California ISO

Hybrid Resources Issue Paper

July 18, 2019

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

The CAISO is committed to enhancing the participation of energy storage in its markets and 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 is launching this new hybrid resource initiative to further the use and usefulness of these unique resources.

As the grid evolves, so has developers' interests in energy storage and its use and operation. CAISO is experiencing an increasing number of inquiries from generation developers interested in pairing energy storage with either existing or proposed generation (conventional or renewable). Such resources have been previously referred to as "hybrid" generation resources – however, through this stakeholder initiative, CAISO intends to update the definition of hybrid resources to encompass any combination of multiple resource technologies combined into a single generating facility with a single point of interconnection. CAISO believes this more expansive definition will best encompass potential future resource combinations seeking combined hybrid treatment with co-location at a single point of interconnection.

For purposes of this issue paper, the CAISO refers to hybrid projects or hybrid resources as a combination of multiple technologies or fuel sources combined into a single resource with a single point of interconnection.[2]

CAISO has observed that the number of combined hybrid resource configurations submitting interconnection requests is growing, comprising approximately 41% of the total capacity currently seeking interconnection.[3] Due to the number of interconnection requests currently in

[1] Eligible energy storage projects include generating units participating in the CAISO market as participating generators, dynamic schedules and participating pseudo-ties.
[2] The CAISO recognizes that this definition may not be universal. For example, pairing a small amount of energy storage with a conventional generator where the storage would only be used to meet station power demand may not require any treatment unique to hybrid resources beyond how the resource is initially studied and modeled. The CAISO intends to explore whether there should be obvious exceptions to this general rule.
[3] As of July 3, 2019, CAISO's Generator Interconnection Queue included 35,341 MWs of hybrid resources seeking interconnection with a total 85,643 MWs of requested capacity at point of interconnections. Therefore, hybrid resource interconnection requests comprise 41.2% of the total requested interconnection MWs currently in the CAISO Generator Interconnection Queue.

the interconnection queue, and given the strong interest expressed by developers and stakeholders, 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, CAISO developed a hybrid resources technical bulletin in 2016 to provide initial guidance on such issues.[4]

The increasing numbers and interest in hybrid resources has surfaced additional technical questions about their configuration, operation, market participation, and settlements of these combined resources. Hybrid resources also raise new operational and forecasting challenges that CAISO intends to address prior to their wide scale adoption and operation on the CAISO system. This issue paper identifies a number of topics to assess how to better integrate hybrid resources and to address operational considerations in anticipation of their growth.

The CAISO has developed this issue paper to provide background on hybrid resources and to begin stakeholder discussions on possible modifications necessary to enable further adoption and participation of hybrid resources. The following subject matters are discussed in the body of this issue paper: 1) Interconnections, 2) Forecasting and Operations, 3) Markets and Systems, 4) Ancillary Services, 5) Deliverability, 6) Resource Adequacy, and 7) Metering, Telemetry and Settlements.

[4] 2016 Hybrid Resources Technical Bulletin: https://www.caiso.com/Documents/TechnicalBulletin-ImplementationofHybridEnergyStorageGeneratingFacilities.pdf

2. Stakeholder Engagement Plan

Table 1 presents the initial schedule for this stakeholder initiative below.

Table 1: Stakeholder Engagement Plan

Date	Milestone
	Issue Paper
July 18	Publish Issue Paper
July 22	Stakeholder Meeting on Issue Paper
August 13	Comments Due on Issue Paper
September	**Straw Proposal**
November	**Revised Straw Proposal**
February	**Second Revised Straw Proposal**
April	**Draft Final Proposal**
TBD	**Board of Governors Meeting**

3. Hybrid Resources Issue Paper

3.1. Background

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: 1) charge from on-site generation; 2) charge from the grid; and 3) charge from on-site generation and the grid.

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

Table 2: Charging configuration impacts

	Contracts	Master File	Metering	Telemetry
Two or more resource IDs				
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
Single resource IDs				
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

	Contracts	Master File	Metering	Telemetry
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

Market Modeling Considerations

CAISO has included the following background on market modeling considerations related to hybrid resources to inform this process and also provide guidance for developers making configuration decisions. 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).[5] Moreover, an EIR can receive certification to be a Participating Intermitted 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 EIR generating units 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:

[5] See CAISO Tariff Appendix A: https://www.caiso.com/Documents/AppendixA_Definitions_Aug1_2014.pdf and CAISO Tariff Appendix Q: https://www.caiso.com/Documents/AppendixQ_EligibleIntermittentResourcesProtocolEIRP_May1_2014.pdf

Single resource ID for energy storage unit and associated generating unit: 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.

With the loss of PIR eligibility/status, CAISO forecasting would not provide a 15-minute market schedule for the resource. 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 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.[6]

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-

[6] Developers might be able to make this selection during the CAISO new resource implementation process, based on the specific characteristics of the project.

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. [7]

Individual resource IDs for energy storage unit and associated generating unit: Option 4 below 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.

Table 3: Summary of modeling impacts

Hybrid generating facility						
Option selection	**VER definition (FERC order 764)**	**VER treatment**	**EIR treatment**	**PIR eligibility**	**NGR treatment**	**Modelling in master file**
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
Multiple resource ID						
Option 4 (all charging options)	Yes	Yes	Yes	Yes	Yes	VER and NGR

[7] CAISO publishes a charge code matrix at: https://www.caiso.com/market/Pages/Settlements/Default.aspx

Contracts

Regardless of the number of resource IDs, any hybrid resource project's Generator Interconnection Agreement (GIA) must include provisions to address both components of the resource, including non-energy storage generating unit and energy storage units. If an energy storage unit addition is a modification to an existing generating facility, then an amendment of the GIA is required.

Hybrid resource projects are required to execute (or amend) a Participating Generator Agreement (PGA) for the entire project. The charging of the energy storage unit from on-site generation can be captured in the schedules for the PGA as a limitation on the generating capability of the on-site generating unit. In addition, the hybrid resource will require a control mechanism or limiting scheme to ensure that the total output of the hybrid generating facility does not exceed the capacity approved in the interconnection study. The hybrid resource will also need to execute (or amend) a Meter Service Agreement (MSA). The MSA allows the CAISO to directly poll the project's settlement quality meter for settlement purposes.

RPS Reporting

The CAISO is currently registered with WECC as a Qualified Reporting Entity (QRE). The CAISO role as a QRE is to submit meter data associated with renewable energy on behalf of ISO Metered Entities using the WREGIS application.[8] CAISO submits meter data into the WREGIS application for those ISO Metered Entities that have requested such service from the CAISO. CAISO intends to continue to provide QRE related RPS reporting to WREGIS in the future for hybrid resources as applicable. CAISO may need to develop new metering requirements or associated practices to allow CAISO and market participants to develop the appropriate data and information needed to provide QRE RPS reporting to WREGIS for hybrid resources under various metering configurations. CAISO will work with stakeholders to identify any related issues and necessary modifications that stakeholders may have identified regarding RPS reporting procedures or requirements for hybrid resources.

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.[9] 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.

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

- 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.

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, CAISO may need to develop new metering requirements and/or new requirements for additional data or inputs from hybrid resource owners to accomplish the necessary RPS reporting.

CAISO will consider all relevant CEC RPS reporting guidelines applicable to hybrid resources. 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 as well. 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.

3.2. Interconnection

Interconnection customers with generating facilities connected to the CAISO controlled grid or to the distribution grid may request to incorporate energy storage into an interconnection request or into a project that has achieved its Commercial Operation Date (COD). If an interconnection customer has not reached its COD, CAISO would review its request under the Material Modification Assessment process (MMA). If the interconnection customer has achieved COD, CAISO would review the request under the modification section of the GIA.[10] Interconnection customers must provide the proposed operating characteristics in the modification request. In particular, if the generating unit will be charged from the CAISO controlled grid at CAISO's direction, CAISO and the Participating TO must study the "negative generation" (*i.e.*, charging mode) for reliability impacts.[11] Generating facilities connected at the distribution level will need to seek approval for such a modification from the Participating TO or UDC, as applicable.

[10] More information on the modification review process for generating facilities in operation is available in the BPM for Generator Management at http://www.caiso.com/rules/Pages/BusinessPracticeManuals/Default.aspx.

[11] If the project desires charging at any time, not at CAISO direction, then the project would require a firm load interconnection and would need to go through the Participating TO's process for load interconnection.

Project sizing and interconnection service limits

If a hybrid generation facility would result in the installation of gross generation capacity in excess of the approved capacity allocated to the project in the GIA, CAISO requires the interconnection customer to propose and install a generation limiting mechanism (*e.g.*, a control or limiting equipment) to limit the output of the hybrid generating facility, so that the total output of the hybrid generating facility cannot exceed the approved capacity at the point of interconnection at any moment.[12]

Interconnection customers should propose the generation limiting mechanism prior to the CAISO commencing study work on the modification request. Interconnection customers will be required to provide the generation limiting mechanism as a condition of the modification's approval. The mechanism will be captured in the GIA and is required to be in place before the project synchronizes to the grid.

3.3. Forecasting and Operations

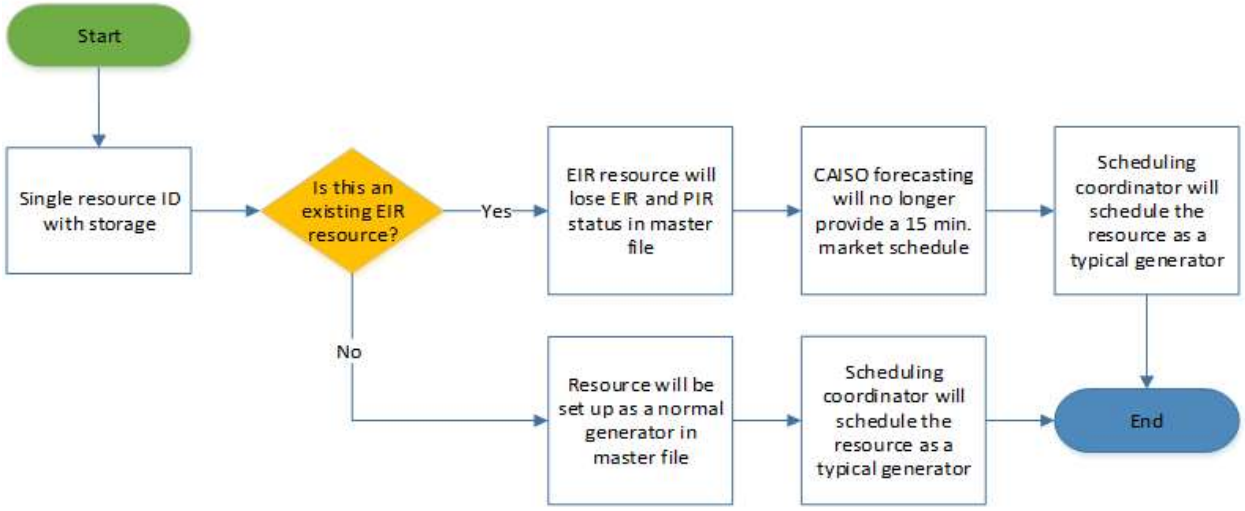
CAISO has identified a number of issues related to forecasting and operations of hybrid resources under different resource ID configurations. The issues included below provide CAISO's initial assessment of possible forecasting and operations related considerations for stakeholder feedback. CAISO also provides potential modifications that may be necessary to address potential risks and to promote the safe and reliable operation of hybrid resources.

Forecasting

The following section discusses forecasting related issues. CAISO has included a diagram that describes the forecasting status for hybrid resources with renewable energy generation components under single resource ID configurations. An energy storage unit is not a VER, therefore, if the 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, if both resources are operated under a single resource ID. Currently, the CAISO provides forecasting for PIRs only. The CAISO Tariff does not have provisions or requirements in place to forecast for non-PIR resources and dispatch them based on that forecast. Figure 1 demonstrates the forecasting and scheduling related requirements for single resource ID hybrid resources.

[12] The CAISO and Participating TO must be able to rely on such a device working consistently. As such, the Interconnection Customer may not modify it.

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



Forecasting issues under a single resource ID configuration

CAISO identified possible forecasting related issues with hybrid resources combined under a single resource ID. One forecasting issue is the inability for the CAISO to be aware of the charging behavior of storage generation components. The charging behavior can cause the potential forecast error to increase. CAISO has provided an initial example analysis of this issue to illustrate the potential forecast error impacts in Table 4. The impact to potential forecast error provided in the example was calculated using the following formula: $\boldsymbol{absolute\ value\ (forecast - actual) \div capacity}$. The example analysis assumes the storage generation component was approximately equal in size to the other hybrid resource component. Because the expected battery behavior is unknown, it was assumed to operate to exacerbate the forecast error by charging and discharging at various instances throughout the day when there was already forecast error present.

Table 4: Example forecast error analysis

Resource Size	Assumed Storage Size	Peak Forecast Error % of Study Day
40 MW	35 MW	9% vs 40%
85 MW	70 MW	4% vs 11%
276 MW	300 MW	1% vs 3%
500 MW	500 MW	6% vs 16%

The example utilizes data selected on a particularly cloudy day that was chosen to help demonstrate possible forecasting risk. The error figures have been calculated using representative resources, not an average of same-sized resources in the market. The analysis

indicates the potential forecast error initially decreases with increasing resource size and then suddenly jumps. CAISO believes this is related to location and sample choice related impacts, rather than an indication of a broader size related forecasting issue.

CAISO also notes that because these single resource ID hybrid configurations would not be considered PIR they would not have a forecast, as discussed above. CAISO believes this may present some risk. CAISO seeks feedback on the need for additional requirements for forecasting for the variable energy generation components of single resource ID hybrid resources. CAISO believes that a modification to require forecasting for these resources, supported by relevant data collection, may be needed. A new requirement would be helpful to ensure reliability because it presents some risk to have these resources participating in CAISO markets without any visibility into their potential forecast as is the case under the current provisions. One additional option may need to be to consider requirements for these single resource ID configurations to provide their own forecast for variable energy resource components.

Related to this potential modification, these single resource ID configurations may need to have meteorological (MET) stations installed to provide the necessary forecasting information. Regarding MET data and site information sheets, CAISO is investigating the need for these resources to provide site info for the entire installed capacity or only for their approved interconnection capacity rights. CAISO is also exploring how to treat oversized resources for these forecasting related modifications. CAISO believes it may be necessary to require forecasting for any variable energy resource component of single resource ID configurations for the full installed capacity of the resource component, even if it is above the project's approved interconnection capacity rights. This may be necessary so that CAISO can have maximum visibility into the potential output of these resources. CAISO seeks feedback on these forecasting related concepts.

Forecasting issues under multiple resource ID configuration

CAISO identified forecasting issues associated with hybrid resources under multiple resource ID configurations. Even with a two resource ID configuration, if the storage is charged from the solar resource, the solar resource's output could still be impacted, depending on the metering configuration. To illustrate this issue, CAISO provides the following examples:

- Example 1: Multiple resource ID solar and storage hybrid with two meters. All energy flows are measured at the relevant meter and accounted for. This example does not present a potential forecasting risk because CAISO can accurately track the solar output and storage charging under this separate metering configuration.
- Example 2: Multiple resource ID solar and storage hybrid with solar meter ahead of the storage meter on the gen-tie. This example demonstrates the potential for excess solar produced energy to charge the storage device without being metered. This could present a forecasting risk because CAISO may not be able to accurately track the solar output and storage charging under this type of single metering configuration.

CAISO seeks feedback on how to best address the issues presented in these two examples and any input on what modifications or new requirements might be necessary to address the

situations described. One initial concept the CAISO is considering is to determine if additional metering or telemetry requirements may be needed to inform the CAISO sufficiently to produce an accurate forecast.

Operations

Operations issues under a single resource ID configuration:

CAISO identified operational issues associated with hybrid resources under single resource ID configurations. Because single resource ID configuration hybrid resources are treated like any other traditional dispatchable resource, they may present potential operational issues. CAISO noted in the forecasting section above that single resource ID configurations would not have a forecast for any variable energy resource components. Additionally CAISO would not have visibility into the state of charge for any storage device components. Both of these data points for variable energy resource forecasting and storage device state of charge information can pose operational risk. This possible risk is present if CAISO is unaware of the resource's potential output, or lack thereof. CAISO would not have certainty that these resources participating in CAISO markets could actually provide the energy or ancillary services awarded through the market. CAISO believes this potential operational risk may necessitate additional forecasting and state of charge transparency requirements.

Single resource ID configuration hybrid resources are generally treated like any other traditional dispatchable resource for bidding, scheduling, and other market participation purposes. This treatment may cause some risk related to the bidding and market timeframes because traditional dispatchable generator self-schedules or bids can only be updated once an hour at 75 minutes prior to the operating hour. For this reason, single resource ID configurations could be awarded at production levels above what they can actually provide, because once bid submission has closed there could be a potential for changes in the fuel of the renewable energy generation component of the resource. This could be an operational risk.

CAISO also notes that single resource ID hybrid resources are less-dispatchable than a traditional dispatchable resource. Single resource ID configurations limit CAISO's visibility into the individual components of these resources, as well as limiting CAISO controllability of each resource component. The resulting risks may be an outcome of allowing single resource ID configurations for hybrid resources that can't be solved, however, CAISO seeks feedback on potential changes that could address these possible risks. This also demonstrates why CAISO believes it is currently more beneficial for hybrid resources to be configured with multiple resources IDs.

Operations issues under multiple resource ID configuration

CAISO identified possible operations related issues associated with hybrid resources under multiple resource ID configurations. Potential operations issues for multiple resource ID configurations are generally related to modeling for planning and engineering, interconnections, and resource configuration modeling.

Multiple resource ID configurations for hybrid resources may pose some challenges for planning and operations engineering. For example, base case modeling is complicated by hybrid

resources with multiple resource IDs. CAISO is also considering if there are any interconnection study implications as well. CAISO intends that this initiative will seek to determine if it would be necessary to develop new types of generator limiting schemes that consider the cumulative generation (net output) from both resource components, rather than just the individual generation from each resource. This could be helpful for multiple resource ID configurations with storage device components. To better describe this issue that has been raised for further discussion CAISO provides the following example:

- Example: Assume a multiple resource ID hybrid resource with the following characteristics. One of the hybrid resource project components is a wind resource with total installed capacity of 150 MW, the second component is a storage device with total installed capacity of 100 MW. This example resource has an approved interconnection capacity rights of 100 MW total.
    - If the wind resource component is dispatched to 150 MW, with the storage device dispatched to charge at -100 MW, the overall net output of the combined hybrid resource is 50 MW of energy production flowing onto the system, which is still within the project's approved interconnection capacity of 100 MWs.
    - Even though the wind resource is operating at a level above the approved interconnection capacity the net output of the combined hybrid resource is within the approved interconnection capacity.

CAISO is exploring if there are any modifications to the modeling for planning and operational purposes that might be needed to accurately capture the potential impacts of such an outcome with charging a storage device at the same time as producing energy from another part of the resource. CAISO understands developers' request for providing for netting treatment of the overall hybrid resource output. This may require additional modifications to the metering approaches and techniques.

CAISO has also include some related discussion on potential systems changes to develop a new hybrid resource constraint concept that is included in further detail in Section 3.4 below. CAISO seeks feedback on any potential changes to planning and operational modeling and studies that stakeholders believe should be considered. CAISO is also seeking feedback on potential concerns related to traditional thermal generation units combined with storage resources under multiple resource ID configurations. CAISO has not identified the need for any specific modifications to address those combination hybrids at this time, but is interested in stakeholder feedback on the topic.

3.4. Markets and Systems

Hybrid resources present new challenges related to market participation and interactions with CAISO systems. The following section includes issues potentially impacting markets or systems. CAISO also seeks stakeholder feedback on the need for other markets or systems enhancements that may be required to accommodate the wide scale adoption of hybrid resources. CAISO will review stakeholder feedback on identified issues and any additional proposed modifications will be included in subsequent straw proposals.

Master File

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 configurations.

Single resource ID charging from on-site generating unit

If the hybrid resource charges the energy storage unit 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."

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.”

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.”

Two or more resource IDs with all charging options

If the hybrid resource 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 hybrid generating facility 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”.

Hybrid Resource Constraint for Multiple Resource ID Configurations

The CAISO has initially identified an issue with current approach intended limit the output of multiple resource ID hybrid resource configurations to their total interconnection rights. This approach is intended to ensure that CAISO markets and operations respect the project interconnection rights for market awards and operator exceptional dispatch, but the current approach can also result in unintended outcomes. Namely, the undesirable stranding of hybrid resource capacity, which can result in CAISO’s inability to access some amount of capacity from the different components of hybrid resources. In other words, the output of the components of these multiple resource ID hybrid resource configurations may be artificially limited by the current implementation approach.

The current approach could cause some reliability concerns given the inability to access capacity from these resources. This could also have a commercial on resource owners and developers. The following table highlights the issue in a numerical example to illustrate the potential impact.

Table 5: Example of the potential stranded capacity issue

Example stranded capacity on hybrid resource with multiple resource IDs	
Project component	**MW value**
Project POI maximum injection rights:	100 MW (total POI rights)
Hybrid resource project components:	Solar PV component: 100 MW installed capacity (Master file Pmax: 50MW)
	Battery Storage component: 100 MW installed capacity (Master file Pmax: 50MW)
Project installed capacity:	200 MW (total installed capacity)
Project Master File Pmax:	100 MW (total master file Pmax)
Potential stranded capacity:	**100 MW** (200 MW total installed capacity – 100 MW total master file Pmax)

CAISO explored potential solutions to this stranded capacity issue from hybrid resources under multiple resource ID configurations. Initially, CAISO believes the best resolution is to develop a new hybrid resource constraint that ensures these resource's output remains less than or equal to the hybrid resource's project's maximum POI rights without stranding capacity from either of the components of the overall hybrid resource. CAISO has also explored the use of other solutions, such as grouping constraints, however other options that could potentially solve the same problems would likely be too complex to implement and could have adverse pricing impacts. At this stage, the CAISO believes the most feasible solution is introducing a hybrid resource constraint.

A possible hybrid resource constraint is under review and will be further developed in upcoming straw proposals. Some of the initial issues and considerations identified with introducing a hybrid resource constraint are included below for stakeholder review.

Hybrid resource constraint related issues for further consideration

There are numerous issues the CAISO will need to consider further should it introduce a hybrid resource constraint. Areas that will require further consideration include: Market impacts, including price formation and settlements issues, forecasting and operational related impacts, and ancillary service related issues.

The conceptual hybrid resource constraint is intended to limit hybrid resource's output to a maximum of each project's interconnection rights through market outcomes and related mitigation of generation awards and schedules. It would not limit or impact the bid amount (MW) or bid price ($) of the hybrid resources subject to the proposed POI capacity constraints. There would also be work required to modify existing functionality to address specific needs for hybrid resources, such as inclusion of ancillary services in the potential solution.

A benefit of this solution is it could incorporate multiple hybrid resource constraints at a single POI, thus allowing multiple hybrid resources under multiple resource ID configurations to be managed to their individual interconnection rights at a single POI. Hybrid resource constraints could potentially be modeled in the CAISO's Energy Management System (EMS) outside of the CAISO's full network model process, easing implementation issues.

Potential market related impacts, including price formation and settlements related issues are important to consider and address for any proposed solution. CAISO expects analysis will be required to understand potential impacts to price formation and settlements. Initial review indicates that any proposal will need to consider how to avoid inappropriate pricing impacts and may require tariff revisions to address such impacts. CAISO also plans to undertake further analysis on possible impacts of virtual bidding at points where these hybrid resource constraints exist. CAISO will carefully consider potential market and pricing impact in developing the potential hybrid resource constraint solution for upcoming straw proposals.

Forecasting and operational impacts of introducing a hybrid resource constraint are also a concern to the CAISO. Regarding forecasting, the hybrid resource constraint may need to be considered in the VER forecasting process. One potential outcome may require incorporating these constraints as an input to CAISO forecasting to allow the CAISO to curtail or adjust the VER forecast as appropriate. CAISO also intends to establish the appropriate hierarchy for the priority of potential hybrid resource constraints and VER forecasting constraints.

CAISO is also exploring how exceptional dispatch (out of market actions) would interact with a hybrid resource constraint. For example; if one generating unit in a multiple resource ID configuration receives an operator instructed exceptional dispatch that would violate the project's interconnection rights, the output of the other generating unit would need to be backed down to avoid violation of the hybrid resource constraint and maximum interconnection rights. Additionally, enforcing hybrid resource constraints on a resource may have an unintended impact of causing violation of other constraints that are also applied to the same resource (*e.g.*, transmission nomograms, generator ramp constraints, etc.).

Considerations related to ancillary services and the interaction with a hybrid resource constraint are also of concern. CAISO's existing market functionality may accommodate these types of constraints, however, there may be additional enhancements required for hybrid resources to provide ancillary services. CAISO seeks to avoid any outcomes that might result in infeasible awards or dispatches and will be considering how to enhance existing technology to avoid such conflicts and infeasible outcomes.

CAISO seeks stakeholder feedback what other market or system enhancements may be required to best accommodate the wide scale adoption of hybrid resources.

3.5. Ancillary Services

The following section discusses hybrid resource ancillary services provisions and identifies related issues for future consideration. In accordance with Appendix K of the CAISO tariff, any hybrid projects that have been defined as either NGR or mixed fuel type generating facilities will be eligible to participate in ancillary services market. Hybrid projects with separate resource IDs will be eligible to provide some ancillary services depending upon the individual generating unit. Specific rules for the various ancillary services are defined in Appendix K. Hybrid projects with a single resource ID are eligible to provide ancillary service as a single combined generating facility, provided it complies with appropriate provisions of Appendix K. Generating facilities will be tested for ancillary services after Commercial Operation Date (COD). There may be some necessary modifications to help facilitate the safe and reliable provision of ancillary services from hybrid resources. CAISO has identified potential areas of modification for stakeholder consideration.

Contingency Reserves

Contingency reserves is a market product that hybrid resources have expressed interest in providing. Contingency reserve products include Non-Spinning and Spinning Reserve as well as Regulation Up and Regulation Down. The current tariff and its appendices provide guidance regarding the requirements of resources to provide these services to the CAISO. The CAISO hopes to open discussions to determine whether these requirements should apply to hybrid resources as-is, or if there should be modifications based on the characteristics of hybrid resources.

For Non-Spinning and Spinning Reserve, the question posed is whether or not the timing for change in power output currently in place can, or should be met by all combinations of mixed fuel resources. In addition, the current droop and dead band governor settings may, or may not be appropriate as the resource mix changes. CAISO believes this initiative should confirm the response of mixed fuel resources to system frequency disturbances as currently captured in Appendix K, or identify the need to more clearly define them for each possible combination of fuels supporting hybrid resources.

For Regulation Up and Down services, the operating characteristics of resources providing these services is clearly defined in Appendix K. CAISO has not identified any outstanding issues on this item related to hybrid resources. CAISO seeks feedback from stakeholders

regarding any situations that hybrid resources present that should be addressed related to these services.

The preservation of the ancillary service capacity is critical. Consequently, the CAISO is exploring what real-time data is needed to inform the CAISO and its market systems that awarded ancillary service capacity is available. Additional telemetry or other data sources may be needed to certify that hybrid resources are indeed able to provide the ancillary services they have been awarded. CAISO is also reviewing circumstances that could merit a change to existing Ancillary Service No Pay or payment rescission rules. CAISO seeks feedback from stakeholders on these hybrid resource related ancillary services questions.

Finally, CAISO is also reflecting on the existing certification requirements and processes and how they apply to hybrid resources. CAISO has not identified any specific changes or clarifications that would apply to hybrid resources at this time, however CAISO seeks stakeholder feedback on these considerations and if any stakeholder believe modifications to the certification provisions are necessary.

Non-Spin

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

Spin

For the provision of Spin service, resources are required to meet the following requirements:

- For resources with Governors; the resource must have the capability to provide Frequency Response with 5% Droop (4% for Combustion Turbines) and a 0.036 Hz dead band.
- For inverter based resources (including storage devices); the resource must have the capability to provide Frequency Response with a droop-like setting of 4% and a 0.0167 Hz dead band.
- For Loads participating in spin; if system frequency is less than or equal to 59.92 Hz, 10% of Spin Awarded Capacity must be curtailed within 8 seconds and change power output within one second. The remaining 90% of the spin award must be curtailed within ten minutes.

CAISO has also identified some items related to the provision of Spin service that may require modifications in future proposals such as the data and information that may be necessary for CAISO to confirm the resource's ability to provide the services. An item that may require updates is related to telemetry needs. CAISO is interested in exploring the need for hybrid resources with renewable energy generation to provide a new data point for the resource "plant potential" from the plant side of inverter/control system. This new plant potential data point may be needed for hybrid resources so that CAISO is aware of the potential output of the resource if it has a variable energy generation component. CAISO may need to require this new data point be provided to ensure the CAISO is only awarding ancillary services the hybrid resource can

actually provide. This requirement may not be feasible under current requirements. CAISO believes it may be necessary to make changes to allow the CAISO markets to maintain capacity for provision of ancillary services. CAISO needs to ensure its' market systems will protect for the necessary headroom by adjusting awards for resource's output based on their potential output, or the plant potential, of the variable energy resource components of hybrid resources providing ancillary services.

An additional data point to make an accurate assessment of a hybrid resource's ability to provide ancillary services is its state of charge. State of charge for storage devices is a current data point for NGR resources. CAISO believes it may be necessary to extend requirements for identifying the state of charge of storage generation components of hybrid resources. Traditionally, state of charge for storage resources has been focused on battery storage. CAISO is exploring the need to define state of charge characteristics or calculations for other types of storage generation as well, for instance, Solar Thermal, Compressed Air, Gravity Train, etc. CAISO seeks stakeholder feedback on what new data points are needed for hybrid resources to provide ancillary services.

Regulation

For Regulation service, CAISO markets must maintain awarded capacity by adjusting the Dispatch Operating Target (DOT) based on the resource's overall potential output or plant potential. CAISO believes that a new "plant potential" data point and visibility to the state of charge are both essential for a resource to provide Regulation service. This is because a resource's output potential impacts and bounds a hybrid resource's ability to provide regulation services. CAISO believes these additional data points may be necessary to include in future proposed modifications for provision of ancillary services by hybrid resources and seeks stakeholder feedback on these proposed changes.

An additional item the CAISO identified to provide regulation service is the need to establish minimum storage generation sizing requirements. For hybrid resources under a single resource ID, CAISO is interested in determining if the creation of a minimum storage sizing requirement makes sense. As a starting point, the CAISO is considering a minimum requirement for the storage generating unit to comprise greater than or equal to 10% of the overall hybrid resource interconnection rights, with a capability to provide the minimum required capacity output for at least 30 minutes. CAISO believes this issue is important to ensure that these resources can reliably provide regulation services. CAISO seeks stakeholder feedback and input on modifications necessary for hybrid resources to provide regulation service.

Certification

As noted above, hybrid resources are eligible to provide ancillary services if they meet CAISO Tariff requirements and are certified under the applicable Appendix K certification provisions. CAISO notes that the current minimum sizing requirements for provision of ancillary services are that resources must be 0.5 MW (500 KW) or greater. CAISO may need to consider if sizing limits should be modified or adjusted to allow hybrid resource components to be combined to meet minimum ancillary services sizing requirements.

Payment Rescission

A final issue CAISO is considering is related to ancillary services payment rescission. If CAISO identifies that a resource that has received an ancillary services award but is undispatchable, unavailable, or provides undelivered capacity, then ancillary service payment rescission is applied. The rescission of payments for ancillary services are described in the CAISO Tariff under Section 11.[13] .

CAISO has identified a potential issue related to payment rescission for hybrid resources that is also related to the other data transparency items discussed previously. Certain hybrid resource configurations can result in CAISO being unable to receive the full information and data necessary to determine if awarded ancillary services are truly available and not undispatchable, unavailable, or undelivered. Specifically, single resource ID configurations would not provide any state of charge data for storage components and CAISO has identified that this data point may be needed to determine and apply a payment rescission. CAISO believes this may further support the inclusion of additional requirements for data provision from hybrid resources under single resource ID configurations.

3.6. Deliverability

The modeling of hybrid facilities depends on the configuration of the underlying generating facilities. The following examples describe the deliverability modeling of various hybrid resource configurations. CAISO seeks feedback from stakeholders on any potential issues that should be considered related to hybrid resources deliverability. Important concepts related to deliverability discussed below include: Full Capacity Deliverability Status (FCDC – may also be referred to as FC), Partial Capacity Deliverability Status (PCDC), and Energy Only (EO) status.

Additive configuration:

The total requested output of a hybrid resource is the sum of the outputs from each underlying resource. Each resource is modeled as one generator in accordance with the deliverability methodology.

Table 6: Example of Additive Configuration

	Ex1: Additive Configuration	
Generating Facilities	100 MW Solar	100 MW/400 MWh BESS
Requested FC Total MW	200 MW	
Study Amount	92 MW	100 MW
If one resource	FC	

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

	Ex1: Additive Configuration	
If two resources	FC	FC

* The study amount is based on the deliverability assessment methodology. A 92% installed capacity is used in all the examples for illustration purpose.

Supplemental configuration:

The total requested output is less than the sum of outputs from each technology and FCDS was requested for the hybrid interconnection request. The hybrid resource is modeled as one generator with the maximum study amount set to the sum of each underlying resource, not to exceed the requested total output. If the hybrid resource is one resource ID, the NQC value shall not exceed the study amount. If the hybrid resource facilities have separate resource IDs, the CAISO calculates and assigns deliverability status for each resource ID from the study amount.

Table 7: Examples of Supplemental Configuration

	Ex2: Supplemental Configuration		Ex3: Supplemental Configuration	
Generating Facilities	100 MW Solar	100 MW/400 MWh BESS	100 MW Solar	10 MW/20 MWh BESS
Requested FC Total MW	100 MW		100 MW	
Study Amount	100 MW		97 MW (92 + 5)	
If one resource	FC up to 100 MW		FC up to 97 MW	
If two resources	EO	FC	FC	FC up to 5 MW
	54% PCDS {(100-50)/92}	50 MW PCDS		
	FC	8 MW PCDS (100-92)		
	Any combination that results in 100 MW study amount between the solar and BESS per deliverability assessment methodology			

Behind-the-meter expansion configuration:

If one or more resources are added to an existing facility or interconnection request through the MMA process or behind-the-meter expansion Independent study process, the total output is limited to what was requested for the original facility. The deliverability assessment models the original facility and treats the expansion as energy-only unless a deliverability transfer request is made. Deliverability transfer calculation was explained in the 2018 Interconnection Process Enhancement initiative. The principle of a deliverability transfer is that the transfer results in the same or lower study amount in the deliverability assessment, based on the methodology adopted at the time of the transfer request. If the hybrid facility is one resource ID, the calculation will result in a PCDS for the resource. If the hybrid resource has separate resource IDs for different underlying resource types, different resource IDs may have different deliverability status.

Table 8: Example of BTM Expansion Configuration

	Ex4: BTM Expansion Configuration	
Original Facilities	100 MW Solar	
Original FC Requested Total MW	100 MW FC	
Study Amount	92 MW	
Expansion Facilities	25 MW / 100 MWh BESS	
Expansion FC Total MW (Limited to Original FC Solar MWs)	100 MW	
If one resource	78% PCDS {92/(92+25)}	
If two resources	Solar	BESS
	FC	EO
	73% PCDS {(92-25)/92}	FC
	Any combination that results in 92 MW study amount between the solar and BESS per deliverability assessment methodology	

CAISO has not identified any specific issues that may cause need for modifications to the deliverability provisions for hybrid resources. CAISO seeks feedback on any deliverability

related issues or considerations that stakeholders believe should be included in future proposals.

3.7. Resource Adequacy

CAISO identified a number of Resource Adequacy (RA) issues that require further consideration. CAISO relies on RA resources to ensure that sufficient capacity is bid into the CAISO's markets to meet forecasted demand and all applicable reliability criteria. RA eligibility must be verified by the interconnection customer with the appropriate Local Regulatory Authority (LRA) and its power purchase agreement counterparty. CAISO discusses some initial RA issues that may require modifications for hybrid resources.

RA deliverability, counting rules, and must offer obligations are the CAISO's primary RA concerns for hybrid resources. Specific requirements regarding the eligibility and treatment of energy storage may prohibit a hybrid fuel type resource ID (single resource ID configuration) and therefore the project would need two resource IDs to qualify for RA. Single resource ID configurations present some challenges related to RA counting rules.

RA Counting Rules and Must Offer Obligations

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. CAISO believes that resolving hybrid resource RA capacity counting rules is important. LRA's Qualifying Capacity (QC) RA counting rules for hybrid resources may have impacts on CAISO markets and operations. RA counting rules should provide fair and accurate capacity valuations. RA counting rules are also important because they could impact a developer's configuration decisions, which can have different impacts on CAISO operations and forecasting.

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.

Counting rules for multiple resource ID hybrid resources

CAISO believes that the RA counting rules for multiple resource ID hybrid resources are straightforward and do not present any significant concerns or barriers to participation in RA. The resource components under each resource ID receive an RA value based upon the applicable counting methodology for the resource type/technology as established by LRAs. For instance, wind and solar resources are evaluated under an effective load carrying capability (ELCC) methodology, and storage resources are generally evaluated based upon their Pmax and duration. These QC methodologies are applied to each hybrid resource component under multiple resource ID configurations and each part of the hybrid resource would receive a standalone QC and NQC once studied by CAISO for deliverability. For these reasons, CAISO believes the current provisions and application of QC counting rules does not present any significant issues or concerns for hybrid resources with multiple resource ID configurations.

Counting rules for single resource ID hybrid resources

CAISO believes there are some important counting rule issues to consider for hybrid resources operating under a single resource ID. Currently, there is not an established QC counting rule for hybrid resources under single resource ID configurations. CAISO believes this is a gap that must be addressed to enable hybrid resources to participate as RA resources and offer RA capacity. Since no established LRA QC counting criteria for single resource ID hybrid configurations exist, as an interim measure, the LRA could establish a QC value based on one of the underlying resource types under the single resource ID hybrid resource using the applicable QC methodology for that resource type. Not having a QC value for the overall hybrid resource could impact the amount of RA capacity the hybrid resource can offer. This QC gap could be addressed by LRA decisions to establish a QC counting methodology for these hybrid resources under single resource ID configurations. The CAISO will work closely with the CPUC and stakeholders to develop an appropriate QC methodology to address this issue in the CPUC's RA proceeding.

In the absence of an LRA counting convention, CAISO must develop default QC values for hybrid resources under a single resource ID. The CAISO Tariff includes default QC counting criteria for most resource types that have been established to apply in the case that an LRA does not establish a QC methodology for certain resources. The CAISO suggests that a potential QC counting methodology for hybrid resources under a single resources ID configuration is to utilize an exceedance methodology. An exceedance approach measures the minimum amount of generation produced by the resource in a certain percentage of hours. For example, the exceedance level previously used to calculate the QC of wind and solar resources was 70%. Another way to describe the exceedance level is that the 70% exceedance level of a resource's production profile is the MWh generation amount that the resource produces at least 70% of the time. This approach utilizes historic production data and could be applied to these hybrid resource configurations in a manner that provides a relatively reliable QC value. The exceedance methodology is suggested as an initial concept for stakeholder discussion but will require further discussion and coordination with the CPUC and LRAs. CAISO seeks stakeholder feedback on potential approaches for evaluating capacity values of hybrid resources under single resource ID configurations and how to establish a default QC methodology for single resource ID configuration hybrid resources.

CAISO has been active and provided input related to hybrid resource counting approaches in the CPUC's RA proceeding. For CAISO's latest input regarding hybrid resource counting, see CAISO Track 3 Proposal Reply Comments in Rulemaking 17-09-020; (March 22, 2019).[14] The CPUC has also indicated that it will hold workshops on this issue and CAISO intends to participate in the CPUC process as well.

Must Offer Obligations for hybrid resources

Must Offer Obligations are a critical aspect of RA. Under multiple resource ID configurations the resource components would receive separate NQCs and could be shown for RA separately as

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

well. This would result in relatively straightforward outcomes. There will be separate and distinct MOOs for each resource component under each resource ID that would reflect the resource's technology type and applicable MOO. For background on applicable MOO provisions, see CAISO Tariff Section 40 and the CAISO Reliability Requirements BPM.[15]

The MOO for hybrid resources under a single resource ID configurations is an issue for further consideration. As noted above, CAISO has identified an existing gap in the RA QC counting rules for these resource configurations. Because these hybrid resource configurations have no currently established QC methodology they would not qualify for RA. If this gap can be addressed by the CPUC and an applicable counting approach is established then they could receive NQCs and qualify for RA. CAISO will need to establish MOO provisions for these hybrid resource configurations. Initially, CAISO believes that the resulting MOO for these resources would need to reflect the QC value provided by new applicable QC methodology and the NQC value for which the resource has been shown for RA. CAISO will need to evaluate any QC methodology established by LRAs for development of any applicable MOO provisions.

3.8. Metering, Telemetry and Settlements

Metering and Telemetry for Distribution or Transmission Connected Hybrid Resources

Hybrid resources 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. 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 generating facilities with two or more resource IDs.

In addition, if the sum of the resource component's ability to generate is greater than the approved interconnection capacity amount, a generation output limiting scheme is required to limit the energy output from the generating facility to the grid.[16] If the hybrid resource facility is a single resource ID configuration that has elected to charge an energy storage unit from the on-site generating unit and negative generation occurs (*e.g.*, the generating facility is pulling power from the grid), the limiting scheme is also required to prevent the generating facility from charging from the grid. If the generating facility trips for one of these reasons, the re-connection

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

[16] A generator limiting scheme must be able to monitor the output of the hybrid resource, and either prevents the unit from injecting more than the interconnection capacity or quickly reduces unit output to return the unit to a point of not injecting more energy than the rated interconnection capacity

of the generating facility will be done in coordination with CAISO and the applicable Participating TO.

There are a number of metering configurations that are available to the generating facility for both distribution connected and CAISO controlled grid connected generating facilities. CAISO includes diagrams of the various metering layout configurations in the appendix below.

Metering and Telemetry for Storage Charging Configurations

Single resource ID charging from on-site generating unit

Where a single resource ID hybrid resource only charges the energy storage unit from its own on-site generating unit, the CAISO would only see the output of the combined generating facility. As such, the resource components would not be individually subject to CAISO dispatch instructions for generation, charging, or discharging purposes. All settlements for the project will be at the point of delivery, based on the metered output to the CAISO controlled grid as adjusted for losses, at five-minute intervals.[17,18]

- Distribution Connected: Metering on the high side of the step-up transformer can be done by a single CAISO revenue meter. If the generating facility is participating in the market, the real time telemetry would be required for the combined generating facility, through a Remote Intelligent Gateway (RIG) or Dispersive Technology and Distributed Network Protocol version 3 (DTDNP3) device to the CAISO Energy Management System (EMS), which is outlined in the BPM for Direct Telemetry[19].

- CAISO Connected: Similar to distribution connected facilities, metering on the high side of the step-up transformer can be done by a single CAISO revenue meter. If the generating facility is participating in the market, real-time telemetry would be required for the combined generating facility through a RIG or DTDNP3 device to the CAISO EMS, as outlined in the BPM for Direct Telemetry.

Single resource ID charging from grid

With a single resource ID for the combined hybrid resource, each resource component will be required to be separately metered and telemetered. Even with a single resource ID, for grid reliability, the CAISO will need the status of each underlying resource. However, the CAISO would still issue dispatch instructions to the single resource ID. Thus, individual resource components would not be separately subject to CAISO dispatch instructions for generation, charging or discharging purposes. All settlements for the hybrid facility will be at the point of delivery, based on the metered output to the CAISO controlled grid as adjusted for losses, at five-minute intervals. Please refer to the figures included in the appendix for diagrams that illustrate the various metering configuration requirements.

[17] Detailed information on market charge codes is available at http://www.caiso.com/Documents/ISOMarketChargeCodesMatrix.xls
[18] CAISO tariff Section 10.1.3 explains permitted netting which would be applicable to this scenario
[19] https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Direct%20Telemetry

- Distribution Connected: Metering on the high side of the step-up transformer will need to be augmented by another CAISO revenue meter for each of the generating units. If the generating facility is participating in the market the real time telemetry would be required for the combined Generating Unit, with separate telemetered points for each generating unit, through a RIG or DTDNP3 to the CAISO EMS which is outlined in the BPM for Direct Telemetry.

    - If the onsite generating unit metering is positioned at the low side of the step-up transformer, it will need an additional low-side meter for the other generating unit. Low side metering of each generating unit will need to be compensated with the step-up transformer losses. The project would require real time telemetry to the CAISO EMS for the combined generating facility, with separate telemetered points for each generating unit, through a RIG or DTDNP3 device outlined in the BPM for Direct Telemetry.

- CAISO Connected: Metering on the high side of the step-up transformer will need to be augmented by another CAISO revenue meter for each generating unit. If the generating facility is participating in the market, the real time telemetry would be required for the combined generating facility, with separate telemetered points for each generating unit, through a RIG or DTDNP3 device to the CAISO EMS, which is outlined in the BPM for Direct Telemetry.

    - If the onsite generating unit metering is positioned at the low side of the step-up transformer, it will need an additional low-side meter for the other generating unit. Low side metering of each generating unit will need to be compensated with the step-up transformer losses. The project would require real time telemetry to the CAISO EMS for the combined generating facility, with separate telemetered points for each generating unit, through a RIG or DTDNP3 device outlined in the BPM for Direct Telemetry.

Two or more resource IDs with all charging options

With two or more resource IDs for a combined generating facility, each generating unit will be separately metered and telemetered. The CAISO would issue separate dispatch instructions to each resource ID. All settlements for the project will be at the point of delivery, based on the metered output to the CAISO controlled grid as adjusted for losses, at five-minute intervals. Please refer to the figures included in the appendix for diagrams that illustrate these different metering configuration requirements.

For hybrid generating facilities that have: 1) separate resource IDs and 2) an energy storage unit that charges from the associated generating unit, *i.e.*, does not charge from the grid based on CAISO dispatch instructions, the following settlement process applies during the charging period:

1. The associated generating unit will be metered and settled in the CAISO market based on its gross output, not the net delivery to the grid after accounting for energy flow to the energy storage unit
2. The energy storage unit will be metered and settled in the CAISO market for the energy flow into the energy storage unit
3. Since the charging of the energy storage unit will be outside CAISO dispatch, it will be settled as per market rules applying to UIE. UIE is the billing determinant for certain cost allocations, such as the flexible ramping product.

- Distribution Connected: Metering on the high side of the step-up transformer will need to be augmented by another CAISO revenue meter for each of the generating units. If the generating facility is participating in the market, the real time telemetry would be required for the combined generating facility, with separate telemetered points for each generating unit through a RIG or DTDNP3 device to the CAISO EMS which is outlined in the BPM for Direct Telemetry. If the onsite generating unit metering is positioned at the low side of the step-up transformer, it will need an additional low-side meter for the energy storage unit. Low side metering of each generating unit will need to be compensated with the step-up transformer losses. The project would require real time telemetry to the CAISO EMS for the combined generating facility, with separate telemetered points for each generating unit through a RIG or DTDNP3 device outlined in the BPM for Direct Telemetry.

- CAISO Connected: Metering on the high side of the step-up transformer will need to be augmented by another CAISO revenue meter for each of the generating units. If the generating facility is participating in the market, the real time telemetry would be required for the combined generating facility, with separate telemetered points for each generating unit through a RIG or DTDNP3 device to the CAISO EMS which is outlined in the BPM for Direct Telemetry.

If the onsite generating unit metering is positioned at the low side of the step-up transformer, it will need an additional low-side meter for the other generating unit. Low side metering of each generating unit will need to be compensated with the step-up transformer losses. The project would require real time telemetry to the CAISO EMS for the combined generating facility, with separate telemetered points for each generating unit through a RIG or DTDNP3 device outlined in the BPM for Direct Telemetry.

Metering and Telemetry for AC and DC Configurations

There are also important differences in the existing metering and telemetry requirements for hybrid resources seeking to participate under AC and DC configurations. For instance, when a solar and storage hybrid resource are both participating as separate resource IDs, then separate meters are required for each of the generating units. Both ISOME and SCME options are applicable in this scenario. Both meters can be aggregated or a single meter can be installed to capture the net output of both generating units.

For hybrid resources configured with DC connections, there are other metering and telemetry needs. For example, under separate resource IDs: Either of the generating units, or both can have DC metering and can participate as SCME. The inverter, transformer and line losses (if any) must be calculated and compensated. The resource should have a transducer on the DC side that meets the LRA or ISO accuracy requirements. Both the meters can be aggregated and SQMD can be submitted to the ISO under SCME option.

For DC connected hybrid resource with a storage unit charging from the other generation unit under separate resource IDs: Both resource components are required to be metered and can participate as SCME. The inverter, transformer and line losses (if any) must be calculated and compensated. The resource should have a transducer on the DC side that meets the LRA or ISO accuracy requirements. These different AC and DC metering and telemetry configurations are also provided with related diagrams to explain the various options in the appendix below. CAISO seeks feedback on any metering, telemetry, and settlements related issues that may need to be considered through this intiative.

4. 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 ISO footprint. At this preliminary phase, it is foreseeable that some of the potential rule changes would apply only in the ISO's balancing authority area, for example rules about interconnection. That fact should not affect this proposed decisional classification, however, because staff does not currently foresee the adoption of rules that will be specific to EIM balancing authority areas. With that said, this proposed classification reflects the current state of this initiative and may change as the stakeholder process moves ahead.

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

5. Next Steps

The ISO will discuss this issue paper with stakeholders during a stakeholder meeting on July 22, 2019. Stakeholders are asked to submit written comments by August 13, 2019 to initiativecomments@caiso.com. A comment template will be available at http://www.caiso.com/informed/Pages/StakeholderProcesses/HybridResources.aspx

6. Appendix

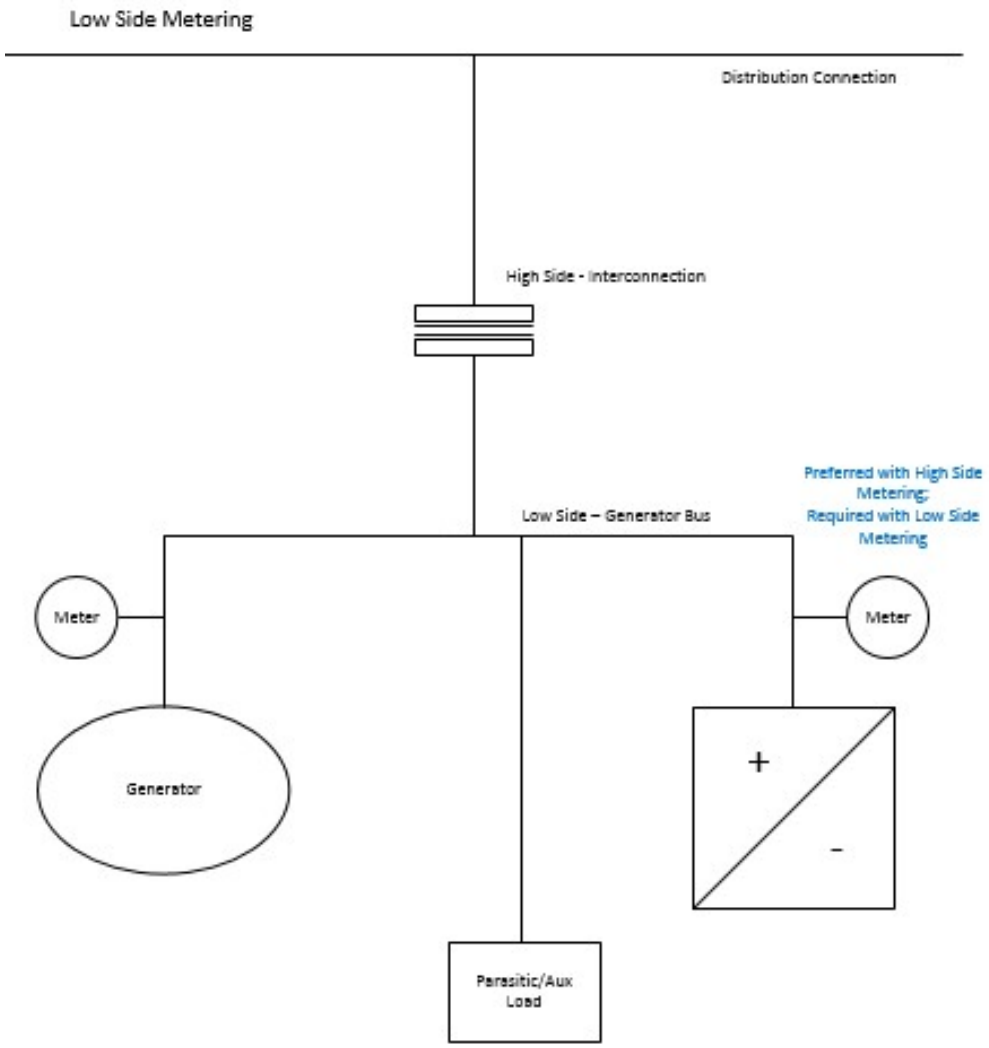
6.1. Metering and Telemetry Diagrams

Distribution or Transmission Connected Hybrid Resources

Hybrid resource facilities can be connected at either the CAISO controlled grid or a utilities' sub-transmission or distribution voltage level. The metering and telemetry requirements are slightly different depending upon the connection. The following diagrams are provided to illustrate the different potential metering layout configurations.

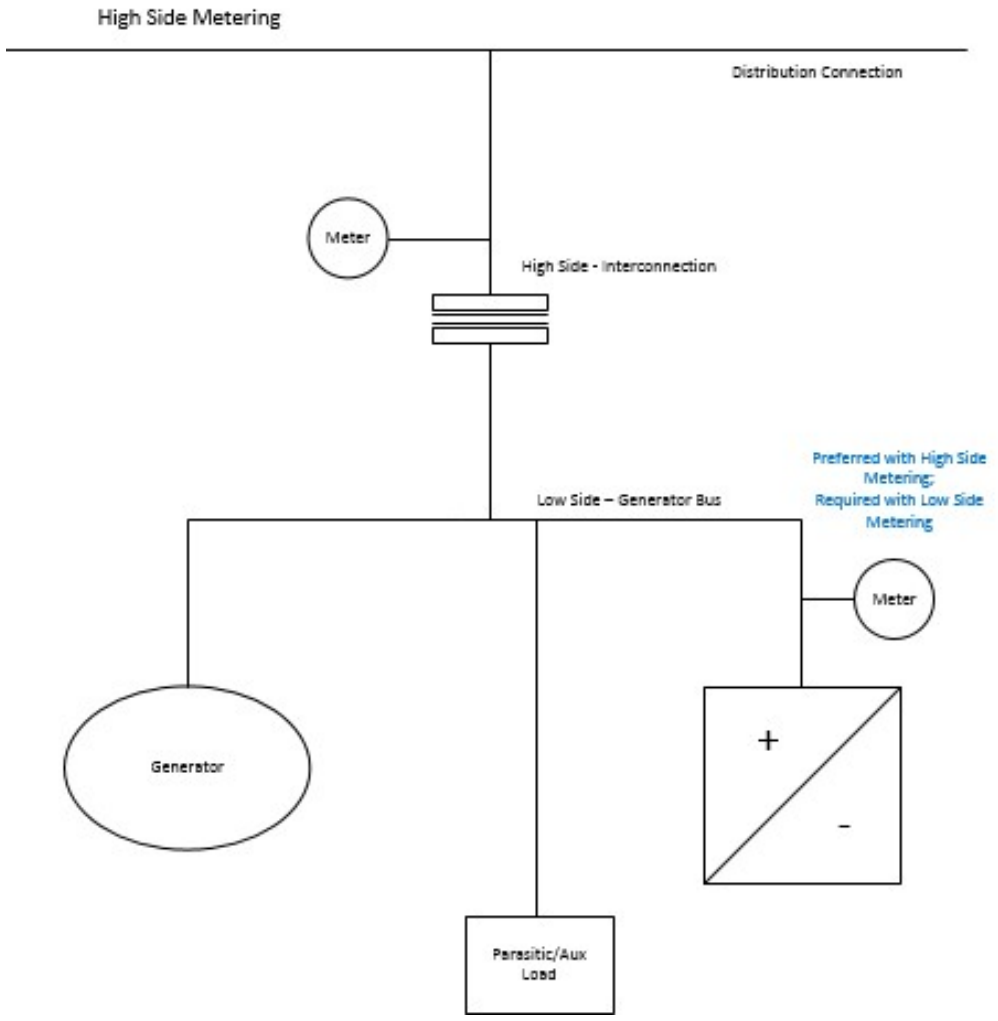
If the meters are connected on the low side of the transformer, the meter data will be compensated to the point of delivery to the CAISO controlled grid.

Figure 2: Low side metering layout for Distribution Connected Generating Facilities



If the distribution connected meter is on the high side of the distribution connected transformer, then that meter will be used as the total output meter and compensated for losses to the CAISO controlled grid point of delivery and the meter on the energy storage unit will be used to monitor the charging and discharging of the energy storage unit.

Figure 3: High side metering layout for Distribution Connected Generating Facilities



Similar to distribution connected generating facilities, the metering layout is the same, just not compensated for losses to the CAISO controlled grid at the point of delivery because the generating facility is connected at that level.

Figure 4: High side metering layout for CAISO Controlled Grid Connected Generating Facilities

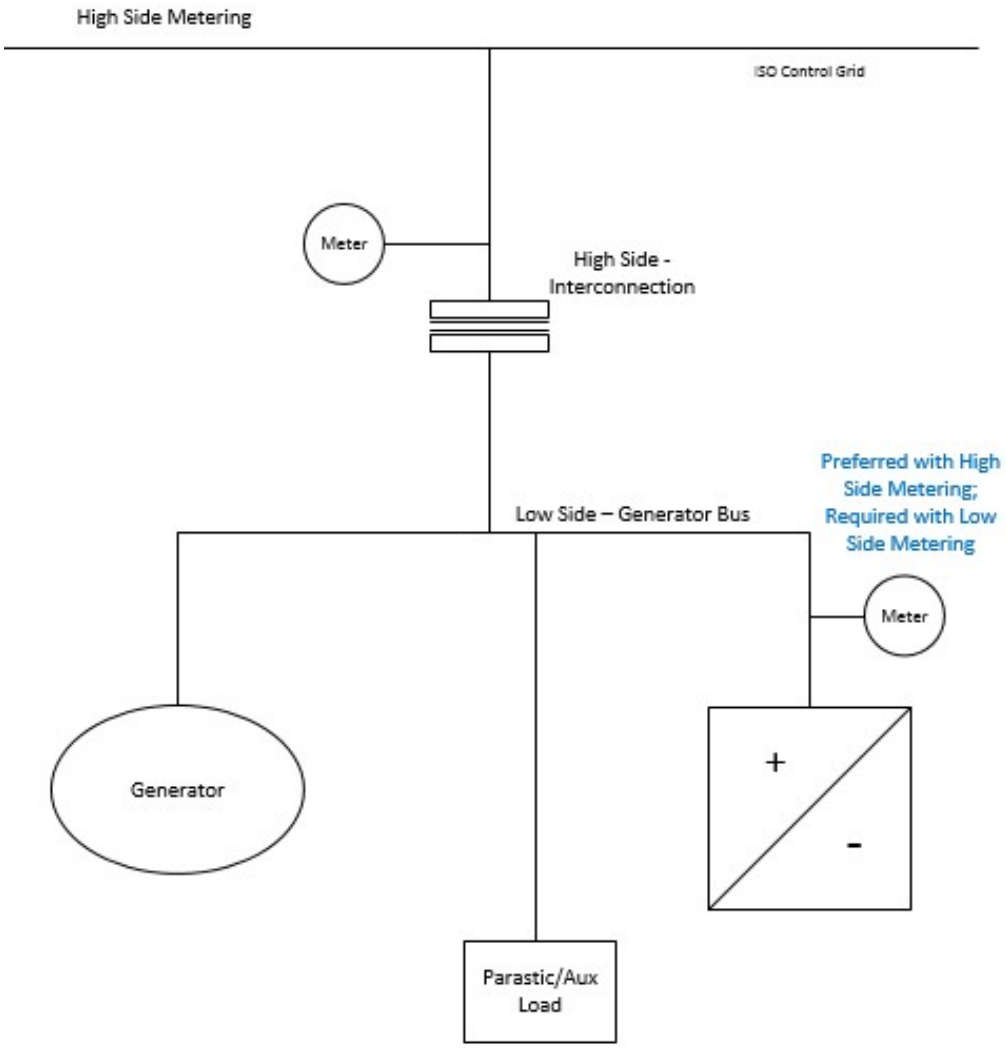
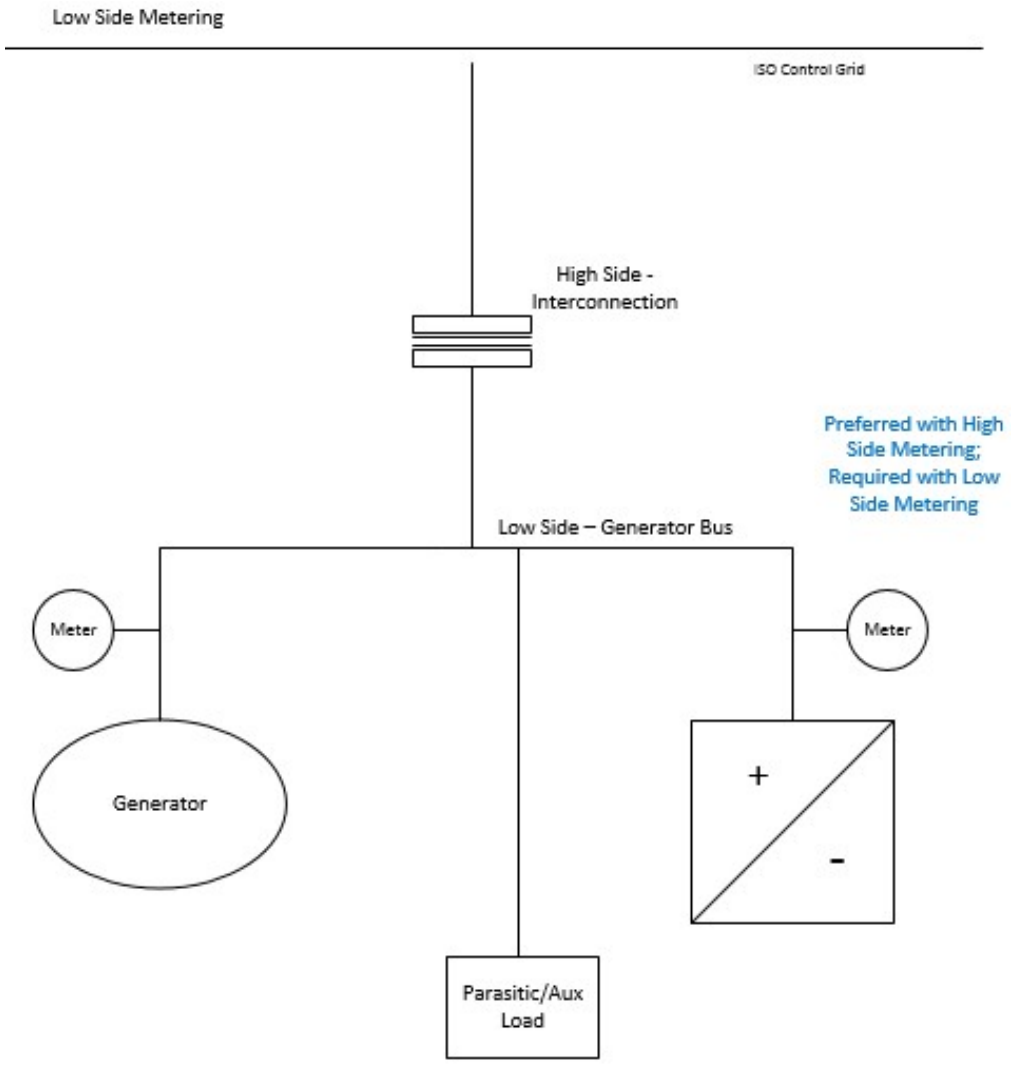


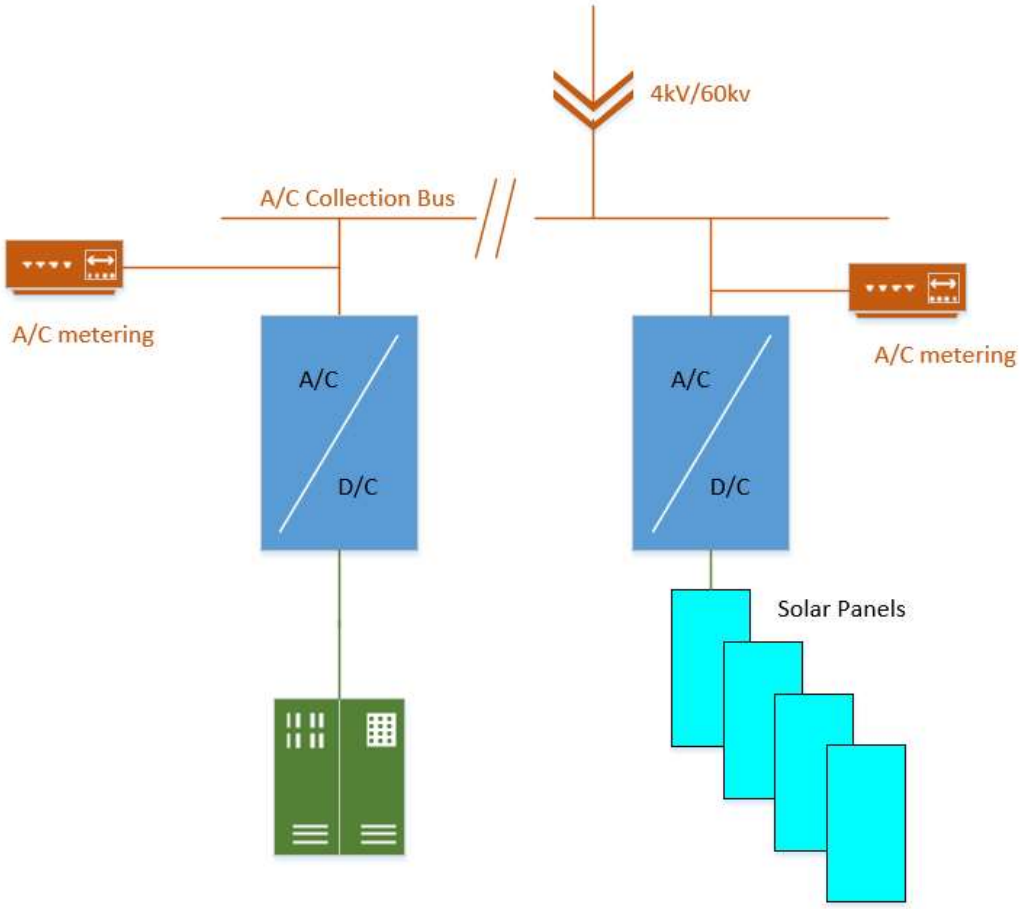
Figure 5: Low side metering layout for CAISO Controlled Grid Connected Generating Facilities



Metering and Telemetry for AC and DC Configurations

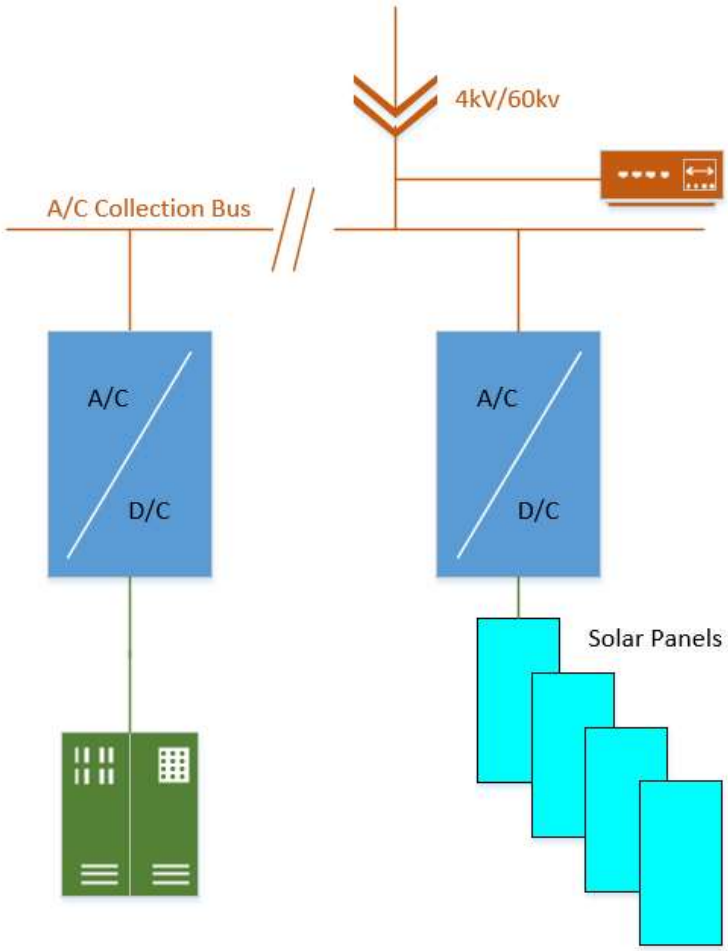
AC connections:

Figure 6: AC connection metering layout for separate resource IDs



AC connection under separate resource IDs: When the generating units are both participating under separate resource ID configurations separate meters are required for each resource. Both ISOME and SCME options are applicable in this scenario.

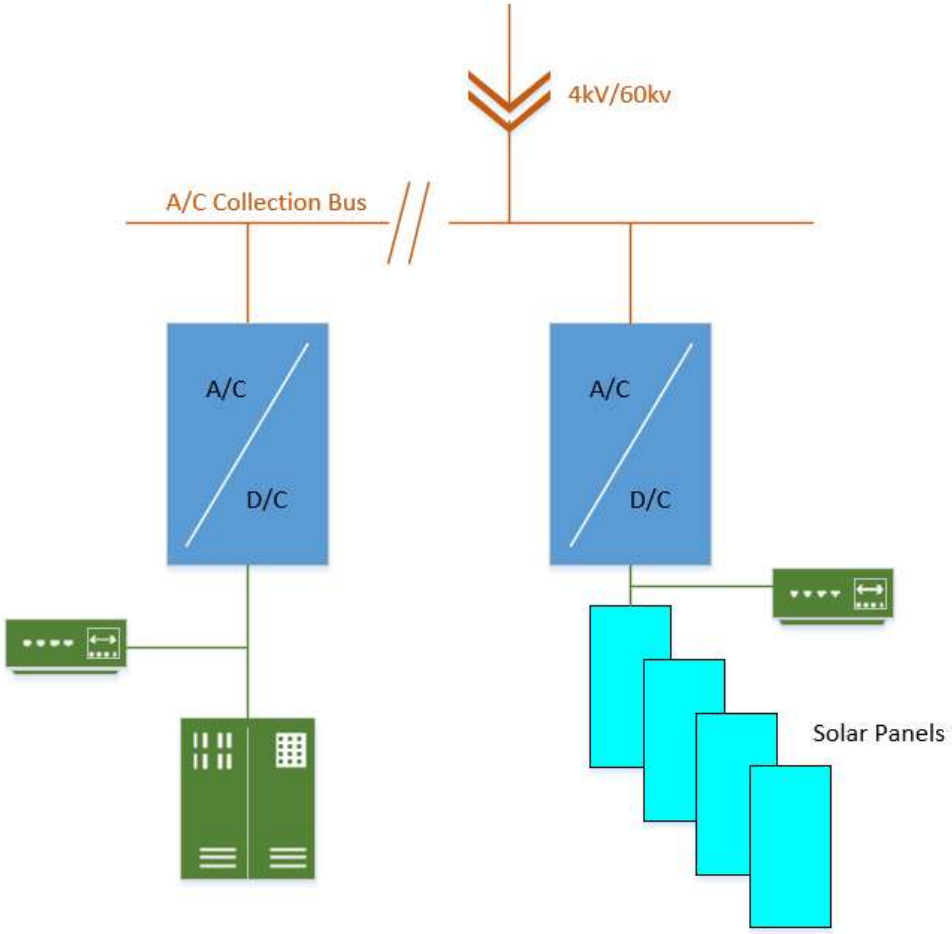
Figure 7: AC connection metering layout for single resource ID



AC connection for single resource IDs: Both the meters can be aggregated, or a single meter can be installed to capture the net output of both resource components. Both ISOME and SCME options are applicable in this scenario.

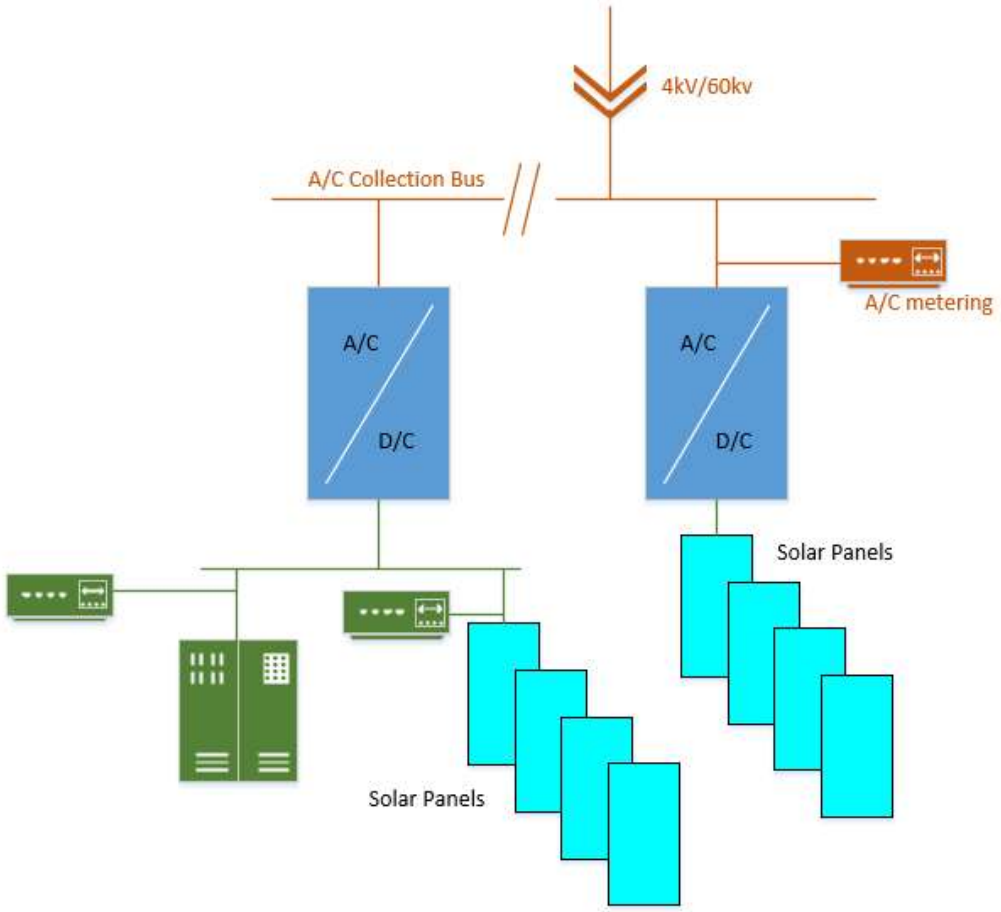
DC connections:

Figure 8: DC connection metering layout for separate resource IDs - SCME



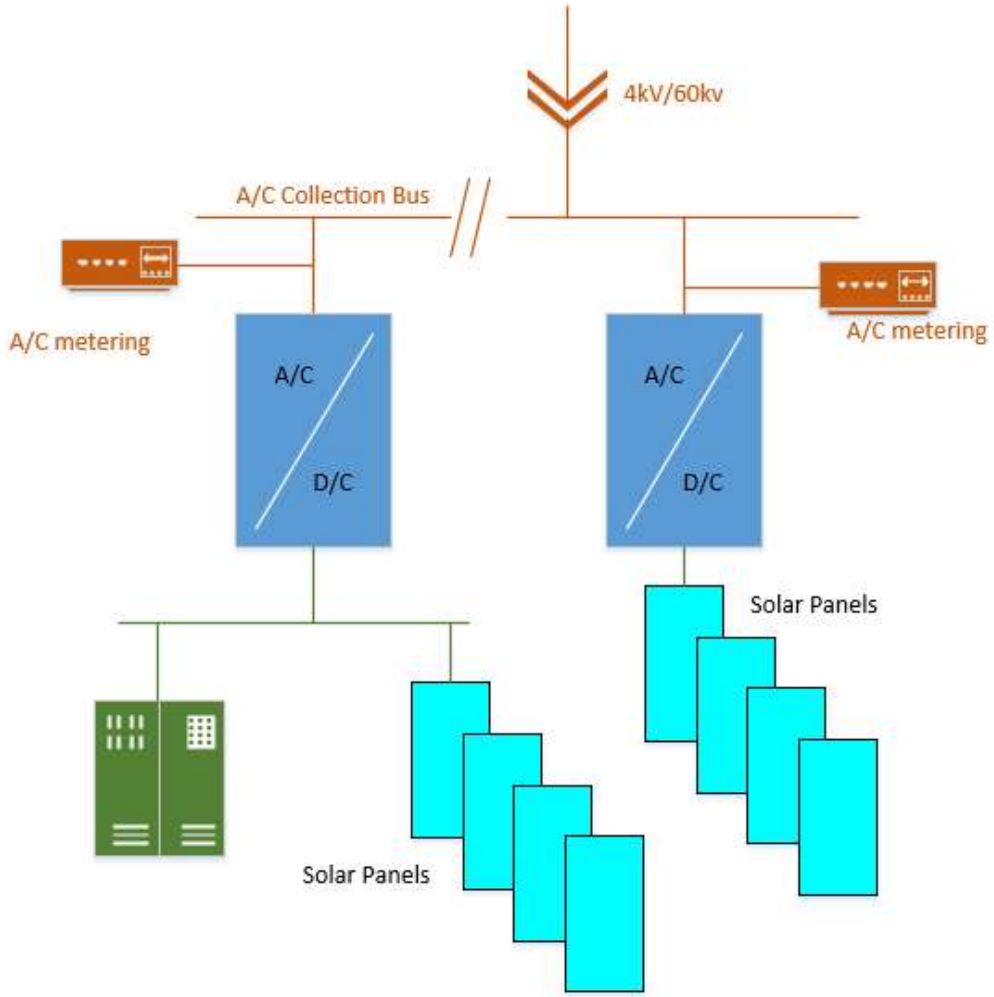
DC connection with separate resource IDs – SCME: Either generating unit, or both can have DC metering and can participate as SCME. The inverter, transformer and line losses (if any) must be calculated and compensated. The resource should have a transducer on the DC side that meets the LRA or ISO accuracy requirement.

Figure 9: DC connection metering layout for single resource ID - Battery charging from Solar



DC connection with single resource ID: Both the meters can be aggregated and SQMD can be submitted to the ISO under SCME option.

Figure 10: DC connection metering layout for separate resource IDs – Battery charging from Solar



DC connection with separate resource IDs: Both generation units are required to be metered and can participate as SCME. The inverter, transformer and line losses (if any) must be calculated and compensated. The resource should have a transducer on the DC side that meets the LRA or ISO Accuracy requirement.