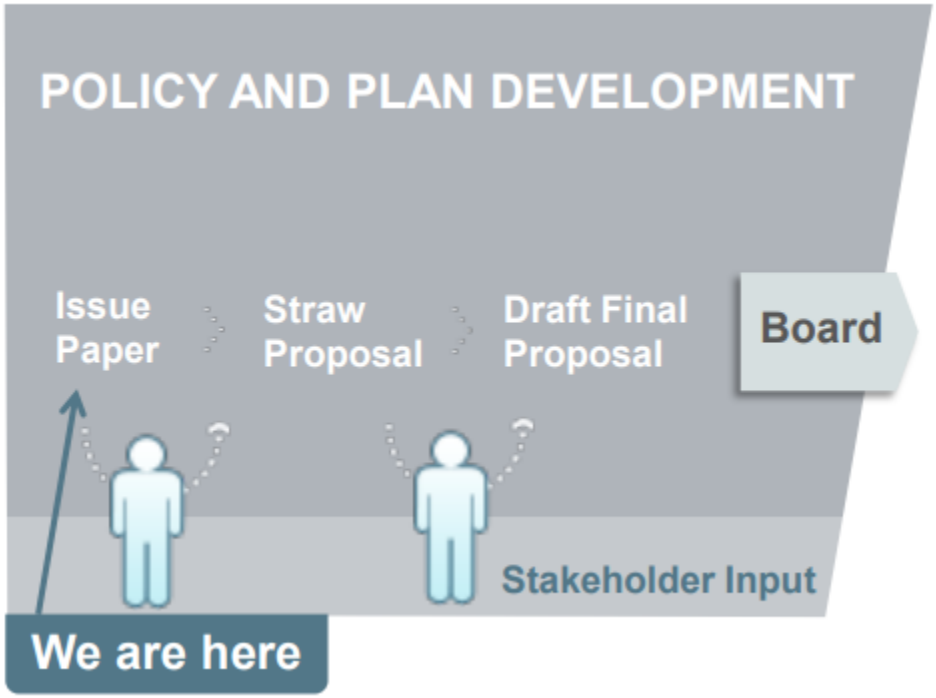
Hybrid Resources Initiative:
Issue Paper Stakeholder Meeting

July 22, 2019

Agenda

Time	Item
10:00-10:05AM	Welcome and Introduction
10:05-11:00AM	Objectives and Background
11:00-11:15AM	Interconnection
11:15AM-12:00PM	Forecasting and Operations
12:00-1:00PM	LUNCH
1:00-1:40PM	Markets and Systems
1:40-2:20PM	Ancillary Services
2:20-3:00PM	Deliverability
3:00-3:30PM	Resource Adequacy
3:30-3:55PM	Metering, Telemetry and Settlements
3:55-4:00PM	Next Steps

Stakeholder Process



Initiative Schedule

Date	Milestone
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

BACKGROUND

What are hybrid resources?

- 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
- Previously, projects pairing energy storage with either existing or proposed generation (conventional or renewable) have been referred to as hybrid generation resources
  - CAISO believes projects do not have to include storage to be considered hybrid resources
  - More inclusive definition will better encompass potential future resource combinations seeking combined hybrid treatment with co-location at a single point of interconnection

Interest in hybrid resources is growing

- CAISO is seeing a significant number of interconnection requests for projects that incorporate hybrid resources
- Hybrid resources in the interconnection queue are growing
- Approximately 41%* of the total capacity currently seeking interconnection is hybrid resource configurations
  - *Note: 41% figure includes all hybrid projects with any resource ID configurations (may be seeking multiple resource ID or single resource ID) and not all capacity included in queue will necessarily achieve commercial operation
- CAISO anticipates that the installed capacity of hybrid resources will grow significantly in coming years

Initiative objectives

- Promote the reliable and efficient integration of hybrid resources
- Address additional technical questions surfaced by increasing numbers and interest in hybrid resources:
  - Configurations, metering, operations, market participation, and settlements
- Address new operational and forecasting challenges raised by hybrid resources
  - New requirements may be needed to provide reliable participation by hybrid resources

Issue Paper topics

- Background
- Interconnections
- Forecasting and Operations
- Markets and Systems
- Ancillary Services
- Deliverability
- Resource Adequacy
- Metering, Telemetry and Settlements

Charging for hybrid resources with storage

- Hybrid resources with storage have different options to charge their storage systems
- Various options can trigger different rules that will apply depending on configuration as single resource ID or multiple resource IDs
- Three options for charging for hybrid resources with storage:
  1. Charge from on-site generation
  2. Charge from the grid
  3. Charge from on-site generation and the grid

Charging configurations: Two or more resource IDs

	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

Charging configurations: Single resource IDs

	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

Market modeling considerations for hybrid resources

- Selection of certain resource ID configurations has numerous consequences
- Market modeling decisions for hybrid resources have important impacts related to the status of the resource components for Eligible Intermittent Resource (EIR) Variable Energy Resource (VER) and Participating Intermitted Resource (PIR) status

Appendices A and Q require an Eligible Intermittent Resource must be a Variable Energy Resource

- An Eligible Intermittent Resource (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
- A Variable Energy Resource (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

Single resource ID treatment for energy storage unit and associated generating unit

- Hybrid resource would continue to retain its VER status as defined in FERC Order 764
  - Would not be treated as an EIR and PIR in the master file or CAISO market settlement
  - Because 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, hybrid resource cannot be certified with a PIR status because CAISO cannot produce an accurate forecast based on the data provided
  - CAISO would be unable to accurately forecast output of solar or wind generating unit due to impact of the charging or discharging storage unit on the output of combined hybrid resource

Single resource ID impacts

- With loss of PIR eligibility/status, CAISO forecasting would not provide 15-minute market schedule for the resource
  - Resource scheduling coordinators will need to schedule these resource configurations by economically bidding or self-scheduling hourly output in the day-ahead market and bidding or adjusting schedules in the real-time market
- Projects operating under a single resource ID are treated like all generating resources that are not PIR, for example:
  - If a non-PIR resource has uninstructed deviation, it is required to settle its Uninstructed Imbalance Energy (UIE) at the real time market price

Important market and settlement impacts related to EIR and PIR status

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

Multiple resource ID option

- If both EIR generating unit and energy storage device are under their own individual resource IDs:
  - EIR generating unit is able to retain its PIR eligibility status
  - Energy storage unit treated as a NGR

Summary of modeling impacts

Hybrid generating facility						
Option selection	**VER definition ***	**VER treatment**	**EIR treatment**	**PIR eligibility**	**NGR treatment**	**Modelling in master file**
Single resource ID						
Option 1 (charge from on-site gen only)	Yes	No	No	No	Yes/No	Generator or NGR
Option 2 (charge 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

(* VER definition under FERC order 764)

Contracts background

- 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
- Charging of the energy storage unit from on-site generation can be captured in schedules for the PGA as a limitation on the generating capability of the on-site generating unit
- Hybrid resources will also need to execute (or amend) a Meter Service Agreement (MSA)
  - MSA allows the CAISO to directly poll the project's settlement quality meter for settlement purposes

RPS reporting background

- 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 submits meter data to WREGIS application for those ISO Metered Entities that have requested submission
- CAISO intends to continue to provide QRE related RPS reporting to WREGIS in the future for hybrid resources
  - For additional information on WREGIS see: https://www.wecc.org/WREGIS/Pages/default.aspx

RPS reporting data and information needs

- 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
- CAISO will work with stakeholders to identify any related issues and necessary modifications regarding RPS reporting procedures or requirements for hybrid resources

California Energy Commission (CEC) has established guidelines for the RPS reporting

- CEC has developed RPS reporting guidelines for hybrid resources combining energy storage with renewable energy resources.
  - California Energy Commission Guidebook: RPS Eligibility: https://efiling.energy.ca.gov/getdocument.aspx?tn=217317
- Provides guidance on reporting approach for hybrids with energy storage under different charging configurations

CEC guidebook guidance

- Hybrid resources with a renewable resource can charge storage device with renewable component and storage can discharge to the grid with both 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
- Hybrid resources with a renewable resource and storage that also has ability to charge from another electric source can charge storage component from renewable component and 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

RPS reporting considerations

- 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
  - If 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

INTERCONNECTION

Interconnection background and issues

- Interconnection customers with generating facilities connected to CAISO controlled grid or 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 an interconnection customer has achieved COD, CAISO would review the request under the modification section of the GIA
- Interconnection customers must provide the proposed operating characteristics in the modification request

Interconnection background and issues

- 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
  - 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
- Generating facilities connected at the distribution level will need to seek approval for such a modification from the Participating TO or UDC, as applicable
  - More information on the modification review process for generating facilities in operation is available in the BPM for Generator Management

Project sizing and interconnection service limits

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

Project sizing and interconnection service limits

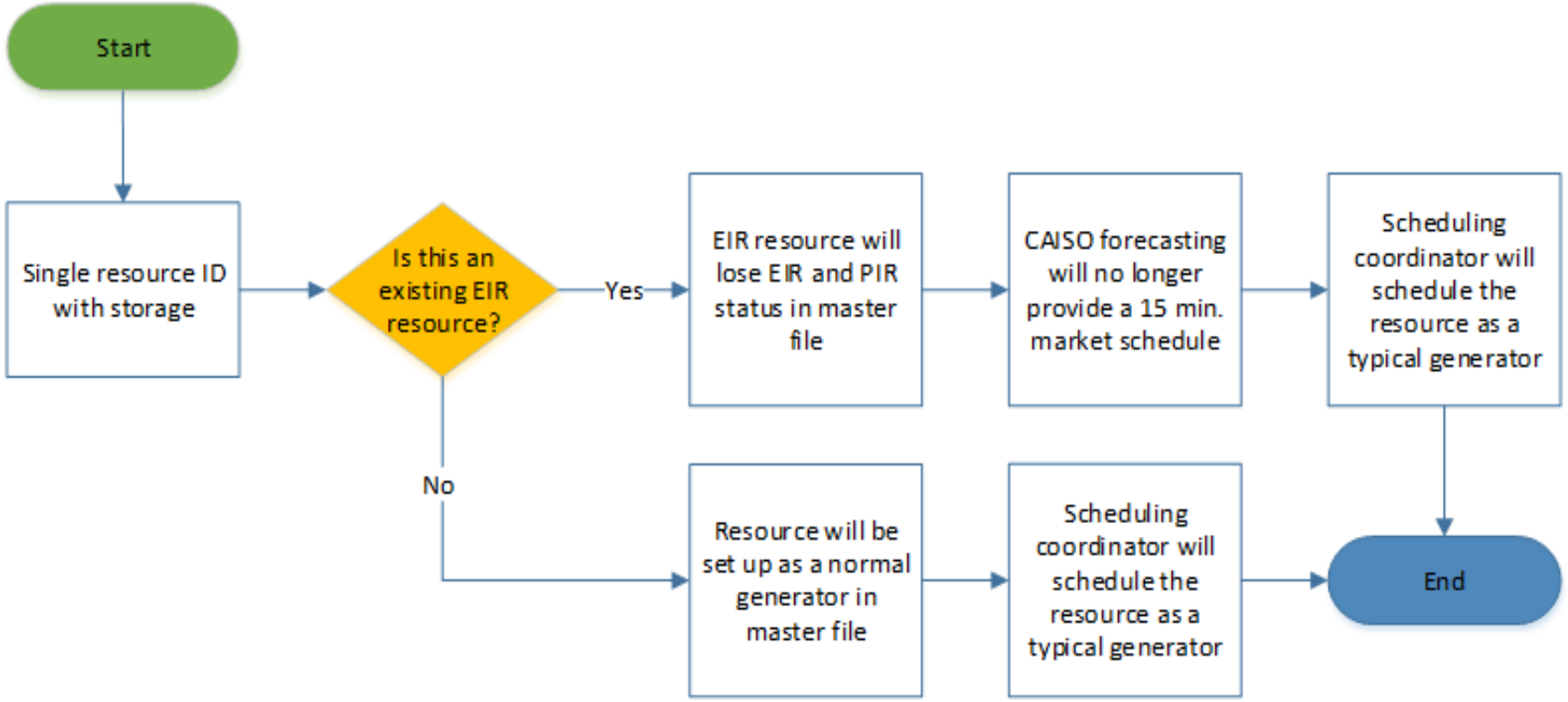
- Interconnection customers should propose the generation limiting mechanism prior to CAISO commencing study work on the modification request
  - Interconnection customers will be required to provide the generation limiting mechanism as a condition of the modification's approval
- Limiting mechanism will be captured in the GIA and required to be in place before project synchronizes to grid
  - CAISO and Participating TO must be able to rely on such a device working consistently so the Interconnection Customer may not modify it

FORECASTING AND OPERATIONS

CAISO has identified a number of issues related to forecasting and operations of hybrid resources under different resource ID configurations

- Forecasting status is an important issue
- An energy storage unit is not a VER:
  - 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
  - Tariff does not have provisions or requirements in place to forecast for non-PIR resources and dispatch them based on that forecast

EIR status diagram for single resource ID hybrid projects



Forecasting issues under a single resource ID configuration

- CAISO unable to be aware of the charging behavior of storage generation components
  - Charging behavior can cause potential forecast error to increase
- CAISO has provided an initial example analysis of this issue to illustrate the potential forecast error impacts

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%

Forecast error under single resource ID configuration

- Analysis assumes storage generation component was approximately equal in size to the other hybrid resource component
  - Because expected battery behavior is unknown, assumed to operate exacerbating forecast error by charging and discharging at various instances throughout day when there was already forecast error present
- Example utilizes data selected on a particularly cloudy day that was chosen to help demonstrate possible forecasting risk
  - Indicates potential forecast error initially decreases with increasing resource size and then jumps up
  - CAISO believes this is related to location and sample choice related impacts, rather than indication of a broader size related forecasting issue

No PIR forecast for single resource ID configurations presents forecast risk

- May be a need for additional requirements for forecasting for 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
  - 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
- Alternative option may be to consider requirements for these single resource ID configurations to provide their own forecast for variable energy resource components

Single resource ID configurations may need to have meteorological (MET) stations installed to provide 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
  - May be necessary to require forecasting for variable energy resource component of single resource ID configurations up to full installed capacity of the resource component, even above project's approved interconnection capacity rights

Forecasting issues under multiple resource ID configuration

- Even with a two resource ID configuration, if storage is charged from solar, visibility of the solar output could still be impacted, depending on the metering configuration, for example:
- Multiple resource ID solar and storage hybrid with solar meter ahead of the storage meter on the gen-tie
  - Demonstrates the potential for excess solar produced energy to charge the storage device without being metered
  - 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
- Additional metering or telemetry requirements may be needed to produce an accurate forecast

Operations issues under a single resource ID configuration

- Because single resource ID configuration hybrid resources are treated like other traditional dispatchable resources they may present operational issues
- No forecast for variable energy resource components and no visibility into the state of charge for storage device components
- 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

Single resource ID configuration hybrid resources are treated like other dispatchable resources for bidding, scheduling and other market purposes

- May cause some risk related to bidding and market timeframes because dispatchable generator self-schedules or bids can only be updated once an hour at 75 minutes prior to the operating hour
- Once bid submission has closed there could be a potential for changes in the fuel of renewable energy generation component of the resource

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
- Demonstrates why CAISO believes it is currently more beneficial for hybrid resources to be configured with multiple resources IDs
- CAISO seeks feedback on potential changes that could address these possible risks

Operations issues under multiple resource ID configurations

- Potential operations issues are generally related to 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

Modeling example for a multiple resource ID hybrid resource

- One of the hybrid resource project components is a wind resource with 150 MW installed capacity, second component is storage device with 100 MW installed capacity, approved interconnection capacity rights of 100 MW total
  - Wind resource is dispatched to 150 MW, with storage device dispatched to charge at -100 MW
  - overall net output of combined resource is 50 MW of energy production flowing onto system, still within the project's approved interconnection capacity of 100 MWs
  - Even though wind resource is operating at a level above approved interconnection capacity the net output of combined resource is within the approved interconnection capacity

Charging a storage device at the same time as producing energy from other resource component

- CAISO is exploring if there are any modifications to the modeling for planning and operational purposes that might be needed to accurately capture potential impacts
- CAISO understands developer requests for providing for netting treatment of the overall hybrid resource output
- May require additional modifications to the metering approaches and techniques
- CAISO seeks feedback on potential solutions to address these issues

MARKETS AND SYSTEMS

Hybrid resources present new challenges related to market participation and CAISO systems

- CAISO master file is a database containing specific resource information that allows market models to optimize the dispatch of system at least cost
- 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.
- Background in issue paper explains existing implementation approaches necessary for charging storage devices under various hybrid resource configurations

Markets and systems issue for multiple resource ID configurations

- 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
- As noted in interconnection and contracts discussion; limiting schemes or controls are required for resources with installed capacity above their interconnection rights
  - Limiting controls focused on reliability but does not address market participation outcomes

Current approach limits resource IDs Pmax in Master File and can result in unintended outcomes

- Output of the components of multiple resource ID hybrid resource configurations may be artificially limited by the current implementation approach
  - Undesirable stranding of hybrid resource capacity
- Can result in CAISO's inability to access some amount of capacity from different components of hybrid resources
  - Also presents commercial impact to project developers

Example of the potential stranded capacity issue

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

- CAISO believes it may be appropriate to develop a new hybrid resource constraint that ensures the resource output remains less than or equal to the hybrid resource project's maximum POI rights without stranding capacity from either component of the overall hybrid resource
- Areas and issues that will require further consideration include:
  - Market impacts, including price formation and settlements issues, forecasting and operational related impacts, and ancillary service related issues

ANCILLARY SERVICES

Hybrid resources are eligible to provide ancillary services

- Any hybrid projects defined as NGR or mixed fuel type generating facilities are eligible to participate in ancillary services market in accordance with Appendix K
  - Hybrid projects with separate resource IDs are eligible to provide some ancillary services depending upon the individual generating unit characteristics
  - 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.
- May be modifications needed to help better facilitate safe and reliable provision of ancillary services from hybrid resources

Preservation of ancillary service capacity is critical

- 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 hybrid resources are indeed able to provide the ancillary services they have been awarded
- CAISO is also reviewing how these data needs are related to existing Ancillary Service No Pay or payment rescission rules and if any modifications to these settlements related items could be needed

Contingency reserves

- Contingency reserve products include Non-Spinning and Spinning Reserve
- Current provisions provide guidance regarding requirements of resources to provide these services
- CAISO hopes 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

Non-Spinning and Spinning Reserve

- Question: For provision of Non-Spin and Spin can, or should, all combinations of mixed fuel resources meet the timing requirements for change in power output currently in place?
- 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
  - May identify the need to more clearly define them for each possible combination of fuels supporting hybrid resources

Non-Spinning and Spinning Reserve

- For 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
- For provision of Spinning reserves, CAISO is considering the need for modified requirements related to the Droop and Dead band settings and frequency response provision for different hybrid resource configurations
- Telemetry and other data acquisition items may be needed for CAISO to able to confirm hybrid resource's ability to provide these ancillary services

Data needs: Plant Potential

- 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
  - New plant potential data point may be needed so that CAISO is aware of the potential output of the resource if it has a variable energy generation component and ensure CAISO is only awarding ancillary services the hybrid resource can actually provide

Data needs: 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 for any resource ID configurations
- 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, *i.e.*, solar thermal, compressed air, gravity train, micro grids or virtual power plants with storage, etc.

Regulation

- Operating characteristics of resources providing these services is clearly defined in Appendix K
- 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

Regulation

- For hybrid resources under a single resource ID, CAISO is interested in determining if the creation of a minimum storage sizing requirement makes sense
- CAISO may need to establish minimum storage generation sizing requirements for regulation
- As a starting point 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

AS Certification

- Hybrid resources are eligible to provide ancillary services if they meet CAISO Tariff requirements and are certified under the applicable Appendix K certification provisions
- 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

- If CAISO identifies that a resource received an ancillary services award but is undispatchable, unavailable, or provides undelivered capacity, then ancillary service payment rescission is applied
- 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
- Single resource ID configurations would not provide needed state of charge data for storage components and CAISO has identified that this data point may be necessary to determine and apply payment rescission

DELIVERABILITY

Deliverability is studied by CAISO and allows for resources to qualify for resource adequacy

- Modeling of hybrid facilities depends on the configuration of the underlying generating facilities
- Terms related to deliverability include: Full Capacity Deliverability Status (FCDS), Partial Capacity Deliverability Status (PCDS), and Energy Only (EO) status
- Three configurations for deliverability assessment:
  - Additive configurations
  - Supplemental configurations
  - Behind-the-meter expansion configurations

Example of Additive Configuration

- 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

	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	
If two resources	FC	FC

The study amount is based on the deliverability assessment methodology, 92% installed capacity is used in all examples for illustration purposes

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
- 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 hybrid resource facilities have separate resource IDs, the CAISO calculates and assigns deliverability status for each resource ID from the study amount

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:
  - Total output is limited to what was requested for the original facility
- Deliverability assessment models the original facility and treats the expansion as energy-only unless a deliverability transfer request is made
  - 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

Behind-the-meter expansion configuration

- If the hybrid facility is one resource ID, the calculation will result in a partial capacity deliverability status (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

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	

RESOURCE ADEQUACY

Resource Adequacy (RA) issues for hybrid resources 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
- Resource Adequacy deliverability, counting rules, and must offer obligations are CAISO's primary RA concerns for hybrid resources

Resource ID configuration plays and important role related to RA

- 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 and must offer obligations

RA counting rules and Must Offer Obligations (MOO)

- RA counting rules and MOOs are vital to ensuring hybrid resources can provide RA to support system and local reliability
- RA counting rules could impact developer's configuration decisions, which can have different impacts on CAISO operations and forecasting
- LRA's Qualifying Capacity (QC) RA counting rules for hybrid resources may have impacts on CAISO markets and operations
  - Each year LRAs establish resource QC values (*e.g.*, CPUC publishes an annual QC list with QCs for all applicable resources)
  - CAISO takes this information and studies resources for their deliverability and produces a Net Qualifying Capacity (NQC) list

Multiple resource ID configurations are not a concern

- CAISO believes that 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
- Must Offer Obligations for multiple resource ID configurations match the corresponding NQC shown for RA based on the applicable MOO for each resource ID resource type/technology

Single resource ID hybrid resources are an issue requiring possible modifications

- 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
- Not having a QC value for the overall hybrid resource could impact the amount of RA capacity the hybrid resource can offer

Default QC methodology for single resource ID hybrids

- In the absence of an LRA counting convention, CAISO must develop default QC values for hybrid resources under a single resource ID
- 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
- CAISO suggests that a potential QC counting methodology for hybrid resources under a single resources ID configuration is to utilize an exceedance methodology

Exceedance approach utilizes historic production data

- 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
- Exceedance QC methodology could be applied to these hybrid resource configurations in a manner that provides a relatively reliable QC value

Must Offer Obligation for hybrid resources with a single resource IDs requires further consideration

- As noted above, CAISO has identified an existing gap in the RA QC counting rules for these resource configurations
- CAISO will need to establish MOO provisions for these hybrid resource configurations
- CAISO believes the resulting MOO for single resource ID hybrids would need to reflect QC value provided by any new applicable QC methodology and 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

METERING, TELEMETRY AND SETTLEMENTS

Metering and telemetry requirements for hybrid resources are slightly different depending upon the point of interconnection

- 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 underlying generation sources

Limiting schemes are necessary

- 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
- If a hybrid resource has a single resource ID configuration and elects 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 generating facility from charging from the grid

Metering and telemetry for storage charging hybrid configurations

- 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

Single resource ID charging from on-site generating unit

- For a single resource ID hybrid resource only charges the energy storage unit from its own on-site generating unit – CAISO would only see the output of combined generating facility
- 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 point of delivery, based on metered output to CAISO controlled grid as adjusted for losses, at five-minute intervals

Single resource ID charging from grid

- For 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, CAISO will need the status of each underlying resource
- However, the CAISO would still issue dispatch instructions to the single resource ID
  - Individual resource components would not be separately subject to CAISO dispatch instructions for generation, charging or discharging purposes
- All settlements for project will be at point of delivery, based on the metered output to CAISO controlled grid as adjusted for losses, at five-minute intervals

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
- CAISO would issue separate dispatch instructions to each resource ID
- All settlements for the project will be at point of delivery, based on metered output to the CAISO controlled grid as adjusted for losses, at five-minute intervals

For two or more resource IDs with an energy storage unit that charges from the associated generating unit

- *i.e.*, Hybrid storage unit does not charge from the grid based on CAISO dispatch instructions, the following settlement process applies during the charging period:
  - The associated generating unit will be metered and settled in CAISO market based on its gross output, not the net delivery to the grid after accounting for energy flow to energy storage unit
  - Energy storage unit will be metered and settled in the CAISO market for the energy flow into the energy storage unit
  - Since the charging of 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

Metering and telemetry for AC and DC configurations

- There are important differences in existing metering and telemetry requirements for hybrid resources participating under AC or DC configurations
- When a solar and storage hybrid resource are both participating as separate resource IDs, 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

Other metering and telemetry needs for hybrid resources configured with DC connections

- 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
- 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
- Resource should have a transducer on the DC side that meets the LRA or ISO accuracy requirements

Next Steps

- Stakeholder written comments requested by August 13, 2019
  - Submit to initiativecomments@caiso.com
  - Comments template will be available at: http://www.caiso.com/informed/Pages/StakeholderProcesses/HybridResources.aspx
- Straw Proposal tentatively scheduled for September 2019