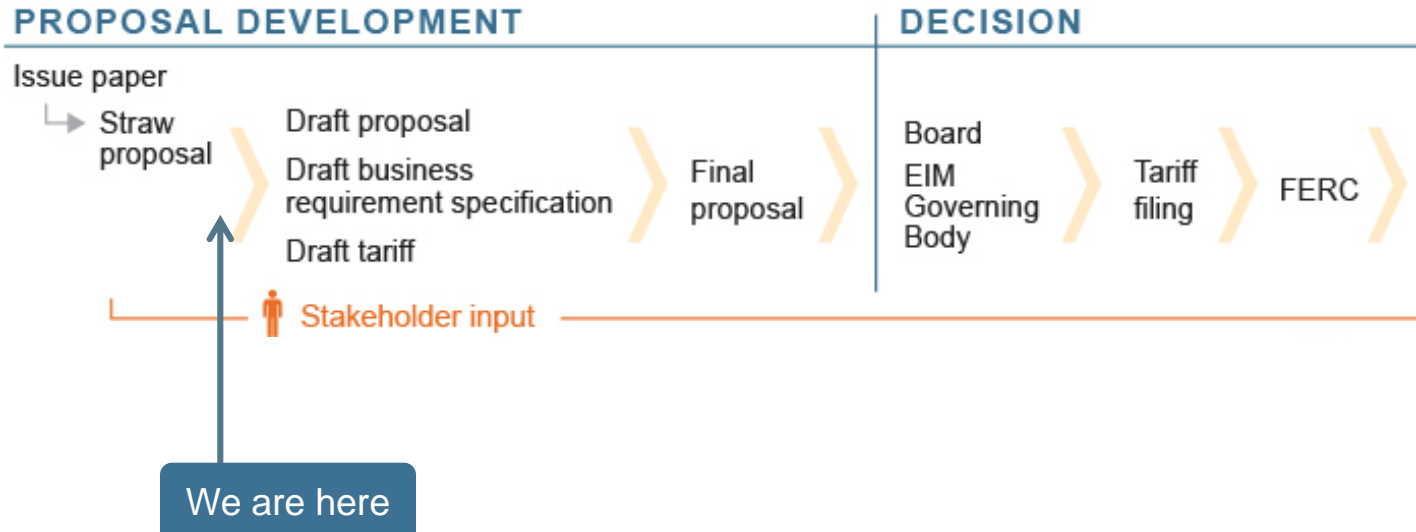




Hybrid Resources: Revised Straw Proposal Stakeholder Meeting

December 17, 2019

ISO Policy Initiative Stakeholder Process

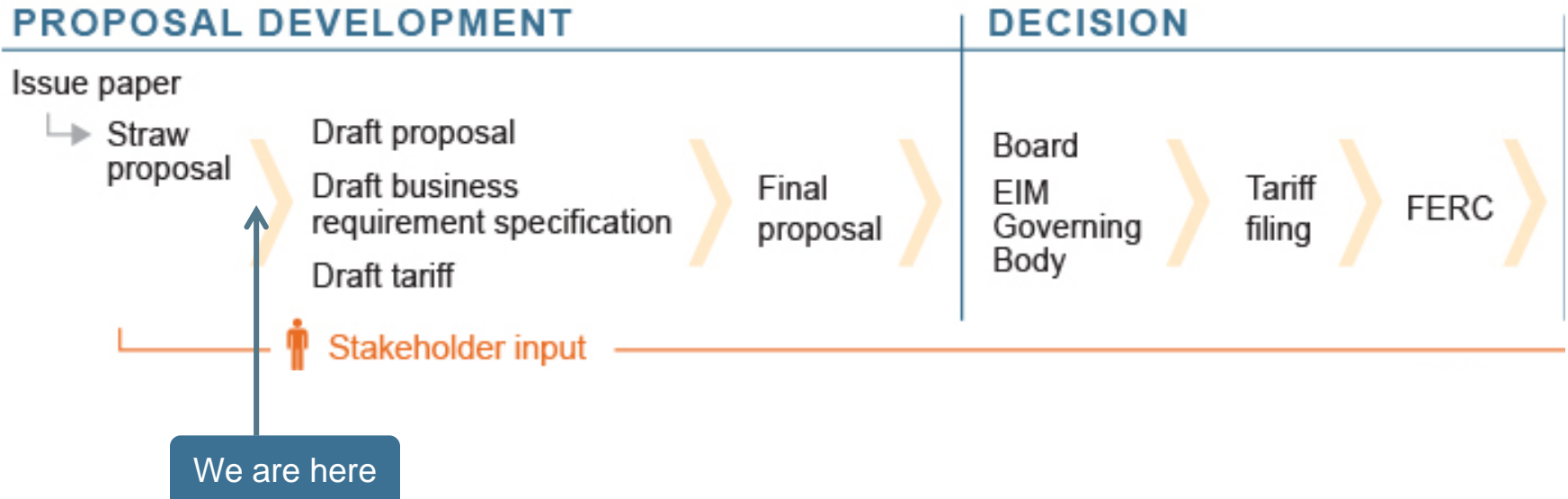


Agenda

| Time | Item |
|-----------------|---------------------------------|
| 10:00-10:05AM | Welcome and Introduction |
| 10:05-10:45AM | Terms and Definitions |
| 10:45-11:30AM | Forecasting |
| 11:30AM-12:00PM | Markets and Systems |
| 12:00-1:00PM | LUNCH |
| 1:00-2:00PM | Markets and Systems (continued) |
| 2:15-2:45PM | Ancillary Services |
| 2:45-3:00PM | Metering and Telemetry |
| 3:00-3:50PM | Resource Adequacy |
| 3:50-4:00PM | Next Steps |

WELCOME AND INTRODUCTION

ISO Policy Initiative Stakeholder Process



Policy initiative schedule

| Date | Milestone |
|-------------|---|
| December 10 | Revised Straw Proposal |
| December 17 | Stakeholder Meeting on Revised Straw Proposal |
| January 14 | Comments Due on Revised Straw Proposal |
| March | Second Revised Straw Proposal |
| May | Draft Final Proposal |
| Q3 | Board of Governors Meeting |

Revised Straw Proposal elements

- Refinements to terminology & definitions
- Business drivers and use cases
- Clarifications to proposed modifications for:
 - Forecasting
 - Markets and systems
 - Ancillary Services
 - Resource Adequacy

Initiative objectives

- CAISO anticipates that hybrid resources and co-located projects will begin to be adopted on a wide scale driving the need for review of existing participation provisions
- Identify enhancements and new market rules and business processes needed to accommodate the unique attributes of hybrid and co-located resources
- Minimize barriers to the efficient and reliable operation and market participation of hybrid resources and co-located projects

Proposal highlights

- Two main aspects of the proposal is to enable improved participation of hybrid resources and co-located resources:
 - Extend existing market functionality used for standalone variable energy resources to hybrid resources to provide feasible market awards and dispatches
 - Address the potential for stranded capacity and energy on co-located projects through the addition of a new interconnection rights constraint to CAISO markets

Hybrid resource participation enhancements

- Proposal will allow hybrid resources to utilize their own forecasted output capability to ensure they receive feasible market awards and dispatch instructions
- CAISO markets will recognize a dynamic upper economic bid range (maximum production limit) for these hybrid resources
 - Enables their participation while minimizing the possibility for infeasible market awards and dispatches
 - This aspect will only apply to CAISO real-time markets

Co-located resources participation enhancements

- Addressing stranded capacity and energy on co-located projects with new interconnection rights constraint
- Proposed interconnection rights constraint will enable CAISO to ensure energy output of co-located resources will be maintained within established interconnection delivery limits while allowing for maximum utilization of co-located resources

TERMS & DEFINITIONS

Hybrid resource definition

- CAISO defines hybrid resources as those projects configured with only single resource IDs
 - Participates and optimized as single resource, for bidding, dispatch, settlements, etc.
- Co-located projects with two or more resource IDs are different from hybrid resources – effectively two distinct resources from CAISO view
 - Generally treated as completely separate resources for the purposes of market participation, bidding, resource adequacy, settlements, etc.
 - One main exception to this rule is coordination of dispatch and operations needed to limit output to project interconnection rights

Proposed Hybrid Resource definition

- **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.

Related terms definitions:

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

Hybrid Resource size requirements

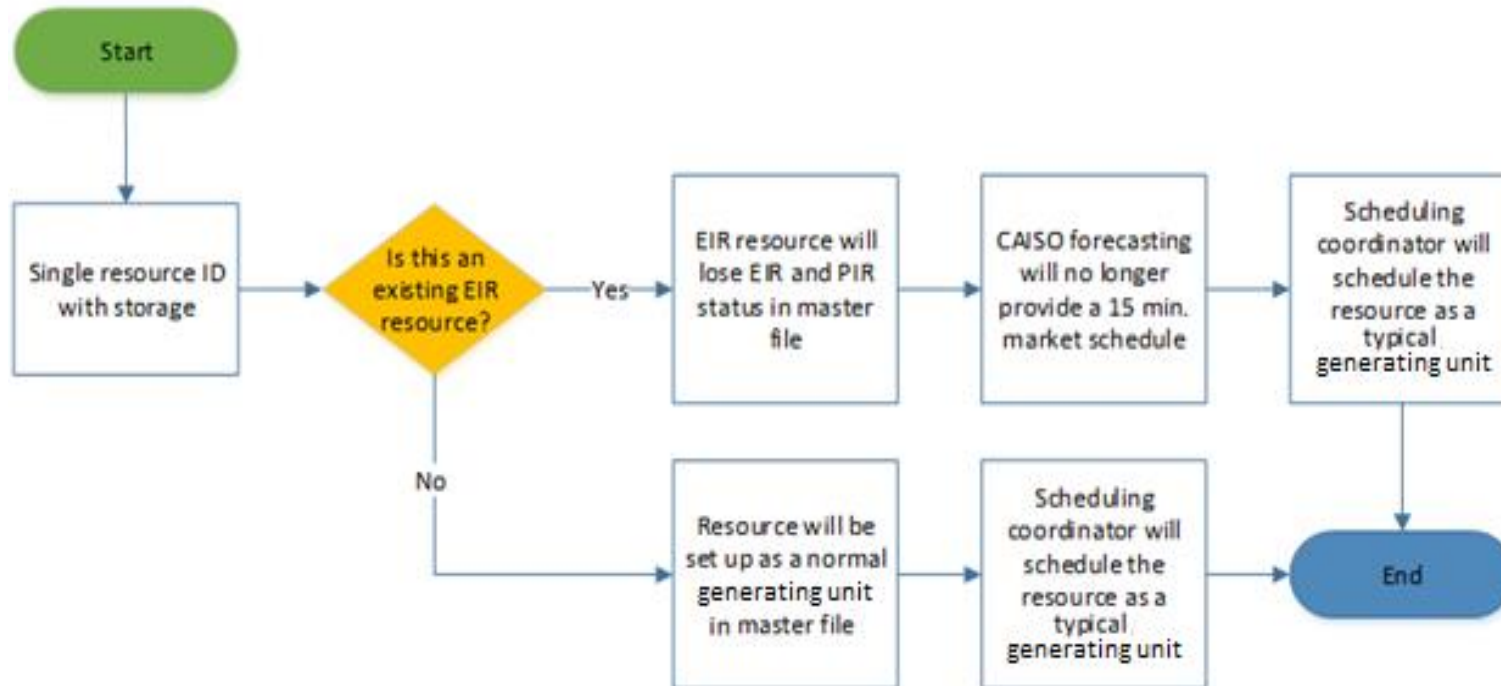
- CAISO proposes to require that hybrid resources meet the minimum sizing requirements for **both** of the underlying generation components:
 - 500kW for any participating generator hybrid resource component
 - 100kW for any storage hybrid resource components
- CAISO has clarified this aspect to avoid confusion regarding the sizing requirements for hybrid resources

FORECASTING

Hybrid resources are not considered VER or EIR resources

- Any hybrid resource combining non-VER generation with VER generation is not eligible to be an EIR or PIR
 - 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.
 - 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.

EIR status diagram for single resource ID hybrid resources



Forecasting related terminology

- **Hybrid Resource Net-to-Grid Operational Forecast:**
 - The overall capability of the hybrid resource as a whole, provided by the hybrid resource SC to the CAISO
 - 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
 - The net-to-grid operational forecast will only be provided and utilized in CAISO Real-Time markets
- **Hybrid Resource VER Component Forecast:**
 - The forecast output capability of only the VER component of a hybrid resource (net of losses and auxiliary load)

Forecasting related clarifications

- **Hybrid Resource Net-to-Grid Operational Forecast:**
 - All hybrid resource net-to-grid operational forecast will only be provided by the hybrid resource SCs
 - CAISO cannot provide forecasting for this aspect due to SC decisions related to onsite optimization and charging or discharging of underlying hybrid resource components
- **Hybrid Resource VER Component Forecast:**
 - CAISO proposes hybrid resource SCs can provide their own VER component forecasts or have the option for CAISO to perform the forecasting for the VER component of hybrid resources
 - 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

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
- Based on stakeholder feedback, CAISO proposes to provide forecasting for the VER component of a hybrid resource for a fee

Hybrid Resource forecasting data requirements

- All hybrid resources with VER components be required to provide the following data and information to 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

Hybrid resource self provided forecasting proposal (Single resource ID)

- CAISO proposes that hybrid resource Scheduling Coordinators must derive their own net-to-grid operational forecasts for the entire hybrid resource's potential output capability
 - Can incorporate the CAISO provided VER forecast into the net-to-grid operational forecast
- This forecasting requirement will only apply to hybrid resources with a VER component

Hybrid resource forecasting and market participation

- Hybrid resources are viewed by CAISO as a dispatchable generator
 - Market awards and dispatch targets based upon cleared schedules and bids, informed by SC's own operational forecasts
- Hybrid resources will be required to follow dispatches like any other non-EIR generation resources
- CAISO will use resource's net-to-grid operational forecasts to ensure hybrid resource market awards and dispatches do not exceed real-time production capabilities of the resource
 - Extends use of existing functionality to update hybrid resource upper economic limit dynamically based on forecast
 - Similar to current VER resource treatment to ensure feasible market awards and dispatch instructions

Hybrid resource self-provided net-to-grid operational forecasting

- Hybrid resource net-to-grid operational forecasts should be provided to the CAISO and updated with 5 minute granularity for minimum of a rolling 3-hour forward basis
- Self-provided forecasting allows flexibility
- Given this flexibility – CAISO will monitor all hybrid resource forecasts for any strategic forecasting that attempts to inappropriately arbitrage price differences or otherwise manipulate market outcomes inappropriately

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

- CAISO 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
- 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)

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

Strategic forecasting 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 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

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

- CAISO is evaluating how impacts of the proposed interconnection rights constraint for co-located projects may need to be considered or incorporated in the VER forecasting process
- CAISO will incorporate these constraints and any related reductions in VER market awards or output as an input to CAISO forecasting
 - Need to allow CAISO to adjust inputs to VER forecasting for any VER resources with interconnection constraints applied
 - CAISO has a similar forecasting methodology in place for VER resources when supplemental dispatch is present

MARKETS AND SYSTEMS

Proposal includes two aspects that each advance the participation of hybrid and co-located resources

- Self-provided net-to-grid operational forecasting for hybrid resources to ensure feasible awards and dispatch
- Interconnection rights constraint for co-located resources to maximize utilization of each resource and overall interconnection rights

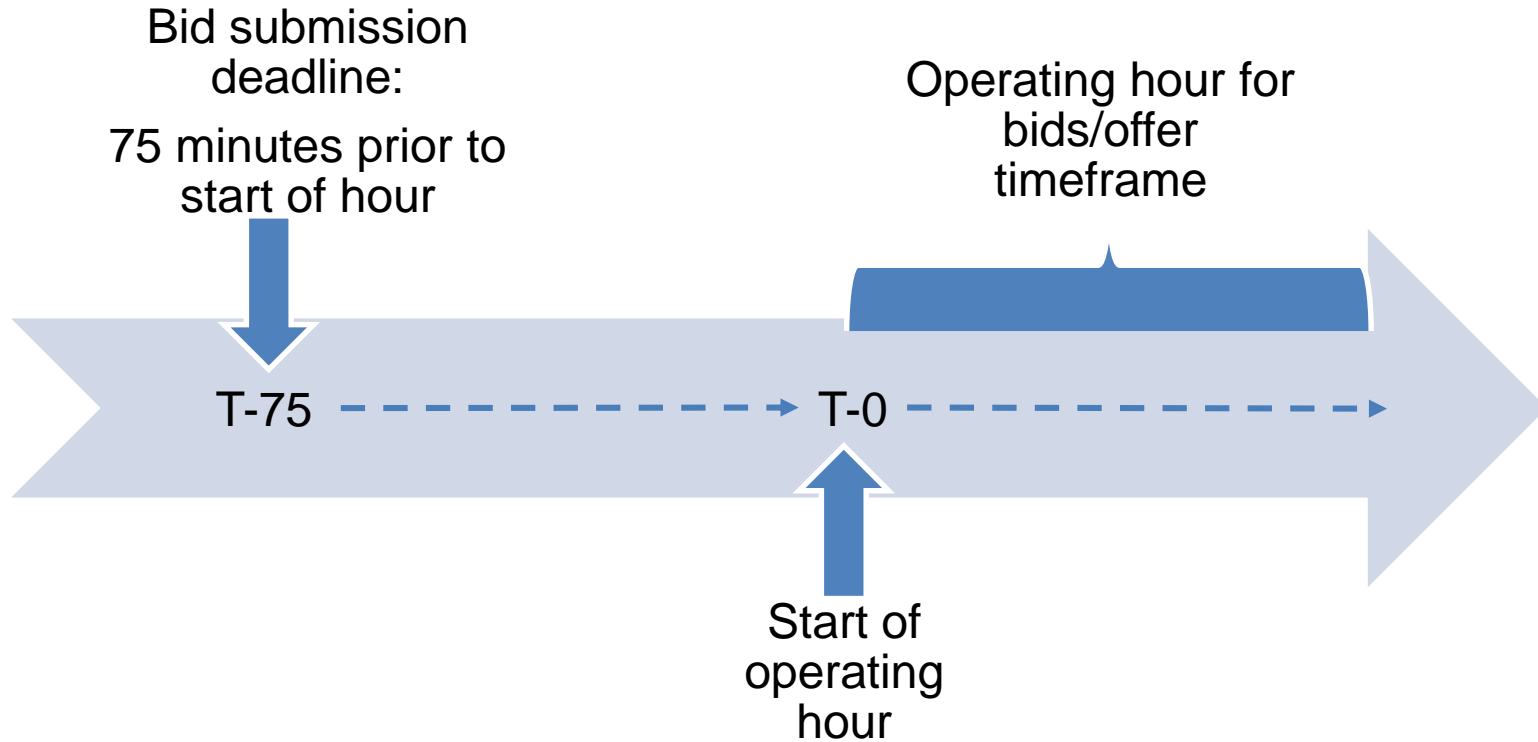
Incorporating Hybrid Resource net-to-grid operational forecasts in market processes

- CAISO proposes to modify the market processes to consider the resource's self-provided net-to-grid operational forecast
 - For hybrid resources (single resource ID configurations) with VER components
 - Self-provided forecasting approach only used to update hybrid resource's upper economic limit in Real-Time market
 - Hybrid resources will still need to provide bids and offers in Real-Time market similar to other resources
- Similar to how market considers VER forecasts today

Utilizing hybrid resource forecasts in market processes

- SC for a hybrid resource submit an economic bid (either with or without a self-schedule) and a self-provided forecast
- CAISO will receive and process the forecast to establish the upper economic limit for that resource
 - If a hybrid resource submits a self-schedule the resource will be a price taker at the submitted forecasted output
 - In other words, CAISO will ensure a feasible dispatch for any self-scheduled hybrid resources by setting the resources upper economic limit at the provided forecast output

Market bidding/offer timing



Bidding timeframes

- CAISO also considered modifications to market systems that would provide for bids/offers for these hybrid resource units to be updated more frequently than current timeframes, closer to real time
 - Currently generator bids and self-schedules can be updated once an hour at 75 minutes prior to the operating hour
- CAISO cannot change bid timing due to extensive interactions in running the current market processes
 - CAISO will not be able to adjust bidding timeframes without impacts to other market processes/timing
 - Changes would require extensive systems and software modifications that are not possible given existing market design

Modeling options and impacts

- Selection of certain configurations has numerous consequences that stakeholders should be aware of and understand
- Four main modeling options described in the proposal:
 - Hybrid – charging from on-site generation only
 - Hybrid – charging from grid only
 - Hybrid – charging from both grid or on-site generation
 - Co-located – charging from on-site generation, grid, or both
- Hybrid Resources can be modeled as a traditional generator or NGR depending on the configuration
- Co-located resources will be modeled according to each resource technology

Modeling options – hybrid resources

- **Option 1 (on-site generation charging only):**
 - 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
- **Option 2 (grid charging only):**
 - Hybrid resource behaves as an energy storage device, charging and discharging to/from the CAISO grid as a single resource
 - Hybrid resource modeled and treated as a NGR in CAISO markets
- **Option 3 (charging both from on-site generation and grid):**
 - Hybrid resource now has the capability of behaving as an energy storage device as a whole, charging and discharging to/from the CAISO grid as a single resource
 - Hybrid resource will be modeled as a NGR in the CAISO market

Modeling options – co-located resources

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

Modeling impacts for mixed-fuel projects with VER and Storage components

| 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 |
|------------------------------------|-----|-----|-----|-----|-----|-------------|

Charging impacts: charging from on-site generation

- CAISO received feedback from numerous stakeholders about ability to charge co-located storage from on-site generation behind the same POI as an important option
 - CAISO has identified this charging configuration is possible in the 2016 technical bulletin and the issue paper for this initiative
- Market and settlement related impacts were previously described
- CAISO has provided tables describing impacts related to different configuration decisions

Charging impacts for hybrid resource configurations

Hybrid Resources (single resource ID)

| Charging Configuration | 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 |

Charging impacts for co-located resources configurations

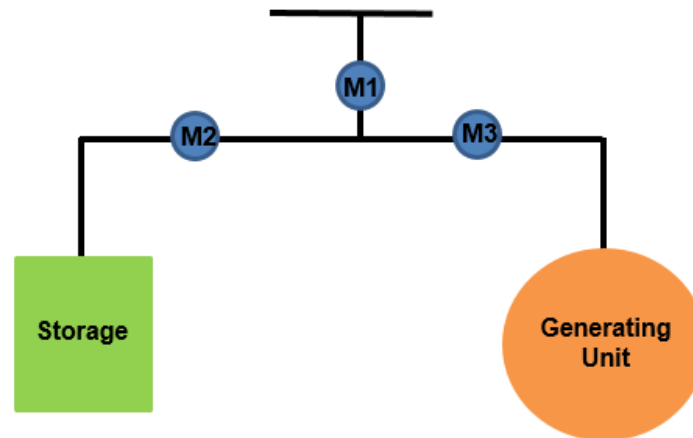
| Co-located Resources (two or more resource IDs) | | | | |
|---|------------------|---|--|---|
| Charging Configuration | Contracts | Master File | Metering | Telemetry |
| Charge from on-site generation | GIA, PGA, MSA, | Each resource identified; storage is NGR fuel = Other | Separate CAISO revenue 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 |

Co-located resources: accommodating charging from on-site generation

- CAISO proposes to require a third meter be installed for co-located resources that select option to charge from on-site generation
- CAISO will use 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
- Concept will allow CAISO to calculate and settle the resources in a manner that allows for the charging of co-located storage from on-site generation without the settlement and financial related concerns that many stakeholders have expressed

Co-located resources with on-site charging option

- Participation and settlement process:
 - The generating unit would bid in CAISO markets
 - The battery would bid the load in CAISO markets
 - 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 and $M3 = 50$
 - Battery is charging 50 MW and $M2 = (-50)$
 - Gen-tie Meter $M1 = 0$



Co-located resources overall output limitation – project interconnection rights

- Currently CAISO limits Pmax on each resource, can result in stranded capacity and energy that cannot be utilized

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

Proposing to develop interconnection rights constraint to address issue

- For co-located projects – two or more resource IDs (NOT hybrid resources), intended to limit output to the maximum of the project interconnection rights
- Will ensure co-located resource 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
 - Developing functionality to optimize for both energy and AS
 - Existing intertie functionality has the capability to consider energy and AS together, this intertie functionality will need to be developed for internal resource constraint to incorporate the ancillary services aspect into the final solution

Interconnection rights constraint for co-located projects

- Proposed constraint will reflect the co-located project's total interconnection rights
 - Adjust market awards, schedules and dispatches to the injection limits included in a new master file field
- Constraint will not limit or impact the bid amount (MW) or bid price (\$) of the co-located resources subject to the proposed constraints
- CAISO will be able to incorporate multiple interconnection rights constraints at a single POI
 - Allows for multiple different sets of co-located projects under multiple resource ID configurations to be managed to their individual interconnection rights at a single POI

Formulation for co-located resource configuration interconnection rights constraint

- CAISO will use the following formulation for proposed interconnection rights constraint:

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

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 |

- 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)
- 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

CAISO has reviewed other potential solutions

- CAISO also explored the use of other solutions, such as grouping constraints and extension of MSG functionality
 - CAISO believes that these other options would be too complex and have adverse pricing impacts
- CAISO believes the most feasible solution is to pursue development of proposed interconnection rights constraint

Interconnection rights constraint implementation timing

- Previously targeted fall 2020 potential implementation
 - Project sizing will not fit in 2020 release with the AS solution that requires a larger implementation lift
 - To develop both AS and energy functions requires moving to fall 2021 implementation

Co-located interconnection limits: interim solution

- CAISO previously proposed to maintain the current implementation approach of limiting the combined Pmax of co-located resources to project's established interconnection rights
 - Status quo presents a significant potential barrier to the development of oversized co-located projects
 - CAISO received strong opposition to this previous proposal to maintain the status quo on this issue in stakeholder responses to the straw proposal
- CAISO considered other options and stakeholder suggestions to address issue and/or allow true Pmax in master file such as tariff requirement that SCs ensure bidding to manage to POI limit and changes to master file processes
 - Would require modifications to systems to allow for controls and reporting to be provided and must consider feasibility of implementing this approach
 - Unable to implement system changes in timely manner to address in interim

Co-located interconnection limits: interim solution

- 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
 - Previously viewed as too burdensome to implement for only a one year period however CAISO is trying to be responsive to stakeholder concerns as best as possible
- This approach should provide some relief for co-located projects to maximize their existing interconnection rights for the greatest potential capacity and energy utilization

Co-located interconnection limits: interim solution

- CAISO notes energy only solution will necessitate co-located resources that select to apply the energy only interconnection constraint in the interim period (fall 2020 – fall 2021) will not be eligible to provide Ancillary Services
 - CAISO recognizes this is a potential area of concern for stakeholders and has considered this issue
- If developer wishes to select co-located configuration and still would like the capability to provide Ancillary Services in interim, CAISO allows the option for co-located resources to maintain current approach
 - Limit combined Pmax of resources to total interconnection rights and forego use of proposed energy only interconnection constraint
 - Allows continued provision of AS from co-located resources in interim if needed

ANCILLARY SERVICES

Ancillary Services provision by hybrid resources

- Any hybrid resources that have been defined as either NGR or mixed fuel type generating facilities will be eligible to participate in ancillary services market
- Co-located projects with two or more resource IDs are eligible to provide ancillary services depending upon the individual generating unit certification
- 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

Data needs and validation of AS capabilities for AS provision by hybrid resources

- Additional telemetry and submission of underlying resource components forecasts and other data is necessary
- Requirement for additional data and telemetry for hybrids resources to qualify for AS provision
 - High Sustainable Limit concept, storage component State-of-Charge and other data needs
- Need this info to ensure actual production capabilities:
 - Will allow hybrid resources to safely and reliably provide AS, fairly compensate resources, and for the market to appropriately pay for the services rendered

High Sustainable Limit concept

- CAISO proposes 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 “High Sustainable Limit” (HSL) of the VER component from the plant side of the inverter/control system
- CAISO previously suggested a similar concept – was initially described as “plant potential”
- Changed the terminology to “High Sustainable Limit” to better describe the data point

High Sustainable Limit concept

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 output for each VER component of hybrid resources as established by the hybrid resource SC
- The 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

Hybrid resources storage components state-of-charge and telemetry data

- State-of-charge for storage devices is a current data point for NGR resources
 - CAISO believes it is necessary to extend requirements for knowing the state-of-charge of storage generation components of hybrid resources
- CAISO also proposes to require telemetry 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 CAISO to assess the capability of the hybrid resource to be able to provide any services it has been awarded

Proposal for additional data and telemetry limited to hybrid resources

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

Payment Rescission (AS No Pay)

- If the CAISO identifies a resource that has received an AS award but its AS capacity is undispatchable, unavailable, or undeliverable, CAISO will apply its ancillary service payment rescission rules
 - Rescission of ancillary services payments are described in the CAISO Tariff under Sections 8 and 11
- Under current requirements, hybrid resources (single resource ID configurations) providing AS will result in CAISO being unable to receive full information and data necessary to determine if awarded ancillary services are truly available or not
 - Specifically, the HSL forecast for VER components and state of charge data for storage components are currently unknown to the CAISO

Frequency response capability from hybrid resources providing spinning reserves

- CAISO proposes that for hybrid resources with energy storage to be certified to provide Spinning Reserves, the resource must demonstrate that it can 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

Frequency response capability from hybrid resources: Governor vs inverter based response

- Under CAISO's current tariff rules for Spinning Reserves, CAISO specifies different frequency response requirements for resources with governors and resources with minimum frequency response devices
 - These requirements drive the sizing needs for energy storage component of a hybrid resource seeking to provide Spinning Reserves
- CAISO proposes that hybrid resources with components that utilize governors should set battery storage sizing requirements in relation to the amount of capacity the resource seeks to certify to provide spinning reserve based on governor configuration requirements under Appendix K

Frequency response capability from hybrid resources – minimum sizing requirement for non-governor enabled

- 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

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

- CAISO has included a proposal in the markets and systems section that would provide for an interim solution to address the combined Pmax value in the CAISO Master File size that can exceed their interconnection rights
- 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

Co-located resources energy only interconnection constraint alternative option for AS provision in interim

- Interim solution will also necessitate that co-located resources that would not be eligible to provide Ancillary Services during interim period (fall 2020 – fall 2021)
- If resources wish to select the co-located configuration and still would like the capability to provide Ancillary Services, co-located resources may limit their combined Pmax to the total interconnection rights and forego use of this proposed energy only interconnection constraint

METERING AND TELEMETRY

Metering and telemetry for AS provision by hybrid resources

- Proposing to require additional data and telemetry for all hybrids regardless of AS certification status
 - High Sustainable Limit forecast for VER components
 - State-of-Charge and charging/discharging telemetry on each storage component
- Separate telemetry and metering requirements is needed for all hybrids resources to ensure CAISO can be aware of the operational capabilities of hybrid resources and their underlying components
- Additionally these requirements will assist CAISO in monitoring the participation and behavior of hybrid resources

RPS reporting

- CAISO is currently registered with WECC as a Qualified Reporting Entity (QRE)
 - CAISO role as a QRE is to submit meter data associated with renewable energy on behalf of ISO Metered Entities using the WREGIS application
 - CAISO intends to continue to provide QRE related RPS reporting to WREGIS in the future for hybrid resources
- CAISO believes current metering configuration options provide flexibility needed to report RPS production accurately
 - CAISO will work closely with project developers during design and implementation of new hybrid resources to ensure that metering configurations allow for RPS reporting and any necessary netting and losses calculations are appropriately developed

RPS reporting – storage conversion losses

- Some stakeholders provided feedback on the issue paper stating that they disagree with the required treatment of losses for hybrid resources with storage components
- CEC RPS Eligibility Guidebook provides:
 - The reportable RPS energy from this hybrid resource configuration would be equal to the renewable energy produced net of any losses from storage
- Treatment of storage conversion losses for RPS purposes is outside of the CAISO's purview
- CAISO does not consider this issue to be in scope of the hybrid resources initiative

RESOURCE ADEQUACY

Resource Adequacy (RA) background

- RA counting rules and Must Offer Obligations (MOO) for hybrid resources are vital
- CAISO defers to Local Regulatory Agencies (LRA's) Qualifying Capacity (QC) RA counting rules
- LRAs establish resource QC values (*e.g.*, CPUC publishes an annual QC list with QC values for all applicable resources)
 - CAISO takes this information and studies resources for deliverability, produces Net Qualifying Capacity (NQC) list annually
- Once QC and NQC of resources are established, resources can be used to meet RA requirements and be shown on RA and Supply plans that establish resource's RA status with CAISO
 - These shown RA resources are then subject to CAISO's RA provisions regarding availability, including CAISO Must Offer Obligations (MOO) requirements

RA counting proposal for hybrid resources

- Recent CPUC PD issued for setting an interim QC methodology for hybrid resources with operational restrictions
- Would adopt the following approach
- Take the QC of either underlying hybrid resource component, which ever is larger will set overall hybrid resource QC value:

ELCC for VER component –or– 4 hour duration sustained output of storage component

- *Subject to deliverability*
- *Capped at interconnection capacity rights*

Hybrid resource QC example

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

Must offer obligation proposal for hybrid resources

- No existing MOO provisions for these resources so CAISO will establish MOO provisions through initiative
- CAISO proposes to adopt CPUC QC method for hybrid resources and has proposed to allow hybrid resources to self-provide forecasts to be utilized by CAISO markets
- CAISO will also refine the following proposal aspects as CPUC finalizes its counting rules for hybrids
- CAISO seeks clarification on some of the aspects of the CPUC approach and will include them in future development

Hybrid resource MOO provisions

- CAISO is still considering how to treat the offer obligation for these hybrid resources shown for RA
- CAISO is currently contemplating Day Ahead market design enhancements and RA offer obligation modifications in other active stakeholder initiatives
 - Any hybrid resource MOO proposals will be coordinated with those efforts to refine this proposal for future iterations
- CAISO proposes that there will be two types of hybrid resource MOOs that will depend on the type of component that drives the overall hybrid resource QC as explained in more detail on following slides

Hybrid resource MOO proposal for storage driven QC: Proposal needs to be coordinated with and reflect the QC methodology

- 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

Hybrid resource MOO proposal for VER driven QC

- 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 net-to-grid operational forecasts

Hybrid resource RA counting and MOO issues for further consideration

- CAISO is considering how to incorporate these RA proposals into its other related RA provisions
- CAISO must consider how to address Local RA and Flex RA related issues:
 - Counting rules for hybrid resources to provide Local and Flex RA
 - Accounting and validation of local RA showings including hybrid resources
- CAISO seeks feedback on these issues and plans to continue to refine these RA related aspects of the proposal

RA counting rules for co-located projects with 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 from CAISO's perspective
- RA value for each separate resource ID based upon the applicable counting methodology for the resource type/technology as established by LRAs
- One related issue that must be addressed is the relationship of the co-located resources QC and proposed interconnection rights constraint

Interconnection constraint RA issue for co-located projects with two or more resource IDs

- Easy to apply QC counting under current approach – the resource developers will work with CAISO to set the Pmax of each resource, which limits the QC of both resources below the interconnection limit
- More complex when considering the interconnection rights constraint CAISO is proposing
 - Once constraint is implemented, co-located resources will have true Pmax reflected in the master file, which means their combined Pmax will exceed their total interconnection rights
 - Will not limit their QC in same way it does under the current implementation

Options for addressing QC related to interconnection constraint

- The QC or NQC process needs to capture that the resources are co-located and have a POI limit that applies to the overall project
- Two options to address this issue:
 - CPUC could choose to work with resource developers to set the total amount of the co-located resource's QCs based upon their preference (split and limited to the POI rights)
 - Alternatively, CAISO could perform a similar split and limit the capacity values when developing the NQC list if CPUC does not want to perform this split
 - CPUC still establish the individual QC values for each resource without consideration of co-located nature/need to cap combined QC at interconnection rights and CAISO could work with developers to limit the NQC of the co-located resources

Must offer obligations for co-located resources

- Must 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
- Result in separate and distinct MOOs for each resource ID that would reflect the resource's technology type and applicable QC and MOO
 - CAISO notes that under these configurations with more than resource ID, there is no possibility for different resources to meet the offer obligations or market awards of other RA resources, each resource ID is viewed as a standalone RA resources if shown on RA showings

NEXT STEPS

Policy and Implementation Schedule

- Comprehensive policy complete in Q2 2020
 - Provides policy certainty provided for developers and participants as soon as possible
- Implementation
 - Initially targeting implementation Fall 2021
 - Interim energy-only interconnection constraint Fall 2020
- Certain tariff items may be able to be implemented before other tech and system upgrades without systems impacts – e.g. tariff items such as default QC methodology for hybrid resources

Next Steps

- Stakeholder written comments requested by January 14, 2020
 - Submit to initiativecomments@caiso.com
 - Comments template will be available at:
<http://www.caiso.com/informed/Pages/StakeholderProcesses/HybridResources.aspx>