



California ISO

**Hybrid Resources
Revised Straw Proposal**

December 10, 2019

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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 interconnection customers 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 was 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 interconnection customers. The CAISO has included two major modifications to its markets and tariff provisions under this initiative that are intended to enhance the ability for mixed-fuel type projects to participate in a more efficient and inclusive manner. The two main aspects of this proposal that will enable this improved participation are related to hybrid resources with a single resource ID and co-located resources with two or more resource IDs.

First, the CAISO has proposed to extend existing market functionality used for standalone variable energy resources to hybrid resources. This aspect of the proposal will allow hybrid resources to utilize their own forecasted output capability to ensure they receive feasible market awards and dispatch instructions. 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 CAISO notes, this aspect of the proposal will only apply to the CAISO's real-time markets. Second, the CAISO's proposal also addresses the potential for stranded capacity and energy on co-located projects with two or more resource IDs through the addition of a newly proposed interconnection rights constraint. This proposed constraint will enable the CAISO to ensure the energy output of co-located resources will be maintained to within their established interconnection delivery limits while maximizing the utilization of these co-located resources. Both of these changes are intended to provide notable improvements to enhance the ability of hybrid and co-located resources to participate in the CAISO markets.

The CAISO proposal provides an approach for hybrid resources whereby the resource's 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. The proposal also provides hybrid resources the ability to be modeled as Non-Generating Resources (NGRs) because many hybrid resources will include energy storage components and hybrid resources may need the ability to charge from the grid, *i.e.*, operate at a net-negative output level. The hybrid resources proposal uses existing market participation models and provides more flexibility and fewer

constraints through coordinated use of energy storage, power electronics, and software technologies.

The CAISO proposes to allow hybrid resources to self-provide production forecasts and operate their hybrid resource around these forecasts in the CAISO markets and real-time operations. The participation for hybrid resources in the CAISO's Day-Ahead market will be aligned with the existing participation of traditional generators, NGRs, and VERs, with the submission of bids or offers.

The CAISO has also 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 has included proposed requirements for metering and telemetry needs to enable the safe and reliable provision of Ancillary Services by hybrid resources. The CAISO proposal will require all hybrid resources to provide data and telemetry for the underlying components of the resource. This requirement will include the forecast for all VER components of hybrid resources, however, the CAISO has also agreed to provide the option for the CAISO to perform forecasting for the VER components of hybrid resources as well. 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. Interconnection customers 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.

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

As the grid evolves, so has interconnection customers' interests in energy storage and its use and operation. The CAISO is experiencing an increasing number of inquiries from interconnection customers interested in pairing energy storage with either existing or proposed generation (conventional or renewable). Such resources have been previously referred to broadly as hybrid resources. However, CAISO has clarified the definition of hybrid resources and 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, represented by a single market resource ID. This clarification intentionally excludes 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 and modification requests for existing generators, and the strong interest expressed by interconnection customers and stakeholders, the CAISO anticipates the installed capacity of hybrid resources will grow 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 projects achieve commercial operation. 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 over the next few years.⁴

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 through this initiative. The proposal includes the CAISO's initial proposals on items that have been identified as necessary to integrate hybrid and co-located resources.

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.

⁴ 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.

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 10	Revised Straw Proposal
December 17	Stakeholder Meeting on Revised Straw Proposal
March	Second Revised Straw Proposal
May	Draft Final Proposal
TBD	Board of Governors Meeting

4. Changes from Straw Proposal

The following changes to the CAISO's hybrid resources proposal have been included in this iteration:

- Refinements to business drivers and use cases.
- Clarifications to forecasting proposal.
 - Inclusion of proposal to provide CAISO forecasting VER components of hybrid resources at the hybrid resource's cost, similar to standalone VER forecasting provided by CAISO.
- Clarifications on modeling and charging capability for hybrid and co-located resource configurations.
- Clarifications on market participation proposal for hybrid resources.
 - Specify that Day-Ahead market participation of hybrid resources is through bidding only – not self-provided forecasts. Similar to current participation of standalone VERs.
 - Clarification that self-provided forecasts will only be submitted and utilized in Real-Time markets to ensure feasible awards and dispatch instructions.
- Inclusion of proposal to require data and telemetry for all hybrid resources and underlying components.
 - Data reporting requirements including forecasting of VER components, state of charge and charging/discharging status for storage components.
 - Specification that all hybrid resources must submit their own forecasts for each of the resource's VER components if the resource has not selected the option for CAISO to perform and provide forecasting for the VER components of hybrid resources.
- Updates to proposals for resource adequacy Qualifying Capacity counting rules and Must Offer Obligations for hybrid resources.

These changes are incorporated and described in greater detail in each of the relevant straw proposal sections.

5. Proposed Hybrid Resource and Related Terminology Definitions

With stakeholder help, the CAISO has been refining its proposed definition of hybrid resources. The CAISO proposes to establish the definition of hybrid resources as a tariff defined term through this initiative. The CAISO 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 type of resource configuration that should be referred to as hybrid resources in the CAISO tariff.

Hybrid Resource Definition

The CAISO proposes to specify this treatment through an updated definition as follows:

- **Hybrid Resource:** “A resource type comprised of a mixed-fuel type project, or a combination of multiple different generation technologies that are physically and electronically controlled by a single owner/operator and Scheduling Coordinator behind a single point of interconnection (“POI”) that participates in the CAISO markets as a single resource with a single market resource ID.”

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 proposed hybrid resources definition will not apply to multi-stage generators or other resource configurations that have multiple units of a single fuel-type or single generation technology.

The CAISO also proposes to require that hybrid resources meet the minimum sizing requirements for both of the underlying generation components: 500kw for any participating generator hybrid resource component and 100kw for any storage hybrid resource components.⁵ The CAISO has clarified this aspect of the proposal to avoid confusion regarding the sizing requirements for hybrid resources.

Related terminology proposed definitions

The CAISO has received many helpful suggestions from stakeholders regarding the definition of hybrid resources and support for additional related terms that should be established as part of this initiative. The CAISO appreciates this feedback and agrees with many of the useful recommendations that have been provided. In response, the CAISO also proposes to include the following terms and associated definitions as part of this proposal.

- **Mixed-Fuel Type Project:** A project located behind a single POI with more than one different fuel-type which could be configured as either a Hybrid Resource (single resource ID) or Co-located Resources (multiple resource IDs).
- **Hybrid Resource Component:** The portion of a Hybrid Resource consisting of capacity of a single fuel type, e.g., a VER-storage Hybrid Resource consists of a both a VER component and a storage component.

Co-located Resources Definitions

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.

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.

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 stakeholders and interconnection customers 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 delivery rights' limits and any master file or systems items specifically related to the proposed co-located interconnection right constraint (described below in section 7.2).

- **Co-located Resource Configuration:** the multiple-resource ID configuration of a Mixed-Fuel Type Project subject to a single POI constraint.
- **Co-located Resource:** The individual, separate resource ID of a Mixed-Fuel Type Project.

The CAISO seeks additional feedback on the revised definitions and additional terms that have been included in this iteration of the proposal.

6. 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 resources in the CAISO system. These descriptions capture the drivers and motivations behind hybrid and co-located resource development. They are not exhaustive, nor should they be considered only applicable to interconnection customers or the CAISO or market participants individually, but rather, a collection of uses and business drivers that may drive the development and utilization of hybrid and co-located resources.

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 also provides guidance for interconnection customer 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 identifies 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

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

The CAISO notes the ITC as a business driver for hybrid and co-located resources because it reduces the costs associated with developing new resources that contain solar and storage combinations. The CAISO believes that this ITC eligibility issue should not drive market design proposals because the ITC is an out-of-market incentive.

Improving Resource Performance Characteristics

In the case of load following or spinning reserves, traditional generating facilities may be required to operate at less than optimal levels while waiting to be called upon to provide energy 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.

Resource Adequacy and Reliability Contribution

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.

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>.

Hybrid and co-located resources may also provide an expedited means to add additional capacity to existing facilities. This possibility can be utilized to maximize the utilization of interconnection rights and RA deliverability of existing projects. These additions may be useful to help meet resource adequacy and reliability needs and the CAISO expects this may also drive the development of these resources.

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 interconnection customers 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. Interconnection customers have found advantages for configurations that leverage DC coupling for all of these reasons.

7. Revised Straw Proposal

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 identified 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 revised 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 revised straw proposal for stakeholder reference.

7.1. Forecasting

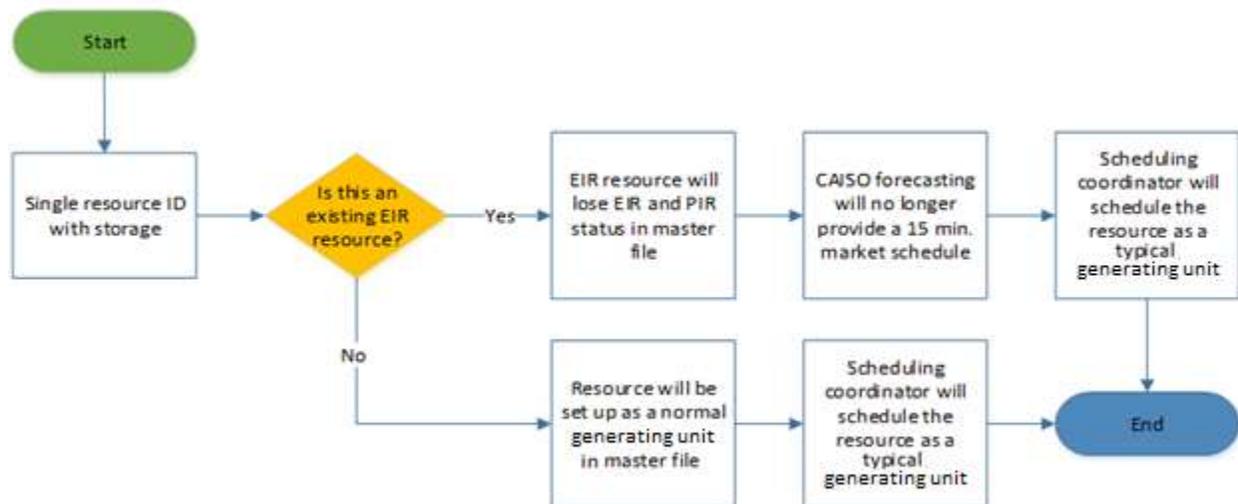
Forecasting Background

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. Figure 1 below describes the forecasting status for hybrid resources with renewable energy generation components under single resource ID configurations.

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."

Figure 1: EIR status diagram for single resource ID hybrid resources



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 forecasts. After consideration of the updated definition of hybrid resources and the proposals for market participation of hybrid resources included in this proposal, the CAISO believes it is necessary to clarify there are two different types of forecasts that will be utilized related to hybrid resources with VER components. The CAISO clarifies the following forecast types that are discussed throughout the proposal:

- Hybrid Resource Net-to-Grid Operational Forecast:** The overall capability of the hybrid resource as a whole, provided by the hybrid resource SC. This net-to-grid operational forecast should incorporate the following: Any VER component forecasted output, any storage component State-of-Charge, and the anticipated charging or discharging operation of any storage component. All of these aspects should all be incorporated in this self-provided net-to-grid operational forecast.⁹ The net-to-grid operational forecast will only be provided and utilized in the CAISO's Real-Time markets.

⁹ All hybrid resource net-to-grid operational forecast will only be provided by the hybrid resource SCs, the CAISO cannot provide forecasting for this overall aspect due to the SC decisions related to the onsite optimization and charging or discharging of each underlying hybrid resource component. This will only apply to hybrid resources with VER components.

- **Hybrid Resource VER Component Forecast:** The forecast output capability of only the VER component of a hybrid resource.¹⁰

The CAISO believes these two different forecasting terms will assist in clarifying the intent of various aspects of the proposal included below.

Hybrid resource self-provided net-to-grid operational forecast proposal

The CAISO proposes that hybrid resource Scheduling Coordinators (SC) must derive their own net-to-grid operational forecasts for the entire hybrid resource's potential output capability. This forecasting requirement will only apply to hybrid resources with a VER component.¹¹

Hybrid resources will be viewed by the CAISO as a dispatchable generator and will have market awards and dispatch targets based upon cleared schedules and bids, which are informed by the SC's own operational forecasts. Hybrid resources will be required to follow dispatches like any other non-EIR generation resources. The CAISO is proposing to use the net-to-grid operational forecasts to ensure a hybrid resource's awards do not exceed the real-time production capabilities of the resource. This aspect of the proposal is discussed in further detail under Section 7.2, below.

Hybrid resources' self-provided net-to-grid operational forecasts should be provided to the CAISO and updated with 5 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. The CAISO will allow self-provided net-to-grid operational forecasts to be updated every 5 minutes in a manner similar to existing EIR forecasting.

The CAISO proposes that SCs for a hybrid resource should submit an economic bid (either with or without a self-schedule) and a self-provided net-to-grid operational forecast, then the CAISO will receive and process 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 net-to-grid operational 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 self-provided net-to-grid operational forecasted output.

For the SC of a hybrid resource to be able to create and submit a forecast for its hybrid 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

¹⁰ The CAISO has proposed that hybrid resource SCs can provide their own VER component forecasts or have the option for the CAISO to perform the forecasting for the VER component of the hybrid resource. The CAISO clarifies that it can only provide forecasting for the VER components and will not provide forecasting for the overall net-to-grid operational capability of hybrid resources.

¹¹ Hybrid resources that do not include VER components will participate similarly to a traditional generating unit, through bids/offers that should reflect their operational capability. The self-provided net-to-grid operational forecast proposal will not apply to any hybrid resources without VER components, e.g., gas and storage hybrid resource combinations.

proposing requiring hybrid resources to follow current provisions for meteorological station data for the VER components of these resources as described in Appendix Q Section 3.1 of the CAISO tariff to ensure all resources use appropriate and adequate data in their wind or solar forecast. The CAISO believes that it is appropriate to require any hybrid resources with VER generation components to follow existing requirements for MET stations for VERs and to also provide that data to CAISO as well.

CAISO forecasting for VER components of hybrid resources

Although CAISO will not consider hybrid resources to be eligible for EIR or PIR treatment, the VER components may retain their VER status as noted above. Even though these resources will not be considered EIR or PIR resources, the CAISO proposes that it will provide the option for CAISO to perform forecasting for the VER components of hybrid resources. Several stakeholders requested that CAISO still provide the option to receive VER forecasts for at least the VER components of hybrid resources and have offered that they would be willing to pay the forecasting fees associated with the existing service for standalone VERs. The CAISO agrees with these suggestions and has changed this aspect of the proposal to allow this option.

It makes sense to allow hybrid resource SCs to receive VER forecasting from the CAISO because of the expertise and capability of the CAISO forecasting approach. The CAISO note that it will charge hybrid resource SCs for the provision of these VER component forecasts, similar to the cost of forecasting charged to standalone VER resources that are provided CAISO forecasts. All hybrid resources will be required to provide all the appropriate forecasting related data, including the telemetry on the VER component and meteorological station data that is necessary for the CAISO to perform this forecasting of the VER component of the hybrid resources, even if they have selected to provide their own VER component forecasting.

The CAISO proposes that all hybrid resources with VER components be required to provide the following data and information to the CAISO:

1. Topo map
2. Site info sheet (designating CAISO or SC provided VER forecast)
3. Met stations per Appendix Q (documented location on topo map and site info sheet)
4. If self-providing VER component forecast, the VER component RT forecast
5. Met data streaming in RT
6. Telemetry actuals on VER components
7. High Sustainable Limit forecast of the VER component (detail on this new term is included in Section 7.3 below)

Monitoring of hybrid resource self-provided net-to-grid operational forecasts

The CAISO notes that given this self-provided forecasting flexibility, the CAISO will need to monitor all hybrid resource forecasts for any strategic forecasting that attempts to inappropriately arbitrage price differences in CAISO's Real-Time markets. The CAISO has received numerous stakeholder requests for additional clarity on the concept of strategic forecasting and seeking clarification on the type of behavior that would be considered inappropriate. The CAISO provides the following description and explanation for consideration and feedback.

Currently, if a standalone VER provides its own forecast, the CAISO monitors for strategic forecasting that seeks to inappropriately take advantage of price differences between the Fifteen Minute Market (FMM) and Real Time Dispatch (RTD). For example, if RTD prices are lower than FMM prices, the SC could submit a forecast higher than its potential output. Then in RTD the SC could submit the actual potential output. This results in the SC being paid a higher price in FMM than it costs to buy back the schedule in RTD. If an SC systematically profits from price differences between FMM and RTD this is evidence of strategic forecasting. If the actual forecast was used, one would observe some instances when the settlement is positive and other times when it is negative, assuming a normal distribution of forecast error.

The CAISO believes this could be possible for hybrid resources given the permission to self-provide forecasts. This is similar to the current possibility that standalone VERs that provide their own forecasts could inappropriately use strategic forecasting. Thus, the CAISO believes that it should be able to discern when a hybrid resource is also behaving in a manner that is systematically profitable that is attributable to this strategic forecasting behavior. The CAISO will use the met data streaming in, as well as telemetry actuals and the self-provided VER component of the forecasts to assist in this analysis and monitoring. If the CAISO observes a resource systematically forecasting in this strategic manner, it would consider this inappropriate behavior and refer the resource to the CAISO DMM and FERC enforcement.

Forecasting for co-located resources (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 that have been 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 7.2, 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. 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.

7.2. Markets and Systems

The CAISO has determined that the following proposed modifications to its markets and related systems are needed to enhance the efficient and reliable participation of hybrid and co-located resources.

Hybrid Resource Forecasting in Real-Time 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 generating unit 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, hybrid resource 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 market processes to consider the resource's self-provided forecast (for hybrid resource single resource ID configurations) similar to the manner the market considers VER forecasts today (update 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 clarifies that this functionality and treatment will apply only to the CAISO's Real-Time markets. 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 functionality of updating the upper economic limit forecast for VERs, thus this proposal should limit the need for significant software modifications. The CAISO clarifies that the Day-Ahead participation for hybrid resources will be aligned with the existing participation of traditional generators, NGRs, and VERs, with the submission of bids or offers. This self-provided forecasting approach will only be used to update the hybrid resource's upper economic limit in the Real-Time market and hybrid resources will still need to provide bids and offers in the Real-Time market similar to other resources.

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 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. The timing of the bidding requirements and subsequent market runs has been established through significant market design efforts and cannot be modified to accommodate the requests of stakeholders for bidding timing to be moved closer to real time. Therefore, the CAISO is not proposing bidding requirement or market timeline changes through this initiative.

Charging Considerations for Hybrid Resources with Storage

Hybrid resources with storage have different options to charge their storage systems. Each option can trigger different market rules that will apply to the hybrid resource depending on whether the resource utilizes a single resource ID or multiple resource IDs.

The CAISO has previously identified three options for charging for hybrid resources with storage components and co-located resources with a storage resources: 1) charge from on-site generation; 2) charge from the grid; and 3) charge from on-site generation and the grid.

The impacts of electing to operate a hybrid resource under the three charging options are summarized in Table 2. These impacts depend on whether the hybrid resource selects to operate under a single resource ID or multiple resource IDs. The CAISO seeks stakeholder input on what market rule or business practices changes that CAISO should consider in connection with these different options.

Table 2: Charging impacts for hybrid and co-located configurations

Hybrid Resources (single resource ID)				
Charging Config	Contracts	Master File	Metering	Telemetry
Charge from on-site generation	GIA, PGA, MSA	Combined unit is modeled as a generating unit or NGR Fuel = Other	Single CAISO revenue settlement quality meter (net metered)	Combined unit output is the telemetry point
Charge from grid via bids and CAISO dispatch	GIA, PGA, MSA	Combined unit is modeled as a NGR Fuel = Other	Separate CAISO revenue meter for gen. and storage	Separate telemetry points for gen. and storage
Charge from both on-site generation and grid via bids and CAISO dispatch	GIA, PGA, MSA	Combined unit is modeled as a NGR Fuel = Other	Separate CAISO revenue meter for gen. and storage	Separate telemetry points for gen and storage

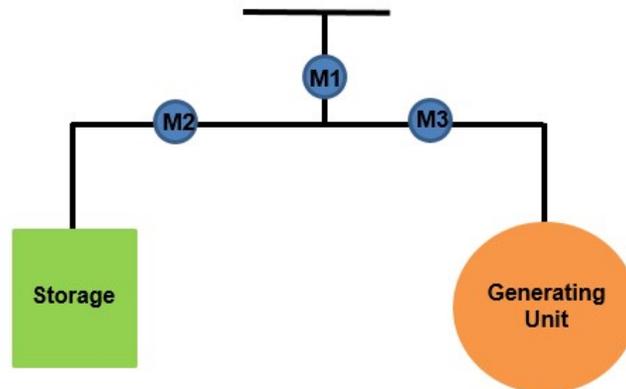
Co-located Resources (two or more resource IDs)				
Charging Config	Contracts	Master File	Metering	Telemetry
Charge from on-site generation	GIA, PGA, MSA,	Each resource identified; storage is NGR fuel = Other	Separate CAISO revenue meter for gen. and storage	Separate telemetry points for gen. and storage
Charge from grid via bids and CAISO dispatch	GIA, PGA, MSA	Each resource identified; storage is NGR fuel = Other	Separate CAISO revenue meter for gen. and storage	Separate telemetry points for gen. and storage
Charge from both on-site generation and the grid via bids and CAISO dispatch	GIA, PGA, MSA	Each resource identified; storage is NGR fuel = Other	Separate CAISO revenue meter for gen. and storage	Separate telemetry points for gen. and storage

Participation and settlement impacts of Co-located resources (two or more resource IDs) charging from on-site generation

The CAISO has received feedback from numerous stakeholders that the ability to charge co-located storage from on-site generation behind the same POI is an important option to allow them to preserve eligibility for ITC purposes. The CAISO has identified this charging configuration is possible in the 2016 technical bulletin and the issue paper for this initiative. The market and settlement related impacts that were previously described to help assist stakeholder understanding of this configuration for charging for co-located storage resources.

The CAISO proposes to allow for an additional metering configuration that should mitigate the previously discussed settlements impacts and concerns regarding ITC eligibility and other undesirable financial impacts. To accomplish this, the CAISO proposes to require a third meter be installed for these co-located resources that wish to select the option to charge from on-site generation. The CAISO will use the three associated meters to perform logical metering calculations that will reflect the fact that the co-located storage resource is charging from on-site generation. This additional metering configuration that should enable this treatment is described below.

Figure 2 – Co-located resources with on-site charging option



The following participation and settlement process would apply:

- The generating unit would bid in the CAISO markets to serve the battery.
- The battery would bid the load equal to the generation of the generating unit.
- The gen-tie meter M1 would register what is either being delivered to the grid or taken from the grid.
- Settlements would sum the three meters.

As an example:

- Generating unit generates 50 MW-H and M3 = 50
- Battery is charging 50 MW-H and M2 = (-50)
- Gen-tie Meter M1 = 0

The CAISO believes this proposed metering concept should allow the CAISO to calculate and settle the resources in a manner that allows for this charging of co-located storage from on-site generation without the settlement and financial related concerns that many stakeholders have expressed.

Market Modeling Considerations

The selection of certain resource ID configurations has numerous consequences that stakeholders should be aware of and understand. One area of importance related to these market modeling decisions for hybrid resources is related to the status of the resource components for VER, EIR and PIR status.

VER, EIR and PIR status

In accordance with CAISO tariff Appendices A and Q, an Eligible Intermittent Resource (EIR) must be a Variable Energy Resource (VER).¹² Moreover, an EIR can receive certification to be a Participating Intermittent Resource (PIR). An EIR is defined 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” while a VER is defined 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.”

The discussion below pertains to only hybrid resources combining energy storage with VER generating components and the extensive modelling impacts of such combinations. Pairings of energy storage with non-EIR units do not have similar market modelling and implementation impacts. Hybrid resources operating under a single resource ID or individual resource IDs can participate under the following options:

Hybrid Resource (single resource ID) with storage and VER components

The hybrid resource would continue to retain its VER status as defined in FERC Order 764, but would not be treated as an EIR and PIR in the master file or CAISO market settlement. This is because its operational characteristics and market behavior do not allow it to be treated as an EIR or PIR under current market settlement rules and processes. Under this option, a hybrid resource cannot be certified with a PIR status because the CAISO cannot produce an accurate forecast based on the data provided. In other words, the CAISO could not accurately forecast the MW output of a hybrid resource due to the impact the charging or discharging storage unit has on the output of the combined hybrid resource.

With the loss of PIR eligibility/status, CAISO forecasting would not provide a 15-minute market schedule for hybrid resources. Therefore the resource’s scheduling coordinator will need to schedule this resource by economically bidding or self-scheduling hourly output in the day-ahead market and bidding or adjusting schedules in the real-time market. Option 1, 2 and 3 below describe the different charging configurations and their impacts for single resource ID hybrid generating facilities.

- **Option 1 (on-site generation only):** If an energy storage unit is aggregating with and charging from an EIR generating unit, the EIR generating unit is no longer eligible to be an EIR or a PIR and the storage device is not eligible to be a NGR. However, the hybrid

¹² See CAISO Tariff Appendix A:

https://www.aiso.com/Documents/AppendixA_Definitions_Aug1_2014.pdf and CAISO Tariff Appendix Q: https://www.aiso.com/Documents/AppendixQ_EligibleIntermittentResourcesProtocolEIRP_May1_2014.pdf

generating facility (the combined resource) can be modeled as a generator or a NGR based on which modeling option the customer elects and is approved by the CAISO.¹³

- **Option 2 (grid only):** If an energy storage unit is aggregating with an EIR generating unit and is charging from the grid, the EIR generating unit is no longer eligible to be an EIR or PIR. This is because the hybrid resource now behaves as an energy storage device as a whole, charging and discharging into the CAISO grid as a single resource. The hybrid resource will be modeled and treated as a NGR in the CAISO market.
- **Option 3 (both from on-site generation and grid):** If an energy storage unit is aggregating with an EIR generating unit and is charging from the grid in addition to the associated EIR generating unit, the EIR generating unit is no longer eligible to be an EIR or PIR. This is because the hybrid resource now has the capability of behaving as an energy storage device as a whole, charging and discharging into the CAISO grid as a single resource. The hybrid resource will be modeled as a NGR in the CAISO market.

Projects operating under a single resource ID are treated like all generating resources that are not PIR. For example: If a resource has uninstructed deviation, it is required to settle its Uninstructed Imbalance Energy (UIE) at the real time market price. A PIR certified resource has forecast updates at 5-minute intervals reducing the risk for PIR certified resources incurring UIE charges. This is in contrast to non-PIR certified resources that do not receive forecasts and would be exposed to UIE charges. UIE charge codes for conventional generation would apply, including the flexible ramp allocation charges due to uninstructed deviations.¹⁴

Co-located resources (two or more resource IDs) with individual resource IDs for energy storage unit and associated generating unit

Option 4 summarizes the impact on modelling the individual generating units based on charging options.

- **Option 4 (on-site generation, from grid or both):** If both the EIR generating unit and the energy storage device are under individual resource IDs, the EIR generating unit is able to retain its PIR eligibility status, with the energy storage unit treated as a NGR.

Summary of modeling impacts

Table 3: Summary of modeling impacts provides a summary of the modeling impacts associated with the various configuration options described above. These impacts are provided to help stakeholders understand the impacts of choosing a particular configuration.

¹³ Interconnection customers might be able to make this selection during the CAISO new resource implementation process, based on the specific characteristics of the project.

¹⁴ CAISO publishes a charge code matrix at:
<https://www.caiso.com/market/Pages/Settlements/Default.aspx>

Table 3: Summary of modeling impacts

Mixed-fuel or multiple generation technology projects with VER and Storage components						
Option selection	VER definition (FERC order 764)	VER treatment	EIR treatment	PIR eligibility	NGR treatment	Modelling in master file
Hybrid Resource: single resource ID						
Option 1 (on-site gen only)	Yes	No	No	No	Yes/No	Generator or NGR
Option 2 (from grid only)	Yes	No	No	No	Yes	NGR
Option 3 (both 1 & 2)	Yes	No	No	No	Yes	NGR
Co-Located Resources: multiple resource IDs						
Option 4 (all charging options)	Yes	Yes	Yes	Yes	Yes	VER and NGR

Master File Modeling

The CAISO master file is a database containing specific resource information that allows the market models to optimize the dispatch of the system at least cost. The master file contains resource specific information including Pmin, Pmax, ramp rate, fuel type, resource adequacy status, ancillary service capabilities (AGC, spin, non-spin), use limitations, start-up information, etc. The following master file background outlines the existing implementation approaches necessary for charging storage devices under various hybrid resource and co-located resources configurations.

Hybrid Resource (single resource ID) charging from on-site generating unit

If the hybrid resource charges the energy storage component from the associated generating unit under a single resource ID, then the resource would be modeled as a generating facility or NGR with the fuel type in the CAISO master file as "Other." This addition of energy storage is comparable to a modification in operating characteristics of the generating facility, thus requiring a change in the master file to reflect its new status and attributes. Below are some examples of

the master file changes that would be made for a single resource ID where the energy storage unit is charged by the other generating unit.

Example 1: A natural gas generating unit that is modeled as a fuel type of “GAS,” when the storage generating unit is added then the fuel type will be changed to “Other.”

Example 2: A wind generating unit that is modeled as a fuel type of “WIND,” when the energy storage generating unit is added then the fuel type will be changed to “Other.”

Example 3: A solar generating unit that is modeled as a fuel type of “SOLR,” when the energy storage generating unit is added then the fuel type will be changed to “Other.”

Hybrid Resource (single resource ID) charging from grid

If the hybrid resource charges the energy storage unit from the grid with a single resource ID, then the resource will be modeled as a NGR with the fuel type in the CAISO master file as “Other.” This addition is comparable to a modification in operating characteristics of the generating facility, thus requiring a change in the master file to reflect its new status. Below are some examples of the master file changes that would be made for a single resource ID where the energy storage unit is charged from the grid.

Example 1: A natural gas generating unit that is modeled as a fuel type of “GAS,” when the energy storage generating unit is added then the generating facility will be modeled as a NGR and fuel type will be changed to “Other.”

Example 2: A wind generating unit that is modeled as a fuel type of “WIND,” when the energy storage generating unit is added then the generating facility will be modeled as a NGR and the fuel type will be changed to “Other.”

Example 3: A solar generating unit that is modeled as a fuel type of “SOLR,” when the energy storage generating unit is added then the generating facility will be modeled as a NGR and the fuel type will be changed to “Other.”

Hybrid Resource (single resource ID) charging from grid and on-site generating unit

If the hybrid resource charges the energy storage unit from the grid and on-site generation with a single resource ID, then the resource will be modeled as a NGR with the fuel type in the CAISO master file as “Other.”

Co-Located Resource Configuration (two or more resource IDs) with all charging options

If the co-located project charges the energy storage unit from the generating unit or the grid with separate resource IDs, then the original generating unit will be modeled with its original fuel type and the energy storage unit will be modeled as an NGR with the fuel type in the CAISO master file set as “Other.” This addition is comparable to a modification in operating characteristics of the generating facility thus requiring a change in the master file to reflect its new status. Below are some examples of the master file changes that would be made for a co-located resource configuration using separate resource ID(s) for addition of energy storage units.

Example 1: A natural gas generating unit that is modeled as a fuel type of “GAS,” when the energy storage generating Unit is added to the generating facility, the gas unit will have a separate resource ID with the fuel type of “GAS” and the energy storage unit will have its own resource ID and be modeled as an NGR with fuel type of “Other.”

Example 2: A wind generating unit that is modeled as a fuel type of “WIND,” when the energy storage generating unit is added to the generating facility, the wind unit will have a separate resource ID with the fuel type “WIND” and the energy storage unit will have its own resource ID and be modeled as an NGR with the fuel type of “Other.”

Example 3: A solar generating unit that is modeled as a fuel type of “SOLR”, when the energy storage generating unit is added to the generating facility, the solar unit will have a separate resource ID with the fuel type “SOLR” and the energy storage unit will have its own resource ID and be modeled as an NGR with the fuel type of “Other”.

The CAISO seeks stakeholder feedback on these modeling options and related business rules for hybrid and co-located resources.

Interconnection Rights Constraint Proposal for Co-located Resources

The CAISO has 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, or potential energy output from individual resources that are part of oversized co-located projects, which can result in the CAISO’s inability to access some amount of capacity and energy from the different components of co-located resources. In other words, the output of co-located multiple resource ID configurations may be limited by the current implementation approach. In response to this issue, 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.

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 to 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, it will just limit the award in the respective markets to the project’s total interconnection rights.

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

The CAISO identified this potential functionality already exists in the market software. However, the CAISO has identified additional work required to modify the existing functionality to provide the project's ability to provide ancillary services in the solution. This intertie functionality will need to be developed for the internal resource constraints to incorporate the ancillary services aspect into the final solution.

Proposed formulation for Co-located resource configuration Interconnection Constraint

For co-located resources (modeled with two resource IDs), the CAISO proposes to use the following formulation for the proposed Interconnection Constraint. Note that this version of the formula assumes the co-located resources include one storage resource, or Limited Energy Storage Resource (LESR) and another generating resource (GR). The proposed formulation will incorporate ancillary services and energy as part of the constraint. The specific equation will be as follows:

$$EN_{GR} + RU_{GR} + SR_{GR} + NR_{GR} + FRU_{GR} + EN_{LESR} + RU_{LESR} + SR_{LESR} + NR_{LESR} + FRU_{LESR} \leq POIL$$

Where:

<i>EN</i>	Energy schedule
<i>RU</i>	Regulation Up award
<i>SR</i>	Spinning Reserve award
<i>NR</i>	Non-Spinning Reserve award
<i>FRU</i>	Flexible Ramp Up award
<i>POIL</i>	Point of Interconnection limit

EN_{LESR} can be negative when the LESR is charging, creating room for other variables. In other words, the constraint will consider the net output of both co-located resources to allow maximum utilization of the project's POI rights.

This assumes that the POI accommodates each resource individually:

$$\begin{aligned} P_{MAX_{GR}} &\leq POIL \\ P_{MAX_{LESR}} &\leq POIL \\ -POIL &\leq P_{MIN_{LESR}} \end{aligned}$$

Additional considerations for interconnection rights constraint for co-located projects

CAISO has identified a number of issues for further consideration related to the proposed interconnection rights constraint. These issues 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. The CAISO believes it will be necessary 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 co-located VER resource 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 has also considered how enforcing these constraints may have any unintended impacts on issues such as exceptional dispatch or causing violation of other constraints that are also applied to the same resource, *e.g.*, transmission nomograms, generator ramp constraints, etc. The CAISO has not identified any problematic outcomes related to these considerations and the potential interaction with the proposed interconnection constraint.

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.

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 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 full interconnection constraint solution can be implemented. The CAISO previously proposed to maintain the current implementation approach of limiting the combined Pmax of co-located resources to the project's established interconnection rights. The CAISO understands the status quo presents a significant potential barrier to the development of oversized co-located projects. The CAISO received strong opposition to this previous proposal to maintain the status quo on this issue in stakeholder responses to the straw proposal.

The CAISO proposes to implement a scaled down "energy-only" version of the proposed interconnection constraint for implementation in fall 2020 to provide a solution to these concerns and stakeholder feedback. This approach should provide some relief for co-located projects to maximize their existing interconnection rights for the greatest potential capacity and energy utilization. The CAISO notes that this interim solution will also necessitate that, in the interim period (fall 2020 – fall 2021), co-located resources that would not be eligible to provide Ancillary Services if they had this energy only interconnection constraint applied. The CAISO recognizes this is a potential area of concern for stakeholders and has already considered this issue in developing this interim solution proposal for an energy-only interconnection constraint. If the Interconnection Customer wishes to select the co-located configuration and still would like the capability to provide Ancillary Services as well, the CAISO would allow the option for co-located resources to limit their combined Pmax to the total interconnection rights and forego use of this proposed energy only interconnection Constraint.

The CAISO believes that the energy and capacity utilization issues should take precedence over Ancillary Services related concerns for this one year interim period. The CAISO notes that interconnection customers will have the opportunity to select a single resource ID hybrid resource configuration that can provide Ancillary Services. The hybrid resource configuration also provides an additional option to mitigate stranded capacity and energy 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 system changes that cannot be implemented in a timely manner. Further, this approach would also require the development of additional tariff requirements and controls to require that SCs ensure bidding of both resources to manage overall output meets the POI limit. There are also challenges related to the potential timing of implementing the 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 as well as other related ideas that were suggested by stakeholders and has determined that it is not a feasible alternative to pursue as an interim solution. The proposed energy-only interconnection constraint being implemented in fall 2020 represents the best solution that the CAISO can offer for the interim to address the operation of oversized co-located projects.

7.3. Ancillary Services

The following section discusses provision of ancillary services (AS) by hybrid resources and co-located projects. The CAISO has identified specific modifications for stakeholder consideration

to ensure that hybrid resources are capable of providing awarded or self-provided ancillary services.

Ancillary Services Background

In accordance with Appendix K of the CAISO tariff, all resources, including hybrid resources defined as either NGR or mixed fuel type generating facilities, are eligible to participate in the ancillary services market. Co-located projects with two or more resource IDs are also eligible to participate. Hybrid projects with a single resource ID are eligible to provide ancillary service as a single combined generating facility, provided the resource complies with appropriate provisions of Appendix K. Generating facilities can be tested for ancillary services after commercial operation.

Ancillary Services under the CAISO tariff consist of Spinning Reserve, Non-spinning reserve, Regulation Up and Regulation Down. The CAISO tariff and its Business Practice Manuals provide guidance regarding the requirements for resources to provide these services. The CAISO is considering whether to revise these requirements for hybrid resources.

For Non-Spinning and Spinning Reserves, the CAISO is considering whether or not the timing for a change in power output, *i.e.*, the ability to respond in one minute and ramp to dispatched capacity within 10 minutes, should be met by all of the individual components of a hybrid resource or the entire hybrid resource as a whole.

For Regulation Up and Down services, the operating characteristics of resources providing these services are clearly defined in Appendix K to the CAISO tariff. 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.

Ancillary Services Proposal

For the provision of Non-Spinning and Spinning reserves, the CAISO proposes that the entire hybrid resource should be able to initiate change in power output within one minute and ramp to dispatched capacity value within ten minutes. The resource may achieve this capability using one or more components of the hybrid resource. The CAISO welcomes stakeholder input on this topic.

Data needs and validation of hybrid resource Ancillary Services capabilities

The CAISO is proposing modifications to ensure these resources can deliver Ancillary Services they have been awarded. The CAISO proposes that hybrid resources seeking to offer Ancillary Services provide I telemetry and submit relevant forecasting data for underlying resource components to permit the CAISO to validate that hybrid resources can 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 proposed requirements 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 Ancillary Services and will be required to meet any certification requirements on a standalone basis, *i.e.*, existing Ancillary Services provisions apply to each individual resource for co-located projects with two or more resource IDs.

High Sustainable Limit concept, storage component State-of-Charge and other data needs

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 “High Sustainable Limit” (HSL) of the VER component from the plant side of the inverter/control system. The CAISO previously suggested a similar concept that was initially described as “plant potential” but has changed the terminology to HSL to better describe the data point. The CAISO proposes the following definition for HSL to begin to refine this term.

High Sustainable Limit (HSL): The maximum output capability of the VER component of a hybrid resource, based upon the full installed capacity of that component. This data point should reflect the VER components high limit of the net-to-grid output for each VER component of hybrid resources as established by the hybrid resource SC. This figure should be continuously updated in real-time at a 5-minute granularity to describe the maximum energy production capability of the hybrid resource VER component.

This new HSL 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 HSL data point to ensure the CAISO is only awarding ancillary services the hybrid resource can actually deliver. This new data point may also be utilized to assist in forecasting for VER components performed by the CAISO, as included in the forecasting section above.

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. The CAISO also proposes to require data on the charging or discharging status for hybrid resource storage components to understand the current operation of these components. This information will be used to allow the CAISO to assess the capability of the hybrid resource to be able to provide any services it has been awarded.

For Regulation services, the CAISO markets must maintain awarded capacity by adjusting the Dispatch Operating Target (DOT) based on the resource’s overall HSL. The CAISO believes that the new HSL 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. These requirements will allow the CAISO markets to maintain capacity for provision of these ancillary services. The

CAISO is currently undertaking related modifications to its day-ahead market rules to ensure its market systems will protect for the necessary headroom on a resource by adjusting awards for resource's output based on their potential output of the VER components, and the state-of-charge of energy storage components of hybrid resources providing ancillary services.

Payment Rescission (AS No Pay)

If the CAISO identifies a resource that has received an ancillary services award but its Ancillary Services capacity undispachable, unavailable, or undeliverable, then the CAISO will apply its ancillary service payment rescission rules. The rescission of ancillary services payments are described in the CAISO Tariff under Sections 8 and 11.¹⁵

The CAISO previously identified that it may need to update its payment rescission rules for hybrid resources. 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 undispachable, unavailable, or undelivered. Specifically, the HSL 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 provision of Ancillary Services. These requirements are needed to assess and apply Ancillary Services payment rescission. 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.

Frequency response capability from hybrid resources providing spinning reserves

The CAISO also is considering clarifying its expectations for hybrid resources comprised of mixed fuel to respond to system frequency disturbances. Initially, the CAISO proposes that in order for a hybrid resources with energy storage to obtain a certification to provide Spinning Reserves, the resource must have the capability provide the frequency response as outlined in Appendix K. Specifically for hybrid resources with energy 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 other fuel components of the resource is off-line or has insufficient fuel or headroom to respond autonomously to a frequency disturbance event. The CAISO, seeks feedback on this initial proposal related to the frequency response capabilities and energy storage sizing for hybrid resources.

The CAISO proposes that for hybrid resources with energy storage to obtain a certification to provide Spinning Reserves, the resource must demonstrate that it can respond automatically to frequency disturbances as outlined in Appendix K of the CAISO tariff. Specifically, for hybrid resources with storage components, the energy storage component must be of sufficient size to

¹⁵ https://www.aiso.com/Documents/Section11_ISOSettlements-Billing_Dec3_2013.pdf

provide the frequency response for the entirety of the certified spinning reserve for situations where other components of the resource are off line.

Under the CAISO's current tariff rules for Spinning Reserves, the CAISO specifies different frequency response requirements for resources with governors and resources with minimum frequency response devices. These requirements will drive the sizing needs for the energy storage component of a hybrid resource seeking to provide Spinning Reserves. The CAISO proposes that hybrid resources with components that utilize governors should set the battery storage sizing requirements in relation to the amount of capacity the resource seeks to certify to provide spinning reserve based on the governor configuration requirements set forth in Appendix K. Hybrid resources without a governor-enabled component should size their energy storage component such that it reflects 10 percent of the capacity certified for provision of Spinning Reserves. In other words, energy storage will need to comprise 10 percent of the capacity certified for provision of Spinning Reserves under these hybrid resource single resource ID configurations.

The CAISO seeks stakeholder feedback on these proposals. The CAISO also notes that it intends to reexamine the Spinning Reserves frequency response requirements for inverter based resources in a separate initiative. Any requirements adopted in such an initiative would also apply to the inverter based components of a hybrid resource seeking to obtain a certification to provide Spinning Reserves.

Co-located resources energy only interconnection constraint interim solution and Ancillary Services related issues

The CAISO has included a proposal in the markets and systems section of the revised straw proposal that would provide for an interim solution to address the fact that co-located resources may have stranded capacity when their combined Pmax values in the CAISO Master File size exceed their interconnection rights. In order to address this issue, the CAISO is developing a co-located resource interconnection constraint that would optimize the utilization of co-located resources and their energy and Ancillary Services output. This solution is planned for implementation in fall 2021. Several stakeholders have submitted feedback they would prefer an interim solution be developed prior to the final solution being provided.

The CAISO has proposed that in the interim it will implement a scaled down "energy-only" version of the proposed interconnection constraint for implementation in fall 2020 to provide a solution to these concerns and stakeholder feedback. This approach should provide some relief for co-located projects to maximize their existing interconnection rights for the greatest potential capacity and energy utilization. The CAISO notes that this interim solution will also necessitate that, in the interim period (fall 2020 – fall 2021), co-located resources that would not be eligible to provide Ancillary Services.

The CAISO recognizes this is a potential area of concern for stakeholders. If the Interconnection Customer wishes to select the co-located configuration and still would like the capability to provide Ancillary Services, the CAISO proposes that co-located resources limit their

combined Pmax to the total interconnection rights and forego use of this proposed energy only interconnection constraint.

The CAISO notes that interconnection customers will have the opportunity to select a single resource ID hybrid resource configuration that can provide Ancillary Services. The hybrid resource configuration also provides an additional option to mitigate stranded capacity and energy concerns while preserving the option to provide Ancillary Services.

7.4. 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 and Telemetry for Hybrid Resources

As noted above, the CAISO is proposing requirements to include additional data and telemetry for hybrid resources providing ancillary services. The CAISO has also explored the need for similar requirements for all hybrid resources, regardless of their AS certification status.

The CAISO proposes that hybrid resources will be required to provide data and telemetry for all of the underlying hybrid resource components. These data requirements will include forecasts for the High Sustainable Limit for VER components, as well as State of Charge data and charging/discharging status telemetry for the storage components of hybrid resources as a general requirement for all hybrid resources. For hybrid resources with other technologies or fuel types such as gas, the CAISO proposes to require similar telemetry and data for those hybrid resource 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 is needed for all hybrids resources to ensure the CAISO can be aware of the operational capabilities of the hybrid resources and their underlying components. Additionally these requirements will assist the CAISO in monitoring the participation and behavior of hybrid resources. Given the flexibility provided by various aspects

of the proposals for hybrid resource participation, especially the self-provided forecast aspect, the CAISO feels that requiring this information is necessary and justified. The CAISO will need this data and telemetry to perform the forecasting for VER components that has been requested by stakeholders as well.

The CAISO is also interested in the ability to 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.

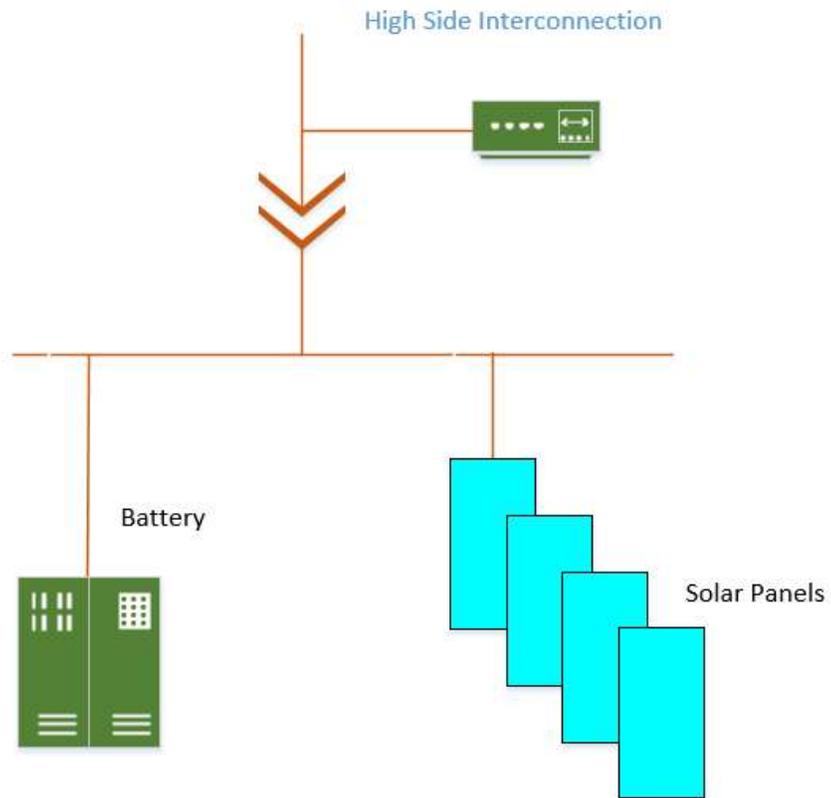
Metering Diagrams

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.

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.

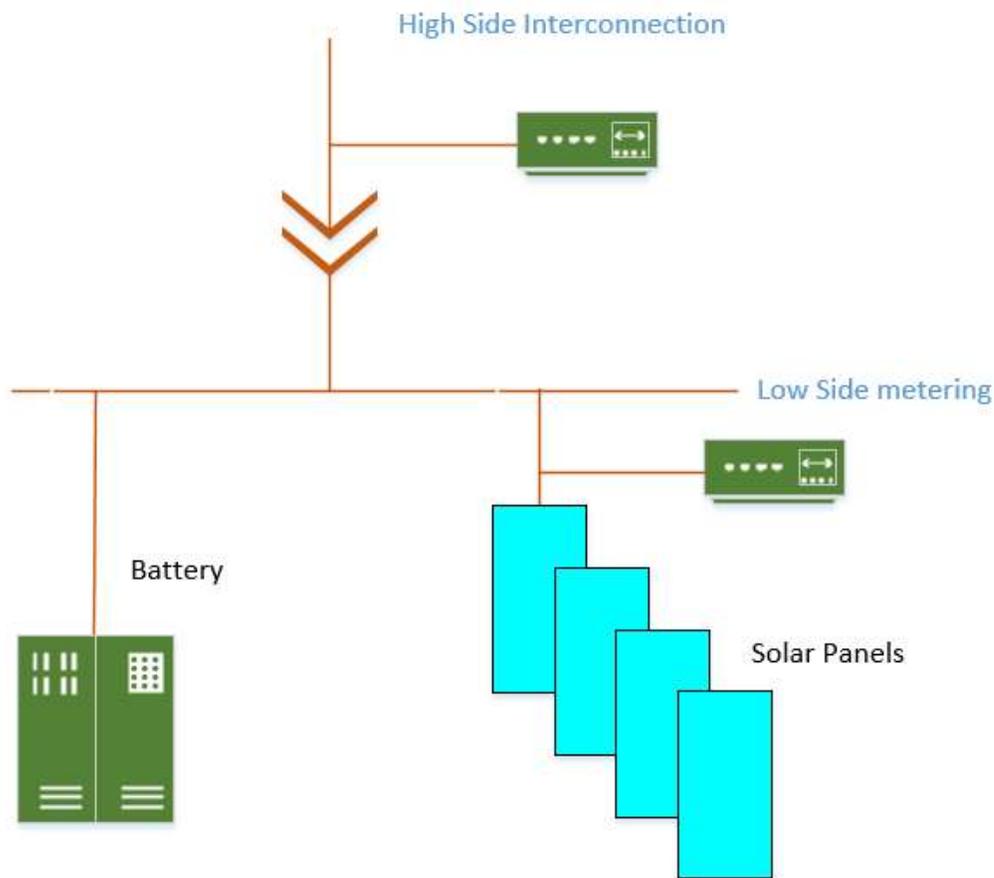
Figure 3: High Side metering, charging from on-site generation



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 an EIR or PIR, so it must schedule or bid into the market, and follow DOT.

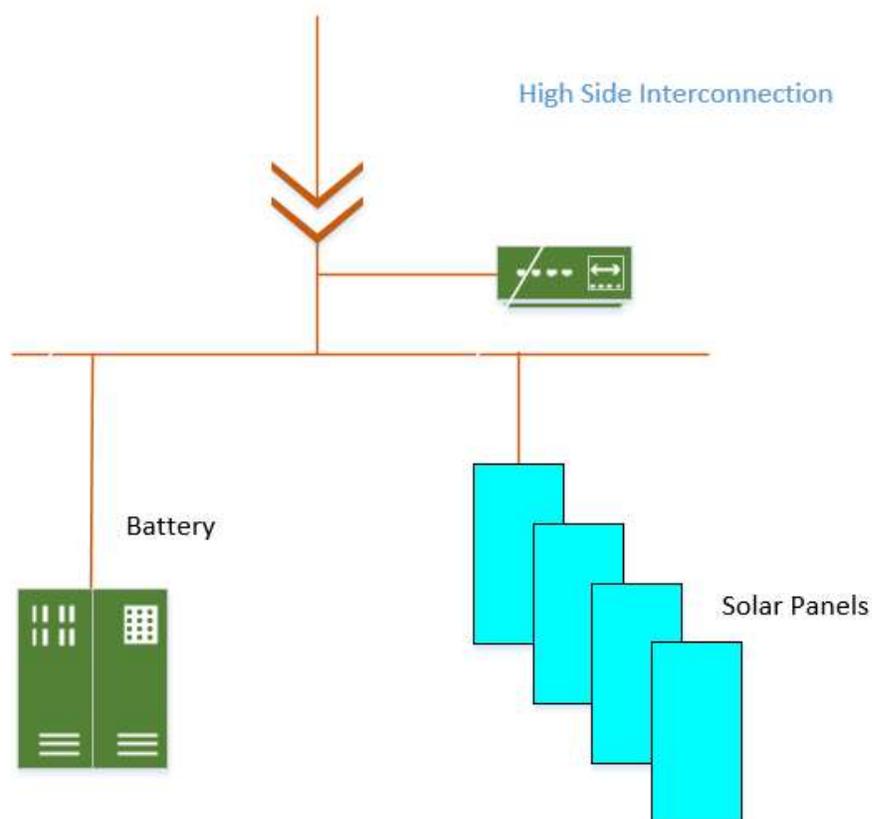
Figure 4: High Side metering, charging from both on-site generation and the grid



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 an EIR or PIR, so it must schedule or bid into the market, and follow DOT.

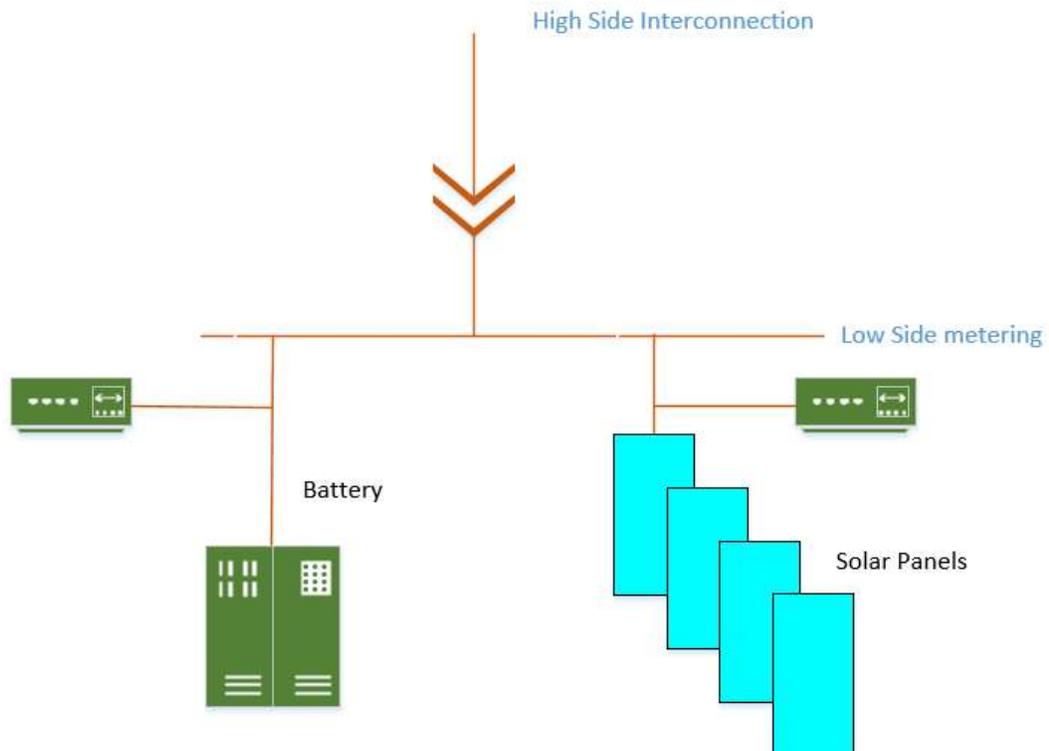
Figure 5: Low side metering, charging only from on-site generation



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 an EIR or PIR, so it must schedule or bid into the market, and follow DOT.

Figure 6: Low side metering, charging from both on-site generation and the grid



RPS Reporting

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.¹⁶ 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

¹⁶ For additional information on WREGIS see: <https://www.wecc.org/WREGIS/Pages/default.aspx>

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.¹⁷ 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:
 - 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

¹⁷ California Energy Commission Guidebook: RPS Eligibility, Ninth Edition, available here: <https://efiling.energy.ca.gov/getdocument.aspx?tn=217317>

closely with project interconnection customers 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.

7.5. 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 interconnection customer'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 (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 NQC 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 NQC counting under this current approach – the resource interconnection customers will work with CAISO to set the Pmax of each resource, which limits the NQC 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 NQC in same way it does under the current implementation. This could result in a NQC 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 interconnection customer 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 a fully 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 a fully informed QC methodology to address this issue at the LRA level through the CPUC's RA proceeding.¹⁸ The CPUC recently issued a proposed decision on this issue, setting an interim QC methodology for hybrid resources with operational restrictions. The interim approach would allow for these hybrid resources to receive a QC value of the greater of either their ELCC based QC for the VER component, or the 4 hour sustained duration of the storage component. The CAISO believes this interim step is heading in the right direction to establish a QC methodology for hybrid resources. There are a number of clarifications that the CAISO believes will be necessary, and the CAISO plans to continue to engage with the CPUC on this issue.

Although the CPUC process is moving forward on this issue, the CAISO plans to 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 a LRA does not establish a QC methodology on its own.

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 and assigns the greater of either components RA value to the hybrid resource. 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 select the greater value of either of the underlying components.

The 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 or the storage component's QC value, whichever is greater. The only difference in the CASIO's default QC methodology proposal and the CPUC PD is that the CAISO is proposing to apply this approach to all hybrid resources, not only those with operational restrictions as the CPUC has proposed. 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 4 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).

¹⁸ 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, see CAISO Track 3 Proposal Reply Comments in Rulemaking 17-09-020; (March 22, 2019).

Table 4: 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 output	100 MW (4 hour duration: 400MWh)	100 MW
Hybrid resource	Greater of ELCC for solar component or 4 hour sustained output Pmax for storage component	200 MW	100 MW

Must Offer Obligations

Must Offer Obligations (MOOs) are a critical aspect of RA. 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. For additional background on applicable MOO provisions, see the CAISO Tariff Section 40 and the CAISO Reliability Requirements BPM.¹⁹

Must Offer Obligations for co-located resources (two or more resource IDs)

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 co-located resources that have been shown for RA. Each resource ID is viewed as a standalone RA resource for RA showings and any resulting MOO.

¹⁹ CAISO Tariff Section 40:

https://www.caiso.com/Documents/Section40_ResourceAdequacyDemonstrationForAllISCsInTheCAISOBBAA_asof_Nov1_2016.pdf. CAISO Reliability Requirements BPM: <https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Reliability%20Requirements>

Must Offer Obligations for hybrid resources (single resource ID)

The offer obligations for hybrid resources shown for RA will be more complex to develop. 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 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. The hybrid resource MOO proposal should be coordinated with and reflect the QC methodology.

The CAISO proposes to set the Real-Time 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 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. The CAISO has clarified that all that hybrid resources would be required to participate in the Day Ahead market through bids and offers or self-schedules and the self-provided forecast functionality would only be applied in the CAISO's Real-Time markets. These issues are important to consider when developing the hybrid resource MOO provisions. 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.

The largest issue to consider is clearly the QC methodology for hybrids that must align with any MOO proposal. The current default QC methodology proposal for hybrid resources is aligned with the CPUC PD. Hybrid resources will receive a QC value of the greater of either their ELCC based QC for the VER component, or the 4 hour sustained duration of the storage component. With this related consideration in mind the CAISO proposes that hybrid resources shown for RA would have the following two potential types of MOO requirements applied.

For hybrid resources with a storage component that drives a larger QC value that would be selected as the overall QC for the hybrid resource, the CAISO proposes to apply a Day Ahead MOO equal to their QC value (or shown MW of RA if only partially shown for RA). These "storage driven" hybrid resources would then have a Real-Time MOO equal to any Day-Ahead awards – this aspect is intended to align with the Day Ahead Market Enhancements initiative and may need to be refined further in the future.

For hybrid resources with VER components that drive a larger ELCC based QC value that would be selected as the overall QC for the hybrid resource, the CAISO proposes that they would not have a Day Ahead MOO – similar to VER resources currently. These "VER driven" hybrid resources will have a Real-Time MOO equal to their self-provided forecasts.

The CAISO understands that this proposal for a MOO for "VER driven" 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.²⁰ 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.

8. 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.

²⁰ 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.

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

9. Next Steps

The ISO will discuss this issue paper with stakeholders during a stakeholder meeting on December 17, 2019. Stakeholders are asked to submit written comments by January 14, 2019 to initiativecomments@caiso.com. A comment template will be available at <http://www.caiso.com/informed/Pages/StakeholderProcesses/HybridResources.aspx>.

10. Appendix – Stakeholder Comments and CAISO Responses

Stakeholder Feedback on Hybrid Resources Definition

Helpful feedback has been provided by stakeholders on all aspects of the hybrid resources straw proposal in their submitted written comments. The CAISO appreciates the engagement and input provided on this initiative. Stakeholder feedback has been included in the revised straw proposal under each major proposal topic. Feedback has been included with stakeholder entities identified and formatted with italicized bullets to indicate it was provided by stakeholders. Some of the stakeholder comments included in each of the sections has been summarized for brevity. Responses and clarifications by the CAISO have been included where applicable. The CAISO has not included supportive feedback received when responses were unnecessary, however CAISO notes that it appreciates all of the positive feedback and supportive comments that have been received.

The CAISO has received the following stakeholder feedback on the hybrid resources definition proposal.

- *CESA supports the proposed definitions and suggested some refinements. CESA believes it may be helpful to also outline how the hybrid resource will be treated in CAISO markets and modeled in the Master File. CESA also suggests that the CAISO treat and model hybrid resources charging from onsite generation only as a generator given that such resources are only capable of positive output to the grid, whereas hybrid resources charging from both onsite generation and the grid as NGRs given that such resources have both positive and negative generation attributes.*

CAISO agrees that the modeling of hybrid resources is important and has taken steps to better outline the potential resource modeling options for hybrid resources in this revised straw proposal. CAISO believes that CESA's suggestion on the suggested modeling of hybrid resources, based on their need or ability to charge from the grid is aligned with the CAISO's expectations, wherein a hybrid resource that does not want the ability or option to charge from the grid should be modeled as a traditional generator, while those that do want the ability or option to charge from the grid should necessarily be modeled as a NGR.

- *EDF, LSA, and Spower support the proposed definitions with suggested additions. They suggest the proposed definition should be accompanied by new associated defined terms including:*
 - *Mixed-Fuel Project, which could be configured as either a Hybrid Resource (single Resource ID) or Collocated Resources (multiple Resource IDs).*
 - *Collocated Resources, the multiple-Resource ID configuration of a Mixed-Fuel Project Collocated Resource, a separate Resource ID of a Mixed-Fuel Project.*
 - *Component, the portion of a Hybrid Resource consisting of capacity of a single fuel type – e.g., a VER-storage Hybrid Resource would have a VER Component and a Storage Component.*

- *EDF, LSA, and Spower: The CAISO should include in the next proposal iteration an explicit statement that a VER Collocated Resource (separate Resource ID) in a VER-storage Mixed-Fuel Project would be treated as a separate project for RPS reporting purposes, consistent with its clarification at the last stakeholder meeting. In other words, round-trip storage losses would not be subtracted from the VER Resource ID output.*

The CAISO agrees with the general concepts of including the suggested defined terms and has included similar concepts in the proposed definition section.

The CAISO intends that co-located resources with separate resource IDs will be treated separately and reported individually for each resource ID for RPS reporting purposes.

The CAISO's understanding is that a co-located storage resource with its own resource ID would not be reported for RPS purposes because they are ineligible for RPS treatment in accordance with the CEC's RPS guidebook. This makes the statement requesting clarification on round-trip storage losses not applicable to co-located resources.

For hybrid resources with a single resource ID with a VER and a storage component together, the CAISO would not subtract round trip storage losses from the RPS reported energy, because that conversion loss would already be captured in the overall metered output of single resource ID hybrid configurations.

- *PG&E: PG&E supports the clarifications made by the CAISO to the hybrid resource definition but requests further details on the minimum sizing requirements section.*
 - *For example, what is the minimum size of solar that can be paired with a 100kW battery to qualify as a hybrid resource?*
 - *Or what is the minimum size of a battery that can be paired with a 500kW solar resource to qualify as a hybrid resource?*
- *PG&E believes that CAISO should consider the impacts of having say a 1 MW battery paired with a 100 MW of storage (or visa versa) if the requirements, market obligations, or compensation of the combined "hybrid" resource are different than the larger resource on its own.*
- *PG&E also believes that there is a potential advantage for energy storage resources participating under the hybrid resource model related to the variable energy resource (VER) forecast component. Since VER forecasts are updated on both 15- minute and 5-minute intervals, the upper economic limit of the hybrid resource's bid curve can be defined on a more granular basis than the bid curves of energy storage resources which can only modify them on an hourly basis in the NGR model.*

The CAISO understands the need for greater clarity on the minimum sizing requirements aspect of the hybrid resource definition. To avoid confusion, the CAISO believes that the minimum sizing requirements for each hybrid resource component should apply, i.e., both the 500kW minimum generator sizing and the 100kW minimum storage sizing requirements should apply to any hybrid resource project. The CAISO believes that the minimum size of solar that can be paired with a 100kW battery to qualify as a hybrid resource should be 500kW. Similarly the

minimum size of a battery that can be paired with a 500kW solar resource to qualify as a hybrid resource should be 100kW.

The CAISO does not believe there should be materially different impacts of having a 1 MW storage resource paired with a 100 MW solar resource (or vice versa). Similarly, the CAISO agrees that the requirements, market obligations, and compensation of the combined “hybrid” resource should not be different than the larger resource would generally have if it was interconnected and operated standalone, unless there are appropriate and justified reasons for any separate treatment.

The CAISO understands the PG&E suggestion that the proposed self-provided forecast option for hybrid resources provides a potential advantage for energy storage resources participating under the hybrid resource model related to the variable energy resource (VER) forecast component.

The CAISO agrees that the option proposed to allow hybrid resource’s self-provided forecasts that can be updated on a 5-minute intervals will provide the ability for the upper economic limit of the hybrid resource’s bid curve to be defined on a more granular basis than the bid curves of energy storage resources which can only modify them on an hourly basis in the NGR model. The CAISO believes the perceived advantage for storage resource components of hybrid resources, as described by PG&E, is not unfair or inappropriate because hybrid resources are sufficiently different than standalone storage resources.

The CAISO believes this proposal is appropriate because it will be necessary to apply this functionality for hybrid resource participation to ensure they receive feasible market awards and dispatch instructions. Further, the CAISO believes that it not necessary to propose alternatives or otherwise resolve this perceived advantage or difference in treatment. The CAISO is open to additional feedback on this position – if stakeholders believe aspect of the proposal would need to be addressed the CAISO is open to considering suggestions and seeks input on if this is necessary in stakeholder’s opinions, and if so, how to modify this aspect of the proposal to address continued concerns related to this issue.

- *Pintail Power: Pintail Power believes that the proposed definition omits the essential component of a hybrid resource: the storage element. Pintail suggests the definition instead limit hybrid resources to only those combination of generation including a storage technology component. Pintail Power believes that explicitly requiring a storage component in the definition is essential to distinguish from, for example multi-unit generators, and that identifying the charging sources is needed to understand the use of hybrid resources within the CAISO.*

The CAISO appreciates Pintail Power’s suggestions regarding the hybrid resource definition and the request to clarify the application of the definition to certain resource types such as multi-unit generators. The CAISO disagrees that it is necessary to explicitly include storage technology as a requirement of hybrid resources. This is because the suggested approach

would preclude combinations of generation technologies that did not include a storage component from qualifying as a hybrid resource.

The CAISO believes that combinations of multi-fuel/multi-technology units should qualify as hybrid resources regardless of the inclusion of storage technology components. Even though CAISO anticipates that a majority of the projected hybrid resource development will include some amount of storage technology components, the CAISO believes that the hybrid resource definition should not be limited in the manner suggested by Pintail Power.

The CAISO agrees with the suggestion to clarify the application of this defined term, hybrid resources should necessarily preclude multi-unit generators or multi-stage generators that do not have multiple generation technologies or multiple fuel types. For example, a solar project with multiple solar units behind a single point of interconnection would not qualify as a hybrid resource. Similarly, a wind project with multiple wind units behind a single point of interconnection would not qualify as a hybrid resource. Further, a multi-stage generator such as certain combined cycle natural gas thermal generating units behind a single point of interconnection would not qualify as a hybrid resource either.

The CAISO agrees with Pintail Power's suggestion that identification of charging sources of hybrid resource storage components is needed to understand and enable the participation of hybrid resource, and this designation will need to be selected by hybrid resource interconnection customers when they are selecting how their resource will be modeled through the CAISO's New Resource Implementation (NRI) process.

- *SCE: SCE agrees with the CAISO's definition and supports the CAISO's intent to explore exceptions to the rule. SCE also supports the CAISO's proposed sizing requirement to conform to its tariff. SCE also supports the CAISO exploring needs of co-located resources (CLR) as differentiated from Hybrid Resources (HR). While the resource-ID-specific distinction clearly distinguishes between the two types of resources, it is appropriate for the CAISO to address needs arising from CLR participation within the scope of this initiative.*

The CAISO appreciates the support for the proposed definition clarifications and agrees with the SCE suggestion to clearly differentiate the co-located resources and to address any co-located related issues through the scope of the hybrid resources initiative. The CAISO has also clarified the definition further to delineate the defined terms for co-located resources and other associated terms arising from or related to the various aspects of the proposal.

- *SDG&E: SDG&E supports CAISO definition of hybrid resources. SDG&E agrees that co-located resources with two or more resource IDs should continue to be treated as separate resources and should be excluded from the hybrid resource definition. However, SDG&E would like the CAISO to clearly note that resources such as multi-stage generators would not be expected to be categorized as a hybrid resource.*

The CAISO agrees with the suggestion to clarify the application of the defined term, hybrid resource should necessarily preclude multi-stage generators that do not have multiple

generation technologies or multiple fuel type components. The CAISO clarifies that a multi-stage generator such as certain combined cycle natural gas thermal generating units behind a single point of interconnection would not qualify as a hybrid resource.

- *Wellhead: Wellhead appreciates the thoughtfulness of CAISO's Hybrid Resources Straw Proposal. Wellhead believes it may be useful for the CAISO to provide some further differentiation between the generator and non-generator models as was done in the 2016 Technical Bulletin on the Implementation of Hybrid Energy Storage generating Facilities.*

The CAISO appreciates the support provided by Wellhead on the proposal overall. The CAISO agrees with the suggestion by Wellhead to provide further differentiation between the potential modeling approaches that can be applied for hybrid resource participation in the straw proposal to better align with the approach utilized in the 2016 Technical Bulletin and provide better clarity on how these configurations will be implemented. These clarifications are mentioned in this hybrid resources definition section and are also included in the appropriate aspects of the proposal related to the modeling of hybrid resources.

Stakeholder Feedback on Business Drivers and Use Cases

- *CalCCA agrees that the use cases for Hybrid Resources and Co-located Resources may overlap. Because of this, it is important to ensure that both configurations can be accommodated and that any differential treatment be applied only where necessary.*

The CAISO appreciates CalCCA's comments and agrees that treatment of hybrid and co-located resources should be as consistent as possible. However, the CAISO notes there are some significant differences that will warrant different treatment for these different configurations.

- *First Solar: FSLR supports the identified business cases, and suggests including black start capability as an additional use case. As inverter-based resources replace fossil units on the grid, identifying new resources capable of black start will be key to ensuring quick recovery from system events. Imperial Irrigation District successfully tested a battery system providing black start services in 2017.*

The CAISO has been made aware of the black start capability of storage resources. The CAISO understands that hybrid resources with storage components, or storage in co-located resources may also provide this capability. However, the CAISO does not believe this function will be a major business driver or use case for hybrid resources.

The CAISO does not intend for the business drivers and use cases provided through this initiative to be an exhaustive list of potential applications and this does not preclude alternative or additional uses and applications from being utilized or developed for participation in CAISO markets. If additional applications become prevalent in the future, the CAISO will address more

specific needs for those use cases in future related initiatives that may be needed to refine the proposals developed under this first hybrid resources proposal.

- *PG&E: PG&E generally supports the presentation of business drivers and use cases described by the CAISO but believes there is value in bundling certain use cases. Due to the varying use cases of hybrid resources and out-of-market incentive of the ITC, PG&E suggests that CAISO entertain two scenarios of hybrid treatment, each containing a specific forecasting proposal, QC counting methodology and MOO. PG&E believes considering these alternatives could be informative given the different operating and production preferences which may lead to inconsistencies in treatment.*
 - *PG&E refers to these two scenarios as “ITC-Driven” and “Market-Driven”, based on the presumed main incentive of creating the resource.*
- *PG&E believes it is important to point out again that any decision regarding hybrid QC methodology (or methodologies) must be decided at the CPUC within its respective stakeholder process.*

The CAISO appreciates the suggestion by PG&E to make specific differentiation for mixed fuel projects that may have operational restrictions due to considerations such as the ITC. The CAISO does not believe it is appropriate to fully differentiate rules for market participation simply to accommodate an out-of-market incentive such as the ITC. Similarly, the CAISO does not believe it is necessary to create separate categories to specifically deal with ITC implications for all aspects of hybrid resource participation.

Rather, the CAISO believes that simply applying different resource adequacy provisions for hybrid resources with operational restrictions should be sufficient. The CAISO does not believe there should be any inconsistent treatment in the market participation of different hybrid resource use cases, other than only those that are truly necessary, and in the CAISO's view, the only material differences that should be considered are the resource adequacy value of resources with operational restrictions, e.g., storage charging restrictions due to ITC considerations.

The CAISO acknowledges the issue that PG&E notes regarding the CPUC decisional authority for QC methodologies for hybrid resources. The CAISO believes the CPUC's recent proposed decision for hybrid resource QC methodology for resources with operational restrictions should align with the CAISO's proposed default QC as updated in this proposal iteration. The CAISO also notes that it may develop default QC criteria under current authority and will continue to propose a default QC methodology for hybrid resources as an aspect of this proposal.

- *Pintail Power believes that CAISO will derive benefit from hybrid resources primarily by time shifting energy production in order to enhance renewable energy production, in other words storing renewable over generation for later dispatch to reduce carbon intensity.*
 - *Pintail Power suggests the ability to move over-generation into storage is primarily driven by CAISO's markets, which will set the economic parameters for large-scale storage, and its transmission and generation constraints. For*

hybrid resources to deliver this value, the storage function must interact with the CAISO grid, by time shifting energy subject to CAISO's schedule, or as a self-scheduled load that offers energy to CAISO.

- *Pintail Power believes that long-duration storage resources will add disproportionate value by spanning market periods to remove constraints on charging or cost of charging. We urge CAISO to evaluate business cases that enable storage of over-generation on weekends (for example the 32 GWh of curtailed solar PV on 21 April 2019) for dispatch during a subsequent week.*
- *Pintail Power fails to see how CAISO benefits from structuring its market to facilitate or favor the profitability of individual entities, particularly when the ITC capture precludes the ability of CAISO to use the storage to benefit all CAISO participants.*
 - *Accordingly, Pintail Power believes that ITC capture should not be a CAISO business driver.*
 - *Likewise, while leveraging DC coupling may be of technical and economic interest to a few projects, we would point out that CAISO does not operate or manage low-voltage DC grids. These technologies accrue benefits to their interconnection customers, and unless there is a reduction of CONE, we fail to see how CAISO stakeholders at large benefit.*

The CAISO agrees that market prices and related market signals will need to drive the ability for storage to economically shift energy production as suggested by Pintail Power. However, the CAISO does not agree that the CAISO should pre-determine schedules for time shifting of energy productions or that self-scheduling to achieve that sort of outcome is the most efficient means to achieve energy shifting. The CAISO believes that market price signals should dictate the most efficient utilization of storage resources to deliver the most value from these resources.

The CAISO understands Pintail Power's suggestion to evaluate a long-duration storage use case as part of this initiative but declines to include such an undertaking as part of this initial hybrid resources initiative effort. The CAISO does not believe that long duration storage use case will inform alternative outcomes or require specific proposal design elements to enable hybrid resource participation in the CAISO markets. However, the CAISO understands this issue will become more important as the penetration of solar and storage resources increases and intends to evaluate the need for future related enhancements.

The CAISO agrees with Pintail Power's view that the CAISO should not be structuring its market provisions to facilitate or favor the profitability of one technology over others – this is inherent in the CAISO's mandate for independence. The CAISO does not intend for any proposal aspects to favor one technology or configuration in the manner suggested by Pintail Power.

The CAISO notes that the ITC business driver has been included because it is a major driver for the development of hybrid resources and the CAISO intends to consider how to develop provisions that facilitate the development and participation of these resources in a transparent and non-discriminatory manner. All of the business drivers and use cases included in the proposal are not specifically intended to be focused only on those beneficial to CAISO. Instead,

they are intended to capture the reasons that interconnection customers and participants would choose to create hybrid resources to help inform the various proposal elements.

- *SCE: SCE agrees with the CAISO's non-exhaustive list of identified areas of impact and their associated opportunities from HR participation. In one observation, the CAISO notes the decline of the ITC from 2022 onward. The interplay of this decline with HR participation preference may lead to HR storage components relying on grid charging, in an increasing number of hours, rather than charging from the paired HR resource.*
 - *While the original intention of interconnection may not have been so, an evolving market may not necessarily support the same participation preferences. SCE suggests the CAISO should recognize that current assumptions made in this initiative may change and allow for a more robust market design.*

The CAISO agrees with SCE's view that the provisions for hybrid resources should be considered in the future due to the evolution and flexibility needed as hybrid resource use cases and participation changes. The CAISO agrees these provisions may need to be reevaluated as circumstances change and intends to refine them in the future as needed.

- *SERC: SERC supports with caveats the CAISO's perspective on Hybrid Resource business drivers and use cases. SERC recommends that the CAISO also consider business drivers and use cases that fall outside of the CAISO market arena, but that may still impact the participation of a hybrid resource in the CAISO market.*
- *SERC believes that microgrids will become a common feature of our distribution system in the future and that some microgrids will choose to participate in the CAISO market as hybrid resources.*
 - *SERC recommends that the CAISO include a Hybrid Resource use case called "Providing resilience through microgrids." This use case should articulate what a microgrid is, how it is likely to be used, and how this might impact CAISO market participation.*
- *SERC believes there will be a desire/need for microgrid projects to maintain some reserve capacity in their battery energy storage systems, to be used for resilience purposes, by keeping it out of the CAISO market. There is currently not a way to achieve this, and this has come up for us as an issue as we work to establish an interconnection agreement with CAISO for our local microgrid project, the Redwood Coast Airport Microgrid.*
- *SERC suggests that the CAISO include accommodations for microgrids, and consider how to allow such resources the ability to hold back a reserve capacity of energy storage for resiliency purposes.*
 - *While SERC understands that CAISO currently has an expectation that the entire capacity of a BESS be available for dispatch, we propose that this requirement be modified for microgrid applications.*

- *One main function of distributed resources in the case of microgrids, is their ability to provide resilience in the form of back up power when needed. Therefore, the ability to partition out a portion of energy storage for resiliency purposes that will never be offered in the CAISO market is an important feature.*

The CAISO understands SERC's suggestion to include microgrids as a use case for hybrid resources under this initiative. The CAISO does not believe that microgrids will drive different rules or provisions needed for hybrid resource participation and has not included this issue as a specific use case in the proposal. However, the CAISO acknowledges the need to consider the issue that SERC raises regarding the storage reserve capacity need for microgrid resiliency purposes. The CAISO understands the need to allow for some amount of storage resources or hybrid resource components to be partitioned for back up islanding capability by resources included in microgrids. The CAISO is currently considering how this issue can be included in this proposal or otherwise accommodated through other avenues.

- *Wellhead: Wellhead appreciates the CAISO including potential hybrid business drivers and use cases as part of this initiative. These use cases can serve as valuable checkpoints for the systems/methods proposed for forecasting, markets and systems, AS, metering and telemetry, and RA. It may also be useful to look ahead include the proposed imbalance reserve product in this list. While not critical, it may also be of some value for the CASIO to also include some discussion of the drivers and use cases for colocated resources, particularly preserving the full value of existing RPS generation.*

The CAISO understands Wellhead's suggestion to create specific categories of use cases and business drivers specifically for hybrid resources and co-located resources to differentiate between the two options. The CAISO agrees this approach could help to inform stakeholders about the configuration options and potential use cases and benefits associated with each.

- *WPTF suggests that CAISO should include a reliability and capacity related business driver or use case. Given that new resources take three years to go through the interconnection queue, there are limited options on how to access additional capacity. One of the best ways to get additional capacity on the grid is to better utilize existing solar and wind interconnections by pairing the resources with storage.*
 - *WPTF encourages the CAISO to prioritize short-term rule changes that can be made via BPM and process changes to enable this capacity to come online quickly and in a reasonable manner.*
 - *WPTF suggests that CAISO should focus on items that will get the CAISO what it needs in terms of reliability rather than minor improvements in the optimization.*

The CAISO agrees with the suggestion by WPTF to include reliability and capacity as a use case. The CAISO believes it has captured this aspect in the current use cases and business drivers. The proposal includes a resource adequacy related item as one of the business drivers and use cases. This item is intended to capture the issue that WPTF suggests has been omitted and the proposal has been refined to better incorporate the aspects that WPTF suggests. The CAISO has incorporated the feedback from WPTF to refine the item in this section, which has been renamed to the “resource adequacy and reliability” use case and business driver.

The CAISO agrees with WPTF that needed additions to existing projects can be useful to meet impending capacity needs and has been working to allow these material modifications to be brought online as quickly as possible. The ability for CAISO to propose and implement short-term changes is limited to provisions that can be implemented without significant system changes, which may preclude some interim measures that have been discussed from being viable options.

Stakeholder Comments on Forecasting Proposal

- *8minute recommends the ISO perform forecasting for the VER components of hybrid resources. 8minute also suggest the ISO allow the hybrid resource operator to generate a VER forecast that replaces the ISO forecast. In either case, the forecasting component of the combined hybrid resource should be performed only for the VER. 8minute suggests the scheduling coordinator will submit a forecast for the combined resource as described in the proposal to set the upper limit for the economic dispatch.*
 - *8minute also notes that the ISO should consider the need to specify a lower (charge) limit for the project so that BESS is not charged from the grid, due to ITC requirements.*
- *8minute recommends that ISO have access to telemetry from the site to show the SOC, number of cycles and power output of the BESS. Further discussion is needed to determine how the ISO will utilize these data points in their operations.*
 - *8minute believes the ISO can use the information suggested to determine a feasible range of output from the hybrid resource in terms of both magnitude and duration.*
 - *8minute also notes that most BESS systems come with limits on the number of cycles per year to maintain battery warranty. If the BESS has reached its limits, then the plant can only utilize the VER component. Similarly, if the BESS is fully charged from the on-site resource, it cannot be used to smooth VER output.*
- *8minute also suggests that hybrid resources be treated like PIRP program participants. This is so that the hybrid resources do not get penalized for missing its target dispatch power level because of inaccuracies in forecasts.*

The CAISO has received many stakeholder suggestions to provide forecasting for the VER components of hybrid resources. The CAISO has included this suggestion in the revised straw proposal and will provide the option for hybrid resources to receive CAISO forecasting for the

VER components. The CAISO will require all meteorological and telemetry data necessary to provide accurate VER component forecasts.

The CAISO disagrees with 8minute's suggestion to include a proposal to create a new way for resources to specify a lower charging limit due to ITC considerations. The CAISO does not believe that ITC considerations should drive market design features. This concern can be addressed through the existing bidding mechanisms available to hybrid resources.

The CAISO agrees with the suggestion for requirements to provide the state of charge and telemetry of the output or charging status of hybrid resource storage components. The CAISO does not believe that the number of cycle's data point for storage components is relevant to the CAISO markets and disagrees that it should be a required data point. The CAISO does not believe that number of cycles or their impact on battery warranties should be an input to the CAISO's market processes or systems. Any associated management of the utilization of storage components should be performed by the resource owner/operators. Resource interconnection customers can choose the co-located option if they believe the risk of hybrid resource operation related to the cycling of battery components is too burdensome.

The CAISO declines to propose to develop a forecasting methodology for hybrid resources as a whole – this suggestion merits consideration but the CAISO believes that it is not possible for the CAISO to accurately forecast hybrid resources due to the decisions made by resource owner/operators to charge or discharge storage components of hybrid resources. The CAISO believes that resource owner/operators should be responsible for forecasting the overall output of hybrid resources, based on their decisions for the onsite optimization of the overall hybrid resource and its underlying components. The CAISO will not have the ability to dictate the behavior or dispatch of underlying hybrid resource components, only the overall resource. The proposal to use the resource provided forecast to ensure feasible dispatch and market awards is necessary to keep the CAISO from having to make inaccurate assumptions about the behavior of individual hybrid resource components.

The CAISO disagrees with 8minute's suggestion that hybrid resources should be allowed to participate or be treated as PIR or EIR resources. The addition of storage components precludes this categorization of hybrid resources and the CAISO cannot propose this treatment. The hybrid resource would continue to retain its VER status as defined in FERC Order 764, but would not be treated as an EIR and PIR in the master file or CAISO market settlement. This is because its operational characteristics and market behavior do not allow it to operate as an EIR or PIR under current market settlement rules and processes. Under this option, a hybrid resource cannot be certified with a PIR status because the CAISO cannot produce an accurate forecast based on the data provided. In other words, the CAISO could not accurately forecast the MW output of an overall hybrid resource with a solar or wind component and a storage component due to the impact the charging or discharging storage unit has on the output of the combined hybrid resource.

Because hybrid resources will be considered fully dispatchable resources, the CAISO does not agree that they should not be penalized for deviations from their market awards and dispatch instructions, rather they should be treated the same as other dispatchable resources. If resource

interconnection customers do not want to be exposed to this risk for deviation from market awards or if they wish to retain their ability to participate as PIR or EIR resources the CAISO notes that they may choose the co-located resource configuration and, with separate resource IDs, any co-located VER resources eligible for PIR or EIR treatment may retain that status and treatment.

- *AWEA believes CAISO's proposal to allow hybrid resources to self-submit forecast schedules should provide hybrid resource owners with the flexibility to optimize their project based on the value driver of the project. AWEA supports CAISO's proposal to allow self-submission of forecasts for hybrid resources. If "strategic forecasting" is something CAISO plans to monitor for, then CAISO should provide all stakeholders with a definition of "strategic forecasting" and clearly define the types of market behavior that CAISO is seeking to prevent.*
 - *Market participants will need a clear understanding of what self-provided forecasting and related bidding behaviors are acceptable and what will be considered "strategic" and potentially problematic.*
- *AWEA suggests that CAISO has proposed that, for all hybrid resources CAISO will not provide forecasting, even for the underlying VER components of the resource. It should be noted that a hybrid resource could well be composed of two individual VER components (e.g. wind and solar).*
 - *AWEA suggests that, at a minimum, when the underlying components of the hybrid resource are VERs, CAISO should continue to provide forecasting for the resource. Additionally, many resource owners may wish to pay a forecasting fee to CAISO in order to obtain a forecast for the portion of a hybrid resource which is VER. CAISO should provide hybrid resources with optional forecasting of the VER component to maximize flexibility.*

The CAISO understands the AWEA suggestion to clarify the strategic forecasting issue and has included further information in the proposal to describe this issue in greater detail.

The CAISO has received many stakeholder suggestions to provide forecasting for the VER components of hybrid resources. The CAISO has included this suggestion in the revised straw proposal and will provide the option for hybrid resources to receive CAISO forecasting for the VER components. The CAISO will require all meteorological and telemetry data necessary to provide accurate VER component forecasts.

- *CalCAA: CAISO is proposing to provide forecasting only for Co-located Variable Energy Resources (VER), and to not provide forecasting for Hybrid Resources. While CalCCA appreciates that with a single Resource ID it might not be possible for CAISO to accurately forecast combined Hybrid Resource production, CalCCA urges CAISO to consider providing forecasting services, as requested by the resource's Scheduling Coordinator, for the VER component of the Hybrid Resource, as long as appropriate metering and meteorological data were provided to the CAISO and the resource paid the VER forecast fee.*

- *This would allow the Hybrid Resource owner to benefit from the CAISO's access to specialized VER forecasting expertise, while the CAISO would benefit from access to more data to improve its forecasting, improved operational situational awareness, and broader sharing of forecasting costs. The resource owner could incorporate the CAISO forecast information into its combined forecast for the Hybrid Resource (or use its own VER forecast), which it would provide to CAISO for CAISO to use, in conjunction with storage State of Charge, to develop the upper economic limit for dispatch targets.*
- *CalCCA urges CAISO to identify in more detail what its concerns may be about potential "strategic use" of the Hybrid Resource forecast, any potential adverse consequences for the CAISO markets, potential mitigation measures, and alternative approaches for determining Hybrid Resource potential that could address the CAISO's strategic use concerns. For example, if CAISO had VER resource visibility and access either to its own or a certified VER forecast, along with storage state of charge visibility, would CAISO still have strategic use concerns?*

The CAISO has received many stakeholder suggestions to provide forecasting for the VER components of hybrid resources. The CAISO has included this suggestion in the revised straw proposal and will provide the option for hybrid resources to receive CAISO forecasting for the VER components. The CAISO will require all meteorological and telemetry data necessary to provide accurate VER component forecasts.

The CAISO declines to propose to develop a forecasting methodology for hybrid resources as a whole – this suggestion is infeasible due to the decisions made by resource owner/operators to charge or discharge storage components of hybrid resources. The CAISO believes that resource owner/operators should be forecasting the overall output of hybrid resources, based on their decisions for the onsite optimization of the overall hybrid resource and its underlying components. The CAISO will not have the ability to dictate the behavior or dispatch of underlying hybrid resource components, only the overall hybrid resource. The proposal to use the resource provided forecast to ensure feasible dispatch and market awards is necessary to keep the CAISO from having to make inaccurate assumptions about the behavior of individual hybrid resource components. The State-of-Charge data point is important for the CAISO to determine if it will be necessary to claw back Ancillary Services awards, based on the current AS no pay provisions.

The CAISO understands the CalCCA suggestion to clarify the strategic forecasting issue and has included further information in the proposal to describe this issue in greater detail.

- *CESA believes that the CAISO should modify the requirements of the self-provided forecast to be based on the available energy output of the generator (based on meteorological or other forecast data) and the available state of charge (SOC) of the battery. Given the flexibility for the battery charging, bidding from such resources are not necessarily limited to the forecasted output of the onsite generator. As such, it appears reasonable to consider how the available SOC of the storage device should be reflected in the self-provided forecast of the hybrid resource acting as an NGR.*

- *CESA recommends that the CAISO develop further details on how bidding for hybrid resources could be updated more frequently (e.g., up to 5-minute intervals) than the current process that allows for an update once an hour at 75 minutes prior to the operating hour. Unlike EIRs, where the CAISO can update their forecasts in near real-time fashion, hybrid resources would be treated as a non-EIR dispatchable generator according to the Straw Proposal, which may overly penalize hybrid resources from forecast deviations.*
 - *While self-provided forecasts should be reasonably accurate, CESA believes that hybrid resources may be unreasonably assessed forecast deviation penalties if not allowed to update their bids closer to the operating hour when forecasts increase in accuracy.*
 - *In addition, though the paired storage resource is intended to mitigate forecast uncertainty of the onsite variable generator, the current proposal for bidding for hybrid resources would make it difficult for storage resources with smaller storage to-generator sizing ratios to mitigate large forecast deviations, which even the best forecasting methods and tools cannot always mitigate or minimize. For projects seeking to enhance renewable energy production through smoothing, this inability to update forecasts more frequently can be harmful, but there may also be other use cases that could benefit from these changes.*
- *CESA seeks further information on how the CAISO will monitor and enforce “strategic forecasting”. With imbalance charges in place for forecast deviations, CESA believes that hybrid resources will have a financial disincentive for such improper strategic forecasting. Clarifications on what constitutes strategic forecasting will be helpful for hybrid resource bidding.*
- *CESA recommends that the CAISO allow for different pathways to ensure accurate forecasts. While having onsite meteorological stations can be one means to provide accurate forecasts, some interconnection customers use alternative means, such as satellite derived solar irradiance data and measurement or sky imagers, in order to track and predict cloud formations and forecast their output. There may be financial burdens or implementation challenges for certain interconnection customers to have onsite meteorological stations to have individual generator operators to submit plant-level forecasts. In addition, if feasible, CESA also wishes to explore whether interconnection customers could receive and access the CAISO-performed forecasts for a service fee. Some interconnection customers and operators, especially those with little experience or market penetration, might not be able to perform a forecast as accurate as that of CAISO.*

The CAISOs’ self-provided forecast proposal for hybrid resources is intended to capture the overall capability of the hybrid resource, including the potential output of all underlying components. As CESA suggests, the proposal states that self-provided forecasts should include the capability of storage components, and the resource should incorporate the state of charge, as well as the onsite optimization of the hybrid resource in its’ self-provided forecast. In other words, the VER component forecast output, the storage component State-of-Charge, and the storage component charging or discharging operations should all be incorporated in the self-

provided forecast. The self-provided forecast should reflect the fact that the onsite optimization of resource components will be left up to the resource owner/operator, not the CAISO. The CAISO will only optimize the use of the overall hybrid resource through the markets at the system level based upon its bids and self-provided forecast.

The CAISO declines to include modifications to bidding timing or market bidding parameters as a part of the scope of this initiative. The concerns raised by CESA can be mitigated through the proposed use of the self-provided forecast to manage the upper economic limit of hybrid resources on a 5 minute basis. The CAISO believes that the issues raised by CESA will be addressed through this proposed modification to provide dynamic upper economic limit for hybrid resources in the Real-Time market. The CAISO cannot change the bidding timing due to existing market design timing, any changes to allow more frequent updates to resource bids would impact the ability for the CAISO markets to function as designed to provide efficient awards and dispatch instructions.

The CAISO understands CESA view that the proposal for hybrid resources to be treated as dispatchable resources may make it difficult for certain configurations or sizing of components to mitigate market price risk. The CAISO declines to address this concern through modifications to the proposal for hybrid resource participation and instead suggests that the co-located resource option would address those risks and allow for projects with relatively small amounts of storage to be paired with larger VER resources.

The CAISO understands the CESA suggestion to clarify the strategic forecasting issue and has included further information in the proposal to describe this issue in greater detail.

The CAISO understands the suggestion that alternative forecasting information can be used to provide accurate forecasting and does not intend to preclude hybrid resources from using any alternative options. However, the CAISO believes that the proposal to require the same meteorological stations is appropriate to ensure the CAISO has consistent data to perform its own forecasts of VER components of hybrid resources. The CAISO has received many stakeholder suggestions to provide forecasting for the VER components of hybrid resources. The CAISO has included this suggestion in the revised straw proposal and will provide the option for hybrid resources to receive CAISO forecasting for the VER components. The CAISO will require all meteorological and telemetry data necessary to provide accurate VER component forecasts.

- *EDF-R supports the overall concept that forecasting be used to limit financial risks of hybrids with VER Components. As noted above, the concept of the forecast as the “upper economic limit” should be applicable to hybrids with significant VER Components, as it is for VERs. However, EDF-R believes this element as proposed is not practical. As noted in the discussion at the stakeholder meeting, assuming at least some market bids for the storage component, CAISO scheduling and settlements for VER-storage hybrids essentially consists of scheduling/settlement for the VER Component plus scheduling/settlement for the Storage Component. While the VER Component output can be forecasted, the output (and charging) activity of Storage Components with any*

market bids would essentially require before-the-fact forecasts of CAISO markets, e.g., market-clearing prices and real-time dispatch pursuant to market bids.

The CAISO disagrees with EDF-R's assertion that the self-provided forecast proposal is not practical. The CAISO is providing this option for hybrid resource participation to enable interconnection customers the flexibility needed to perform the onsite optimization of hybrid resource components. This does not mean that the self-provided forecasts will necessarily be the most efficient or optimal utilization of the hybrid resource components at a system-wide level, and will require that hybrid resource owner/operators make some assumptions about market prices and dispatches, as well as anticipate the way they would be charging or discharging storage components of hybrid resources. This would all be necessary to provide the proposed self-provided forecast for hybrid resources.

The CAISO suggests that for the resource components to be optimized at the system wide level by the CAISO markets, the option for co-located resources is available. Co-located resource configuration will allow for each part of the project to be optimized at the system wide level by the CAISO markets. The CAISO believes this will result in greater benefits to the system and more efficient utilization of resources.

- *First Solar: While a predominant focus of this initiative rightly should be on the integration of on-site storage with a VER, FSLR believes that alternative hybrid structures will seek interconnection in the future. To that end, CAISO should clarify that hybrid resources composed of two separate VERs (e.g., solar + wind) will retain their status as EIR generating resources.*
- *Additionally, while FSLR agrees with the concept that scheduling coordinators should have the capability to provide forecasts, we also believe there is no reason for CAISO to prohibit scheduling coordinators from accessing CAISO's forecasting capabilities for the VER component(s) of a hybrid resource. CAISO should clarify that it is willing to continue offering that as a service.*
- *FSLR believes that CAISO's belief that the storage asset can mitigate forecast variability is somewhat misplaced; such a strategy would harm that resource's ability to meet its forecast in subsequent hours of the day and, in particular, during system net load peak conditions.*
 - *The result of this requirement would be a different cycling strategy of the battery, which may harm its long-term life and associated value proposition as an RA resource. FSLR understands CAISO's desire to treat hybrid resources as dispatchable. It should still be possible, however, to provide data visibility on the VER forecast, charging schedule, and net POI forecast such that weather intermittency can be identified. FSLR encourages the CAISO to review the data requirements it would need access to in order to facilitate hybrid resources being EIRs.*

The CAISO does not believe that hybrid resources comprised of solar and wind components should be considered EIRs, even if only wind and solar components have been combined under

a single resource ID. The combination of more than one fuel type – even of VER resources only – will cause issues for the forecasting and market treatment of those hybrid resources that will preclude them from being considered EIRs.

The hybrid resource would continue to retain its VER status as defined in FERC Order 764, but would not be treated as an EIR and PIR in the master file or CAISO market settlement. This is because its operational characteristics and market behavior do not allow it to be treated as an EIR or PIR under current market settlement rules and processes. Under this option, a hybrid resource cannot be certified with a PIR status because the CAISO cannot produce an accurate forecast based on the data provided. In other words, the CAISO could not accurately forecast the MW output of a solar or wind generating unit due to the impact the charging or discharging storage unit has on the output of the combined hybrid resource. If interconnection customers wish to create multi-fuel projects of only VER type resources to retain their EIR status they should choose to be configured as two or more resource IDs under the co-located resources option.

The CAISO has received many stakeholder suggestions to provide forecasting for the VER components of hybrid resources. The CAISO has included this suggestion in the revised straw proposal and will provide the option for hybrid resources to receive CAISO forecasting for the VER components. The CAISO will require all meteorological and telemetry data necessary to provide accurate VER component forecasts.

The CAISO intends that hybrid resource participation is heavily reliant on the management of the resource components by the resource owner and the onsite optimization of resource components will need to be performed by the resource owner, not the CAISO. The CAISO does not believe that the concerns regarding the cycling of hybrid resource storage components is relevant to the CAISO market provisions and disagrees that it should be explicitly considered in the participation of hybrid resources.

The CAISO does not believe that number of cycles or their impact on battery warranties should be an input to the CAISO's market processes or systems. Any associated management of the storage component use should be performed by resource owner/operators and managed through their use of bids/offers and the self-provided forecast for hybrid resources. Resource owners can choose the co-located resources option if they believe the risk of hybrid resource operation related to the cycling of battery components is too burdensome or may risk violating warranty provisions that are necessarily outside of the CAISO market's considerations.

- *LSA: LSA supports the overall concept that forecasting be used to limit financial risks of hybrids with VER Components. As noted above, the concept of the forecast as the "upper economic limit" should be applicable to hybrids with significant VER Components, as it is for VERs. However, this element as proposed is not practical. As noted in the discussion at the stakeholder meeting, assuming at least some market bids for the storage component, CAISO scheduling and settlements for VER-storage hybrids essentially consists of scheduling/settlement for the VER Component plus scheduling/settlement for the Storage Component. While the VER Component output can be forecasted (see below), the output (and charging) activity of Storage*

Components with any market bids would essentially require SC before-the-fact forecasts of CAISO markets, e.g., market-clearing prices and realtime dispatch pursuant to market bids, which would be problematic for any resource.

- *Instead, LSA believes the forecasting requirement for VER-storage hybrids should be limited to the VER Component. At a minimum, as long as they are willing to provide met data and separate telemetry to CAISO, hybrids should be able to: Receive CAISO forecasts for their VER components; and Be allowed to deviate from their Dispatch Operating Targets (DOTs) using their VER capacity.*
- *LSA suggests the CAISO should be able to use the proposed “interconnection rights constraint” functionality to accommodate the dual nature of Hybrid Resources, (e.g., meteorological data needed for VER forecasts).*
 - *LSA believes the interconnection rights constraint could use a new Master File field to tie together the multiple Resource IDs of Collocated Resources, to adjust Energy and Ancillary Services market awards, schedules, and dispatches in order to enforce the overall project maximum POI injection rights without stranding capacity. This ability to tie two Resource IDs together in the Master File could also be designed to tie two Components of a hybrid together. The VER Component could be treated like a VER, receiving VER forecasts and perhaps even participating in PIRP (have CAISO forecast output, submit RT schedules, and adjust those schedules in real time to reflect forecast changes, as it does for PIRs). The Storage Component could then be bid or scheduled separately, since the resource owner would have no way to anticipate the outcome of its storage-related bids, and the Master File functionality would net the two components to produce a combined Resource ID settlement.*

The CAISO disagrees with LSA’s assertion that the self-provided forecast proposal is not practical. The CAISO is providing this option for hybrid resource participation to enable resource interconnection customer the flexibility to perform the onsite optimization of hybrid resource components. This does not mean that the self-provided forecasts will necessarily be the most efficient or optimal utilization of the hybrid resource components at a system-wide level, and will require that hybrid resource owner/operators make some assumptions about market prices and dispatches, as well as anticipate the way they would be charging or discharging storage components of hybrid resources. This would all be necessary to provide the proposed self-provided forecast for hybrid resources.

The CAISO disagrees with the LSA suggestion that the forecast self-provided for hybrid resources should be limited to the VER components of the resource, and that hybrid resources should be allowed to deviate from their forecasts or dispatch targets. Hybrid resources would continue to retain VER status as defined in FERC Order 764, but would not be treated as an EIR and PIR in the master file or CAISO market settlement. This is because its operational characteristics and market behavior do not allow it to be treated as an EIR or PIR under current market settlement rules and processes. Under this option, a hybrid resource cannot be certified with a PIR status because the CAISO cannot produce an accurate forecast based on the data provided. In other words, the CAISO could not accurately forecast the MW output of a solar or

wind generating unit due to the impact the charging or discharging storage unit has on the output of the combined hybrid resource. The option for co-located resources will allow VER resources to retain their EIR status and treatment.

The CAISO has received many stakeholder suggestions to provide forecasting for the VER components of hybrid resources. The CAISO has included this suggestion in the revised straw proposal and will provide the option for hybrid resources to receive CAISO forecasting for the VER components. The CAISO will require all meteorological and telemetry data necessary to provide accurate VER component forecasts.

The CAISO declines to propose the treatment suggested by LSA to use the interconnection constraint proposal to better accommodate hybrid resources or to somehow optimize the utilization of hybrid resource components. This suggestion is infeasible due to the decisions and assumptions required for the onsite optimization of hybrid resource components. The CAISO will not be able to determine when hybrid resource components should be charging or discharging and how much of the VER component output should be used to charge the storage component. These are only some examples of the complexity that would preclude the suggestion by LSA from being developed.

The only option that would allow this type of treatment of onsite optimization of underlying components for hybrid resources is for the CAISO to develop a new hybrid resource participation model. This option has already been discussed and precluded from the scope for this initiative due to the complexity and implementation burdens associated with such an undertaking. The CAISO may need to revisit this possibility in future phases of hybrid resource initiatives, but given the existing plans for implementation of the other market design enhancements, the CAISO declines to develop a new market model at this time.

The CAISO not proposing to allow for different bids to be provided for hybrid resource components as part of this initial phase of hybrid resource participation. The current proposal allows for bids to be provided only for the overall hybrid resource as a whole and the CAISO will treat hybrid resources similarly to other dispatchable generators. Similarly, the CAISO will not allow for separate dispatch instructions of the underlying components of hybrid resources as suggested by LSA. This is not feasible given the current market design and resource ID configuration in the Masterfile. The possibility for the resource components to be optimized at the system wide level by the CAISO markets is available through the option for co-located resource configuration. Co-located resources will be optimized at the system wide level by the CAISO markets and will result in greater benefits to the system and more efficient utilization of resources.

- *PG&E: ITC-Driven hybrid resources should self-provide a forecast of total output to the CAISO as per the recommendations in the CAISO's Straw Proposal. For Market-Driven hybrid resources the CAISO should apply its current practice of forecasting VERs to the VER components of Market-Driven hybrid resources. This approach builds off of existing functionality and ensures consistency between resource types, even when those*

resource types are components of hybrid resources. PG&E believes SCs should be allowed to pay a forecast fee to receive the CAISO forecasts of the VER components of hybrids.

- PG&E suggests that the Day-Ahead (DA) VER forecast (determined by the CAISO) would be made available to the Scheduling Coordinator and automatically incorporated into the CAISO systems as the VER component of the total Day-Ahead (DA) capability (MW capacity) of the hybrid resource. Since the energy storage component can be considered the “dispatchable” portion of a hybrid resource, its overall DA capability must be reflected in its DA bids. PG&E believes that SCs should submit to CAISO only their DA energy storage component bids, then the CAISO could add the DA VER component to arrive at a total DA capability of the single resource ID.*
- PG&E suggests that in the Real-time (RT) market, the CAISO’s request for hybrid resource forecasts could again be viewed from the perspective of its components. VERs are currently forecasted on an hourly basis (as well as at 15- and 5- minute intervals) and this treatment should be available for VER components of hybrid resources. For the energy storage component, there is less reliable information as to what its output will be, but nevertheless there are some indicators. DA awards and current state-of-charge (SOC) are two such data points that could be useful to determine likely production forecasts. One important point is that the rolling forward basis may depend on the size of the energy storage resource, or else lead to inaccurate results.*

The CAISO maintains that it is appropriate to require all hybrid resource to self-provide their total forecast output. The CAISO has received many stakeholder suggestions to provide forecasting for the VER components of hybrid resources. The CAISO has included this suggestion in the revised straw proposal and will provide the option for hybrid resources to receive CAISO forecasting for the VER components. The CAISO will require all meteorological and telemetry data necessary to provide accurate VER component forecasts.

The CAISO disagrees with the PG&E suggestion that the Day-Ahead (DA) VER forecast be automatically incorporated into the CAISO systems as the VER component of the total Day-Ahead (DA) capability (MW capacity) of the hybrid resource. The CAISO believes that hybrid resources should participate in the Day Ahead market in the same manner as other dispatchable resources since they will be treated as such by the CAISO markets. This means that the hybrid resources will only provide bids that should reflect their expect output potential in the day ahead market. The self-provided forecast proposal will only apply to hybrid resource participation in the Real-Time market.

Similarly, the CAISO disagrees with the PG&E suggestion that the CAISO’s should use the forecast of the hybrid resource components in the Real-time (RT) market. The CAISO will not optimize the use or dispatch of hybrid resource components. This would require numerous assumptions and decisions on how the resource components should operate that are not possible or appropriate for the CAISO to determine. The CAISO maintains that the resource owner/operator should be responsible for all onsite optimization of the hybrid resource components, and the hybrid resource’s resulting overall self-provided forecast output.

Both suggestions by PG&E are not possible under the hybrid resource participation option being envisioned by the CAISO in this proposal, however, the co-located resource option will allow for these suggestions through the separate treatment of VER forecasting and individual resource participation through two or more resource IDs.

- *Pintail Power: We agree that hybrid resources (with storage per our revised definition) should improve forecasting capability. Indeed, the storage element is analogous to securing a fuel supply for a fossil-fuel generator; once the fuel is secured, the resource can then be economically dispatched. CAISO's proposals regarding zero-marginal cost Variable Energy Resources (VERs) seem sound, but forecasting needs to go beyond VERs with co-located storage. Forecasting must include the availability of grid-charged storage to relieve over-generation constraints as well as provide dispatchable energy.*

The CAISO agrees with the suggestion by Pintail Power that the hybrid resource self-provided forecast should reflect the capability of all of the underlying hybrid resource components. Similarly the bids provided by hybrid resources willing to utilize the NGR model and charge from the grid can allow those resources to be used to charge from the grid during over-generation conditions. The CAISO views all hybrid resources as able to provide dispatchable energy. The CAISO does not propose to provide forecasting for the storage components of hybrid resources, rather, the CAISO only intends to provide the VER component forecasts as an option – hybrid resources will still be required to self-provide their total net output forecasts to ensure feasible dispatch and market awards.

- *SCE: SCE assumes that the CAISO's focus on detailed forecasting data on the VER component of HRs is based on the belief that the storage component may be used to firm and shape the VER component output during non-peak load hours. While that is one of the business drivers identified by the CAISO, it is not the only one. In fact, in its Straw Proposal, the very next case after the VER-firming case is one in which the storage component is used to shift energy production. In such a scenario, excessive focus on the forecasting of the VER component will not provide any meaningful baseline for the storage component participation. In fact, with the aggravation of the duck curve and the prevalence of price spikes, it is more likely that shifting energy production is the predominant behavior of HRs. Additionally, relying on forecasts prone to larger error, will not enhance the accuracy of information being fed to the CAISO. The CAISO recognizes the need for accuracy with its presented analysis of HASP forecasts having twice the error magnitude of RT forecasts. SCE urges the CAISO to include consideration of making system changes to allow updating schedules closer to RT. This is a necessary prerequisite to prevent the diminishing of gains from accurate forecasting.*

The CAISO believes the current proposal to utilize self-provided forecasts for hybrid resources to update their upper economic limits on a 5-minute basis will address the issue raised by SCE. The CAISO does not agree that it is necessary to consider other system changes to allow updating schedules closer to RT – this is possible under the existing proposal.

- *SDG&E: While SDG&E generally agrees with the requirement for scheduling coordinators of hybrid resources to provide their own forecasts, it may be beneficial for*

the CAISO to invest in designing a model to forecast the output of hybrid resources based on the state of charge of the energy storage device and the potential output of the variable energy resource.

The CAISO believes that the hybrid resource owner/operators should incorporate all aspects of the underlying resource components in the hybrid resource's self-provided forecast. This would include the state of charge for storage components. The CAISO understands SDG&E's suggestion to develop a CAISO market participation model that considers these inputs but the CAISO declines to propose such modifications under this initial hybrid resource initiative. Such an ambitious undertaking may need to be revisited in future initiative phases when it would be more realistic to implement such a concept.

- *Wellhead: Wellhead supports the CAISO proposal for forecast granularity and the need for an on-site met station or other best available technology. Wellhead believes that it may also be useful to examine if the form of the forecasts provided should be available energy output for the generator model, and available SOC for the NGR model. If the CAISO intends on using an energy forecast for the NGR model, it would be useful to see some example of how this would be applied.*

The CAISO agrees with the Wellhead suggestions regarding the forecasting for hybrid resources. Under either the traditional participation model or the NRG model the CAISO proposal intended that the self-provided forecast include the total expected output of the hybrid resource, including the state of charge of any storage components and the VER forecast output, as well as the expected charging status of the storage component to represent the net output potential of the hybrid resources. The CAISO is interested in exploring if the proposal should be refined to specifically indicate if the form of the forecasts provided should be available energy output for the generator model, and available SOC for the NGR model, but at this time, CAISO does not believe that it is necessary to differentiate the forecast form in this manner.

- *WPTF: WPTF requests that the CAISO clarify what it means by a "viewed by the CAISO as a dispatchable generator."*
 - *Does this mean only renewables that are fully dispatchable every 5-minutes are eligible? It is our understanding that about 40% of existing wind and solar is still non-dispatchable either physically or contractually.*
 - *Does the CAISO intend to exclude these resources from becoming part of a hybrid resource?*
- *WPTF also notes that the data provided on potential hybrid resource forecasting error does not match what the CAISO provides stakeholders monthly on average real-time forecast error.*

The CAISO clarifies that it intends that hybrid resources will all be treated as dispatchable generators that will participate under either the traditional energy generation or NGR models. This means that hybrid resources are always treated as dispatchable. They would not be treated as or EIR or PIR resources, as established through the 2016 hybrid resource technical bulletin.

Hybrid resources would continue to retain VER status as defined in FERC Order 764, but would not be treated as an EIR and PIR in the master file or CAISO market settlement. This is because its operational characteristics and market behavior do not allow it to be treated as an EIR or PIR under current market settlement rules and processes. Under this option, a hybrid resource cannot be certified with a PIR status because the CAISO cannot produce an accurate forecast based on the data provided. In other words, the CAISO could not accurately forecast the MW output of a hybrid resource with a solar or wind component and storage component, due to the impact the charging or discharging storage unit has on the output of the combined hybrid resource.

Any VER resources are eligible to be incorporated in hybrid resources, but the overall hybrid resource will always be considered dispatchable regardless of the underlying components design or operating restrictions. The CAISO does not intend to preclude them from participating as a hybrid resource, however, the overall resource will not be treated as non-dispatchable, regardless of the underlying components dispatchability. If this treatment is problematic for certain resources, the option for co-located resources will allow a non-dispatchable VER resource to retain its current treatment under its own resource ID.

The CAISO also notes that the forecasting data that was included in the straw proposal was only intended to illustrate that the hybrid resources charging restrictions and operations can exacerbate forecast error. The figures included were selected to illustrate worst case scenarios and associate risk and were not intended to match other data provided on average forecast error.

Stakeholder Feedback on Markets and Systems Modifications

- *8minute appreciates the effort made by the ISO to define a workable scenario where the scheduling coordinator will create a bid for the hybrid resource that can be updated hourly and the forecast that can be updated every 5 minutes to set the upper and lower (charge) economic dispatch limit. Additionally, the ability to control grid charging for preserving the ITC is very important. The plant owner/scheduling coordinator assumes a risk in covering the missed energy in the real-time market. One way to address this risk is to continue treating the VER component of the hybrid resource as an eligible intermittent resource (EIR), and only require the plant owner/scheduling coordinator to make up for shortfalls from the BESS component.*
- *8minute suggests, in the two resource ID case, the inability to control the grid charging behavior in order to preserve ITC is a significant issue. If the ISO provides a way of using market bids to control grid charging of the BESS for the ITC period, most interconnection customers including 8minute would prefer the two-resource ID option as long as the Pmax/stranded resource issue is also addressed as planned.*
 - *8minute asks for clarification if it is allowable for a BESS, regardless of its SOC, bid in such a way so that its “charge” bid is only selected to charge from the on-site VER?*
 - *8minute asks for clarification if a scheduling coordinator submit a “combination” bid that contains the generation patterns of both the PV and the BESS? Finally,*

we expect many hybrid plants to prefer to fully participate in the markets by allowing grid charging as soon as the ITC period expires. Therefore, any proposed telemetry and metering should be set up such that no additional physical/repeated interconnection study work should be required to switch modes after the ITC expires.

- *8minute suggests that for oversized AC plants, the ISO should not make the excess generation the “marginal unit” for the local LMP and this should not have any impact on local price because it is managed inside the Hybrid Resource. The ISO should accommodate one or both of the following control options for this type of Hybrid Resource. 1. The solar onsite plant controller should report via telemetry the “current generation” and the “potential generation”. If the “potential generation” is greater than the Interconnection Limit and the storage facility can charge it, the ISO should instruct the storage resource to charge from excess generation. 2. The existing Hybrid Resource Constraint should include the option for the energy storage system to self-schedule charge of PV generation in excess of the Interconnection Limit instead of allowing the PV to be curtailed.*

The CAISO clarifies the proposal for self-provided forecasting will only set the hybrid resource's upper economic limit. The lower limit noted by 8minute is not included in this proposal and would be limited by the Pmin for the traditional generation model and Pmin and minimum energy level for the NGR model hybrid resources. The CAISO believes that the bids and NGR functionality will allow adequate capability for hybrid resources to limit their charging from the grid as necessary.

The CAISO agrees with the suggestion by 8minute that the forecast risk will be assumed by hybrid resource owner/operators. The CAISO does not believe that this risk should be transferred to the CAISO markets and operations and is appropriate given the flexibility provided for hybrid resources under the proposed approach. The CAISO notes that this risk can be avoided completely by resource interconnection customers by choosing the co-located resource option that allows the CAISO markets to best optimize the utilization of the separate resources. VER resource under the co-located resource option can maintain their EIR treatment that mitigates most of the risks associated with changes in forecast output.

The CAISO clarifies that it has included a metering configuration concept in this proposal to allow for the option to select the co-located resource configuration with the ability to charge the storage from on-site generation.

The CAISO clarifies that for the bids provided by hybrid resources, scheduling coordinators should submit a single bid curve that contains the total offer for the combined hybrid resource components. This means that any hybrid resources bids would not be split amongst the various components, but should instead reflect the overall hybrid resource's offer curve.

The CAISO disagrees with 8minute's suggestion that the CAISO markets should direct hybrid resources instruct the storage resource to charge from excess onsite generation or to direct the energy storage system to self-schedule charge of PV generation in excess of the

Interconnection Limit instead of allowing the PV to be curtailed. The CAISO proposal will not determine when or how to operate underlying hybrid resource components.

The onsite optimization of hybrid resource components must be managed by the resource owner/operator. The CAISO will only provide market participation at the hybrid resource level and will optimize the use of the total resource based upon its bids and self-provided forecasts. The owner/operator will need to determine how to operate the underlying resource components. If resource interconnection customers want the CAISO to manage each of the resource components they have the option to choose the co-located resources configuration that will require each separate resource component to be configured with its own resource ID. This option will allow the CAISO market to best optimize the utilization of each of the co-located resources.

- *CalCCA supports using the Hybrid Resource forecast to establish the upper economic limit for the resource. For Co-located Resources, CalCCA supports CAISO's proposal to limit the combined output to the Point of Interconnection rights.*
- *CalCCA urges CAISO to consider developing functionality to allow Co-located storage resources to be charged, either partially or exclusively, from the Co-located VER resource, perhaps via a Self-Schedule from the VER resource and corresponding storage resource Self-Scheduling and Bidding. This would allow the Co-located Resource owner to mitigate inverter and POI limitations, maximize preferred resource production, optimize ITC value, and continue to participate in the Eligible Intermittent Resource program, while providing CAISO with access to any net VER output and the storage output.*
 - *CalCCA urges CAISO not to limit Co-located Resource storage charging only from the grid; that is, allow Co-located VER resource to charge the storage resource. Similarly, given appropriate metering, CAISO should allow Hybrid Resources to be charged from the grid to the extent desired by each project operator so that project and grid operations can be optimized.*
- *CalCCA believes that there may be valid reasons for a resource owner to prefer a single Resource ID (Hybrid Resource) or multiple Resource IDs (Co-located Resource), However, both VER charging and/or grid charging should be allowed for both Hybrid Resource and Co-located resource configurations pursuant to preferences expressed in the Resource Bids.*

The CAISO's understands the suggestions by CalCAA regarding the treatment of co-located resources charging. The CAISO clarifies that it has included a metering configuration concept in this proposal to allow for the option to select the co-located resource configuration with the ability to charge the storage from on-site generation.

The CAISO agrees with CalCCA's suggestion on hybrid resources being allowed to charge from the grid, this option is already included in the current provisions and CAISO will continue to allow grid charging for hybrid resources through utilization of the NGR model.

- *CESA supports the proposed implementation of forecasts to the market mechanisms applicable to hybrid resources but with hybrid resources being allowed to update their*

upper economic limit more frequently (e.g., every five minutes). However, an upper economic limit appears to be only applicable to generators. As noted previously, hybrid resources operating as an NGR do not have such an upper limit bounded by the forecasted output of the generator considering the paired storage resource has the ability to charge from the grid. The upper economic limit for hybrid resources as NGRs should be reflected in the Revised Straw Proposal as being limited by the forecasted generator output plus the SOC of the paired storage resource.

- *CESA does not support the CAISO's interim proposal to apply an interconnection rights constraint for co-located resources, which would set the Pmax of the storage device in the Master File below the rated capacity of the storage resource, resulting in stranded capacity. CESA understands that the CAISO is proposing this as an interim solution until a longer-term solution can be developed and implemented but allowing limiting schemes and controls to ensure the point of interconnection (POI) rights are not violated is a feasible and more optimal option. Limiting schemes and controls are currently used for many storage projects today in order to prevent certain operations, such as charging from the grid, so CESA would prefer the CAISO work to discuss and develop solutions that would allow such limiting schemes and controls to be used to ensure POI rights are not violated.*

The CAISO's intent for the self-provide forecast for hybrid resources is to apply the forecast to update the upper economic limit dynamically on a 5-minute basis. This is intended to apply to both options for hybrid resource models, including for traditional generator and NGR models. The CAISO is proposing to extend this existing VER resource functionality to all hybrid resources. For hybrid resources under the NGR model the CAISO's intent is that the self-provided forecasts provide the resources expected output that should include all aspects of the underlying resource components, including any VER component forecast and the storage component state of charge and charging or discharging status, to provide a net expected output that can be used to update the overall hybrid resource's upper economic limit.

The CAISO understands CESA's position on the interim treatment of co-located resources. The CAISO recognized that it is not optimal to have to limit co-located resources combined Pmax to the total interconnection rights and has provided a proposed solution. Unfortunately, the suggestions made by CESA on addressing this issue in the interim are not feasible in a timely manner because they would require system modifications and software changes that require implementation projects. Simply relying on the existing limiting schemes as suggested by CESA and other stakeholders will not be feasible because they will not be reflected in market participation. The existing limiting schemes are not reflected through market constraints so the CAISO markets will not recognize these limits until the proposed interconnection constraint solution can be implemented. The CAISO declines to change its proposed interim approach for limiting the Pmax of co-located resources to the total interconnection limit due to implementation limitations.

- *The CPUC believes that the CAISO's proposed model for market participation of hybrid resources creates significant inefficiencies by requiring each hybrid resource to optimize its own use rather than rely on the market to support optimization decisions. Under the*

current proposal, hybrid resources would submit forecast output to the day-ahead market and submit bids up to their forecast output that would dictate when they would discharge.

- The forecast output would combine the output from all parts of the resource, and it would place a constraint on market dispatch. Functionally, the hybrid resource's bids will turn into a self-schedule that will not allow flexible dispatch needed for the market to optimize.*
- The CPUC believes that the market's ability to optimize resource use and participant's incentives to maximize profit and reduce risk of potential losses will be distorted by the constraint caused by the resources' forecast output.*
 - The forecast would not allow the market to shuffle or adjust use of the resource to reach an optimal outcome, other than possibly to decrease dispatch at some hours and cause the resource to hold the charge overnight. CPUC Staff believes that this proposal will fall short of achieving the most efficient results possible in the day ahead market.*
 - Without accurate predictions of prices, hybrid resources cannot forecast the profit maximizing schedule. This is not different than any other resource, although other resources have more flexibility and can bid into the market in a way that allows the market to manage the resource optimally. Because they would have to forecast their output under the CAISO's proposed model, hybrid resources cannot allow the market to optimize their use.*
- CPUC suggested possible alternatives:*
 - State of charge limits for market dispatch, resource determines when to charge. One alternative that may improve the market outcomes would use forecast state of charge limits as a guide for bids and dispatch. Under this proposal, participants would submit a forecast state of charge for the storage portion of the resource at a specified hour. The forecast state of charge would work best if the participant could submit a forecast output and state of charge up to a certain hour and bids for several hours after that. The market could then optimize drawing down the forecast state of charge over the rest of the day. While this would be an improvement, it would still require the resource to decide when to charge.*
 - Market determines optimal charging and discharging schedule. Another alternative would allow the market to have a greater role in determining optimal resource use to achieve economically efficient results. The market would need to be able to manage both charging and discharging of the storage resource to achieve maximum efficiency. The CAISO may need to design a new resource model specifically for hybrid resources to accomplish this level of efficiency. A new model could represent both storage and generation pieces of the resource explicitly but also contain constraints to ensure that they operate in tandem. This type of model could even feature a constraint that ensures the storage charges exclusively from the on site generation, but still manage that to charge at the lowest priced, most efficient times. A model for hybrid resources would need to be able to contain all the standard parameters for each part of the resource such as min and max output, as well as similar constraints on the overall resource.*

For hybrid resources this could also contain constraints that would ensure the resource charges from the on-site generation only, and that the charging times could be either self-scheduled or set by the market.

- *CPUC Staff would like to better understand, from the CAISO, what obstacles would need to be overcome to pursue the design of a new resource model.*

The CAISO agrees with CPUC assertion that hybrid resources proposal will not result in the most efficient possible outcomes. The CAISO suggests that for this to be achieved the CAISO would need to develop a new hybrid resource model, which is infeasible in the timing of this initiative's intended implementation. Otherwise, the most efficient utilization of these mixed-fuel resources will only be accomplished through the co-located resources approach as identified and stressed by the CAISO in the first two iterations of this initiative.

The CAISO is providing the option for single ID hybrid resource participation to enable resource interconnection customer the flexibility needed to perform the onsite optimization of hybrid resource components. This does not mean that the self-provided forecasts will necessarily be the most efficient or optimal utilization of the hybrid resource components at a system-wide level, and will require that hybrid resource owner/operators make some assumptions about market prices and dispatches, as well as anticipate the way they would be charging or discharging storage components of hybrid resources. The CAISO declines to include the CPUC's suggested alternatives in this initial phase of the hybrid resources initiative because of the complexity associated with the assumptions mentioned above.

The suggested approaches are not feasible to implement without significant system and market design changes that are not possible in the proposed implementation timeframe for this initiative. The CAISO is undertaking numerous other market design changes and has numerous implementation efforts to manage those projects – this initiative was launched outside of the normal CAISO stakeholder catalog to deal with the pressing needs of these pending resource developments and cannot be implemented in any further expedited manner given the host of other items that are also being concurrently developed and implemented. The CAISO will consider these CPUC alternative suggestions and other stakeholder input on other alternative approaches that may make the hybrid resource option a more efficient and optimal outcome in the future phases of this effort. In the meantime the best option for the more efficient utilization of mixed-fuel projects to be optimized at the system level will be the co-located resources option that retains the individual resource IDs for each project's underlying resources and will optimize the use of each resource to the greatest extent possible.

- *EDF and LSA believe that the CAISO should consider ways to mitigate the "stranded asset" problem on an interim basis before the proposed fix is implemented in Fall 2021. EDF and LSA believe that project operation under the collocated resource configuration (which CAISO has stated is its preferred model, and which is contemplated under many PPAs and interconnection customer business plans) will simply not be viable if large amounts of capacity are "stranded" in markets and operations.*
- *EDF and LSA suggest that the CAISO consider allowing VER Resource IDs to exceed their Master File PMaxes in real time when the other Resource ID(s) were under theirs,*

as long as the overall project Pmax was respected and the CAISO has access to VER met data and telemetry. This option is based on the current CAISO rules allowing VERs to exceed their Dispatch Operating Targets (DOTs) in real time under most circumstances.

- This flexibility would partially mitigate the Master File problem by “unstranding” up to 50 MW of the solar Resource ID, at least in real time, allowing it to produce at its full 100 MW.
- CAISO concerns that current real-time limiting schemes are not sufficiently limiting POI output may be legitimate. However, that very real problem should not impede consideration of this mitigation option. CAISO should be testing and enforcing the effectiveness of these controls in any case, e.g., through a regular validation check that the sum of the real-time production from all collocated Resource IDs does not exceed the allowed POI output level.
- EDF and LSA suggest the CAISO consider more flexible Master File updates. CAISO systems already allow projects to change the Resource ID maximum output split in the Master File; the problem with this approach is the current process that only includes one value per project in the Master File and only updates the Master File every couple of weeks. The CAISO could consider process changes that would either allow more frequent Master File updates or hourly values (instead of a single value) for each project.
 - EDF and LSA also suggest that the CAISO consider multiple values for each Resource ID: Even if the current two-week Master File update process cannot be made more dynamic, as described above, allowing up to 24 hourly maximum values for each Resource ID would help. The project SC could thus submit Resource ID splits that would reflect expected VER Resource ID output and then update them every two weeks to reflect monthly/seasonal changes.
- EDF and LSA suggest the CAISO consider storage injections “on the side:” Physical, metered/telemetered direct “internal” connection between the VER and storage Resource IDs, “behind” both Resource ID meters to the grid, to limit scheduling and output to the grid (as measured by the “grid” meters) to the Resource ID values in the Master File.
 - Thus, in a given hour for the sample project above, the Solar Resource ID could inject 50 MWh directly into the storage facility and schedule/inject 50 MWhs into the grid, allowing the VER Resource ID to produce the full 100 MW in that hour. CAISO could read the internal meter for RPS purposes (so that portion of the VER Resource ID could be reported to the CEC), but the financial settlement with CAISO would reflect only the grid meters.
- EDF and LSA suggest that CAISO also reconsider the energy-only solution early: The Proposal implied that implementing the new functionality for Ancillary Services awards and dispatches was more difficult than for Energy. For example, the Proposal documents states that existing inertia modeling functionality could be used to accommodate Energy-related elements, and one of the presentation slides says that the A/S solution requires a larger implementation lift.
- EDF and LSA suggest the CAISO allow switching between single- and multiple-Resource ID configurations: The tremendous economic impacts of stranding significant

amounts of capacity under a collocated-resource configuration may lead many resources to begin operations as hybrids and switch to collocated resources after the problem is fixed. Some projects may also begin operations as hybrids in order to more easily comply with ITC rules and then convert to collocated resources afterwards to take advantage of greater charging flexibility from the grid.

- *The CAISO should consider an expedited NRI process – e.g., just modifying any metering and Master File arrangements – for resources switching between hybrid and collocated- resource configurations (in either direction). Such resources would have already gone through the entire NRI process in order to begin operations and should not have to start over as though they were completely new resources.*

The CAISO has thoroughly considered the options that EDF and LSA suggest to deal with the interim issues associated with the co-located resource option. The CAISO cannot allow co-located VER resources to exceed their Masterfile PMaxes in real time. The CAISO markets cannot reflect these parameters and operations of co-located resources without significant system changes that cannot be implemented sooner than the proposed interconnection constraint solution. Similarly, the CAISO has considered allowing more frequent Masterfile updates to address this concern and that option will also require significant implementation lift that is not feasible in the interim timeframe.

The CAISO has considered the suggestion to allow resources to inject or charge outside of market awards and dispatches as well. This approach is not allowed under the current market designs and will result in deviations from market awards and dispatches that the CAISO cannot allow due to the unintended market consequences. If resource interconnection customers wish to have this type of capability they have the option to utilize the hybrid resource single resource ID configuration that would allow for the type of charging and netting behavior that was suggested by EDF and LSA.

The CAISO has considered the energy only option solution discussed with stakeholders carefully and due to implementation constraints it is not possible to implement this more limited solution option in fall of 2020, given the other projects that are already slated for implementation during the fall 2020 release.

The CAISO notes that it agrees with the suggestion and, in fact, already allows for the fast tracking of existing resources through the NRI process for material modifications and switching for hybrid resources and co-located resources. The NRI process requires numerous documentation and design inputs to be provided and once these have been done initially the NRI process can be moved faster for existing resources that are making more minor changes such as switching configurations or adding additional capacity to existing projects.

- *First Solar seeks clarification on the forecasting/scheduling process. As way of example:*
 - *The day ahead forecast for an operating interval is 100 MW*
 - *In the 15 minute market, the forecast is 95 MW*

- *In the 5 minute market, the forecast is 97 MW*
- *Actual plant production for that 5 minute market interval has the potential to be 98 MW*
- *FSLR asks for CAISOs clarification of the following questions under this example:*
 - *Does the scheduling coordinator have the ability to modify the resource's forecast (and schedule) based on the revised forecasts available*
 - *Would the actual production of 98MW be limited to 95 MW or 97 MW based on a revised UEL, or would the 100 MW day ahead schedule set the UEL*
 - *What would the energy imbalance calculation be based upon?*
 - *FSLR raises these clarifying questions, as forecast accuracy improves significantly the closer it is given to the operating interval.*
- *FSLR suggests that CAISO should acknowledge that forecast risk will result in a desire by scheduling coordinators to be conservative in their forecast submittal, particularly on a day ahead basis, and that this conservative forecast should not be considered economic withholding / attempts at market manipulation.*
- *For co-located projects, FSLR requests the CAISO create an option where the storage component's ability to charge from the grid would be limited to either explicit MWh limitations, or restricted outright, for the first roughly 6 years of asset life. Independent dispatch of the VER and storage components has a strong likelihood of adversely impacting the project's ITC.*
 - *FSLR disagrees with the assertion made during the stakeholder meeting that there is an accounting solution to solve this issue. The data exists today to compare, on an interval-by-interval basis, the VER production against the battery's charging and discharging. Any audit conducted would immediately recognize when grid charging occurred and likely result in a reduction in ITC benefit. ITC risk is a bright line for hybrid resource development. FSLR believes it is reasonable to include a limitation on grid charging for co-located resources, which would be lifted after the ITC has been fully monetized (roughly year 6). After that time, the battery could be dispatched independently.*
- *What is the CAISO's expectation for reporting availability on hybrid and co-located resources? Assuming a 50 MW solar asset coupled with a 50 MW battery (50 MW POI), if 50% of the solar resource is out of service is the new overall resource availability then limited to 25 MW, or does the battery's 50 MW capacity still reflect that resource's total availability?*

The CAISO provides the following initial responses to the First Solar questions regarding their simplified example for a hybrid resource: The day ahead forecast for an operating interval is 100 MW – The CAISO clarifies that the day ahead market will not use hybrid resource forecasts, it will only use hybrid resource bids (similar to the way the day ahead market uses bid from VER resources today). The self-provided forecasts for hybrid resources will only be utilized in the real-time markets. In the 15 minute market, the forecast is 95 MW. In the 5 minute market, the forecast is 97 MW. Actual plant production for that 5 minute market interval has the potential to be 98 MW.

The CAISO confirms that the hybrid resource scheduling coordinator will have the ability to modify the resource's forecast (and schedule) based on the revised forecasts available. The CAISO clarifies that the resources market award would be limited to 97MWs because of the revised upper economic limit provided by the last self-provided forecast in the five minute market of 97 MW – even though it has an actual production potential of 98MW. If the resource produced 98MWs in real-time and was metered at 98MW of output for that period the energy imbalance calculation would be based upon the 97MW market dispatch. If the hybrid resource deviated and produced its maximum potential 98MWs it would be assessed 1MW of energy imbalance. The CAISO also notes that resources that deviated from market awards and dispatches will also be subject to other allocation based charge codes for UIE such as flexible ramping product and any associated exception dispatch costs if the deviation was net negative.

The CAISO clarifies that the self-provided forecast aspect of the proposal for hybrid resources is limited in its application to the real-time market. The participation of hybrid resources in the DA market will be based upon their submission of bids/offers or self-schedules. The CAISO believes that hybrid resource owner/operators will need to provide DA bids that reflect the proposed must offer obligation (MOO) requirements.

The CAISO understands First Solar's position regarding the potential impact of grid charging or perceived grid charging on hybrid resource's eligibility for ITC treatment. The CAISO has specified that both co-located and hybrid resource configurations have the option to charge from the grid or to charge from the on-site VER component or co-located VER resource. This is included in the revised straw proposal.

The CAISO cannot take any position regarding the ITC eligibility of hybrid or co-located resources. Similarly, the CAISO is not in a position to confirm or deny any parties' assertions that the ITC eligibility will, or will not, be impacted due to CAISO's current treating of proposed rules, provisions, and treatment of hybrid and co-located resources. The CAISO does not believe that the issue of ITC eligibility should drive particular market design proposals or other changes to existing market mechanisms to accommodate resource interconnection customer's concerns or wishes to ensure their ITC eligibility. Resource interconnection customers are appropriately the responsible party for any ITC eligibility related considerations, not the CAISO.

The CAISO clarifies that the availability of hybrid resources should be assessed on the total availability of the overall hybrid resource based on the underlying resource components capabilities. In the First Solar example of a 50MW hybrid resource with 50MW interconnection rights, and resource components of 50MW of solar and 50MW of storage - the CAISO notes that if the solar resource component was only 50% available the overall hybrid resource would still have the ability to produce up to its 50MW it should be considered 50% available. To better illustrate and clarify the availability issue, the CAISO also provides an additional example wherein the hybrid resource is comprised of a 50MW solar component and a 50MW storage component with 100MW of interconnection rights. In this scenario, if the solar resource was only 50% available (for example, if 50% of the solar resource component was experiencing a forced outage, meaning the solar component has a 25MW maximum output potential, not to be

confused with 50% output potential due to fuel availability) and the storage component was still 100% available the overall hybrid resource availability should be considered to be 75% available since its maximum output would be 75MWs.

- *NextEra recommends the CAISO consider accelerating the timing of the interconnection constraint for combined resources. The Straw Proposal current states that the interconnection constraint will be implemented in the fall of 2021. However, the CAISO should ensure that the interconnection constraint is in-place and functioning in time to accommodate the on-line requirements of the recent California Public Utilities Commission (CPUC) Proposed Decision Requirement Electric System Reliability Procurement for 2021-2023 (R16-02-007 (Sept. 12, 2019)). In that decision, resources capable of providing incremental resource adequacy capacity must be on-line by August 1, 2021. Accordingly, a couple months of advancement of the interconnection constraint solution would greatly assist the market in offering capacity into the upcoming CPUC solicitation.*

The CAISO appreciates the suggestion by NextEra on the implementation timing of the interconnection constraint for co-located resources. Unfortunately, it is not as simple as only moving up the implementation a couple of months as suggested even though it may be of great value. The CAISO's implementation efforts require significant planning and coordination with the other 22 ongoing active stakeholder initiatives. The CAISO believes that it is not feasible to move up the implementation timing on the proposed interconnection constraint solution as proposed but has included an accelerated option for the energy only constraint in this proposal. The CAISO also notes that the existing options for both single resource ID hybrid resources and two or more resource ID co-located resources are available before the fall 2021 implementation release and resource interconnection customers can utilize either approach – though, the CAISO acknowledges that there are some unfortunate implications related to use of either approach.

- *PG&E recommends that the CAISO consider future enhancements to the Hybrid model to ensure consistency with other models (i.e. NGR, VER and DERP). The proposal for hybrid resources raises important issues that the CAISO should treat as ongoing and in relation to other initiatives.*
 - *Rather than creating the hybrid model as only a means of facilitating these new types of resources, the CAISO should take a more holistic approach and incorporate the learnings of other models in future initiatives.*
- *PG&E also notes that the stranded capacity of co-located resources under a single interconnection constraint may constitute a deliverability conflict that should be resolved in the deliverability rights as designated in the interconnection study process.*
 - *PG&E is confused as to why the CAISO is describing stranded capacity as a new issue. If multiple resources are built co-located behind a single point of interconnection (POI) and that POI has a transmission capacity right which is less than the combined Pmax of all the resources at the POI, then the current solution would be that the resources or new resource would have to pay for an*

interconnection upgrade while existing resources would retain their deliverability. If the new co-located resources paid for a transmission upgrade, then no capacity would be stranded.

- *It appears that the CAISO is proposing that if co-located resources wanted to reduce costs by not paying for an interconnection upgrade, having an interconnection constraint in the master file would treat the resources more favorably than having to reduce their Pmax capacity in the master file. This problem defined by the CAISO might be better described as a stranded energy or stranded deliverability problem that results from having to limit the Pmax of co-located resources to a given transmission capacity constraint.*
- *PG&E is not sure whether this should be considered in scope of the Hybrid Resources Initiative. The new interconnection rights constraint could possibly apply to other situations and might require further consideration. The interconnection rights constraint issue is similar to how imports are treated at an intertie, but more clarification on how LMPs are calculated would be needed. Normally, this situation would lead to a congestion component.*

The CAISO understands PG&E's suggestion to consider future enhancements to the hybrid model to ensure consistency with other models (i.e. NGR, VER and DERP). However, CAISO notes that it is really applying existing resource models for utilization with hybrid and co-located resources so more clarification on exactly how PG&E believes these other resource models should be considered for consistency will likely be needed. The CAISO agrees that hybrid and co-located resources raise many important issues that the CAISO will treat as ongoing and in relation to other initiatives. The CAISO is making efforts to take a holistic approach and plans to incorporate the insights from other related efforts in future phases of these initiatives as suggested by PG&E.

The CAISO understands the viewpoint of PG&E on the issue related to co-located resource's interconnection rights and Masterfile Pmax limitations. The CAISO agrees that it is closely related to deliverability and the need to pay for additional interconnection capacity as noted by PG&E. However, the CAISO notes that the issue is also very important to allow for the maximum utilization of the existing interconnection rights and the ability to inject maximum amounts of energy from one or more co-located resources when other co-located resources in these mixed-fuel projects are not producing energy. Perhaps the CAISO's use of terminology of stranded capacity has muddled the waters because it is clearly also an energy related issue, not only a capacity related issue.

The CAISO disagrees with PG&E's suggestion that this issue need not be included in scope of the hybrid initiative. Co-located resources are well within the scope of this initiative because they are also often mixed-fuel projects and are very similar to hybrid resources. The CAISO firmly believes this interconnection constraint issue is vital to ensure that the CAISO can access co-located resources in the most efficient way possible and allow the CAISO markets to optimally dispatch co-located resources. Therefore, the CAISO does feel this will be a very important item to keep within the scope of this initiative effort and implementation plan.

The CAISO plans to continue to coordinate this effort with other related efforts. Additionally, the suggestion by PG&E to consider the LMP formation issues associated with the interconnection constraint is already incorporated into the proposal. The CAISO has noted that this solution would indeed create a congestion component at the resource level but has proposed to keep that artificial congestion from being included in the LMPs since it is not true congestion, only an artifact of the interconnection constraint itself, when no real congestion is occurring in the ISO controlled grid due to the constraint. The CAISO has clarified this aspect of the proposal, but also seeks additional feedback from PG&E and others on the need for any further explanation or clarification on these related price formation issues.

- *Pintail Power believes that the straw proposal needs to be expanded to support the business drivers of time shifting to enhance renewable energy production. Owners, operators, and Scheduling Coordinators seek to maximize the profitable delivery of energy from the hybrid resource, which necessitates a positive Park Spread.*
 - *Analogous to Spark Spread, Park Spread reflects the difference between the Locational Marginal Price (LMP) and the Marginal Cost of Energy (MCOE).*
- *Pintail power suggests that there must be consideration of the cost of power placed into storage, which may be de minimus or even negative at times when charged from the grid. Then there must be consideration of the Electric Rate -- MWh charged per MWh discharged, which is essentially the inverse of round-trip efficiency. Likewise, there must be consideration of dispatchable hybrid resources that use stored energy to reduce the Fuel Heat Rate during discharge. .*
- *Pintail Power suggests that another factor that should be considered is that the available of storage will increase system net load. This may potentially result in higher LMP during periods of over-generation while reduce the LMP and CO2 emissions during other hours. Accordingly, the market optimization must accommodate the impact of storage or local minimization of LMP during each hour may not result in global minimization of system cost over periods of days, weeks, or years.*

The CAISO understands the comments of Pintail Power on these market optimization and hybrid resource and storage efficiency related issues. The CAISO declines to incorporate these aspects into the proposed modification for hybrid and co-located resources under this proposal. The CAISO does not believe these issues should be within the scope of this phase of the hybrid resources initiative. The CAISO agrees with Pintail Power on the points made about the importance of understanding the economics and optimal utilization of hybrid resources and storage resources. However, the CAISO believes that the hybrid resource proposal is intended to allow resource owner/operators to manage these considerations behind the point of interconnection for these resource and do their own onsite optimization of hybrid resource components.

The CAISO is not proposing to develop a new hybrid resource model at this time due to implementation constraints. Although a new resource model would need to consider and address the issues noted by Pintail Power, the CAISO believes that level of market optimization of hybrid resource components will need to wait until future phases of the initiative are considered.

- *SCE agrees with the CAISO's proposal of developing an interconnection rights constraint that ensures CLR outputs are limited up to the maximum interconnection injection rights. SCE also believes grouping of constraints and extension of MSG functionality may result in a suboptimal solution.*
 - *SCE requests that the CAISO provide further details on the proposed constraint, including detailed functional form. While the interim solution may result in stranded capacity, SCE agrees with the CAISO's approach to provide a holistic constraint that accounts for both energy and ancillary services.*
 - *Further, SCE supports the CAISO in not proceeding with the alternative to allow the true Pmax to be input in the master file. SCE is concerned that allowing a value that the resource may not be allowed to realize is not a robust solution and risks violating the CAISO's CCE3 policy.*
 - *Finally, SCE supports the CAISO not including in the LMP, any congestion that may be created from this proposal. As the CAISO stated, any such congestion would be an artifact of the interconnection constraint and not representative of reality.*
- *SCE requests clarification on HR participation envisioned by the CAISO. During the stakeholder call, the CAISO had indicated that it expected HRs to participate based on net energy output, incorporating together the output of all components. SCE requests additional clarification on this part. Specifically, there are also two other cases that need elaboration by the CAISO.*
 - *The first is when the net energy output of the facility is zero. Thus, the facility's storage is utilizing exactly the amount produced by the supply component.*
 - *The second is when the net energy output of the facility is negative. Thus, the facility's storage is utilizing all of the amount produced by the supply component, as well as charging off the grid. In both these cases, the net energy output is non-positive.*
 - *Will the CAISO consider the net zero and net negative outputs as schedules?*

The CAISO appreciates SCE's support on the proposed interconnection constraint and interim position co-located resource Pmax limitations. The CAISO understands the SCE view related to risking violation of the CCE3 provisions related to the co-located Pmax issue and agrees this aspect should be carefully considered. The CAISO has included additional details on the proposed interconnection constraint as requested by SCE and seeks additional feedback on the proposed constraint formulation and related price formation issues.

The CAISO understands SCE's requests for additional clarification on the proposed participation of hybrid resources. The CAISO notes that the self-provided forecast of hybrid resources is only intended to be applied to the Real-Time market and to be utilized to dynamically update the hybrid resource's upper economic limit. The CAISO clarifies that the hybrid resource bid/offers will be the main input used for the market awards and will dictate the schedules of the hybrid resource, the self-provided forecast will only be used to adjust the upper economic limit in the Real-Time market to ensure that the hybrid resource's market awards and dispatch targets are feasible. The CAISO proposal will allow for hybrid resources modeled as NGRs to bid to receive charging awards and dispatch instructions if economic, or to self-schedule to ensure

that they are awarded and dispatched to charge from the grid if the resource must charge from the grid or is expected to have a net negative output during certain periods. The CAISO proposal does not allow for self-provided forecasts to be negative.

- The resource owner/operator will need to provide a self-provided forecast of zero potential net energy output when the resource's net energy output is zero and the facility's storage is utilizing exactly the amount produced by the supply component. The CAISO also clarifies that similarly, hybrid resources should submit a self-provided forecast of zero when the net energy output of the facility is anticipated to be negative and the facility's storage component is utilizing all of the amount produced by the supply component, as well as charging off the grid. The CAISO intends the self-provided forecast will be limited on the lower bound at zero and any grid charging from hybrid resources modeled as NGR resources would accomplish negative output, i.e., grid charging, through its' bid/offers and self-provided forecast of zero potential net energy output. *Wellhead: Wellhead supports updating the upper economic limit every 5 minutes but notes that the upper limit would seem to apply only to hybrids modeled as a generator. Wellhead fully supports the CAISO's proposal to add an IC rights constraint for colocated resources. Wellhead also supports the elimination of the congestion component at the resource pricing node which will result from the implementation of the IC rights constraint. Wellhead notes that the proposed interim solution for an IC rights constraint is suboptimal. Wellhead understands CAISO's reluctance to trust on-site limiters but given the short time until the IC constraint can be put in place, it would seem to be a superior option to stranding capacity.*

The CAISO clarifies that the self-provided forecast proposal and dynamic upper economic limit will be applied to all hybrid resources, including both those modeled as traditional generators and those modeled as NGRs. The self-provided forecasts and upper economic limit of hybrid resources will be limited by the lower bound of zero net energy output. The NGR hybrids will utilize their bid/offers or self-schedules to accomplish grid charging when their expected net energy production is negative, i.e., they wish to charge from the grid.

The CAISO acknowledges that Wellhead's feedback that the proposed interim approach to the co-located resource Pmax limitation issue is suboptimal is fair. The CAISO cannot simply rely on onsite limiters and controllers to address this issue. These interconnection limitations are only able to limit the physical output of resources, they are not reflected as constraints in the CAISO's market processes. To simply rely on these onsite limiters would potentially result in frequent infeasible market awards and dispatch instructions for co-located resources. The CAISO is unable to implement changes to the market processes to incorporate the proposed interconnection constraint until fall 2021. The CAISO has explored other interim options and has determined that any other possible solutions would also require material system changes and implementation efforts that are not feasible in a shorter timeframe than the preferred proposed solution.

- *WPTF notes that resources are optimized by the CAISO market via a "participation model" – these are set structures for different resource types. WPTF suggests that the*

CAISO appears to be proposing to use the Variable Energy Resource (VER) participation model, but this may not enable adequate functionality to allow the storage resource to charge from the grid.

- *WPTF asks that the CAISO consider how a Hybrid resource will be able to use the NGR model – the only model that allows for a negative Pmin – and either provide its own forecast or enable telemetry to allow the CAISO to forecast the variable energy resource piece and add this to the storage upper economic limit each hour. If a resource has to provide their own forecast, already they will have to meter their VER separately from the storage. There is no other way to get an accurate forecast. WPTF believes that it may be beneficial to allow the CAISO to provide the forecast and enable systems that are set up to add the discharge portion of the storage resource. WPTF admits this is simpler to say than do, but things like outage cards and accurate accounting will be a challenge no matter which entity provides the forecast.*
- *WPTF suggests the CAISO consider an alternative interim solution for the Interconnection Rights Constraint. WPTF suggests that common practice for co-located resources is to install a locking mechanism such that energy will never flow in excess of the interconnection rights, thus the Pmax issue falls squarely within CAISO market rules. WPTF notes that the BPM and tariff clearly compel Scheduling Coordinators and the Masterfile to accurately reflect a resource’s Pmax based on design capabilities.*
 - *WPTF believes that the fact that the New Resource Implementation (NRI) process or CAISO operators object to this does not mean the CAISO may waive their own tariff requirements. If the CAISO is going to allow over-sizing (which is already does) then they must allow the Pmax to reflect the actual design capability of the resources.*
 - *WPTF notes that the CAISO already has a requirement that colocated resources must not bid above their interconnection value within the Generator Management BPM in section 6.5.3. although this is not very clear. WPTF suggests the CAISO clarify this requirement to restrict hourly aggregate energy offers to the interconnection value. This means the market will never receive offers the resources cannot individually provide over the interconnection.*

The CAISO clarifies that it is not proposing that hybrid resources utilize the VER resource model as WPTF suggests. Rather, the proposal already allows for hybrid resources to select either the traditional generator model or the NGR model for participation. This optionality has been established as the two hybrid resource modeling options since 2016, when the CAISO published the hybrid resources technical bulletin. The CAISO has already proposed what WPTF is suggesting and will allow for hybrid resources to self-provide forecasts and bids/offers or self-schedules to allow for net negative energy output, i.e., grid charging. The CAISO declines to incorporate the WPTF suggestion to create a net energy forecast that considers the state of charge or charging and discharging status of hybrid resources modeled as NGRs. The CAISO will not consider the onsite optimization of hybrid resources in its markets, the hybrid resource owner/operator will need to perform this activity and provide the CAISO with the resource’s bid/offers and self-provided forecast of its’ net energy output.

The CAISO disagrees with WPTF's assertion that it is waiving or violating any of its tariff requirements with the proposed interim approach to address interconnection limits and co-located resource's combined Pmax limitations. The CAISO notes that it must limit the combined Pmax of co-located resources to avoid infeasible market awards and dispatch instructions until the proposed interconnection constraint is implemented. The CAISO cannot simply rely on onsite limiters and controllers to address this issue. These interconnection limitations are only able to limit the physical output of resources, they are not reflected as constraints in the CAISO's market processes. To simply rely on these onsite limiters would potentially result in frequent infeasible market awards and dispatch instructions for co-located resources.

The WPTF suggestion to simply rely on a tariff requirement to limit the aggregate bids of co-located resources will not provide a feasible solution without associated system changes to adjust the CAISO market software that will require implementation. The CAISO has already explored other interim options suggested by WPTF and other stakeholders and has determined that any other possible solutions would also require material system changes and implementation efforts that are not feasible in a shorter timeframe than the preferred proposed solution. The CAISO suggests that resource interconnection customers also have the option to select the hybrid resource configuration that can address these concerns. Additionally, resource interconnection customers can obtain additional interconnection rights through the interconnection process where they would pay for any upgrades identified necessary to allow for additional interconnection rights.

Stakeholder Feedback on Ancillary Services Proposal

- *8minute recommends the ISO to expand and clarify the definition of "plant potential".*
- *8minute also notes that some PV + storage plants are being designed with significant DC and AC overcapacity, and we would like to understand how "plant potential" relates to oversized plants. 8minute intends to operate hybrid plants with more AC power than interconnection limit where BESS will charge from the excess AC power, or the PV will be curtailed. This mode of operation should be accommodated by ISO regulations. If grid charging is not allowed, if VER is not producing any energy, the BESS may not provide any ancillary services that require grid charging (e.g. Reg-down)..*

The CAISO agrees with 8minute's recommendation to clarify the definition of the plant potential terminology discussed in the straw proposal. The CAISO has determined it will be most helpful to utilize the terminology "high sustainable limit" or HSL, rather than continue to discuss the term plant potential. The CAISO believes that high sustainable limit is a more accurate term for the issue that is being discussed. The CAISO has included this change in the proposal and provided an initial definition for further consideration.

The CAISO clarifies that the high sustainable limit provided by oversized hybrid resource projects will need to reflect their full output potential including the total installed capacity of the resource components. This is because the onsite optimization of hybrid resources will be conducted by the resource owner/operator. In other words, the resource owner/operator will

need to choose how to optimize the hybrid resource components and thus, decide when to charge and discharge the storage and when to curtail the VER component, and this will be especially important when these resource components are oversized compared to the hybrid resource's interconnection rights.

- *CESA supports the CAISO's ancillary services proposal but seeks clarification on the CAISO's definition of "resource potential" and how it differs from the self-provided forecast. CESA also requests that the proposal account for how hybrid resources would be able to provide ancillary services when treated as generators versus NGRs.*
- *CESA also takes note of the CAISO's question around an SOC metric for other types of non-lithium ion battery storage. As CESA understands it, these other technologies should be able to submit SOC bid parameters that reflect their ability to provide ancillary services. CESA is open to answering further questions from CAISO regarding this matter if there are specific concerns.*

The CAISO understands CESA's request for clarification of the resource potential issue and has determined it will be most helpful to utilize the terminology "high sustainable limit" or HSL, rather than continue to discuss the term plant potential. The CAISO believes that high sustainable limit is a more accurate term for the issue that is being discussed. The CAISO has included this change in the proposal and provided an initial definition for further consideration.

The CAISO appreciates CESA's input regarding the use of existing state of charge functionality by other storage technologies beyond battery storage.

- *First Solar supports the creation of Plant Potential and State-of-Charge data points. To ease understanding here, FSLR suggests that Plant Potential be renamed Headroom to recognize that CAISO is particularly interested in monitoring the potential incremental energy the plant can dispatch (up to its POI).*
 - *Related to the provision of frequency regulation service, the dispatch signals received in one interval have a direct impact on the state-of-charge available in the subsequent interval. For this reason, both Headroom and State-of-Charge may need to be dynamic data points so that CAISO can monitor in real time the availability of the hybrid resource.*
- *FSLR requests the CAISO provide additional details on the ancillary services no pay provisions and associated reporting obligations for situations where a dramatic change in Headroom and/or State-of-Charge occurs due to a sudden change in solar / wind availability. As an example, what process does CAISO envision when significant variability in one operating interval impacts the Headroom and/or State-of-Charge for an awarded ancillary service in a subsequent operating interval?*

The CAISO agrees with the recommendation by First Solar to change the terminology being used for the plant potential item. The CAISO believes that it will be most helpful to utilize the terminology "high sustainable limit" or HSL, rather than continue to discuss the term plant potential. The CAISO believes that high sustainable limit is a more accurate term for the issue that is being discussed. The CAISO has included this change in the proposal and provided an initial definition for further consideration. The CAISO agrees with First Solar's suggestion that

the HSL and state of charge will need to be dynamic data points and also notes that the CAISO will need to have additional data on the status of hybrid resource storage components current charging or discharging status that will also require dynamic data points.

The CAISO understands First Solar's request for further clarification on the AS no pay application for hybrid resources that may experience drastic changes in potential output due to VER component's fuel variability. The CAISO is proposing to treat hybrid resources the same as other dispatchable generators providing AS. This means that if a hybrid resource is receives an AS award it will be expected to maintain the capability to provide the associated services. If a hybrid resource with a VER component experiences a significant drop in the fuel availability the CAISO expects that the hybrid resource will need to maintain the ability to provide any awarded AS capability through the use of the other hybrid resource component, namely the storage component. If the CAISO determines that the hybrid resource was unable to maintain the capability to provide the AS that it has been awarded the CAISO will apply AS no pay provisions the same manner as it would for other traditional dispatchable resources. The CAISO proposal appropriately assigns all risk associated with any related AS no pay settlements to the hybrid resource owner/operator.

- *PG&E: PG&E is skeptical of the ability of ITC-Driven hybrid resources to offer AS given the strict charging criteria of the energy storage system. For example, a solar plus storage hybrid resource may struggle to provide or respond to AS signals when operating under a strict charging schedule during daylight hours but may otherwise be available to do so during evening hours.*

The CAISO understands the concerns raised by PG&E regarding the ability of hybrid resources with operational constraints to provide AS. The CAISO believes that the current proposal to apply existing AS no pay provisions to hybrid resources that wish to participate in the AS market will provide adequate incentive for those resource to provide the services they have been awarded. The CAISO does not believe that there is a need to specifically preclude certain types of hybrid resource from providing AS, rather, the market signals and settlement consequences of failure to deliver or maintain AS capability that has been awarded to hybrid resources should be the appropriate mechanism to ensure the safe and reliable provision of AS by hybrid resources.

Stakeholder Feedback on Resource Adequacy Proposal

- *8minute recommends requiring only the BESS component to submit a MOO in the day-ahead. In real time, the MOO should be the combined MOO of the hybrid resources limited by the interconnection capacity. We also recognize that RA related work is ongoing on other proceedings and would like to suggest that the two efforts synchronize the treatment of hybrid resources as they reach their final stages.*

The CAISO understands the recommendation by 8minute energy regarding the DA and RT MOO proposal for hybrid resources. The CAISO agrees with 8minute's recommendation that the DA MOO for hybrid resources be equal to the storage component of the hybrid resource.

However, the CAISO notes that this aspect of the DA MOO proposal will need further consideration to address certain circumstances and hybrid resource configurations that may not work well and may cause some concern of allowing a potential for withholding or exercise of market power.

The CAISO agrees with the 8minute suggestion to ensure that any RA related provisions proposed through this initiative be coordinated with other related and ongoing RA modifications and will continue to refine all RA related aspects in a coordinated manner. To that end, the CAISO notes that the current RA enhancements MOO proposal will remove the Real Time MOO for RA resources and only require a DA MOO to align with the proposed DA market enhancements modifications that make this change to remove the RT MOO for all RA resources necessary. The CAISO is still considering the best approach to address the MOO provisions for hybrid resources that participate in the RA program.

- *CalCCA supports CAISO's proposed interim methodology for setting Hybrid Resource RA Net Qualifying Capability using the VER Effective Load Carrying Capacity (ELCC) plus Storage NQC, subject to deliverability and interconnection POI rights. This interim approach would treat Hybrid Resources and Co-Located Resources similarly for purposes of RA NQC, which would reflect underlying physical capabilities of similar Hybrid and Co-located resources.*
 - *Some parties at the October 3 stakeholder meeting argued that it isn't possible to get the full VER output plus the full storage output. CalCCA disagrees. As an engineering matter, it is entirely possible to obtain the full output of both the VER resource (which itself can be excess of the ELCC) and the storage resource during the periods when both resources are needed. The ELCC approach significantly already discounts the VER resource capabilities and doesn't consider how VER resources will be operated in conjunction with storage resources. CalCCA believes that CAISO's proposal is appropriate as an interim measure. Any modifications can be made to reflect realworld experience. If supported by data identifying significant differences between the performance of Hybrid Resources and Co-located Resources, CAISO could propose treating these resources differently.*
- *CalCCA supports having separate Must Offer Obligations (MOO) for Co-located Resources. For Hybrid Resources, CalCCA supports CAISO's proposal for the MOO to be based on the self-provided, combined resource forecast. Resource Adequacy Proposal*

The CAISO appreciates CalCCAs support of the RA proposals for hybrid and co-located resources. The CAISO has adjusted its proposal for a default hybrid resource QC to align with the recent CPUC PD for hybrid resource QC that limits the overall QC of hybrid resources to the greater of the single QC value of either of the hybrid resource components. The CAISO notes that this updated proposal is not aligned with the feedback provided by CalCAA, although CAISO believes that it is reasonable to propose as a default QC methodology. The CAISO will continue to work with the CPUC to develop a more accurate QC methodology for hybrid resources.

- *CESA supports the establishment of a default RA counting methodologies for hybrid resources as outlined in the Straw Proposal, but we understand that this is likely the purview of the California Public Utilities Commission (CPUC). Regardless, RA valuation should be differentiated by hybrid resources between those that involve storage paired with dispatchable and non-dispatchable generation, as well as those that are operating as a generator versus an NGR.*
- *CESA believes that an additive methodology is appropriate for hybrid resources operating as an NGR, regardless of whether the storage device is paired with a dispatchable (e.g., Pmax of gas) or non-dispatchable generator (e.g., ELCC for solar). The flexibility of the storage resource to charge from either the grid or the onsite generator provides assurances of “fuel” for charging such that the storage resource should be counted for its four-hour sustained discharge.*
 - *However, for hybrid resources with operational constraints (e.g., charging only from onsite generator) that operate like a generator, the storage resource is limited in the fuel available by the onsite generator, which suggests that a simple additive approach may not accurately estimate the capacity value of the hybrid resource. The CPUC is actively considering effective load carrying capability (ELCC) proposals and conducting studies through the RA and RPS proceedings to develop counting methodologies for such resources, so CESA recommends that the CAISO not make a premature determination on this matter in this initiative. In the interim, CESA is supportive of an additive methodology subject to deliverability and POI constraints.*
- *For co-located resources, RA capacity methodologies appear more straightforward, with the qualifying capacity (QC) and net qualifying capacity (NQC) determined on an additive basis. CESA recommends that CAISO perform the split on capacity values when developing NQC list to account for the POI limit, which offers the greatest flexibility, where the CAISO can manage resource deliverability.*
- *Otherwise, CESA is supportive of the establishment of must-offer obligations (MOOs) as defined in the Straw Proposal and the coordination of this initiative with the DayAhead Market Enhancements (DAME) Initiative and the RA Enhancements Initiative.*

The CAISO agrees with CESA's assertion that QC methodologies are deferred to the CPUC. However, the CAISO notes that it does have authority to develop default QC methodologies for inclusion in the CAISO tariff and intends to do so for hybrid resource default QCs through this initiative. The CAISO also notes that the CPUC has recently issued a PD on the hybrid resources QC methodology that the CAISO has incorporated into its' proposal for the hybrid resources default QC methodology.

The CAISO agrees with CESA's suggestion that the CAISO determine the split of NQC value for co-located resources during the NQC process to account for the POI limit. This will also be accomplished through the current Pmax limit approach that will be used in the interim until the proposed interconnect constraint solution is implemented. Once the proposed interconnection constraint has been implemented, the CAISO agrees that it will need to utilize the annual NQC process and related deliverability assessment to determine the appropriate NQC split for co-

located resources since the Pmax NQC constraint may no longer be binding, but the interconnection rights limits will continue to be a binding NQC constraint that must be reflected.

- *EDF and LSA: RA value: EDF-R supports the CAISO revised proposal to reflect approved stand-alone methodologies for the different components that make up the resource, because: (1) The reliability value of the components to CAISO should be the same under either single or multiple Resource IDs; and (2) adoption of the CAISO's prior Exceedance proposal could encourage project selection of this configuration just to maximize RA value.*
- *EDF and LSA suggest the following for hybrid resource Must-Offer Obligations: Adding 100MW/40 MWh of storage to a 100 MW VER project (picking an extreme example) should not magically make a project into a non-VER and/or impose the significant risks of DA scheduling on such a resource. As proposed in comments on the Issue Paper, MOOs should reflect the relative components that make up the hybrid. For example, the MOO for this hypothetical resource should be as follows:*
 - *DA MOO: Same as for a stand-alone storage resource (since the VER component should have no DA MOO):*
 - *DA MOO = DA MOO for a 10 MW/40 MWh storage project*
 - *RT MOO: Same as for the separate resources but limited for the POI output limitation, i.e.: RT MOO = (RT MOO for a 100 MW VER) + (RT MOO for a 10 MW/40 MWh storage project), but not more than 100 MW*

The CAISO appreciates the feedback on RA proposals for hybrid resources provided by EDF and LSA. The CAISO clarifies that it is not proposing to “magically” make hybrid resources with VER components into non-VER resources as EDF and LSA assert. The proposed definition and market treatment of hybrid resources allows for these resources to continue to be categorized as VER resources, however it necessarily precludes them from being considered EIR or PIR resources. This paradigm has been described in the proposal under the markets and systems section above. If resource interconnection customers wish for VER resources to continue to receive EIR or PIR status, they have the option to choose a co-located resource configuration with separate resource IDs that will allow for that categorization and related treatment to be selected and maintained.

The CAISO agrees with EDF and LSA's recommendation that the DA MOO for hybrid resources be equal to the storage component of the hybrid resource. However, the CAISO notes that this aspect of the DA MOO proposal will need further consideration to address certain circumstances and hybrid resource configurations that may not work well and may cause some concern of allowing a potential for withholding or exercise of market power. The RT MOO for hybrid resource has been removed from the proposal to align with other ongoing RA related efforts. The CAISO notes that any RA related provisions proposed through this initiative be coordinated with other related and ongoing RA modifications and will continue to refine all RA related aspects in a coordinated manner. To that end, the CAISO note that the current RA enhancements MOO proposal will remove the Real Time MOO for RA resources and only require a DA MOO to align with the proposed DA market enhancements modifications that make this change to remove the RT MOO for all RA resources necessary. The CAISO is still

considering the best approach to address the MOO provisions for hybrid resources that participate in the RA program.

- *First Solar supports the RA counting approach to hybrid resources articulated in the straw proposal, including using it as the default NQC for hybrid resources while the CPUC develops its own QC methodology for hybrids. Considering the CPUC has not yet implemented a QC for hybrid resources, this will bridge a current gap in the RA program.*
 - *Looking at the counting approach itself, ELCC + the 4 hour sustained capability of the battery (capped at POI) accurately represents the resource's availability during likely peak periods and aligns with current state policy on the individual components. ELCC accounts for the contribution of the VER resource's contribution to RA. On peak days, the hybrid resource would first prioritize charging the battery component. During the evening peak, the VER's production would still occur, plus the battery's contribution.*
- *FSLR highlights that there are several configurations at play, and the CAISO should not use Pmax for the battery in this context. The battery could be designed for 2.5 hours (or similar) maximum output. Spread over a 4 hour window, its RA capacity would be lower.*

The CAISO understands First Solar's feedback on the storage component related QC issues and agrees that the proposal should be clarified. The CAISO clarifies the intent of the hybrid resource QC methodology proposal is the greater of the VER component ELCC QC or the storage component's four hour sustained duration capability. The CAISO agrees that simply using the Pmax of the storage component could overvalue the RA contribution of hybrid resources with storage components.

- *PG&E believes that the CAISO's proposal for hybrid QC counting methodology is inconsistent with its proposal for hybrid must-offer obligation. This inconsistency likely stems from attempting to create a single counting methodology and must-offer obligation which applies to all hybrid resources. This discussion around QC counting methodology will obviously have to be done in concert with the CPUC's discussion of hybrid resources.*
 - *Due to the ITC out-of-market incentive, some hybrid resources may choose to use a battery to firm and shape solar production to ensure that they are credited with the full federal incentive. These hybrid resources should not be counted for QC in the same way a market-driven hybrid resource should, and additionally their MOOs should reflect this separate treatment. PG&E's approach presents the following options:*
 - *ITC-Driven: QC Counting Methodology – For ITC-Driven resources it does not make sense to create a QC value that adds the Pmax of the energy storage component to the ELCC of the VER component. These hybrid resources will likely be operated in a way which firms and shapes the output at a consistent or somewhat consistent amount. The purpose of the energy storage component would be to maximize the solar output and shift some of the solar production from the middle of the day to the shoulder hours in the morning and afternoon.*

- *The CPUC should look into developing a new ELCC counting methodology for these hybrid resources. We think resource owners and SCs would need to forecast the firmed and shaped level of production of the hybrid resource to assist the CPUC in evaluating a new ELCC calculation.*
- *This counting methodology may be simplified to include the ELCC value of the VER resource plus some adder from the storage component, but it would be distinct from the Market-Driven hybrid resource in that the Pmax of the storage component would not be fully added.*
- *Must-Offer Obligation – This issue of a MOO and incentive mechanisms for meeting that obligation are tough issues and PG&E is still grappling with what would be appropriate. Under the current framework of resources having MOOs in the market we think the must-offer obligation for ITC-Driven hybrid resources would be equal to their self-provided forecasts as stated in the CAISO’s Straw Proposal.*
 - *As proposed by the CAISO, the MOO would be updated to match hybrid resource self-provided forecasts. PG&E has supported the idea of MOOs varying with expected resource availability across the hours of the day in the RA Enhancements Initiative, however in the long run we question the effectiveness of using RAIM penalties to guide market participant behavior for certain types of resources.*
- *Market-Driven QC Counting Methodology – For Market-Driven hybrid resources, PG&E proposes the QC counting methodology would be additive as presented in the CAISO’s Straw Proposal. Assuming no transmission constraints, the RA value would be calculated by adding the ELCC value of the VER component with the Pmax of the energy storage component. PG&E agrees with the CAISO’s counting example that it provided in the Straw Proposal and presentation, however this example was simplistic because the interconnection rights were large enough to accommodate the combined installed capacity of the solar resource and Pmax of the battery component.*
- *Must-Offer Obligation: DA MOO – Again, MOOs and incentive mechanisms for them are tough issues that PG&E is still working though, but under the current framework PG&E thinks that for Market-Driven hybrid resources the DA MOO would be equal to the Pmax of the energy storage component in all hours, consistent with current NGR treatment, with the option but not requirement of adding the DA VER forecast. This is based on the current DA bidding requirements of EIR resources. The RA Enhancements initiative is currently contemplating requiring all RA resources, VER included, to have a MOO in the DA market. This is a major change to bidding requirements for RA resources. The CAISO could decide to only make the VER component of these hybrid resources subject to a DA MOO once the RA Enhancements Initiative is complete and implemented.*

The CAISO has updated the proposal for the default hybrid resource QC methodology to reflect stakeholder feedback and better align with the CPUCs recent PD for the hybrid resource QC methodology. The CAISO believes this change will address some of the concerns and feedback that has been provided by PG&E. The CAISO agrees with PG&E's suggestion that hybrid resource should ideally be assessed under an ELCC methodology. This is easier said than done however, but the CAISO will continue to work with stakeholders and the CPUC to move towards the use of ELCC for hybrid resource's QC determination in the future. The CAISO notes that any ELCC based QC methodology for hybrid resources should be applied on a resource specific basis and would not support the application of a class average ELCC-based approximation QC methodology similar to the current CPUC approach for wind and solar resources. The CAISO believes that would result in inaccurate assessments of hybrid resource RA contributions and would recommend that any application of ELCC-based QC methodologies be done on a resource specific basis.

The CAISO also agrees with PG&E's suggestion that the DA MOO proposal for hybrid resources should be modified and has updated the hybrid resource MOO proposal to be equal to the storage component QC of hybrid resources. However, the CAISO notes that this aspect of the DA MOO proposal will need further consideration to address certain circumstances and hybrid resource configurations that may not work well and may cause some concern of allowing a potential for withholding or exercise of market power. The RT MOO for hybrid resource has been removed from the proposal to align with other ongoing RA related efforts. The CAISO notes that any RA related provisions proposed through this initiative be coordinated with other related and ongoing RA modifications and will continue to refine all RA related aspects in a coordinated manner. To that end, the CAISO note that the current RA enhancements MOO proposal will remove the Real Time MOO for RA resources and only require a DA MOO to align with the proposed DA market enhancements modifications that make this change to remove the RT MOO for all RA resources necessary. The CAISO is still considering the best approach to address the MOO provisions for hybrid resources that participate in the RA program.

- *Pintail Power: We believe that QC must reflect the ability of the resource to dispatch when needed by the grid. The Effective Load Carrying Capability (ELCC) reflects the shifting of the need for capacity away from the availability of solar resources to provide such capacity, i.e., a measure of non-coincidence of supply and demand. In the example of Table 5 the 100MW solar resource with 44% ELCC as 44 MW QC; the 100MW storage system with four-hour duration is shown as 100MW QC.*
 - *In fact, the solar resource is not dispatchable, and cannot reliably contribute capacity when the sun is not shining. Although this provides a means for increasing the revenue of solar projects, the ELCC approach does not provide reliable capacity for CAISO. When considering QC for storage resources, we believe it is essential to also consider the availability of the storage to dispatch capacity when needed.*
- *For the example 4-hour duration storage, it would be necessary to immediately recharge the battery in order for it to continue to provide QC. The energy for charging will not be*

available at night from a co-located solar+storage resource, may not be available during a contingency, or may not be affordable, or may require charging from high carbon resources. Charging from high-priced power would increase the resource's MCOE, and despite Must-Offer-Obligation (MOO), the resource might never be dispatched because its cost was too high.

The CAISO understands the feedback provided by Pintail Power on the RA related proposals for hybrid and co-located resources. The CAISO has changed the proposal for the default hybrid resource QC methodology to align with the CPUC's recent PD for the hybrid resource QC methodology. The CAISO believes this change will address some of the concerns and feedback that has been provided by Pintail Power.

- *SDG&E agrees with the CAISO that RA counting rules should provide fair and accurate capacity valuations. SDG&E also agrees with the CAISO that there is currently a gap because there is not an established QC counting rule for hybrid resources under single resource ID configurations. SDG&E understands that under the hybrid resource proposal, the CAISO is proposing to adopt a default QC methodology for each of the underlying resources of the hybrid resource and then combines each resource's QC values together to establish the QC value for the hybrid resource.*
 - *For Solar resources, the CAISO is proposing to use the CPUC's Effective Load Carrying Capability (ELCC) methodology. SDG&E questions whether this means that the CAISO will be changing the current default exceedance methodology as specified in Tariff Section 40.8.1.6 to the ELCC methodology or if the ELCC methodology would only be applied for the hybrid resource?*
- *In SDG&E's opinion, the default QC methodology for hybrid resources should be ELCC based. However, SDG&E understands that the CAISO is not equipped to perform such analysis annually and therefore a simpler approach may be appropriate. SDG&E supports the CAISO's proposal but the QC methodology should only be limited to hybrid resources without any operational limitations (such as the ITC requirement), the hybrid resource QC should be the ELCC value of the renewable resource plus the QC of the storage project.*
- *For Hybrid resources that have operational limitations, SDG&E recommend to use: the larger of (i) the ELCC-based QC of the intermittent resource or the QC of the dispatchable resource, whichever applies, and (ii) the QC of the storage device.*
 - *This option has the advantage of certainty: the grid operator (the CAISO) has certainty that the hybrid resource can deliver at least the amount of QC.*
- *SDG&E notes that the NQC values for all resources are capped at their interconnection rights and are subject to deliverability studies performed by CAISO as well.*

The CAISO understands SDG&E's question regarding the default QC proposal and the existing default QC for solar and wind resources being an exceedance methodology. The CAISO clarifies that it is not proposing to include any changes to existing default QC methodologies for wind or solar resources through this initiative. The CAISO acknowledges that this issue should potentially be revisited in other more appropriate venues in the future.

The CAISO agrees with SDG&E's suggestion that hybrid resource should ideally be assessed under an ELCC methodology. This is easier said than done however, but the CAISO will continue to work with stakeholders and the CPUC to move towards the use of ELCC for hybrid resource's QC determination in the future. The CAISO notes that any ELCC based QC methodology for hybrid resources should be applied on a resource specific basis and would not support the application of a class average ELCC-based approximation QC methodology similar to the current CPUC approach for wind and solar resources. The CAISO believes that would result in inaccurate assessments of hybrid resource RA contributions and would recommend that any application of ELCC-based QC methodologies be done on a resource specific basis.

The CAISO has changed the proposal for the default hybrid resource QC methodology to align with the CPUC's recent PD for the hybrid resource QC methodology. This recent PD has proposed to adopt the suggestion by SDG&E for hybrid resource with operational limitations.

- *Wellhead: For clarity, Wellhead believes the CAISO should differentiate between VER-hybrids and Gas-hybrids as well as how the resource is modeled.*
- *Generator Model*
 - (1) *Hybrid Gas = Gas Pmax + Pmax (4-hour ES duration sustained output)*
 - (2) *Hybrid VER = Min (VER total daily output / 4, Pmax (4-hour ES duration sustained output))*
- *The generator model does not support charging from the grid, so the fuel available to the integrated energy storage is limited to the total daily output of the VER Non-Generator Model*
 - (3) *Hybrid Gas = Gas Pmax + Pmax (4-hour ES duration sustained output)*
 - (4) *Hybrid VER = ELCC for VER component + Pmax (4-hour ES duration sustained output) All models are subject to deliverability and capped at IC rights as proposed.*

The CAISO appreciates the feedback Wellhead has provided on these issues. The CAISO agrees that it is helpful to clarify and differentiate these various hybrid resource configurations as provided in the helpful diagram submitted by Wellhead. The CAISO has incorporated some aspects of this feedback into the hybrid resource default QC methodology proposal.