California ISO

Hybrid Resources Straw Proposal

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1. Executive Summary

As the grid evolves, so have the interests in combining generation technologies such as co-locating solar or wind with energy storage to create more flexible resources to benefit the system. The CAISO is experiencing an increasing number of inquiries from developers interested in pairing energy storage with either existing or proposed generation (conventional or renewable). The CAISO anticipates that hybrid resources and co-located projects will begin to be adopted on a wide scale in the coming years.

This stakeholder initiative has been launched by the CAISO to identify potential new or enhanced market rules and business processes needed to accommodate the unique attributes of hybrid resources. The CAISO is striving to minimize barriers to the efficient and reliable operation and market participation of hybrid resources and co-located projects. These flexible and dynamic resources present both challenges and opportunities that the CAISO plans to address and leverage with input from stakeholders and developers.

The CAISO effort provides an approach for hybrid resources whereby the hybrid operator or scheduling coordinator internalizes the characteristics of the components behind the point of interconnection and offers energy and/or ancillary services at the POI in the same way as a conventional resource. This approach allows the hybrid resource owner to conduct their own onsite optimization of the underlying resource components and appear to the CAISO as a traditional generation resource. It also allows for use of existing market participation models and provides more flexibility and fewer constraints through coordinated use of energy storage, power electronics, and software technologies.

The CAISO has identified a number of possible modifications that will enable these resources to be integrated safely and efficiently. The CAISO's straw proposal includes proposals for modifications to forecasting, markets and systems, Ancillary Services, metering and telemetry, and Resource Adequacy.

The CAISO proposes to allow hybrid resources to self-provide production forecasts and modify its systems to utilize these hybrid resource production forecasts in the CAISO markets and operations. The CAISO proposes to extend existing market functionality for these production forecasts in a manner similar to the current treatment afforded variable energy resources. Through these changes, the CAISO markets will recognize a dynamic upper economic bid range (maximum production limit) for these hybrid resources to enable their participation while minimizing the possibility for infeasible market awards and dispatches.

The straw proposal also addresses the potential for stranded capacity on co-located projects at a common point of interconnection with two or more market resource IDs through the addition of a new interconnection rights constraint. This constraint will enable the CAISO to ensure the energy output of co-located resources will be maintained to within their established interconnection injection limits.

The CAISO has also included some proposed requirements for metering and telemetry needs to enable the safe and reliable provision of Ancillary Services by hybrid resources. The CAISO

also addresses the need for new Resource Adequacy provisions for hybrid resources through this initiative, including proposals for default Qualifying Capacity counting rules and Must Offer Obligations for hybrid resources.

2. Introduction

Interest in energy storage is significant and continues to grow as state and federal policy makers and regulators support energy storage development and its ability to potentially help decarbonize the grid.[1] In California, energy storage paired with wind and solar is viewed as a means to better optimize variable energy resources and creates a synergy to help the grid accommodate and integrate more renewable energy resources to reduce greenhouse gases. Developers have responded to this interest in energy storage as the CAISO is seeing a significant number of interconnection requests for projects that incorporate stand alone and hybrid energy storage resources.

The CAISO is committed to enhancing the participation of energy storage in its markets and is continually working with stakeholders to identify potential new or enhanced market rules and business processes needed to accommodate the unique attributes of energy storage. For instance, the CAISO has focused on energy storage issues in its on-going energy storage and distributed energy resources initiative for the past few years, and the CAISO has begun this hybrid resource initiative to further the use and usefulness of these unique resources.

As the grid evolves, so has developers' interests in energy storage and its use and operation. The CAISO is experiencing an increasing number of inquiries from generation developers interested in pairing energy storage with either existing or proposed generation (conventional or renewable). Such resources have been previously referred to as "hybrid" generation resources – however, through this stakeholder initiative, the CAISO intends to clarify the definition of hybrid resources. The CAISO believes it is necessary to specify that hybrid resources are any combination of multiple resource technologies combined into a single generating facility with a single point of interconnection and represented by a single market resource ID.

A related aspect of this definition clarification is to exclude co-located projects at a single point of interconnection with two or more market resource IDs from the definition of hybrid resources. The CAISO will continue to discuss these co-located projects at a single point of interconnection with two or more resource IDs through this initiative and any necessary proposals to integrate them and enable their market participation are still going to be included in the topics covered in the scope of this initiative. The CAISO believes it is necessary to make this important distinction and the reasons it is necessary are discussed in greater detail below.

Due to the number of interconnection requests currently in the interconnection queue or modification requests for existing generators, and the strong interest expressed by developers and stakeholders, the CAISO anticipates the installed capacity of hybrid resources will grow

[1] Eligible energy storage projects include generating units participating in the CAISO market as participating generators, dynamic schedules and participating pseudo-ties.

significantly in the coming years. Given this interest in hybrid energy storage resources and questions about how existing rules may apply, the CAISO developed a hybrid resources technical bulletin in 2016 to provide initial guidance on such issues.[2]

The CAISO has observed that the number of combined hybrid resource or co-located project configurations submitting interconnection requests is growing, comprising approximately 41% of the total capacity currently seeking interconnection.[3] Historically, approximately 7% of the MWs of interconnection projects make it to commercial operation, therefore, if historical trends continue, the CAISO expects approximately 2,500 MWs of these hybrid resources and/or co-located projects currently in the queue to achieve commercial operation. The CAISO notes that these numbers are estimates and actual development figures will vary as more projects enter and leave the queue and also due to procurement targets and other impacts.

The increasing interest in hybrid resources has surfaced additional technical questions about these resources. Hybrid resources also raise new operational and forecasting challenges that the CAISO intends to address prior to their wide scale adoption and operation on the CAISO system. This straw proposal includes the CAISO's initial proposals on items that have been identified as necessary to integrate hybrid and co-located resources. The following topics have been included discussed in the body of this issue paper: 1) Forecasting 2) Markets and Systems, 3) Ancillary Services, 4) Metering and Telemetry, and 5) Resource Adequacy.

[2] 2016 Hybrid Resources Technical Bulletin: https://www.caiso.com/Documents/TechnicalBulletin-ImplementationofHybridEnergyStorageGeneratingFacilities.pdf

[3] As of July 3, 2019, CAISO's Generator Interconnection Queue included 35,341 MWs of hybrid and/or co-located resources seeking interconnection with a total 85,643 MWs of requested capacity at point of interconnections. Therefore, hybrid resource and/or co-located interconnection requests comprise 41.2% of the total requested interconnection MWs currently in the CAISO Generator Interconnection Queue.

3. Stakeholder Engagement Plan

Table 1 presents the remaining schedule for this stakeholder initiative.

Table 1: Stakeholder Engagement Plan

Date	Milestone
September 30	Publish Straw Proposal
October 3	Stakeholder Meeting on Straw Proposal
October 17	Comments Due on Straw Proposal
December	Revised Straw Proposal
February	Second Revised Straw Proposal
April	Draft Final Proposal
TBD	Board of Governors Meeting

4. Hybrid Resource Definition

Initially, the CAISO proposed the following hybrid resource definition, included in the issue paper: "The CAISO refers to hybrid projects or hybrid resources as a combination of multiple technologies or fuel sources combined into a single resource with a single point of interconnection." This definition was intended to be broad enough to encompass any number of market resource ID configurations for these resources. However, because the prior proposed definition lead to some confusion, the CAISO feels it is necessary to further clarify the definition.

The CAISO proposes to clarify the definition of hybrid resources and believes it will be necessary to consider only multiple resource technologies combined into a single generating facility with a single point of interconnection and represented by a single market resource ID as the only true "hybrid resources". The CAISO proposes to specify this treatment through an updated definition as follows:

> "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."[4]

The CAISO also proposes to require that hybrid resources meet the minimum sizing requirements for at least one of the underlying generation components, either 500kw for a participating generator or 100kw for storage resources.[5]

The CAISO also believes it is necessary to differentiate co-located projects with two or more resource IDs as separate resources and exclude them from the definition of hybrid resources. This difference is needed because co-located resources with two or more resource IDs and a common POI are effectively two separate and distinct resources from the CAISO's viewpoint. They are treated as completely distinct resources for the purposes of market participation, resource adequacy, settlements, etc. One main exception to this rule being the coordination of dispatch and operations needed to limit output to the project's interconnection rights, which is included in an aspect of the proposal discussed below.

The CAISO understands that developers and project owners may view these co-located projects as a variation of hybrid resources and could believe that there is a need to coordinate their joint operations. However, the CAISO believes these projects should simply be considered co-located projects with a common POI. The only aspect of these co-located resources that will require coordination related to the CAISO markets and operations is the project's joint POI

[4] The CAISO recognizes that this definition may not be universal. For example, pairing a small amount of energy storage with a conventional generator where the storage would only be used to meet station power demand may not require any treatment unique to hybrid resources beyond how the resource is initially studied and modeled. The CAISO intends to explore whether there are any obvious exceptions to this general rule.

[5] CAISO Tariff Section 4.6.3.2 requires participating generators to be 500 kW or greater. Pursuant to Order No. 841, the CAISO has proposed to lower the minimum capacity requirement for storage resources to 100 kW, effective December 3, 2019.

injection rights' limits and any master file or systems items specifically related to the proposed co-located interconnection right constraint (described below in section 6.2). The CAISO seeks stakeholder feedback on the modified hybrid resource definition and the exclusion of co-located resources with a common POI from the modified definition.

5. Hybrid Resource Business Drivers and Use Cases

The following section outlines initial concepts related to the different business drivers and use cases that the CAISO believes will contribute and motivate the development of hybrid resources and co-located projects in the CAISO system. These descriptions are intended to begin a dialogue with stakeholders about the drivers and motivations behind hybrid resource development. This aspect of the proposal is also intended to help inform the various options that should be provided and any modifications that the CAISO may need to propose to best integrate these resources into the market. It will also provide guidance for resource developers to select the appropriate project design/configuration necessary to accomplish their commercial objectives. Equally important, it can help enable these resources to maximize their participation in the CAISO markets and minimize potential reliability risks associated with their integration.

The CAISO believes that there are a number of various business drivers and objectives, with several benefits and services that hybrid and co-located resources can provide. The CAISO anticipates that hybrid and co-located resources will be versatile in the provision of these different uses and services. However, the CAISO believes that there will be only a few primary use cases that produce the majority of the development and participation of these resources. The CAISO describes the business drivers and use cases for stakeholder consideration. The CAISO seeks stakeholder feedback to better understand these business drivers and use cases to help refine future proposals.

The CAISO has initially identified the following hybrid resource use cases and business drivers, recognizing some of these use cases will overlap:

- Enhancing renewable energy production
- Shifting energy production and price arbitrage
- Providing ancillary services
- Capturing Investment Tax Credit
- Improving resource characteristics
- Capturing resource adequacy value
- Leveraging DC coupling benefits
- Multiple-Use applications

The CAISO seeks feedback on any unidentified use cases or business drivers that stakeholders suggest for inclusion in subsequent proposal iterations.

Enhancing Renewable Energy Production

Renewable energy generation is inherently variable and resource's power output can change rapidly over short periods of time. For instance, solar output can vary greatly on partly cloudy

days. Wind generation output can also change rapidly during varying weather conditions. Energy storage can store energy during times of high renewable resource availability and discharge when renewable output is low to maximize or extend the availability of renewable energy on the grid. This reduces the risk of curtailment and reduces the need for other potentially less efficient or more costly resources to provide these services.

Renewable firming and smoothing is possible with the addition of energy storage. Renewable firming involves storage and renewable generation with the objective to use storage to fill in variations in production so that the combined output from renewable energy generation plus storage is more consistent and predictable. By using these technologies in combination, it is possible to smooth out short-duration variation in the production of renewables.

Renewable curtailment is sometimes seen in areas of high solar and other renewable penetration when there is overall excess production on the system. Energy storage can also help to enable production to continue with renewable energy being stored and available for discharge when curtailment needs end. Energy storage can help with this firming of renewable production to increase the amount of renewable energy that is delivered and reduce reliance on carbon-based technologies, reducing greenhouse gas emissions.

Shifting Energy Production and Price Arbitrage

Energy shifting and arbitrage is described as generating electricity at times when market prices are low and storing that energy for later release when market prices are high. Energy storage used in conjunction with renewable energy generation can be charged using low-cost energy from the renewable generation so that stored energy may be used to offset other purchases or sold when it is more valuable.

Providing Ancillary Services

Hybrid resources can provide ancillary services similar to traditional generation. Rather than needing to be online, spinning, and synchronized with the grid, hybrid resources, being inverter-based technologies, can be available to the grid almost immediately. Similarly, energy storage components simply need to be charged and available for dispatch.

Capturing Investment Tax Credit

Investments in renewable energy are more attractive due to the contribution federal tax incentives. The investment tax credit (ITC) for storage systems that are charged by a renewable energy system more than 75% of the time are eligible for the ITC. This ITC is currently 30% for systems charged by PV and declining to 10% from 2022 onward.[6]

[6] Storage charged by a renewable energy system 75%–99.9% of the time are eligible for that portion of the value of the ITC. For example, a system charged by renewable energy 80% of the time is eligible for the 30% ITC multiplied by 80%, which equals a 24% ITC instead of 30% (the tax credit is vested over 5 years, and recapture can apply in unvested years if the percentage of renewable energy charging declines). Storage resources that are charged by the renewable energy system 100% of the time on an annual basis can claim the full value of the ITC. See https://www.nrel.gov/docs/fy18osti/70384.pdf.

These tax incentive guidelines can drive the adoption of hybrid and co-located resources. Specifically, these considerations may impact developer decisions for the particular configuration of hybrid resources or co-located resources, and the number of resource IDs selected.

Improving Resource Performance Characteristics

In the case of load following or spinning reserves, traditional generators may be required to operate at less than optimal levels while waiting to be called upon to provide services. Adding some energy storage can enhance the efficiency of certain resources by avoiding standby or minimum operating levels during periods when supply exceeds demand, which can be costly and may reduce environmental benefits.

The addition of storage to other generation technologies can enhance these resource's characteristics, such as ramp rates and minimum load. In combination, these enhanced resources may be able to provide energy and ancillary services more efficiently and maximize resource owner profitability while reducing overall costs.

Capturing Resource Adequacy Value

Hybrid resources may be developed to receive capacity value. Energy storage can be used to support peak capacity requirements by storing energy during times of low demand and by acting as a peaking resource when demand is high. When combined with renewable energy technologies, storage can drive synergies that may enhance the overall resource adequacy value of the resources. This can eliminate the need to procure more costly resource adequacy capacity or longer term, defer the need to build additional generation capacity.

Leveraging DC Coupling Benefits

Traditional storage plus solar applications have combined independent storage and solar PV inverters at an AC bus. An alternative approach of coupling energy storage to solar arrays with a DC-to-DC converter can maximize production and profits for these hybrid resources.

DC coupled solar and storage can allow for higher round-trip efficiencies. DC coupling may also allow developers to capture new revenue streams not possible with traditional AC-coupled storage, including energy clipping recapture and low voltage harvesting. It can also help ensure eligibility for tax incentives. Developers have found advantages for configurations that leverage DC coupling for all of these reasons.

6. Straw Proposal

The following sections provides the CAISO's straw proposal for hybrid resource related issues that require modifications to accommodate participation of hybrid resources and co-located resources with two or more resource IDs. The following topics are included in the straw proposal for discussion and further development:

- Forecasting
- Markets and Systems
- Ancillary Services
- Metering and Telemetry
- Resource Adequacy

The CAISO also identified some additional items that were discussed in the issue paper as topics related to hybrid resources that could potentially require modifications. At this time, the CAISO believes that some of the previously identified topic areas do not require any modifications for enabling hybrid resource participation, thus they are not included in this straw proposal. Background on all previously discussed issues has been provided in the CAISO's July 18 issue paper. Selections from the previous background material are also included in the background section of the appendix of this straw proposal paper for stakeholder reference.

The CAISO provides initial proposals for modifications to the other topic areas that have been included in the following straw proposal sections. The CAISO seeks feedback and additional stakeholder input on these initial proposals.

6.1. Forecasting

Forecasting Background

The following section discusses forecasting related issues. The CAISO has included a diagram that describes the forecasting status for hybrid resources with renewable energy generation components under single resource ID configurations. An energy storage unit is not a VER.[7] As such, if a generating unit was an EIR prior to the addition of the energy storage unit, it would no longer be eligible to be an EIR or PIR,[8] if both resources are operated as a hybrid resource under a single resource ID. Currently, CAISO provides forecasting for EIRs only. The CAISO tariff does not have provisions or requirements in place to forecast for non-EIR resources and dispatch them based on that forecast.

[7] FERC Order No. 764 defines a variable energy resource as "a device for the production of electricity that is characterized by an energy source that: (1) is renewable; (2) cannot be stored by the facility owner or operator; and (3) has variability that is beyond the control of the facility owner or operator."

[8] Appendix A to the CAISO tariff defines an Eligible Intermittent Resource as "A Variable Energy Resource that is a Generating Unit or Dynamic System Resource subject to a Participating Generator Agreement, Net Scheduled PGA, Dynamic Scheduling Agreement for Scheduling Coordinators, or Pseudo-Tie Participating Generator Agreement."

Forecasting Proposal

Forecasting for hybrid resources (single resource ID configuration)

The CAISO previously discussed the options for hybrid resources (single resource ID) to be forecasted by the CAISO similar to existing VER forecasting provided for EIRs, or for these resources to have an option to provide their own forecast. After consideration of the updated definition of hybrid resources and the proposals for market participation of hybrid resources included in this straw proposal, the CAISO believes hybrid resource Scheduling Coordinators (SC) will need to provide their own forecasts to enable participation of these resources. This forecasting aspect of the proposal will apply to hybrid resources with a VER component.

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 aspect of the proposal is discussed in further detail under Section 6.2, below.

Hybrid resource forecasts should be provided to the CAISO and updated with 5 or 15 minute granularity for a minimum of a rolling 3-hour forward basis. The CAISO believes this is appropriate to propose adopting provisions similar to the existing minimum EIR forecasting granularity and timeframe.[9] The CAISO will allow self-provided forecasts to be updated every 5 or 15 minutes in a manner similar to existing EIR forecasting. If a SC for a hybrid resource submits an economic bid (either with or without a self-schedule) and a self-provided forecast, then the CAISO will receive and processes the forecast which will establish the upper economic limit for that resource in the fifteen minute market (FMM). If a hybrid resource submits a self-schedule the resource will be a price taker at the submitted forecasted output – in other words, the CAISO will ensure a feasible dispatch for any self-scheduled hybrid resources by setting the resources upper economic limit at the provided forecasted output.

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.

For the SC/operator of a hybrid resource to be able to create and submit a forecast for the resource, the forecaster will need the VER component of the resource to have a meteorological station(s) to feed accurate meteorological data into the forecast. For this reason the CAISO is also proposing requiring hybrid resources to follow current provisions for meteorological station data for the VER components of these resources as described by Appendix Q Section 3.1 of the CAISO Tariff to ensure all resources have adequate data being used in their wind or solar forecast creation. The CAISO believes that it is appropriate to require any hybrid resources with

[9] As provided in Section 4.8.2.1.1, the Scheduling Coordinator may submit such forecast in fifteen or five minute granularity. If the Scheduling Coordinator submits the forecast in five minute granularity, the CAISO will use the average of the three five-minute forecasts provided by the Scheduling Coordinator to determine the MWh to be cleared in the FMM for that resource.

VER generation components to follow existing requirements for MET stations for VERs. The CAISO does not intend to require that resources also provide all MET station data to CAISO since they are provided the flexibility of self-providing forecasting. The CAISO is not proposing to conduct or provide its own forecasting for these resources.

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 (described under section 6.2, below) 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.

Forecasting related analysis

The CAISO conducted the following analysis related to potential forecast error associated with hybrid resources. The CAISO assumed the most common hybrid resource combination for this study, which was a solar resource combined with an energy storage resource. The analysis compares hybrid resource generation forecasts at the time of Real Time Dispatch (RTD) versus Real Time Pre Dispatch (RTPD) and the Hour Ahead Scheduling Process (HASP). The CAISO chose these timeframes to portray how forecast creation time impacts the accuracy and potential charging and discharging of the battery to meet the forecasts. The CAISO also evaluated how 5- versus 15-minute forecasts could improve forecasts and battery usage.

For this analysis, the absolute value of the difference between the forecast and observed generation data was calculated. The absolute value of the supplemental dispatch was added back into the observed generation data to remove any variability or errors due to curtailments. The calculated maximum and average error between the forecast and observations is an approximate measure of how much the battery would have had to charge or discharge to ensure the awards do not exceed the resource provided forecast. The analysis is provided for a high variability solar day that has large forecast impacts.

Table 2: HASP forecast timeframe – Maximum and average absolute forecast error for forecasts submitted to the market 75-minutes before the effective forecasting interval using 15-minute forecast and observation resolution.

Resource Size (MW)	Max Error (MW)	Average Error (MW)
40	15	3
85	52	9
275	152	22
550	247	35

Table 3: RTPD forecast timeframe – Maximum and average absolute forecast error for forecasts submitted to the market 15-minutes before the effective forecasting interval using 15-minute forecast and observation resolution.

Resource Size (MW)	Max Error (MW)	Average Error (MW)
40	13	3
85	54	8
275	161	23
550	290	40

Table 4: RT forecast timeframe – Maximum and average absolute forecast error for forecasts submitted to the market 5-minutes before the effective forecasting interval using 5-minute forecast and observation resolution.

Resource Size (MW)	Max Error (MW)	Average Error (MW)
40	17	3
85	52	7
275	167	22
550	263	32

On the same day across all solar resources, the accuracy of the forecast at these three horizons was calculated using the absolute value of (forecast – actual) divided by the capacity. HASP forecasts had the highest error at 4.25%, followed by RTPD at 2.81%, and finally RTD had the lowest forecast error of 2%. The potential forecast error for hybrid resources indicates that, on average, forecast error could be somewhat significant due to the interactions of the energy storage and VER components.

The CAISO believes a common goal of all forecasting providers should be to minimize the average forecasting error observed. The CAISO has also included a proposal to update hybrid resources upper economic limits every 5 minutes according to their self-provided forecasts in a manner similar to the existing treatment of EIRs.[10] This proposal is described in detail in section 6.2, below.

6.2. Markets and Systems

The CAISO determined that there are some necessary modifications to its markets and systems to enable the efficient and reliable participation of hybrid resources and co-located projects. The CAISO has included its initial proposals here for stakeholder consideration.

Incorporating Hybrid Resource Forecasts in Market Processes

The CAISO proposes to treat hybrid resources the same as any other traditional dispatchable resource for bidding, scheduling, and other market participation purposes. This treatment may cause some risk related to the bidding and market timeframes because traditional dispatchable generator self-schedules or bids can only be updated at 75 minutes prior to the operating hour. Given the time lag between bid submission and dispatch, single resource ID configurations could receive awards above what the hybrid resource can provide given forecast changes.

To address the risk and issues associated with such possible outcomes, the CAISO proposes to modify existing market functions for hybrid resource participation. Specifically, the CAISO proposes to modify the market processes to consider the resource self-provided forecast (for hybrid resource configurations) similar to the manner the market considers VER forecasts today (updated upper economic limit dynamically every 5 minutes based upon VER forecast).

The CAISO will incorporate hybrid resource forecasts so that the CAISO markets consider updated forecasts of resource capabilities and update the hybrid resource's upper economic limit dynamically every 5 minutes. The CAISO believes it can leverage this existing functionality for VERs and extend this treatment for hybrid resources (single resource ID). Updating hybrid resource capabilities based upon their forecast is similar to the existing paradigms of updating the upper economic limit forecast for VERs, thus this proposal should limit the need for significant software modifications.

The CAISO has also considered the possibility of modifications to market systems that would provide for bids/offers for these hybrid resource units to be updated more frequently than the current timeframes and closer to real time (generator bids and self-schedules can only be

[10] The proposal to allow self-provided forecasts only applies to hybrid resources with VER components.

updated once an hour at 75 minutes prior to the operating hour). The CAISO has determined that it would require extensive systems and software modifications to incorporate more granular bidding capabilities. Therefore, the CAISO is not proposing such extensive system and market timeline changes through this initiative at this time.

Interconnection Rights Constraint (Two or more Resource IDs)

In the hybrid resources issue paper, the CAISO noted the existing shortcomings of limiting the output of co-located projects with a common POI and two or more resource IDs to their total interconnection rights. The existing approach is intended to ensure that the CAISO markets awards and dispatches are limited to the project interconnection rights. The CAISO also noted that the current approach can also result in some undesired outcomes. Namely, the stranding of some capacity from oversized co-located projects, which can result in the CAISO's inability to access some amount of capacity from the different components of these two or more co-located resources. In other words, the output of co-located multiple resource ID configurations may be artificially limited by the current implementation approach. The following table highlights the issue in a numerical example to illustrate the potential impact.

Table 4: Example of potential stranded capacity issue

Example of stranded capacity on co-located resource with two resource IDs	
Project characteristics	**Size (MWs)**
Project POI maximum injection rights:	100 MW (total POI rights)
Co-located project resources:	Solar PV resource: 100 MW installed capacity (Master file Pmax: 50MW)
	Energy Storage resource: 100 MW installed capacity (Master file Pmax: 50MW)
Project installed capacity:	200 MW (total installed capacity)
Project master file Pmax:	100 MW (total master file Pmax)
Potential stranded capacity:	**50 MW** (100 MW POI right – 50 MW Pmax of each individual resource ID)

The CAISO proposes to develop a new interconnection rights constraint that ensures these resources' outputs remain less than or equal to the co-located project's maximum POI injection rights without stranding capacity from either of the co-located resource IDs.[11]

[11] Previously, CAISO has referred to this proposed constraint as a "hybrid resource constraint" in the issue paper. CAISO believes the terminology for this constraint must be updated to clearly reflect the updated definition of hybrid resources and specify that this constraint will only apply to co-located projects

The CAISO believes this proposed interconnection rights constraint is the best resolution to this issue. The CAISO has also explored the use of other solutions, such as grouping constraints and extension of MSG functionality, however, the CAISO believes that these other options that might be able solve the same problems would be too complex and have adverse pricing impacts. At this stage, the CAISO believes the most feasible solution is to pursue development of the proposed interconnection rights constraint.

The purpose of the interconnection rights constraint is to limit co-located resource output to the maximum of the combined project's interconnection rights. This constraint will reflect the co-located project's total interconnection rights by adjusting market awards, schedules and dispatches to the injection limits included in a new master file field. The constraint will not limit or impact the bid amount (MW) or bid price ($) of the co-located resources subject to the proposed constraints.

A benefit of this proposed solution is that the CAISO will be able to incorporate multiple interconnection rights constraints at a single POI, thus allowing multiple different sets of co-located projects under multiple resource ID configurations to be managed to their individual interconnection rights at a single POI. The CAISO also believes that these interconnection rights constraints can be modeled in the CAISO's Energy Management System (EMS) outside of the CAISO's full network model process, which also has the benefit of easing implementation issues.

The CAISO initially stated that this functionality already exists in the market software. However, the CAISO has identified additional work required to modify the existing functionality to provide for ancillary services in the solution. The CAISO notes that the existing intertie functionality has the capability to consider energy and ancillary services together. This intertie functionality will need to be developed for the internal resource constraints to incorporate the ancillary services aspect into the final solution.

Interim solution for co-located project interconnection rights

Initially, the CAISO had been targeting fall 2020 for the implementation of the proposed interconnection constraint. After further review, the CAISO determined that including the ancillary service functionality in the solution by 2020 is not feasible. Given the implementation lift, the constraint is initially be proposed for implementation in the fall of 2021. In response to the implementation timing, the CAISO has reviewed potential interim solutions to mitigate potential impacts before the interconnection constraint can be implemented.

The CAISO proposes to maintain the current implementation approach of limiting the combined Pmax of co-located resources to the project's established interconnection rights. The CAISO is proposing to allow resource developers to select the amount of Pmax for each co-located resource to effectively have an option when determining how to split the total interconnection rights among the co-located resources. For co-located projects that are oversized in regards to their interconnection rights, this approach can still result in potential stranded capacity on some portion of each co-located resource. The CAISO understands the status quo presents a

with two or more Resource IDs and would not be applied to hybrid resources (single Resource ID configurations).

possible barrier to the development of oversized co-located projects. This concern will be relived with the implementation of the proposed interconnection constraint in fall 2021. Developers also have the option of selecting a single resource ID hybrid resource configuration that can also mitigate stranded capacity concerns.

The CAISO explored the possibility for allowing the project's true Pmax in master file prior to implementing the proposed interconnection constraint. To allow for this outcome, the CAISO determined that it would necessitate the development of tariff requirements and controls to require that SCs ensure bidding of both resources to manage overall output to POI limit. This approach is challenging because of the modifications to the CAISO systems to allow for controls and reporting to be provided that would also require additional implementation and systems modifications. The CAISO considered the feasibility of implementing this approach in a timely manner and has determined that it is not a feasible alternative to pursue as an interim solution.

Additional considerations for interconnection rights constraint for co-located projects

CAISO has identified a number of areas that will require careful consideration related to the proposed interconnection rights constraint. These areas include:

- Forecasting impacts for co-located VER units
- Price formation and settlements impacts
- Exceptional dispatch and out of market actions

As noted in the forecasting section above, the CAISO is still evaluating how the proposed interconnection rights constraint for co-located projects may need to be considered or incorporated into the VER forecasting process. One 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 forecasting to allow the CAISO to curtail or adjust the VER forecasts as appropriate.

Potential market related impacts, including price formation and settlements related issues are important to consider and address for any proposed solutions. The CAISO's initial review and analysis of any potential pricing impacts indicates that there are not any significant pricing impacts presented by this proposed solution. One pricing related issue that has been identified is related to congestion at the individual resource level. The CAISO identified there is a potential for the interconnection rights constraint to create a congestion component at the resource pricing node for each individual resource.

The CAISO notes that this congestion component at the resource specific level is a result of the proposed constraint. The CAISO does not believe this congestion issue is of concern for pricing, as long as this artificial congestion cost is not included in the pricing and settlement for resources under this constraint. The suggested exclusion of the congestion from pricing is appropriate because, in reality, there is no actual congestion between the resources and the POI. Therefore, the CAISO proposes to exclude this congestion component from the determination of LMPs and any related settlement of resources with the proposed interconnection constraints. The CAISO believes this outcome is possible under current tariff authority and should not present a significant concern for this aspect of the proposal.

The CAISO is still exploring the potential for any possible impacts of virtual bidding at points where these interconnection rights constraints would exist. If any significant impacts are identified, the CAISO will include an explanation and any necessary modifications to the proposal in subsequent iterations. The CAISO has also identified that it is considering how exceptional dispatch (out of market actions) would interact with the proposed interconnection rights constraint. For example; if one generating unit of a co-located multiple resource ID configuration receives an operator instructed exceptional dispatch that would violate the project's interconnection rights, the output of the other generating unit would need to be backed down to avoid violation of the constraint and the combined project's maximum interconnection rights. Additionally, the CAISO is considering if enforcing these constraints may have an unintended impact of causing violation of other constraints that are also applied to the same resource, *e.g.*, transmission nomograms, generator ramp constraints, etc.

The CAISO also seeks stakeholder feedback on any other market or system enhancements that may be required to best accommodate the wide scale adoption of hybrid resources and co-located projects.

6.3. Ancillary Services

The following section discusses provision of ancillary services (AS) by hybrid resources and co-located projects. There may be some necessary modifications to help facilitate the safe and reliable provision of ancillary services from hybrid resources. The CAISO has identified specific modifications for stakeholder consideration to ensure that hybrid resources are capable of providing awarded ancillary services.

Ancillary Services Background

In accordance with Appendix K of the CAISO tariff, any hybrid resources that have been defined as either NGR or mixed fuel type generating facilities will be eligible to participate in ancillary services market. Co-located projects with two or more resource IDs are eligible to provide some ancillary services depending upon the individual generating unit type. Specific rules for the various ancillary services are defined in Appendix K. Hybrid projects with a single resource ID are eligible to provide ancillary service as a single combined generating facility, provided it complies with appropriate provisions of Appendix K. Generating facilities can be tested for ancillary services after commercial operation.

Contingency Reserves are Operating Reserves that are used during a contingency and consist of Spinning and Non-Spinning Reserve. Regulation is another Ancillary Service that also includes Spinning and Non-Spinning Reserves. The CAISO tariff and its appendices provide guidance regarding the requirements of resources to provide these services to the CAISO. The CAISO is still considering whether these requirements should apply to hybrid resources as-is, or if there should be modifications based on the characteristics of hybrid resources.

For Non-Spinning and Spinning Reserve, the question posed is whether or not the timing for change in power output currently in place can, or should be, met by all combinations of mixed fuel resources. The CAISO believes this initiative should confirm the response of mixed fuel

resources to system frequency disturbances as currently captured in Appendix K, or identify the need to more clearly define them for each possible combination of fuels supporting hybrid resources. Initially, the CAISO proposes that for hybrid resources with energy storage to be certified to provide Spinning Reserves, the resource must demonstrate that they can provide the frequency response as outlined in Appendix K. Specifically for hybrid resources with gas-storage combinations, the energy storage component must be of sufficient size to provide the frequency response for the entirety of the certified spinning reserve for situations where the gas portion of the unit is off-line. The CAISO, seeks feedback on this initial proposal related to the frequency response capabilities and energy storage sizing for hybrid resources with gas-storage combinations.

For the provision of Non-Spinning reserves, hybrid resources should be able to initiate change in power output within one minute and ramp to output value within ten minutes. The CAISO has not identified any potential modifications to Non-Spinning reserves provisions for hybrid resources. The CAISO welcomes stakeholder input on this topic for any Non-Spinning reserves related issues that should be further considered.

For Regulation Up and Down services, the operating characteristics of resources providing these services is clearly defined in Appendix K.[12] The CAISO has not identified any issues requiring modifications on this item related to hybrid resources. The CAISO seeks feedback from stakeholders regarding any other needed modifications for hybrid resources providing these services. The CAISO is also reviewing circumstances that could merit a change to existing Ancillary Service No Pay or payment rescission rules. The CAISO seeks feedback from stakeholders on these hybrid resource related ancillary services issues.

Finally, the CAISO is also considering the existing certification requirements and processes and how they apply to hybrid resources. The CAISO has not identified any specific changes or clarifications that would apply to hybrid resource AS certification at this time. The CAISO seeks stakeholder feedback on any needed modifications to the AS certification provisions for hybrid resources.

Ancillary Services Proposal

Once a resource has received an AS award, preserving the awarded AS capacity is critical. The proposed modifications for hybrid resources is to ensure these resources can deliver the services they have been awarded. The CAISO has explored what real-time data is needed to inform the CAISO systems that awarded ancillary service capacity is available. The CAISO believes that additional telemetry and submission of underlying resource components forecasting data will be needed to certify that hybrid resources are indeed able to provide the ancillary services they have been awarded. This additional information is important for hybrid resources to safely and reliably provide AS, the generator to be fairly compensated, and for the market to appropriately pay for the services rendered.

The CAISO notes that the following proposal for additional data and telemetry will not apply to hybrid resources that do not elect to provide AS. The proposed requirements will only apply to

[12] Footnote to Appendix K.

those hybrid resources seeking to provide AS and do not apply to co-located projects with two or more resource IDs. Co-located projects with two or more resource IDs will continue to be treated as separate resources for provision of AS and will be required to meet any certification and AS provisions requirements on a standalone basis, *i.e.*, existing AS provisions apply to each individual resource for co-located projects with two or more resource IDs.

Plant Potential and State-of-Charge requirements for provision of Ancillary Services

The CAISO proposes that hybrid resources (single resource ID) providing Spinning Reserve, Non-Spinning Reserve, and Regulation that have a VER component (renewable energy generation) must provide a new data point for the "plant potential" of the VER component from the plant side of the inverter/control system. This new plant potential data point is needed for hybrid resources so that the CAISO is aware of the potential output of the resource if it has a VER generation component. The CAISO needs to require this new "plant potential" data point to ensure the CAISO is only awarding ancillary services the hybrid resource can actually deliver.

An additional data point that would be required to make an accurate assessment of a hybrid resource with energy storage generating components ability to provide ancillary services is the storage component's state-of-charge. The state-of-charge for storage devices is a current data point for NGR resources. The CAISO believes it is necessary to extend requirements for knowing the state-of-charge of storage generation components of hybrid resources.[13]

For Regulation service, the CAISO markets must maintain awarded capacity by adjusting the Dispatch Operating Target (DOT) based on the resource's overall potential output or plant potential. The CAISO believes that the new "plant potential" data point and visibility to the state of charge are also both essential for a resource to provide Regulation service. This is because a resource's output potentially impacts and bounds a hybrid resource's ability to provide regulation services.

The CAISO believes it is necessary to propose these requirements for hybrid resources that wish to provide Spinning and Non-Spinning Reserves and Regulation service to allow the CAISO markets to maintain capacity for provision of these ancillary services. The CAISO is currently undertaking related modifications to ensure its' market systems will protect for the necessary headroom by adjusting awards for resource's output based on their potential output, or the plant potential, of the VER components and the state-of-charge of energy storage components of hybrid resources providing ancillary services.

Payment Rescission

If the CAISO identifies a resource that has received an ancillary services award but is undispatchable, unavailable, or provides undelivered capacity, then ancillary service payment

[13] Traditionally, state-of-charge for storage resources has been focused on battery storage. CAISO is exploring the need to define state-of-charge characteristics or calculations for other types of storage generation as well, for instance, Solar Thermal, Compressed Air, Gravity Train, etc. CAISO has not received detailed stakeholder input on this issue as described in the issue paper but continues to seek additional feedback.

rescission is applied. The rescission of ancillary services payments are described in the CAISO Tariff under Section 11.[14]

The CAISO previously identified that payment rescission for hybrid resources may need to be updated. Under the current requirements, hybrid resources (single resource ID configurations) providing AS will result in the CAISO being unable to receive the full information and data necessary to determine if awarded ancillary services are truly available and not undispatchable, unavailable, or undelivered. Specifically, the plant potential forecast for VER components and state of charge data for storage components are currently unknown to the CAISO.

In the section above, the CAISO is proposing that these data points must be submitted to the CAISO for hybrid resources to qualify for AS. These requirements are needed to assess and apply AS payment rescission. The CAISO proposes to update systems and processes related to AS payment rescission to incorporate these data points. The CAISO will utilize this additional data to calculate and determine hybrid resources ability to actually provide AS that has been awarded and apply any necessary payment rescission.

6.4. Metering and Telemetry

Metering and Telemetry Background

Hybrid resources and co-located projects can be connected at either the CAISO controlled grid or at the utilities' sub-transmission or distribution voltage level. The metering and telemetry requirements are slightly different depending upon the point of interconnection. In general, a meter is needed for each resource ID, and, depending upon where the meter is connected, the meter will need to be compensated for losses to the point of interconnection with the CAISO controlled grid. The CAISO has also provided metering and telemetry diagrams in the appendix below.

Telemetry for the single resource ID charging from the on-site generating unit can be the net output of the generating unit and will not likely require modification if it's an existing unit. However separate telemetry will be needed for a single resource ID charging from the CAISO grid or providing AS, or generating facilities with two or more underlying generation sources.

Metering Diagrams

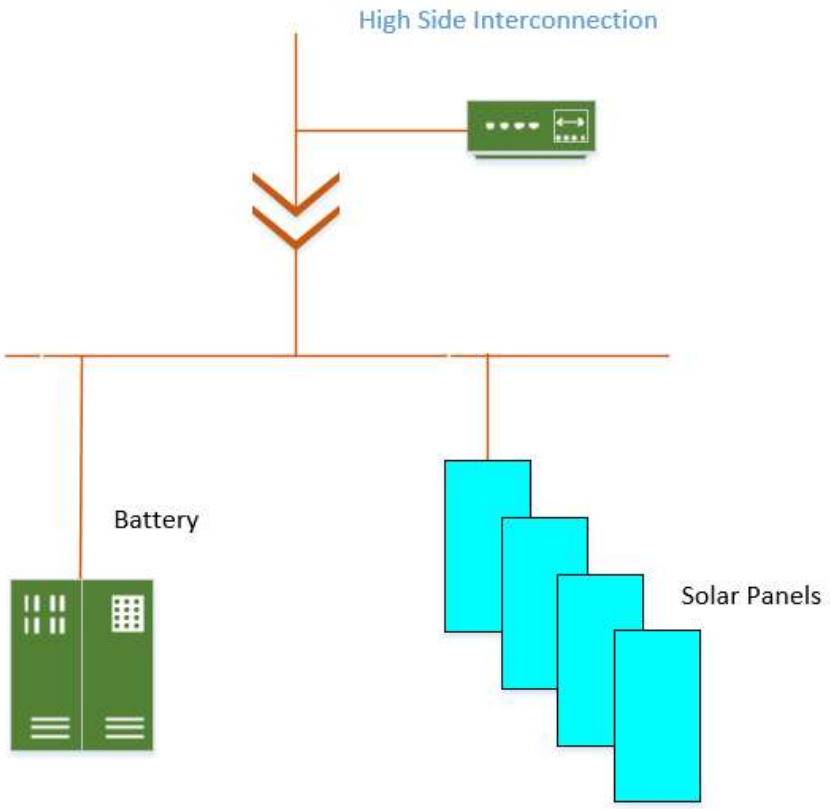
The CAISO held a hybrid resources metering and telemetry workshop on August 27. The CAISO discussed related issues with stakeholders and received feedback in response to the workshop. The CAISO provides the following clarifications and associated diagrams for hybrid resources (single resource ID) in response to this feedback. The CAISO seeks feedback on these metering configurations and any need for further clarification or modifications to be included in subsequent proposals.

[14] https://www.caiso.com/Documents/Section11_ISOSettlements-Billing_Dec3_2013.pdf

High Side metering, charging from on-site generation:

The storage device will only charge from on-site generation and will not charge from the grid. A limiting scheme must be in place to prevent charging from the grid. The high side meter will measure the total resource output for settlements and RPS reporting if generation source is eligible. The hybrid resource not eligible to be a VER, so it must schedule or bid into the market and follow its Dispatch Operating Target (DOT).

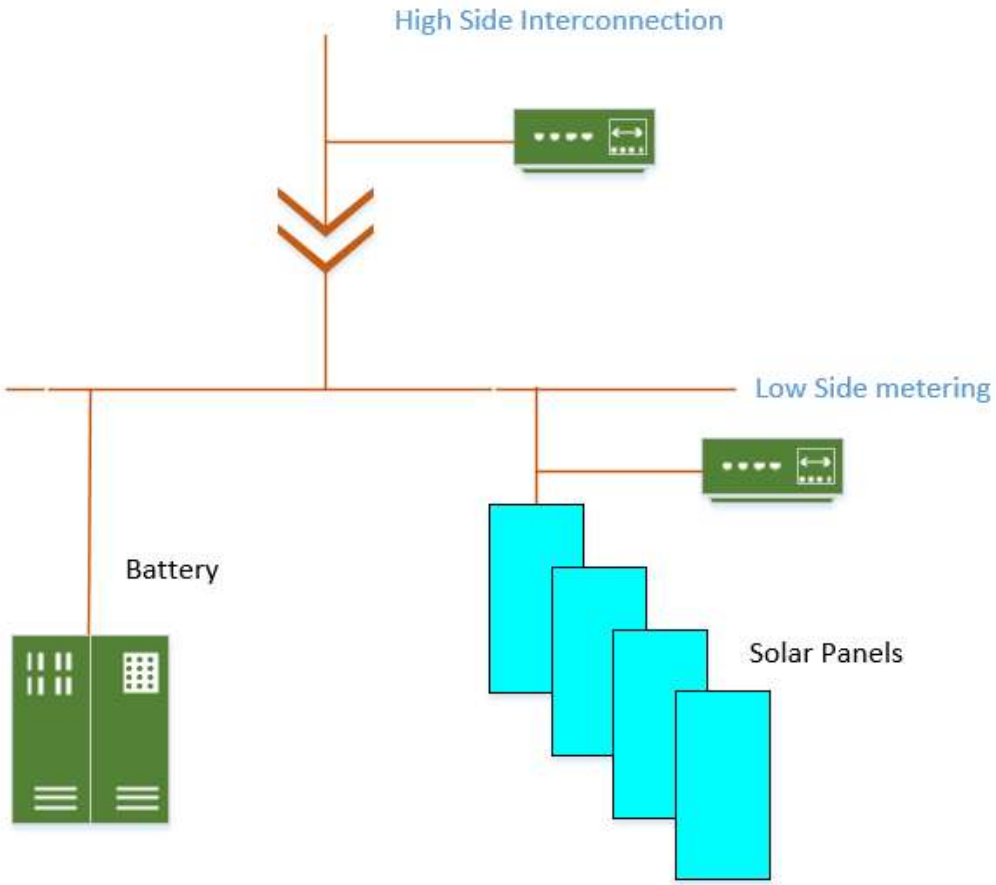
Figure 1: High Side metering, charging from on-site generation



High Side metering, charging from both on-site generation and the grid:

The storage device will charge from on-site generation and the grid. The high side meter will measure the total resource output (gen and load) for settlements, and a second meter is required for RPS reporting calculations if generation source is eligible. The hybrid resource is not eligible to be a VER, so it must schedule or bid into the market, and follow DOT.

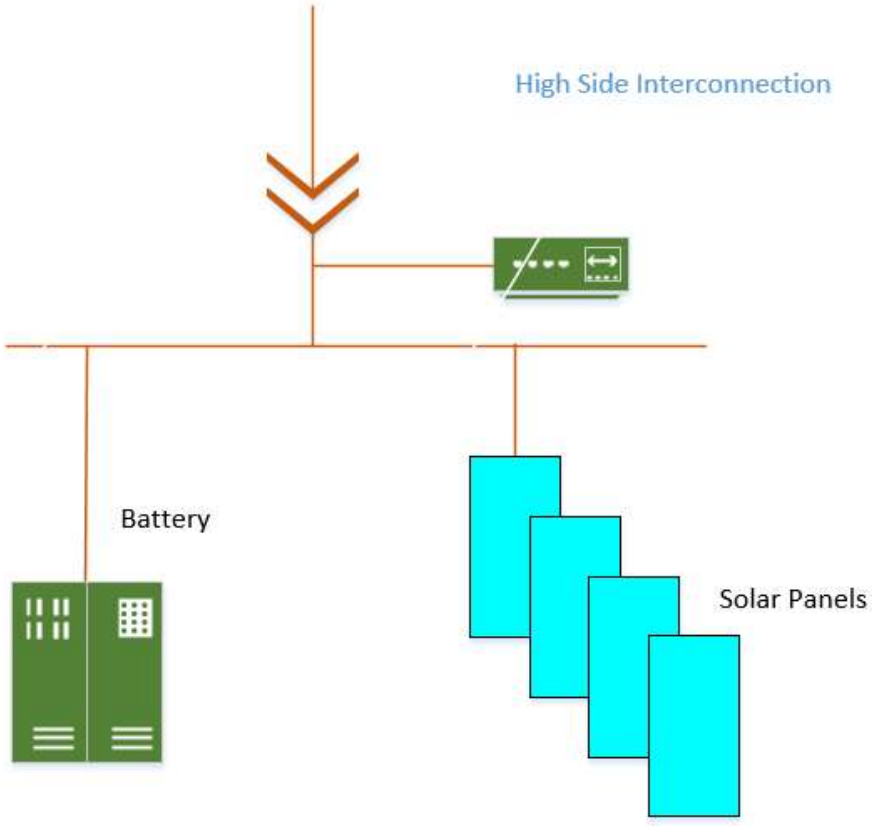
Figure 2: High Side metering, charging from both on-site generation and the grid



Low side metering, charging only from on-site generation:

The storage device will charge from on-site generation and will not charge from the grid. A limiting scheme must be in place to prevent charging from the grid. The low side meter will measure the total resource output (gen and load) for settlements, and for RPS Reporting calculations if the generation source is eligible. The hybrid resource is not eligible to be a VER, so it must schedule or bid into the market, and follow DOT.

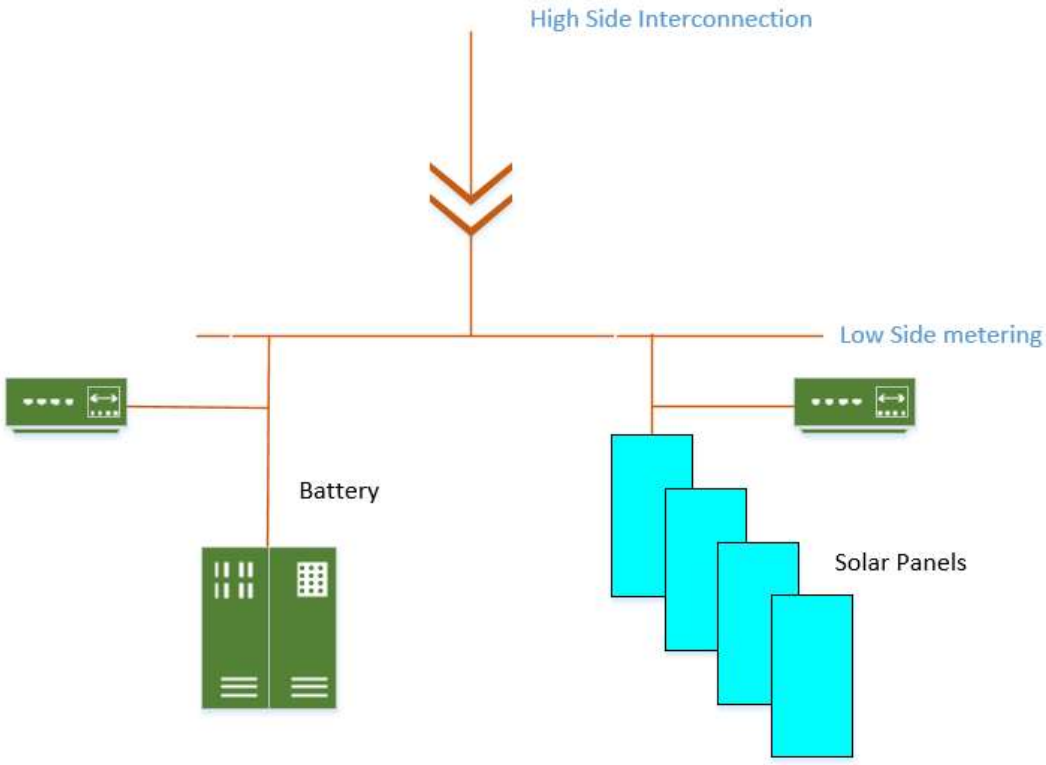
Figure 3: Low side metering, charging only from on-site generation



Low side metering, charging from both on-site generation and the grid:

The storage device will charge from on-site generation and the grid. Both meters will be combined to measure the total resource output for settlements and RPS reporting if the generation source is eligible. The hybrid resource is not eligible to be a VER, so it must schedule or bid into the market, and follow DOT.

Figure 4: Low side metering, charging from both on-site generation and the grid



Ancillary Services Data and Telemetry Proposal

The CAISO is proposing additional data and telemetry requirements for hybrid resources providing ancillary services. Specifically, the CAISO is proposing to require forecasts for the plant potential of hybrid resources with VER components and state of charge data for the storage components of hybrid resources. This additional information is needed to determine the resource capabilities and assess any need for AS payment rescission.

Metering and Telemetry for Hybrid Resources with VER Components

As noted above, the CAISO is proposing requirements to include additional data and telemetry for hybrid resources providing ancillary services. The CAISO is also considering if similar requirements are needed for all hybrid resources with VER components, regardless of their AS certification status. In other words, the CAISO is seeking feedback on requiring forecasts for

the plant potential of hybrid resources with VER components and state of charge data for the storage components of hybrid resources as a general requirement for all hybrid resources with VER components. Additionally, the CAISO may need to require separate metering requirements for each underlying component of hybrid resource as well. There are number of reasons that the CAISO is considering these potential requirements.

Separate telemetry and metering requirements may be needed for all hybrids with VER components to ensure the CAISO can forecast expected renewables production on a five-minute basis. Additionally, these requirements will allow CAISO to better understand the expected renewable production in advance of actual operations. This information can help ensure the CAISO commits needed dispatchable resources to meet all NERC real-time control performance standards. Lastly, separate metering and telemetry also allows the CAISO to calculate the percentage of load served by renewables in real-time, which is provided to the public so stakeholders and policy makers are aware of the progress made reaching the states' energy and environmental goals.

The CAISO is still considering this aspect for further discussion and stakeholder input. CAISO seeks feedback on the need for these requirements to be included in future proposals.

RPS Reporting Background

The CAISO is currently registered with WECC as a Qualified Reporting Entity (QRE). The CAISO's role as a QRE is to submit meter data associated with renewable energy on behalf of ISO Metered Entities using the WREGIS application.[15] The CAISO submits meter data into the WREGIS application for those ISO Metered Entities that have requested such service from the CAISO. The CAISO intends to continue to provide QRE related RPS reporting to WREGIS in the future for hybrid resources, as applicable.

The CAISO identified the need to develop new metering requirements and associated practices to allow the CAISO and market participants to develop the appropriate data and information needed to provide QRE RPS reporting to WREGIS for hybrid resources under various metering configurations. The California Energy Commission (CEC) has established guidelines for the RPS reporting associated with renewable energy resources, and more specifically, has developed RPS reporting guidelines for hybrid resources combining energy storage with renewable energy resources.[16] The CEC RPS Eligibility Guidebook discusses how energy storage can be integrated into a RPS facility under Section 3F:

- The CEC guidebook states that hybrid resources with a renewable resource component can charge the storage with the renewable component and the storage component can discharge to the grid with both component's outputs qualifying for RPS reporting, as follows:

[15] For additional information on WREGIS see: https://www.wecc.org/WREGIS/Pages/default.aspx
[16] California Energy Commission Guidebook: RPS Eligibility, Ninth Edition, available here: https://efiling.energy.ca.gov/getdocument.aspx?tn=217317

    - The reportable RPS energy from this hybrid resource configuration would be equal to the renewable energy produced net of any losses from storage.

- The CEC guidebook also states that a hybrid resource with a renewable resource component and storage component that also has the ability to charge from another electric source can charge the storage component from the renewable component and the other electric source at the same time:
    - The reportable RPS energy from this hybrid resource configuration would be equal to the renewable energy produced net of any losses from storage and any energy from the other electric source.

Some stakeholders provided feedback on the issue paper stating that they disagree with the required treatment of losses for hybrid resources with storage components. This question of how to treat storage conversion losses for RPS purposes is outside of the CAISO's purview. The CAISO is not in a position to apply a different treatment to the calculation of storage conversion losses for hybrid resource RPS reporting because that determination is one that is made by the CEC. If stakeholders believe this treatment of losses for hybrid resource RPS reporting should be changed, they should take up the issue with the CEC for consideration in future CEC RPS eligibility guidebook updates. The CAISO, therefore, does not consider this issue to be in scope of the hybrid resources initiative.

RPS reporting related metering and calculations

The CAISO believes that resource owners may be able to achieve this type of RPS reporting without having to combine under a single CAISO resource ID. However, as noted above, to accurately calculate the correct RPS energy for reporting purposes, the CAISO previously identified that it may be necessary to develop new metering options or requirements and/or new requirements for additional data or inputs from hybrid resource owners to accomplish the necessary RPS reporting. After review, the CAISO has not identified any specific modifications necessary to accomplish RPS reporting for hybrid resources for inclusion in this straw proposal.

The CAISO believes that current metering configuration options will be sufficient to ensure appropriate and accurate RPS reporting for hybrid resources. The CAISO intends to work closely with project developers during the design and implementation of new hybrid resources to ensure that the metering configurations allow for RPS reporting and any necessary netting and losses calculations are appropriately developed. The CAISO seeks stakeholder feedback on the need for any specific modifications to the existing metering options and approaches that would be needed for proper RPS reporting.

The CAISO notes that it will consider all relevant CEC RPS reporting guidelines applicable to hybrid resources when determining the necessary calculations and reporting activities. The CAISO will also consider any other applicable LRA guidelines for RPS reporting. For instance, if another LRA in a different state has alternate or conflicting RPS reporting requirements for hybrid resources, the CAISO may need to determine how to provide reporting that will comply with other LRA RPS reporting guidelines. The CAISO seeks stakeholder feedback on the current CEC RPS reporting guidelines and any other applicable LRA RPS reporting guidelines that should be further considered through this initiative.

6.5. Resource Adequacy

Resource Adequacy Background

The Resource Adequacy (RA) counting rules and Must Offer Obligations (MOO) for hybrid resources are vital to ensuring that hybrid resources can participate and provide RA to support system and local reliability.

Under current RA tariff provisions, the CAISO defers to Local Regulatory Agencies (LRA's) Qualifying Capacity (QC) RA counting rules. These LRA QC counting rules for hybrid resources may have impacts on CAISO markets and operations. The CAISO believes that RA counting rules should provide fair and accurate capacity valuations. RA counting rules are also important because they can have impacts on developer's configuration decisions, which can also have different impacts on the CAISO visibility of resource components and the CAISO markets and operations.

Each year LRAs establish resource QC values (*e.g.*, CPUC publishes an annual QC list with QC values for all applicable resources). The CAISO takes this information and studies resources for their deliverability and produces a Net Qualifying Capacity (NQC) list annually. This detail is important because it has consequences for certain hybrid resource configurations.

Once the QC and NQC of resources are established the resources can be used to meet RA requirements and be shown on RA and Supply plans that establish the resource's RA status with the CAISO. These shown RA resources are then subject to CAISO's RA provisions regarding availability, including the CAISO's Must Offer Obligations (MOO) requirements. Both the QC methodology and the resulting offer obligations are important to the success of the RA program and need to be addressed for hybrid resources with a single resource ID configuration.

Resource Adequacy Proposal

Counting rules for co-located projects (common POI and two or more resource IDs)

RA counting rules for co-located projects with a common POI and two or more resource IDs are relatively straightforward and do not present significant concerns or barriers to participation in RA. The project's components will receive an RA value for each separate resource ID based upon the applicable counting methodology for the resource type/technology as established by LRAs. For instance, wind and solar resources are evaluated by the CPUC under an Effective Load Carrying Capability (ELCC) methodology, and storage resources are generally evaluated based upon their Pmax and four hour duration sustained output. These QC methodologies are applied to each co-located project's underlying resources and each individual resource ID would receive a standalone QC and NQC once studied by the CAISO for deliverability.

The CAISO believes the current provisions and application of QC counting rules do not present significant issues or concerns for co-located resources with two or more resource IDs. However, the CAISO anticipates one related issue that must be addressed is the relationship of the co-located resources QC and the proposed interconnection rights constraint to limit the output of the resources to their joint interconnection rights. Under the current implementation,

the QC of co-located resources must be limited to their total interconnection rights as does their total Pmax in the master file. This should be relatively easy to apply for QC counting under this current approach – the resource developers will work with CAISO to set the Pmax of each resource, which limits the QC of both resources below the interconnection limit.

This interaction of co-located resource QCs will become more complex when considering the interconnection rights constraint the CAISO is proposing in this initiative. Once the constraint is implemented, co-located resources will have their true Pmax reflected in the master file, which means their combined Pmax will exceed their total interconnection rights. The related energy awards and dispatch coordination issues will be resolved by the proposed interconnection constraint. However, allowing the true Pmax value in the master file will not limit their QC in same way it does under the current implementation. This could result in a QC value for the combined resource that exceeds the interconnection rights for co-located projects.

To address this future concern, the CAISO proposes the QC determination process capture that the resources are co-located and have a POI limit that applies to the overall project. There are two logical options to address this issue. One option is for the CPUC to work with the resource's owner to set the total amount of the co-located resource's QCs based upon their preference (split and limited to the POI rights). Alternatively, the CAISO could perform a similar split and limit the capacity values when developing the NQC list. The CPUC could simply establish the individual QC values for each resource without any consideration of their co-located nature or the need to cap their combined QC at their interconnection rights, and the CAISO could work with the resource developer to limit the NQC of the resources to their interconnection rights. The CAISO seeks stakeholder feedback on these two options.

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).[17] 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

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

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.

The CAISO provides a simple numerical example in Table 5 to illustrate the default QC proposal for hybrid resources. The example assumes a hybrid resource with interconnection rights of 200 MW and installed capacity of 200 MW (100 MW solar, 100 MW minimum 4-hour storage).

Table 5: Hybrid resource QC example

Resource/component	QC methodology for tech type	Installed capacity	QC value
Solar	ELCC (Assume 44% ELCC value for solar for example monthly QC value)	100 MW	44MW (100MW x 44% ELCC = 44MW)
Storage	4-hour sustained duration	100 MW (4 hour duration: 400MWh)	100 MW
Combined hybrid resource	ELCC for solar component plus Pmax for storage component	200 MW	144 MW

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.[18]

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 for all hours similar to a traditional generator.[19] 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

[18] 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

[19] 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.

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. The CAISO seeks stakeholder feedback on this MOO proposal for hybrid resources.

7. EIM Governing Body Role

This initiative proposes to modify market rules to facilitate participation by hybrid resources, including rules governing interconnection, providing ancillary services, metering and a range of other topics. Staff believes the EIM Governing Body should have an advisory role in the approval of the proposed changes.

The rules that govern decisional classification were amended in March 2019 when the Board adopted changes to the Charter for EIM Governance and the Guidance Document. An initiative proposing to change rules of the real-time market, or rules that apply to all market time frames, now fall within the primary authority of the EIM Governing Body either if the proposed new rule is EIM-specific in the sense that it applies uniquely or differently in the balancing authority areas of EIM Entities, as opposed to a generally applicable rule, or when the proposed market rules are generally applicable, if "an issue that is specific to the EIM balancing authority areas is the primary driver for the proposed change."

Here, the EIM Governing Body will have an advisory role because the proposed changes contemplated in this paper would apply generally and uniformly to all market time frames and across the entire CAISO footprint. At this preliminary phase, it is foreseeable that some of the potential rule changes would apply only in the CAISO's balancing authority area, for example rules about interconnection. That fact should not affect this proposed decisional classification, however, because staff does not currently foresee the adoption of rules that will be specific to EIM balancing authority areas. With that said, this proposed classification reflects the current state of this initiative and may change as the stakeholder process moves ahead.

If any stakeholder disagrees with this proposed classification, please include in your written comments a justification of which classification is more appropriate.

8. Next Steps

The ISO will discuss this issue paper with stakeholders during a stakeholder meeting on October 3, 2019. Stakeholders are asked to submit written comments by October 17, 2019 to initiativecomments@caiso.com. A comment template will be available at http://www.caiso.com/informed/Pages/StakeholderProcesses/HybridResources.aspx