for managing its capacity market, which is known as the Installed Capacity Market. Each year, the New York State Reliability Council determines the annual Installed Reserve Margin necessary for the NYISO to sufficiently fulfil its Resource Adequacy criteria. The NYISO then determines the Minimum Installed Capacity Requirement (ICAP) for each LSE to meet their system and local needs which is the sum of the forecasted control area peak load in addition to the reserve margin plus 1. This ICAP value is adjusted for historic availability by multiplying the Minimum Installed Capacity Requirement times one minus a rolling monthly average Effective Forced Outage Rate of Demand (EFORd)[50] value which translates to the Minimum Unforced Capacity Requirement (UCAP) for each capacity zone.

PJM

The centralized capacity market PJM relies on is called the Reliability Pricing Model (RPM). The process for estimating the Installed Capacity requirement and the use of an auction to procure capacity is similar to NYISO's ICAP market. First a Loss of Load Expectation (LOLE) study is used to determine the Installed Reserve Margin (IRM) which sets the ICAP requirement expressed as a reserve percent (*e.g.*, 15%) based on historic peak load. The EFORd ratio is then applied to the ICAP obligation to establish the Forecast Pool Requirement (FRP) measured as an UCAP value (*i.e.*, FRP = (1 + IRM)*(1 – Pool Wide Average EFORd). The FRP multiplied by the forecasted peak load for the upcoming year is used as the target in the capacity auction and is PJM's UCAP obligation known as the Reliability Requirement. Lastly, portions of the UCAP requirement are allocated to several zones served by a single utility. PJM procures resources on behalf of the LSEs unless LSEs opt out of the RPM capacity market to instead self-supply using the Fixed Resource Requirement Alternative.

PJM also has a non-performance assessment. The non-performance assessment evaluates performance of resources during emergency conditions. Resources that fail to perform are subject to non-performance charge. Resources that over-perform may be eligible for over-performance credit. The resource's expected performance is compared to actual performance for each real-time settlement interval for which an Emergency Action has been declared by PJM. "Emergency Actions" mean any emergency action for locational or system-wide capacity shortages that either utilizes pre-emergency mandatory load management reductions or other emergency capacity, or initiates a more severe action. Performance is assessed for Emergency Actions.

[50] EFORd is a measure of the probability the resource will be on a forced outage and unable to serve load if needed.

MISO

MISO has a voluntary incremental central capacity market known as a Planning Resource Auction (PRA). It is the responsibility of LSEs to determine their forecasted coincident peak which MISO uses to establish the overall system Planning Reserve Margin (PRM). Each LSE is provided with a minimum ICAP responsibility and is given the choice to meet their PRM by participating in the PRA, or using bilateral contracts, similar to CAISO, which constitutes the majority of MISO's forward capacity procurement. However, there are several competitive retail zones within MISO's jurisdiction, accounting for roughly 10% of system load, that operate using the PRA process exclusively.

ISO-NE

ISO-NE uses a Forward Capacity Market which is a centralized market run every year to procure resources three years in advance for system and zonal needs. The Installed Capacity Requirement (ICR) is set based on a loss of load study accounting for the expected load forecasts and the projected installed resources necessary to meet the reliability standards. The ICR is converted to a Net Installed Capacity Requirement (NICR) which subtracts the Quebec Control Interconnection Credit. Unique to the other capacity markets, ISO-NE uses a purely financial obligation model where New England's system operator procures enough capacity and settles payments while it is LSEs that pay for their allocated share of resource needs. ISO-NE also does not consider forced outage rates, unlike the other centralized markets, when calculating a resource's qualifying capacity. Generators instead are incentivized through the use of performance payments to recognize the outages they anticipate and to only offer an ICAP quantity that they are likely to perform. The Pay-for-Performance (PFP) tool is a monthly capacity performance payment (credit or charge) based on system conditions and resource performance during scarcity condition. A scarcity condition is defined as any five-minute interval when the system cannot meet its reserve requirement. The performance payment is an exchange between suppliers (*i.e.*, money collected from those who underperform is used to pay those that over perform), similar to the CAISO's RAAIM.

Table 4: Survey of methodologies and factors determining capacity contribution for thermal, solar, wind, and hydro resources

Resource type	Attributes	NYISO	PJM	MISO	ISO-NE
Existing resources	**Capability verification test**	Capability period: summer (June 1 - Sept 15) and winter (November - April 15)	Seasonally: Summer (June - August) and winter (December - February)	Annual, 1 year prior to deliverability year	Seasonally: summer (June - September) and winter (October - May)
New or returning resources	**Capability**	DMNC is seasonal	ICAP is a summer net dependable capacity	Total Interconnection ICAP is seasonal	Seasonal claimed capacity
	Forced outage	Class average	Blend of class average and outage data	Class average	NA

Resource type	Attributes	NYISO	PJM	MISO	ISO-NE
Thermal	**Equation**	**UCAP = (DMNC) * (1 - AEFORd); UCAP = (DMNC) * (1 - AOF)**	**UCAP = (ICAP) * (1 - EFORd)**	**UCAP = (Total Interconnection ICAP) * (1 - XEFORd)**	Summer and winter Qualified Capacity
	Summary	Based on 5 year average of DMNC test data which is a generators proven ability to generate power. AEFORd factor is used if full GADS data is provided, otherwise an Average Outage Factor (AOF) from GADS average production data is used	Summer net dependable capacity	Total Interconnection ICAP is equal to the lesser of its GVTC or its Total Capacity Tested	Seasonal claimed capacity (SCC) calculated using the median value of five years of summer and winter data
Solar	**Equation**	**UCAP = (Nameplate Capacity) * (Production Factor)**	**UCAP = ICAP**	**UCAP = (Total Interconnection ICAP) * (1 - XEFORd)**	
	Summary	Uses a derating factor that averages one year of historical production during peak hours 14:00 through 18:00 in summer (June, July, August) and 16:00 through 20:00 in winter (December, January, February) of the previous season (winter, summer)	The capacity rating of three years of historical operating data during hours 13:00 through 18:00 for months June, July and August or class average capacity factor	3 year historical average output during hours 15:00 through 17:00 EST in summer (June, July, and August) Note: New or returning PV sources need 30 consecutive days of historical data during summer months for hours 15:00 through 17:00 EST	Five year median net output from 14:00 through 18:00 for summer months June - September and 18:00 through 19:00 during the winter months October - May
Wind	**Equation**	**UCAP = (Production Factor) * (Nameplate Capacity)**	**UCAP = ICAP**	**UCAP = (Total Interconnection ICAP) * (Wind Capacity Credit)**	

Resource type	Attributes	NYISO	PJM	MISO	ISO-NE
	Summary	Uses a derating factor that averages one year of historical production during peak hours 14:00-18:00 in summer (June, July, August) and 16:00-20:00 in winter (December, January, February) of the previous season (winter, summer)	The capacity rating of three years of historical operating data during hours 13:00 through 18:00 for months June, July and August or class average capacity factor	Historical wind availability is used to calculate system-wide ELCC value across all CPNodes with an 80% confidence level. This value determines a Wind Capacity Credit for each wind farm based on a maximum capacity at the highest 8 coincident peaks during summer. Ten years of averaged data is used and all hours are considered.	Five year median net output from 14:00 through 18:00 for summer months June - September and 18:00 through 19:00 during the winter months October - May
Hydro	**Equation**	**UCAP = (Production Factor) * (Nameplate Capacity)**	**UCAP = ICAP**	**UCAP = (Total Interconnection ICAP) * (1 - XEFORd)**	
	Summary	Run-of-River uses a derating factor based on a rolling average of the hourly net energy during the 20 highest load hours for the previous 5 summer and winter capability periods	Hydro summer net capability is determined using tests taken annually during summer period (June-August) based on expected head and streamflow under summer conditions	3 to 15 year historical median hourly integrated net output during hours 15:00 through 17:00 EST in summer (June, July, and August)	Five year median net output from 14:00 through 18:00 for summer months June - September and 18:00 through 19:00 during the winter months October - May

9.2. RA Import Analysis

The CAISO provides the following analysis for NRS-RA imports that has been discussed in the RA imports section of the proposal. Figure 24 provides the Day Ahead bidding and awards for all 24 hours (on average). Figure 25 provides the HASP bidding and awards for all 24 hours (on average). Figure 26 provides SC awards and self-schedules as a percentage of RA showings for all 24 hours (on average).

Figure 24: Day Ahead bids, awards, self-schedules, and non-delivery – 24 hour average

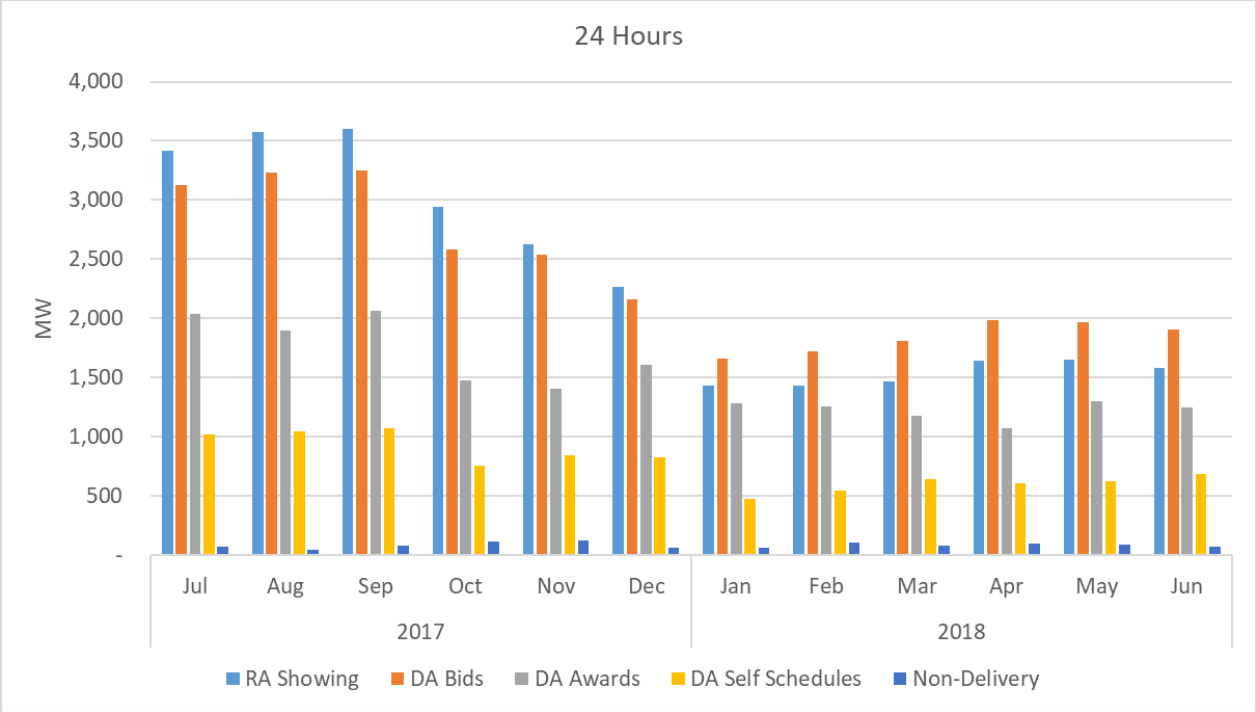


Figure 25: HASP bids, awards, self -schedules, and actual non-delivery – 24 hour average

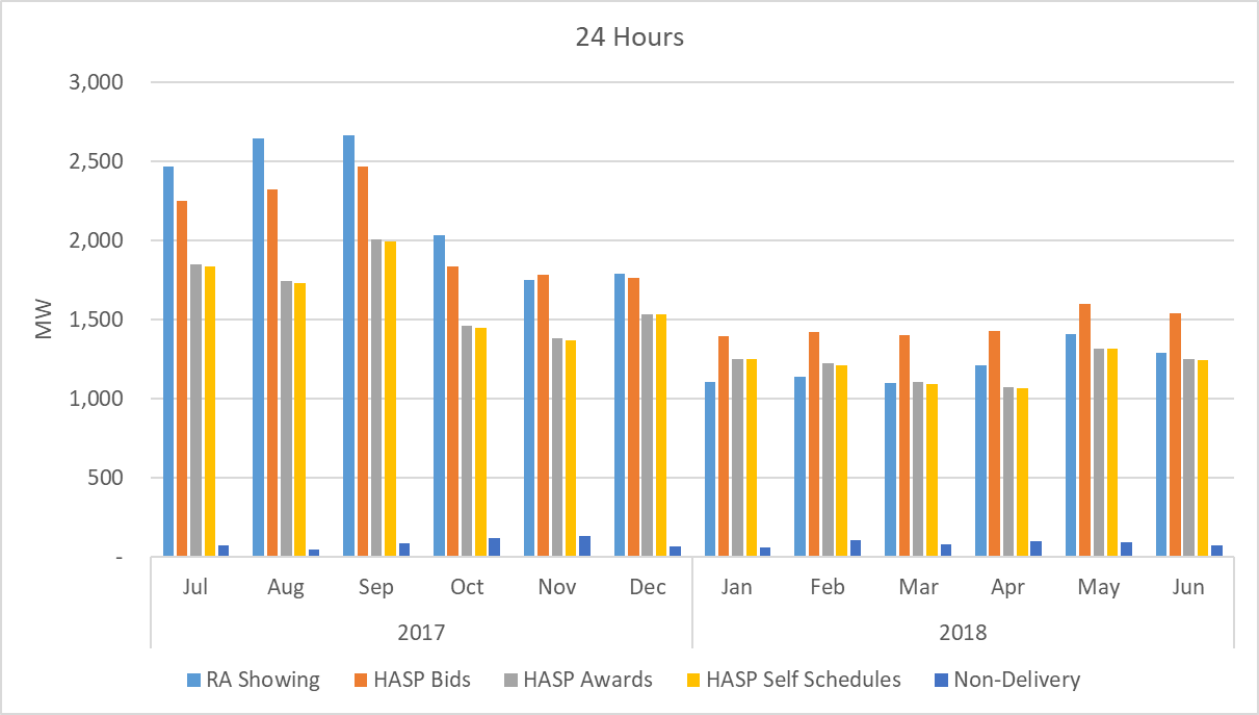


Figure 26: SC Awards and Self Scheduled as % of RA showings – 24 hour average

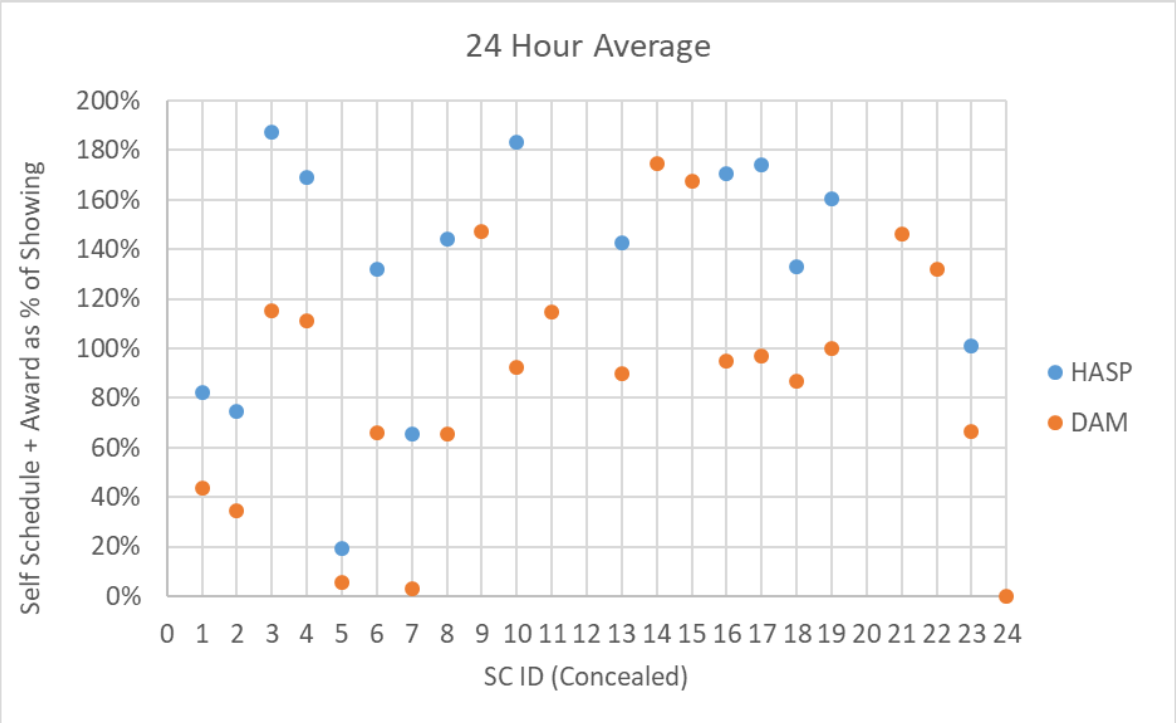


Table 5 provides NRS-RA import DA bids and awards data by SC for AAH hours (on average).
Table 6 provides NRS-RA import DA bids and awards data by SC for all 24 hours (on average).

Table 5: Day Ahead NRS-RA bids and awards by SC: July 2017 – June 2018 (average in AAH hours)

SC # (SCID concealed)	RA Showing MW	DA Bid MW	DA Award MW	DA Self Schedule MW
1	176.78	187.69	75.15	4.40
2	5.72	10.47	4.46	0.55
3	303.54	543.91	342.23	23.67
4	23.85	26.36	24.67	22.76
5	155.61	155.45	16.09	0.29
6	233.42	182.65	182.65	182.65
7	173.11	173.57	12.00	0.06
8	25.24	26.80	18.30	17.91
9	56.93	98.93	77.02	59.40
10	300.68	312.83	307.10	293.78
11	112.88	121.89	120.97	119.73
12	4.27	7.97	7.84	7.84
13	76.72	80.43	68.44	65.74
14	16.53	24.72	23.85	23.89
15	50.39	82.39	82.16	5.85
16	9.25	10.57	9.93	9.80
17	2.43	2.96	2.79	2.74
18	29.09	29.55	21.91	21.51
19	9.98	9.90	8.79	8.72
20	7.99	14.63	14.19	14.26
21	9.94	12.56	12.13	12.04
22	50.78	60.07	59.07	55.74
23	384.21	377.28	354.92	40.10
24	118.86	118.86	-	-
SC # (SCID concealed)	**Self Schedule + Award MW**	**Bid as % of Showing**	**Award as % of Showing**	**Self Schedule + Award as % of Showing**
1	79.55	106%	43%	45%
2	5.01	183%	78%	88%
3	365.90	179%	113%	121%
4	47.44	111%	103%	199%
5	16.37	100%	10%	11%
6	365.30	78%	78%	157%
7	12.06	100%	7%	7%
8	36.21	106%	73%	143%
9	136.43	174%	135%	240%
10	600.88	104%	102%	200%
11	240.70	108%	107%	213%
12	15.67	187%	183%	367%
13	134.18	105%	89%	175%
14	47.74	150%	144%	289%
15	88.01	164%	163%	175%
16	19.72	114%	107%	213%

17	5.53	122%	115%	228%
18	43.43	102%	75%	149%
19	17.51	99%	88%	175%
20	28.45	183%	178%	356%
21	24.16	126%	122%	243%
22	114.81	118%	116%	226%
23	395.02	98%	92%	103%
24	-	100%	0%	0%

Table 6: Day Ahead NRS-RA bids and awards by SC: July 2017 – June 2018 (24 hour average)

SC # (SCID concealed)	RA Showing MW	DA Bid MW	DA Award MW	DA Self Schedule MW
1	176.03	181.08	76.43	0.92
2	5.46	9.44	1.77	0.11
3	298.92	537.26	338.45	4.93
4	23.38	23.22	21.19	4.74
5	154.58	154.36	8.70	0.06
6	233.29	114.92	114.93	38.05
7	173.03	173.02	5.33	0.01
8	25.09	26.30	12.92	3.73
9	55.14	96.18	68.66	12.38
10	299.91	219.01	215.54	61.20
11	111.69	104.64	103.90	24.94
12	4.27	8.02	7.84	1.63
13	76.07	73.44	54.69	13.70
14	16.48	24.09	23.76	4.98
15	49.46	81.67	81.51	1.22
16	9.20	7.01	6.71	2.04
17	2.42	1.85	1.77	0.57
18	29.05	29.48	20.80	4.48
19	9.92	9.84	8.11	1.82
20	7.96	14.42	14.22	2.97
21	9.88	12.08	11.95	2.51
22	50.13	54.93	54.50	11.61
23	369.35	257.72	235.29	8.36
24	119.01	118.99	-	-
SC # (SCID concealed)	**Self Schedule + Award MW**	**Bid as % of Showing**	**Award as % of Showing**	**Self Schedule + Award as % of Showing**
1	77.35	103%	43%	44%
2	1.88	173%	32%	35%
3	343.38	180%	113%	115%
4	25.94	99%	91%	111%
5	8.76	100%	6%	6%
6	152.98	49%	49%	66%
7	5.35	100%	3%	3%
8	16.65	105%	52%	66%
9	81.04	174%	125%	147%
10	276.75	73%	72%	92%

11	128.84	94%	93%	115%
12	9.47	188%	183%	222%
13	68.39	97%	72%	90%
14	28.74	146%	144%	174%
15	82.73	165%	165%	167%
16	8.75	76%	73%	95%
17	2.34	76%	73%	97%
18	25.28	101%	72%	87%
19	9.93	99%	82%	100%
20	17.19	181%	179%	216%
21	14.45	122%	121%	146%
22	66.12	110%	109%	132%
23	243.64	70%	64%	66%
24	-	100%	0%	0%

Table 7 provides NRS-RA import HASP bids, awards, and non-delivery data by SC for AAH hours (on average). Table 8 provides NRS-RA import HASP bids, awards, and non-delivery data by SC for all 24 hours (on average).

Table 7: HASP NRS-RA bids, awards, and non-delivery by SC July 2017 – June 2018 (average in AAH hours)

SC # (SCID concealed)	RA Showing MW	HASP Bid MW	HASP Award MW	HASP Self Schedule MW	Self Schedule + Award MW
1	171.59	179.20	68.32	67.20	135.52
2	4.62	8.00	3.87	3.80	7.67
3	290.92	429.98	329.71	329.24	658.95
4	22.96	25.18	22.84	19.55	42.39
5	71.04	70.62	7.84	6.44	14.28
6	210.77	181.01	181.72	181.72	363.44
7	12.77	12.10	1.96	1.86	3.81
8	25.33	26.82	17.87	17.80	35.68
9	52.20	91.56	68.93	63.55	132.48
10	298.06	303.98	304.59	304.82	609.41
11	112.86	121.23	120.45	120.47	240.92
12	4.27	7.83	7.83	7.83	15.66
13	76.41	79.84	67.37	66.79	134.17
14	15.40	24.07	24.07	24.07	48.13
15	46.23	75.92	76.12	75.94	152.06
16	8.40	9.64	9.66	9.66	19.31
17	2.20	2.71	2.72	2.72	5.43
18	29.20	29.54	20.36	20.27	40.63
19	9.99	9.88	8.60	8.60	17.20
20	7.49	13.29	13.01	13.01	26.03
21	9.38	11.70	11.42	11.41	22.83
22	48.80	58.83	58.57	55.56	114.13
23	330.85	322.60	323.14	323.50	646.64

SC # (SCID concealed)	Bid as % of Showing	Award as % of Showing	Self Schedule + Award as % of Showing	Non-Delivery MW	Non-Delivery as % of Awards
1	104%	40%	79%	0.62	1%
2	173%	84%	166%	0.09	2%
3	148%	113%	227%	6.24	2%
4	110%	99%	185%	0.05	0%
5	99%	11%	20%	0.13	2%
6	86%	86%	172%	0.67	0%
7	95%	15%	30%	0.11	5%
8	106%	71%	141%	0.09	1%
9	175%	132%	254%	0.12	0%
10	102%	102%	204%	3.77	1%
11	107%	107%	213%	0.29	0%
12	183%	183%	366%	0.03	0%
13	104%	88%	176%	0.34	1%
14	156%	156%	313%	0.08	0%
15	164%	165%	329%	0.80	1%
16	115%	115%	230%	0.20	2%
17	123%	123%	246%	0.06	2%
18	101%	70%	139%	0.32	2%
19	99%	86%	172%	0.07	1%
20	177%	174%	348%	0.18	1%
21	125%	122%	243%	0.17	1%
22	121%	120%	234%	0.14	0%
23	98%	98%	195%	1.69	1%

Table 8: HASP NRS-RA bids, awards, and non-delivery by SC July 2017 – June 2018 (24 hour average)

SC # (SCID concealed)	RA Showing MW	HASP Bid MW	HASP Award MW	HASP Self Schedule MW	Self Schedule + Award MW
1	171.44	173.78	70.75	69.99	140.74
2	4.19	7.24	1.58	1.55	3.13
3	293.21	425.07	328.21	328.15	656.36
4	22.96	22.47	20.19	18.67	38.86
5	59.93	59.58	5.98	5.61	11.59
6	158.18	113.84	114.13	114.13	228.26
7	5.49	5.33	1.82	1.79	3.60
8	25.33	26.57	12.82	12.80	25.62
9	51.61	91.62	64.06	60.11	124.17
10	233.69	213.62	214.08	214.15	428.22
11	111.90	104.90	104.63	104.64	209.27
12	4.10	7.81	7.84	7.84	15.68
13	76.42	73.54	54.60	54.31	108.91
14	15.36	24.00	24.03	24.03	48.05
15	46.23	76.25	76.39	76.26	152.66
16	7.72	6.56	6.58	6.58	13.16
17	1.99	1.73	1.74	1.74	3.47
18	29.17	29.52	19.42	19.40	38.82

19	9.99	9.87	8.00	8.00	16.01
20	7.44	13.12	13.04	13.04	26.09
21	9.29	11.43	11.34	11.34	22.67
22	45.48	55.00	54.90	53.81	108.71
23	330.91	217.86	218.36	218.48	436.84
SC # (SCID concealed)	**Bid as % of Showing**	**Award as % of Showing**	**Self Schedule + Award as % of Showing**	**Non-Delivery MW**	**Non-Delivery as % of Awards**
1	101%	41%	82%	0.34	0%
2	173%	38%	75%	0.04	3%
3	145%	112%	224%	4.86	1%
4	98%	88%	169%	0.03	0%
5	99%	10%	19%	0.12	2%
6	72%	72%	144%	0.50	0%
7	97%	33%	66%	0.04	2%
8	105%	51%	101%	0.03	0%
9	178%	124%	241%	0.06	0%
10	91%	92%	183%	1.68	1%
11	94%	94%	187%	0.17	0%
12	191%	191%	383%	0.01	0%
13	96%	71%	143%	0.22	0%
14	156%	156%	313%	0.02	0%
15	165%	165%	330%	0.67	1%
16	85%	85%	170%	0.07	1%
17	87%	87%	174%	0.02	1%
18	101%	67%	133%	0.30	2%
19	99%	80%	160%	0.07	1%
20	176%	175%	351%	0.20	2%
21	123%	122%	244%	0.13	1%
22	121%	121%	239%	0.17	0%
23	66%	66%	132%	0.78	0%

9.3. Operationalizing Storage Resources

The CAISO has a small amount of storage resources operating on the grid today, but that number is likely to grow rapidly during the next few years. Storage resources are different than other resources, in that they have to be charged by the market in order to have energy available for discharge. The real-time market may not allow enough lead time to recognize the dispatch needs for storage resources and to dispatch the storage resources sufficiently to meet those needs. Being unable to charge a storage resource for anticipated future needs could create reliability concerns for grid operation. Additionally, the current day-ahead and real-time market constructs potentially allow for significant financial harm to storage resource owners.

Operationalizing Storage

Storage has been cited as a component of the long-term solution to meet California goals to reduce and eventually eliminate greenhouse gas emissions. These resources are also often discussed as a part of near-term solutions for current grid conditions as well. Storage has been

included in discussions and statements from both the CAISO and CPUC processes regarding replacement capacity for existing resources in the gas fleet planning retirement, resolving local issues, and addressing potential near-term RA shortfalls in upcoming years.

Today there is relatively little storage, about 150 MW (excluding pumped hydro), of grid connected storage resources installed on the system. This does not include behind the meter storage resources, such as resources installed in households or businesses. However, there are several thousand MW of storage generation in the CAISO interconnection queue, which could potentially be developed and deployed on the system within the next few years. When new storage generation is installed on the system the CAISO will need tools to effectively manage these resources. Specifically, the CAISO must be able to use these resources' flexible capability and their ability to charge during non-peak hours when there is more generation (generally during peak solar hours) and then discharge during peak net load periods of the day when system needs are greatest.

The CAISO uses market price signals to determine when all resources on the grid should be dispatched or not. The premise is that the least expensive resources are dispatched first and more expensive resources are only dispatched in least cost order if they are needed. The CAISO has the local market power mitigation tool, which can be used to compel resources to generate, based on CAISO residual supply index tests and estimates of what the marginal cost is for the resource to operate. The CAISO's day-ahead market matches demand with least cost supply for each of the 24 hours in the day in one cost minimization problem. This problem includes the costs and operating characteristics for the entire fleet of resources available to the CAISO, including storage resources. Generally this could include charging storage resources during the lowest priced hours of the day and discharging them during the highest priced hours of the day. This market also has the latitude to start additional resources at different points in the day, again preserving the concept of cost minimization, in order to make sure that the system has enough generation online to meet local, peak, and ramping needs across the entire footprint.

The real-time market optimization is different. If conditions are forecast to be particularly tight, resources may be committed in the short-term unit commitment process (STUC) up to 4 hours in advance. Further, the CAISO only looks at expected market conditions up to 105 minutes in advance to send binding dispatch instructions to specific resources in the 15-minute market. This implies that if a storage resource is essential to meeting system energy needs, that resource may only start receiving dispatch instructions to charge 105 minutes prior to when the resource is needed. All storage resources currently in the market are able to charge and discharge at the same speed, so if the state of charge for the resource was 0% it would be able to charge for, at most, 90 minutes before being required to dispatch in the subsequent interval when the CAISO needs for the resource. This charge would allow for only 90 minutes of discharge. If the actual need for the resource is 4 hours in duration, or potentially more, the resource would have insufficient lead time to sufficiently charge to meet those needs.

This could be exacerbated if system conditions are already tight, leaving little additional energy or capacity available to charge the storage resources. An extreme scenario is illustrated in the example below.

Example

Assume a system has only 2 resources: a 300 MW gas resource and a 50 MW storage resource with 200 MWh of storage capability. Dispatch instructions for generation and storage charging are awarded in the day-ahead market to meet system needs over the course of the entire day. The real-time market dispatches resources based on prices, bids, and system needs up to only 105 minutes into the future.

In this simple example, assume that system needs are very tight in the evening and that the system actually requires the full power available for dispatch of the resource (50 MW PMax) and also requires all of the energy available that the resource could provide at full charge (200 MWh). In the day-ahead, market the resource is scheduled to charge during the morning hours, hours 9-12, and discharge as needed in the five hour window from hours 18 to 22.

The hypothetical storage resource bids into the day-ahead market to charge at any price lower than $30/MWh and to discharge at any price higher than $60/MWh. Because the day-ahead market performs a cost minimization, and the resources available are sufficient to avoid a power balance constraint violation, the market chooses to optimally charge the storage resource fully when prices and loads are lowest, at $50/MWh, then to discharge the resource fully between when the system loads and prices are the highest, at $100/MWh. The day-ahead optimization realizes that although the storage resource bids only to charge when prices are lower than $30/MWh, it is actually optimal to charge when prices are $50/MWh because they will be higher later in the day, and the price spread captured by the resource will be greater than the $30/MWh bid into the market.

In the real-time market, like the day-ahead market, the resource initially starts the day at 0% state of charge. The resource also updates bids in the real-time market to match the prices that energy was awarded at in the real-time market.[51] The real-time market does not look forward across all 24 hours as does the day-ahead market, and generally compares prices bid into the market with current real-time prices. During the hours 9 through 11, the resource bids to charge at $50/MWh and actual real-time market prices are $60/MWh. Because prices are higher than the charging bids, the resource does not charge and receives real-time dispatch instructions for 0 MW of output. Market bids, prices and dispatch persists through hour 16. In hour 17, the real-time market begins to include expected needs for hour 18 when dispatching resources. At this time, the market determines that the storage resource will be needed to discharge in hour 18. Unfortunately, at this time, there is no additional generation that can be scheduled to allow the market to charge the storage resource for use in later hours because the system requires the maximum amount of output from the gas resources just to meet load.

[51] These results hold even for resources that bid the same values in both the day-ahead and real-time markets.

Table 9: Example Storage Bids and Schedule

Hour	9	10	11	12	…	17	18	19	20	21	22	23	24
Load	190 MW	190	190	200	…	300	330	335	345	350	340	280	210
DA Bid ↓	$30/MWh	$30	$30	$30		$30	$30	$30	$30	$30	$30	$30	$30
DA Bid ↑	$60/MWh	$60	$60	$60		$60	$60	$60	$60	$60	$60	$60	$60
DA Price	$50/MWh	$50	$50	$50		$60	$100	$100	$100	$100	$100	$80	$70
DA Sched	-50 MW	-50	-50	-50		0	30	35	45	50	40	0	0
DA SOC	50 MWh	100	150	200		200	170	135	90	40	0	0	0
RT Bid ↓	$50/MWh	$50	$50	$50		$50	$50	$50	$50	$50	$50	$50	$50
RT Bid ↑	$100/MWh	$100	$100	$100		$100	$100	$100	$100	$100	$100	$100	$100
RT Price	$60/MWh	$60	$60	$60			$1,000						
RT Sched	0 MW	0	0	0	0								
RT SOC	0 MWh	0	0	0	0								

This scenario also has significant financial repercussions for both the storage resource owner and for grid reliability. The storage resource makes money in the real-time market in the morning because actual prices are higher than day-ahead prices and the resource is able to buy back the real-time schedule to charge at higher prices than originally paid in the day-ahead market. However, these revenues may be very small compared to potential losses that could accrue in the evening because of scarcity prices. The resource owner will be required to buy all of the energy scheduled in the day-ahead market at these scarcity prices because the resource was never charged and therefore is incapable of providing energy to the system.

CAISO Market Implications

Although the example discussed above is stylized, similar outcomes can occur on the CAISO system today. Further, these outcomes could occur without prices or bids changing from day-ahead to real-time markets.

Similar to the actual CAISO markets, in the example above there is nothing that guarantees schedules in the real-time market match those in the day-ahead market. In fact, the real-time market is set up specifically to be agnostic about day-ahead schedules. This allows real-time schedules to generally be based on market bids, where resources bidding in at lower values are dispatched first and resources bidding in higher values are only dispatched when needed. This allows for revenues to only increase, for traditional generators, if bids are unchanged between the day-ahead and real-time markets.[52]

The current CAISO day-ahead and real-time markets do not function in this manner for storage resources. Storage resources bid in a dollar amount to charge and a different, generally greater, bid to discharge. If the day-ahead market finds such a time that the resource will

[52] When bids are unchanged for traditional generation from the day-ahead market to the real-time market, they generally earn more revenue in the real-time market compared to the day-ahead market. For example, if real-time prices are higher than day-ahead prices this increases the real-time schedule and revenue. When prices are less in the real-time market this will decreases real-time schedules relative to day-ahead schedules and again increases total revenues, and allows resources to buy back energy at lower day-ahead prices.

achieve the 'spread' indicated by the bids, it will schedule the batteries to charge and discharge. For example, if a resource bid to charge at $0/MWh and discharge at $30/MWh, the ISO would schedule the resource to charge if day-ahead prices were $50/MWh during the lowest net-load periods and $90/MWh at the peak periods. Overall costs in the day-ahead market would be minimized, and the resource would receive revenue in excess of implied costs, which are represented by the spread between the charge and discharge portions of the bid curve.

The real-time market may also make similar tradeoffs if there are differences in prices between current binding intervals and prices in expected future advisory intervals. However, the real-time 5-minute market only considers market conditions up to 12 intervals in the future, or about one hour in advance of the current time. On most days, the lowest point on the net load curve is more than 8 hours prior to the peak net load. A storage resource bidding at $0/MWh to charge would not be dispatched to charge in the real-time market, unless real-time prices were actually below that level. The real-time market would only select a storage resource to charge 'uneconomically,' or at prices above $0/MWh, after it detected prices in an advisory future period greater than the current binding price plus the price spread. This could occur from forecasting very high prices and system tightness in future periods, with prices potentially set by the penalty price for the power balance constraint if supply is not available to meet demand.

Discussion

The CAISO has considered numerous options to address the above scenarios, including (1) all storage resources shown for system and local resource adequacy be required to bid economically into the day-ahead market, and (2) a storage resource's day-ahead schedule is fully self-scheduled into the real-time market to ensure the resource is charged and available to meet energy needs in the real-time market. If the CAISO elects to take this path, then these resources would be ineligible to bid any additional flexibility into real-time markets.

The CAISO recognizes that requiring that storage resources self-schedule into the real-time market at their day-ahead schedules is not without potential challenges. Storage resources generally can quickly shift from charging to discharging and are capable of ramping very quickly. However, requiring a storage resource to self-schedule in the real-time market can also cause these resources to miss out on potential opportunities to earn additional revenues from discharging energy during very high priced period when system conditions are tightest, or from charging when system prices are lowest and there is excess supply available in the real-time market. These conditions often occur during hours that the system has the highest ramping needs.

The CAISO is also assessing if there is a need to bifurcate storage capacity into flexible resource adequacy resources or system/local resource adequacy resources, but not both. If this split is required, storage resources shown for flexible resource adequacy would only be permitted to bid into the day-ahead market for imbalance reserves and AS, but would be prohibited from providing energy bids. Storage resources shown for flexible resource adequacy can bid into the day-ahead market and clear for the imbalance reserve product. These resources will be able to manage their state-of charge through real-time bids, and the CAISO can use them in real-time similar to any other resources on the system. These resources will be

able to capture real-time price spikes and arbitrage these opportunities as they arise in the real-time market. Storage resources shown for system/local RA would be required to bid energy in the day-ahead market, but would be precluded from providing imbalance reserves. Further, system/local storage RA capacity must self-schedule day-ahead awards into the real-time market.

Storage resources that are not shown for resource adequacy will not have bidding obligations imposed on them. They may choose to arbitrage energy prices in the day-ahead market, offer imbalance reserves into the energy market, or to arbitrage short-duration price spikes in the real-time market. To the extent the resource can be managed in the real-time market, a storage resource could choose to participate in all three markets. These resources will be eligible to bid in the day-ahead market and receive associated market awards, and bid into the real-time market and receive dispatch instructions in the 15-minute and 5-minute markets. The real-time awards may be contrary to day-ahead market schedules, and may make certain state of charges, necessary to meet day-ahead awards for later hours, infeasible. This could result in financial risk for such resources, since they would still be financial bound to energy awards form the day-ahead market.

The CAISO also considered including using a field, similar to the end-of-hour state of charge parameter, to manage state of charge for storage resources with day-ahead schedules. The CAISO also considered potential changes to the real-time market to manage state of charge for storage resources. Expanding the real-time market to include a lengthier time horizon, which would likely need to be larger than 8 hours, to allow for sufficient time for storage resources to charge may be something that CAISO addresses in the future, but given current technology limitations is not something that can be considered today. The real-time model must arrive at a solution in a sufficiently short time to allow for the CAISO to deliver dispatch instructions to resources. Significantly extending the time horizon considered for dispatch may cause the market software to fail to complete a run in the limited window available to find a solution.

9.4. Hybrid Resources

CAISO provides this section of the appendix for hybrid resources to provide stakeholders with the latest proposed modifications for hybrid resources related to RA. Hybrid Resources are a combination of multiple generation technologies that are physically and electronically controlled by a single owner/operator and Scheduling Coordinator and behind a single point of interconnection ("POI") that participates in the CAISO markets as a single resource with a single market resource ID.

CAISO has observed that combined hybrid resource configurations submitting interconnection requests or modifying existing facilities to this configuration are growing in number. Due to the number of interconnection requests currently in the queue and strong interest expressed by various developers and stakeholders, CAISO anticipates that hybrid resources will grow in installed capacity in future years.

Hybrid resources raise new operational and forecasting challenges that CAISO plans to address prior to the wide scale adoption of these resource configurations are operational on CAISO's

system. CAISO believes that the RA rules for hybrid resources are an important issue that needs timely resolution.

9.4.1.Forecasting

Forecasting for hybrid resources (single resource ID)

The CAISO believes hybrid resource Scheduling Coordinators (SC) will need to provide their own forecasts to enable participation of these resources. Hybrid resources will be viewed by the CAISO as a dispatchable generator and will have market awards and dispatch targets based upon these self-provided forecasts. Hybrid resources will be required to follow dispatches similar to any other non-EIR generation resources. The CAISO is also proposing to apply these forecasts to market functions to ensure awards do not exceed the production capabilities of hybrid resources. This forecasting aspect of the hybrid resources straw proposal will apply to hybrid resources with a VER component.

The CAISO also notes that given this self-provided forecasting flexibility, the CAISO will monitor all hybrid resource forecasts for any strategic forecasting that attempts to inappropriately arbitrage price differences between the CAISO FMM and five minute market.

Forecasting for co-located projects with common POI (two or more resource ID configuration)

The CAISO believes that forecasting provisions for co-located resources with two or more Resource IDs do not need any modifications at this time. VERs co-located with other resources under two or more resource ID configurations will still receive the same forecast treatment under existing VER forecasting provisions.

However, the CAISO notes the potential for forecasting impacts of introducing an interconnection rights constraint for co-located resources is a possible issue that could require modifications. The CAISO is still evaluating how the proposed interconnection rights constraint for co-located projects may need to be considered or incorporated in the VER forecasting process. One potential outcome may be to introduce a requirement for the CAISO to incorporate these constraints and any related reductions in VER market awards or output as an input to the CAISO forecasting. This may be needed to allow the CAISO to adjust the VER forecasts for these co-located resources as appropriate. The CAISO has a similar forecasting methodology in place for VER resources when supplemental dispatch is present, and is exploring if co-located resources with constrained interconnection rights could use this process as well. The CAISO seeks stakeholder feedback on the need for this issue to be addressed in subsequent proposal iterations and any recommended approaches to mitigate potential inappropriate impacts to VER forecasts.

9.4.2.Hybrid Resources RA provisions

CAISO believes that resolving hybrid resource RA capacity counting rules is a high priority issue for a number of reasons. CAISO is concerned with ensuring that CPUC RA counting rules for hybrid resources provide accurate capacity valuations for resource adequacy purposes.

Additionally, the counting rules for these resources are important to determine because it will likely drive decisions by resource owners related to combined hybrid resources under a single resource ID or co-locate resources with multiple resource IDs. The following proposal aspects have been included the CAISO's hybrid resources straw proposal and are included here for reference.

Counting rules for hybrid resources (single resource ID)

Currently, there is not an established QC counting rule for hybrid resources under single resource ID configurations. The CAISO believes this is a gap that must be addressed to enable hybrid resources to participate as RA resources and offer RA capacity. Lack of a QC value for these hybrid resources will impact the ability for hybrid resources to provide RA capacity. This QC methodology issue could be addressed by LRA decisions to establish a QC counting methodology for hybrid resources.

The CAISO is committed to working closely with the CPUC and stakeholders to develop an appropriate QC methodology to address this issue at the LRA level through the CPUC's RA proceeding. The CAISO has been active and provided input related to hybrid resource counting approaches in the CPUC's RA proceeding. For CAISO's latest input regarding hybrid resource counting, see CAISO Track 3 Proposal Reply Comments in Rulemaking 17-09-020; (March 22, 2019).[53] The CPUC has also indicated that it will hold workshops on this issue and the CAISO intends to participate in the CPUC process as well.

In the absence of an LRA counting convention, the CAISO must develop QC values for hybrid resources under a single resource ID to apply in its tariff as a default provision. The CAISO tariff includes default QC counting criteria for most resource types in case an LRA does not establish a QC methodology on its own. The CAISO previously suggested applying an exceedance methodology to hybrid resources in its issue paper. Based on stakeholder feedback and additional CAISO assessments, the CAISO has determined that the previously suggested exceedance methodology can result in undervaluing the reliability contributions of hybrid resources. Therefore, the CAISO is not proposing to advance the suggestion of utilizing an exceedance methodology for the hybrid resource default QC methodology.

The CAISO proposes to adopt a default QC methodology that utilizes the existing CPUC methodology for each of the underlying resource components generation technology and combines each component's technology type based QC value in an additive manner. In other words, for the most common expected hybrid resource combination of solar plus storage, the CAISO proposes to utilize the existing QC methodologies for solar and storage components and add them together. These existing CPUC QC approaches are Effective Load Carrying Capability (ELCC) for solar and four-hour sustained output for storage. Therefore, under this example, the hybrid resource would have an overall QC that consists of the solar components ELCC QC value plus the storage component's QC value. The CAISO notes that NQC values for all resources are capped at their interconnection rights and are subject to deliverability study by CAISO as well.

[53] CAISO Rulemaking 17-09-020; Track 3 Proposal Reply Comments: http://www.caiso.com/Documents/Mar29-2019-ReplyComments-Track3Proposal-ELCCResourceAdequacyProgram-R17-09-020.pdf

Must Offer Obligations for hybrid resources

Must Offer Obligations (MOOs) are a critical aspect of RA. The offer obligations for co-located resources with two or more resource IDs are straightforward. Each resource ID would receive separate NQCs and could be shown for RA separately as well. This would result in separate and distinct MOOs for each resource ID that would reflect the resource's technology type and applicable QC and MOO. The CAISO notes that under these configurations with more than resource ID, there is no possibility for different resources to meet the offer obligations of other RA resources, each resource ID is viewed as a standalone RA resources if shown on RA showings. For additional background on applicable MOO provisions, see the CAISO Tariff Section 40 and the CAISO Reliability Requirements BPM.[54]

The offer obligations for hybrid resources (single resource ID configurations) is more complex. Since there is no existing MOO provisions for these resources, the CAISO intends to establish the MOO provisions through this initiative. The CAISO has proposed a default counting rule for the QC of hybrid resources above and a proposal to allow hybrid resources to self-provide forecasts that would be utilized by the CAISO markets to ensure feasible awards and dispatches. Along the same lines, the CAISO proposes to set the MOO for hybrid resources equal to their self-provided forecasts. This results in a variable MOO similar to the treatment for VER resources, so that the offer obligations reflect the variable nature of their output. This also requires they provide bids based upon their forecast output. The CAISO believes this approach aligns with the view that hybrid resources are somewhat similar to both variable resources and traditional generating units.

One outstanding question that the CAISO is still considering is how these resource's offer obligations should be established in either the Day Ahead and/or Real Time markets, or both. Initially, CAISO believes that hybrid resources providing RA should be required to participate in the Day Ahead market. Any hybrid resource MWs shown for RA would have Day Ahead offer obligations equal to their self-provided forecasts. The next issue the CAISO is still considering is how to treat the offer obligation for these hybrid resources shown for RA in the Real Time market. The CAISO also notes that it is currently contemplating Day Ahead market design enhancements and RA offer obligation modifications in other active stakeholder initiatives and plans to coordinate any proposed hybrid resource MOO proposals with those efforts to refine this proposal for future iterations. These other related proposals will assist in refining future proposals for the offer obligations for hybrid resources.

The CAISO understands that this proposal for a MOO for hybrid resources to be variable based upon the self-provided forecast may raise some concerns related to the potential for these hybrid resources to manipulate their forecasts to allow them to withhold capacity or allow a possibility for the exercise of market power. For hybrid resources without VER components (and no forecasting requirement) their RA offer obligation will be set at the shown RA MW value

[54] CAISO Tariff Section 40: https://www.caiso.com/Documents/Section40_ResourceAdequacyDemonstrationForAllSCsInTheCAISOBAA_asof_Nov1_2016.pdf. CAISO Reliability Requirements BPM: https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Reliability%20Requirements

for all hours similar to a traditional generator.[55] The CAISO believes that these hybrid resources will, by and large, consist of combinations including renewable VER generation components and energy storage components. The CAISO also anticipates that these VER-storage combo hybrids will be developed with an intended use case of maximizing renewable production (as described in the use case discussion included above) and therefore have an incentive to maximize their energy production. Therefore, the CAISO also believes that any concerns related to the potential for physical withholding or market power are minimal. The CAISO also noted in the proposal for allowing self-provided forecasts that the CAISO will monitor hybrid resource self-provided forecasts for any strategic forecasting that may be intended to inappropriately take advantage of the flexibility provided under these proposals.

[55] CAISO is still considering how these hybrid resources with no VER component and no forecasting requirements may need different modifications to their offer obligations relative to today's practice. For example, CAISO may need to develop new offer obligations that reflect bidding capability for resources with effectively no Pmin or with dynamic Pmin. CAISO seeks feedback on these and related issues.