UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Hybrid Resources	**)**	**Docket No. AD20-9-000**

TECHNICAL CONFERENCE COMMENTS OF THE
THE CALIFORNIA INDEPENDENT SYSTEM OPERATOR CORPORATION

The California Independent System Operator Corporation ("CAISO") respectfully submits the following responses to questions raised in July 23, 2020 technical conference and the August 10, 2020 Commission notice issued in the above-captioned proceeding.[1]

1. While this conference uses the term "hybrid resources" to refer to resources consisting of a generation resource and an electric storage resource paired together, we recognize that these resources can be configured differently, from the generation resource and energy storage resource being located at the same facility but operating separately ("colocated") to the generating facility and energy storage facility operating as one "hybrid" resource. How are these two terms used in the industry? What configurations are most common, and are there new configurations emerging?

In these comments and in its ongoing Hybrid Resources stakeholder process, the CAISO refers to a hybrid resource as a single market resource with the following characteristics:

- comprised of two or more fuel types or generating technologies (*e.g.*, solar photovoltaic generation and lithium-ion storage);

[1] Terms not otherwise defined herein have the meanings set forth in Appendix A to the CAISO tariff, and references to specific sections, articles, and appendices are references to sections, articles, and appendices in the current CAISO tariff and revised or proposed in this filing, unless otherwise indicated. The CAISO processes interconnection requests pursuant to its Generator Interconnection and Deliverability Allocation Procedures ("GIDAP"), Appendix DD to the CAISO tariff.

- physically and electronically controlled by a single owner/operator and scheduling coordinator;
- behind a single point of interconnection;
- participates in the CAISO markets as a single resource with a single market resource ID;
- optimized by the CAISO in the market as a single resource; and
- metered and telemetered at the high side of the interconnection transformer.[2]

In contrast, co-located resources are behind a single point of interconnection, but participate in the CAISO markets as separate resources with different market resource IDs. The scheduling coordinator bids each resource individually, and each resource is individually metered and telemetered.[3]

It is unclear at this time which model will be most common; however, nearly all proposed hybrid and co-located projects in the CAISO generator interconnection queue consist of one variable energy resource (primarily solar photovoltaic or wind) paired with lithium-ion energy storage. CAISO stakeholders have not advocated for other configurations beyond the hybrid resource model and co-located resources model.

[2] At a minimum. Other metering and telemetry points may be necessary depending on the resource's elections and configuration.

[3] This construct would allow for co-located hybrid resources.

2. What are some of the indicators of increasing interest by developers in hybrid resources? Where and in what circumstances does interest in hybrid resources appear to be greater? Approximately what percentage of interconnection requests for resources in interconnection queues are composed of hybrid resources? Has there been an increase in requests by hybrid resource developers to participate in energy, capacity and ancillary services markets operated by RTOs/ISOs?

There has been a sudden and dramatic increase in hybrid and co-located projects in recent years in the CAISO. As of September 1, 2020, the CAISO had 349 active generator interconnection requests.[4] 166 interconnection requests (47.6 percent) are hybrid or co-located projects. Of the active 116 interconnection requests submitted in 2020, 67 (58 percent) are hybrid or co-located projects (65 combined generation and storage, two combined solar and wind generation).

Additionally, the CAISO expects the majority of hybrid and co-located resources coming online over the next year will have done so through the generator interconnection modification process for existing resources, particularly variable energy resources adding storage without an increase in interconnection capacity.[5] Through the modification process, 45 projects are scheduled to come online by the end of 2021. 29 propose to be co-located resources and 16 proposed to be hybrid resources.

3. How have the economics underlying hybrid technologies changed over the last three to five years? What future trends do you anticipate in this regard? Given these anticipated future trends, please comment on how you anticipate hybrid resources might be configured going forward. How could these changes impact interconnection requests?

The CAISO defers to developers and load-serving entities on this question.

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4 https://rimspub.caiso.com/rims5/logon.do#.

5 *See* Section 25.5 of the CAISO tariff; Article 5.19 of Appendix EE to the CAISO tariff.

4. We understand that increasing numbers of hybrid resources are participating as a single resource in energy, capacity and ancillary services markets operated by RTOs/ISOs. What are the advantages to the hybrid resource participating as a single resource? What are the disadvantages?

Both the hybrid resource model and the co-located resources model have distinct advantages. By combining energy storage and a variable energy resource in a hybrid resource configuration, the scheduling coordinator can manage the intermittency of the variable energy resource behind the point of interconnection. The CAISO can then dispatch hybrid resources like other non-intermittent, dispatchable resources based on their bids. The hybrid model also allows the scheduling coordinator to self-manage the battery's state-of-charge with the variable energy resource's output, effectively performing its own onsite optimization. Although market operators will continue to need to monitor hybrid resource data, shifting some responsibility to the hybrid resource's scheduling coordinator reduces the CAISO's processing burden required for multi-variable optimization and allows more focus on the hybrid resource's submitted bids. The hybrid resource model also provides the scheduling coordinator more flexibility to manage the interplay between the generating units. This flexibility may be crucial for the owner's power purchase agreement obligations, tax incentives, or operations and maintenance expenses.

In contrast, the co-located resources model allows the market operator's security-constrained economic dispatch to optimize both generating units at all times. The battery component, for example, would only be charged or discharged when the market determines it is optimal to do so. This model can also facilitate a project with multiple power purchase agreement obligations that would be complicated by treating the generating units as a single hybrid resource.

5. What factors are driving developers' decisions in how to configure hybrid resources? For example, what factors do developers consider when deciding to either charge the storage component of the hybrid resource solely from a co-located generation resource or to charge from the grid? In addition, alternating current coupling and direct current coupling are two technical options for interconnection of hybrid or co-located resources. What factors influence developers to choose one form of coupling over another?

The CAISO defers to developers and load-serving entities on this question.

6. How can an interconnection customer in your region propose to interconnect a resource composed of two or more resource types, operated as a single resource at a single point of interconnection? What are the advantages and disadvantages of pairing resource types into a single interconnection request?

Interconnection customers proposing to construct hybrid or co-located resources can do so under a single interconnection request.[6] Their interconnection process is virtually identical to any single-resource interconnection request. The CAISO generally does not inquire whether the resource intends to participate as a hybrid resource or co-located resources until the project approaches commercial operation.[7]

7. What are the benefits and challenges of adding an energy storage resource to an existing generation resource? What are the benefits and challenges of adding an energy storage resource to an existing interconnection request that is already in an interconnection queue? What additional studies would be required to do this, and would the process be the same or different depending on whether the addition is to an existing generation resource or to an existing interconnection request? Also, with respect to the addition of an energy storage resource to an existing generation resource, would the new storage resource be subject to the full interconnection study process, and, if so, would any aspect of the request or study process differ from a traditional interconnection request for a new generating facility? Under what circumstances would the addition of an energy storage resource to an existing interconnection request be considered a material modification that would require the interconnection customer to go through the

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[6] *See* Appendix 1 to Appendix DD to the CAISO tariff.

[7] Generally the CAISO inquires six months prior to the scheduled commercial operation date, then affirms the decision in the New Resource Implementation process three months before commercial operation, http://www.caiso.com/participate/Pages/NewResourceImplementation/Default.aspx. The CAISO also may inquire earlier if the interconnection customer is transferring deliverability capacity from another interconnection customer to ensure the transfer includes the correct amount of deliverability capacity.

interconnection process again or obtain a new queue position? Please describe how this request would be processed.

The benefits of adding energy storage to an existing generator are manifold. Energy storage has potential to reduce intermittency, support frequency and voltage, and allow market operators and load-serving entities to rely on variable energy resources for capacity during demand periods where energy would otherwise be diminished or unavailable. Storage also can reduce curtailment and negative pricing when variable production is high and net demand is low.

There are minimal challenges to adding storage to an existing generator interconnection request or to an operational generator. If the storage addition requires additional interconnection service capacity or would materially change the electrical characteristics of the interconnection request—both of which are uncommon in the CAISO's extensive experience—then the developer would need to submit a separate interconnection request for the CAISO to study the storage addition.[8] Far more often, the storage addition can be accomplished through a modification request.[9] The CAISO and participating transmission owner study the modification to ensure there is no material change in electrical characteristics,[10] and that the modification would not negatively impact the cost or timing of other interconnection requests.[11] Even where

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8 *See* Section 25.1 of the CAISO tariff.

9 *See* Section 6.7.2.2 of Appendix DD to the CAISO tariff; Section 25.5 of the CAISO tariff; Article 5.19 of Appendix EE to the CAISO tariff.

10 Pursuant to Section 25.1 of the CAISO tariff, a modification cannot materially change the reliability characteristics of an existing interconnection request, as doing so would cause reliability concerns. This is very uncommon for storage additions, and generally only occurs for very large storage additions relative to the existing generator.

11 *See* "Material Modification," Appendix A to the CAISO tariff.

one occurs, the CAISO allows the interconnection customer to mitigate the impact (where mitigation is possible) and to modify the modification request to try to avoid any issue. In simplest terms, adding storage to an existing interconnection request or existing generator follows the same process as all other modifications.[12]

8. How is the maximum output of a hybrid resource calculated currently? How is the interconnection service request sized? For example, is it sized to the combined maximum output of each of the hybrid components, limited to a level of output that corresponds to how the resource is expected to operate, or some other amount?

The maximum output of a hybrid resource is the sum of the maximum outputs of each generating component, not to exceed the interconnection service capacity. The interconnection customer can request any level of interconnection service capacity during the interconnection request process, not to exceed the sum of the maximum outputs of each generating component.[13]

Each generating unit participating as a co-located resource can produce up to its maximum output unless the interconnection customer requested less interconnection service capacity than the sum of the maximum outputs of the co-located resources. Where that occurs, the interconnection customer must submit PMaxes for each co-located resource in the CAISO's Master File such that the sum of the PMaxes does not exceed the interconnection service capacity. Alternatively, the CAISO has proposed an aggregate capability constraint that would optimize the output of the co-located resources based upon security-constrained economic dispatch. The aggregate capability constraints would allow the combined Pmaxes of the co-located resources to

12 *See* Section 6 of the CAISO Business Practice Manual for Generator Management.

13 *See* Section 3.1 of Appendix DD to the CAISO tariff.

exceed the interconnection capacity, but would limit the combined schedules of the co-located resources to the interconnection capacity.[14]

9. If a hybrid resource opts not to be studied to charge from the grid, is the resource allowed to later change its decision? If so, is this change or possibility reflected in an interconnection agreement? If so, how? If a hybrid resource seeks to make this type of change, is there a requirement that the resource undergo an additional study or studies?

No developer or stakeholder has expressed an interest in being *studied* without the ability to charge from the grid. The ability to charge from the grid rarely results in separate network upgrades, interconnection facilities, or any other costs the generator would not otherwise incur. As such, developers have no incentive to avoid the possibility to charge from the grid in interconnection studies.

Some developers do not want to charge their battery component from the grid *once operational*. These resources may submit a Pmin of 0 in the CAISO's Master File,[15] or their scheduling coordinators could simply refrain from submitting bids to charge from the grid. If the resources later want to charge from the grid, they may submit a Master File change request at any time, which the CAISO processes in 11 business days.[16]

10. Are hybrid resources able to participate in the energy, capacity and ancillary services markets operated by RTOs/ISOs using existing frameworks or market rules? If so, how do they participate? Are market rule changes needed to enable the participation of hybrid resources? Are RTOs/ISOs exploring market rule changes, and if so, what changes are they pursuing?

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14 *See CAISO*, Transmittal Letter, Docket No. ER20-2890-000 (September 16, 2020).

15 Preventing the CAISO's optimization from even knowing the resource *could* charge from the grid.

16 Section 30.7.3.2 of the CAISO tariff.

Yes. Hybrid resources may participate in the CAISO markets today like any other resource. They would either use the Non-Generator Resource model (if they include energy storage, which virtually all do) or the Participating Generator Model (if they do not). For co-located resources, each generating unit may participate in the CAISO markets based on its generating technology and operational characteristics. For example, co-located storage and solar resources would participate as one Non-Generator Resource and one Variable Energy Resource, completely distinct from each other.

The CAISO is actively exploring enhancements to its rules and participation models tailored to the unique characteristics of hybrid and co-located resources in its Hybrid Resource stakeholder initiative.[17] The CAISO has proposed several enhancements to hybrid and co-located participation models in Docket No. ER20-2890-000, and intends to submit additional enhancements in 2021.

11. Hybrid resources consisting of more than one technology type could potentially participate in the market as the separate component parts, or as a single integrated hybrid resource. Should hybrid resources have a choice of whether to participate in the energy, capacity and ancillary services markets operated by RTOs/ISOs as each of the resource types or as a single resource type? If so, why is this flexibility important?

Yes. Please see the CAISO's response to question 4.

[17] https://stakeholdercenter.caiso.com/StakeholderInitiatives/Hybrid-resources.

12. Does operating a hybrid resource as separate components (i.e., co-located) rather than as a single integrated resource create challenges for RTOs/ISOs in accurately modeling whether hybrid resources will provide operating reserves? If so, is this problem addressed if the resource operates as a single integrated hybrid resource?

There is insufficient experience and data for any party to answer this question at this time. Although each model may offer advantages and disadvantages, the CAISO does not foresee any significant challenge at this time.

13. What is the current ability of RTOs/ISOs to model hybrid resources? Is there a preferred approach?

Please see the CAISO's responses to questions 1 and 4. The CAISO does not have a preferred approach. There is insufficient experience and data for any party to prefer an approach at this time.

14. Hybrid resources with certain characteristics may be able to provide essential reliability services. For example, when configured with advanced controls, these resources may be able to provide fast frequency response and dynamic voltage regulation. What considerations (e.g., models, tools, training) are needed to improve planning and operations models and utility practices to account for the various controlled operating modes of hybrid and co-located resources?

The CAISO believes it is well positioned to capture the unique benefits of storage, hybrid, and co-located resources. The CAISO believes parties need more experience with such resources in operation before making other considerations.

15. In some cases, RTOs/ISOs require variable energy resources to provide data and forecasts of resource production based on weather and other factors. Would the same requirements apply to hybrid resources with a variable energy resource component, or how may these requirements differ?

Yes. In Docket No. ER20-2890-000, the CAISO has proposed to revise its tariff to ensure hybrid resources with a variable energy component continue to provide meteorological data for that component. Please refer to the CAISO's transmittal letter in

that filing for a detailed explanation of why meteorological data is critical for market operators.[18]

16. Are existing dispatch systems in the RTOs/ISOs capable of dispatching hybrid resources as a single resource? What are the challenges and/or limitations of such dispatch?

Yes. The CAISO can dispatch hybrid resources as a single resource. There are no material challenges or limitations in doing so.

17. What are the technical considerations regarding state of charge of the electric storage component of hybrid resources? Are there different factors pertaining to state of charge that are dependent on whether the resource is co-located or operates as a single integrated hybrid resource?

Tracking the state-of-charge may be useful for the market operator to issue dispatch schedules the hybrid resource can meet. Three scenarios highlight this need: First, the hybrid resource may need to produce its full output, requiring both the storage component and the other generating unit to produce power at their full outputs. This scenario requires the storage component to be sufficiently charged. Second, the CAISO may dispatch the hybrid resource for energy when the variable energy resource has diminished capacity. This scenario requires the storage component to be sufficiently charged to meet the dispatch. This scenario is likely to occur in the early evening hours when solar photovoltaic generation is decreasing faster than demand is decreasing, creating a net peak demand. This is a likely scenario because many hybrid resources in California will be solar paired with storage. Third, if a hybrid resource consists of a variable energy resource and storage, knowing the state-of-charge enables the market operator to anticipate when the hybrid resource can and cannot

[18] http://www.caiso.com/Documents/Sep16-2020-Tariff-Amendment-Hybrid-Resources-Phase-1-ER20-2890.pdf.

meet its energy schedules based on sudden changes to the variable energy component's production due to weather changes. If the market operator knows the storage component is sufficiently charged or has sufficient room to charge, it can assume the storage will make up any difference that would have resulted in intermittency and imbalance energy from the variable energy resource alone, thereby allowing the market operator to forego requiring other generators to make up the difference.

18. Do existing RTO/ISO market power mitigation rules appropriately recognize the particular operating characteristics of hybrid resources?

Because hybrid resources will participate in the CAISO as non-generator resources, they would not be subject to local market power mitigation under the existing tariff.[19] Moreover, the CAISO does not have a default energy bid tailored to the unique characteristics of hybrids resources. In its ESDER stakeholder initiative, the CAISO currently is developing a default energy bid for storage resources participating as non-generator resources.[20] Once the CAISO has experience with mitigating storage resources and operational experience with hybrid resources, the CAISO intends to explore whether mitigating hybrid resources is warranted, and what the appropriate default energy bid would be.

Co-located resources could be subject to market power mitigation depending on each resource's generating technology and participation model. In other words, existing rules would apply regardless of the resources' co-location.

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19 *See* Sections 31.2 and 39 of the CAISO tariff.

20 https://stakeholdercenter.caiso.com/StakeholderInitiatives/Energy-storage-and-distributed-energy-resources#phase4.

19. Are there established best practices for metering a hybrid resource for participation in wholesale markets? For example, with one meter, or with multiple meters that provide visibility into individual subcomponents or inverters, or some other configuration?

It would be premature to believe any approach is a "best practice" at this time. Although the CAISO has developed potential metering configurations,[21] market operators and participants have little experience with hybrid resources at this time. Additionally, hybrid resource configurations are certain to be very different from one another in many ways that materially impact metering. The following questions, for example, would impact the metering configuration:

- Will the hybrid resource provide ancillary services or reliability services besides energy?
- Do the components share inverters?
- Are the components DC- or AC-coupled inverters?
- Does the scheduling coordinator or market operator have renewable generation reporting requirements?
- Does the hybrid resource have significant auxiliary load or station power demand?
- What are the local regulatory authority's metering requirements?
- Will the resource island from the transmission grid and operate as a microgrid in the event of an outage?

[21] *See* CAISO, Hybrid Resources Draft Final Proposal, Section 4.4, *available at* http://www.caiso.com/InitiativeDocuments/DraftFinalProposal-HybridResources.pdf.

The variability among resource configurations requires flexibility in metering configurations. Only by allowing the resource owner to work with the market operator can parties ensure the meters accurately capture the hybrid resource's performance.[22]

Although there is a significant need for flexibility, some basic metering requirements are obvious. Co-located resources require separate meters to isolate their respective energy flows at all times. Hybrid resources require one meter at their single point of interconnection to meter their aggregate output and demand from the transmission grid. If the hybrid resource includes a renewable generating component, it likely will have a reporting requirement consistent with state or federal public policy.[23] Therefore, it will require a second meter to isolate the renewable generating component's production from the other components.

20. What are any other potential implications, advantages, and concerns for RTOs/ISOs regarding hybrid resources?

Market operators, developers, and stakeholders need more experience with these resources before reaching any conclusions or establishing best practices.

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[22] For this reason the CAISO allows hybrid resources to be Scheduling Coordinator Metered Entities ("SCMEs"). SCMEs submit Settlement Quality Meter Data Plans ("SQMD Plans") to the CAISO describing how the scheduling coordinator will collect, maintain, aggregate, and submit Settlement Quality Meter Data in accordance with CAISO tariff and, where applicable, local regulatory authority metering and settlement standards. The CAISO reviews SQMD Plans to ensure accurate metering and tariff compliance. Section 10.3.7.1 of the CAISO tariff. SQMD Plans must include (1) the type, programming, and configuration of all associated metering devices; (2) how the Scheduling Coordinator or its agent will collect, validate, aggregate, and submit associated Meter Data; (3) single-line diagrams with professional engineer stamps (or equivalent) depicting the physical elements and relationships among the metering device(s); (4) any calculation or algorithm to derive Settlement Quality Meter Data from the metering device(s); (5) process for aggregating individual Scheduling Coordinator Metered Entities and/or Resource IDs; and (6) plans and schedules to perform regular tests of the metering devices and audit the associated Meter Data pursuant to CAISO Tariff requirements.

[23] For the Western renewable energy generation reporting, *see* https://www.wecc.org/WREGIS/Pages/default.aspx.

21. How do RTOs/ISOs currently calculate the capacity value of resources? Would those methods accommodate the characteristics of hybrid resources, or would new or modified methods be needed?

Local regulatory authorities generally calculate capacity values in the CAISO balancing authority area for resource adequacy purposes. The California Public Utility Commission currently outlines a counting methodology for hybrid resources that includes accounting for energy needed to charge a hybrid battery component and a reduction of capacity for a wind or solar component of the hybrid resource to account for the expected impact to a loss of load event, or an electric load carrying capability methodology. This is a slightly different result than the resource adequacy capacity valuations for co-located resources, which is simply the sum of the resource adequacy of the underlying components.

In its Resource Adequacy Enhancements stakeholder process, the CAISO is proposing an Unforced Capacity ("UCAP") accounting methodology for resource adequacy capacity, targeting implementation in the 2023 resource adequacy year.[24] This counting methodology essentially would use average availability of the hybrid resource during the critical hours of need on the system for the quantity of resource adequacy capacity for the resource. The resource adequacy enhancements will continue to assign resource adequacy credit to each co-located resource based on that resource's technology type.

[24] https://stakeholdercenter.caiso.com/StakeholderInitiatives/Resource-adequacy-enhancements.

22. If new or modified methods are needed, how should the capacity value, including any seasonal variations, be determined for hybrid resources?

The CAISO agrees that ISO/RTOs and stakeholders should explore capacity values for hybrid resources. The CAISO currently is exploring the application of its proposed UCAP methodology to hybrid resources in its Resource Adequacy Enhancements stakeholder initiative, which would vary by peak and off-peak season.

23. If an interconnection customer proposes to add an additional resource to an already existing resource or an existing interconnection request, should the capacity value of the existing resource or the existing interconnection request be modified? Why or why not? What options exist for determining such changes to capacity value?

Adding another resource to an existing resource behind the point of interconnection typically will affect the capacity value of the facility in one of two ways. First, where there is a corresponding increase in interconnection service capacity,[25] the additional resource capacity will serve incremental demand. Second, even if there is no corresponding increase in interconnection service capacity, adding an additional resource—nearly always energy storage in the CAISO—may enable a solar or wind resource to mitigate its variability and thus increase output.[26] Doing so allows market operators and load-serving entities to rely on variable energy resources for capacity during demand periods where energy would otherwise be diminished or unavailable.[27]

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[25] Existing resources can request additional interconnection service capacity by submitting a new interconnection request. *See* Section 25.1 of the CAISO tariff.

[26] Up to the interconnection service capacity. Owners can add a new resource by submitting a new interconnection request, or through the modification process so long as the addition does not increase the interconnection service capacity or materially alter the electrical characteristics. Please refer to the CAISO's answer to question 7.

[27] Adding energy storage also can reduce curtailment and negative pricing when variable production is high and net demand is low.

24. What is the status of efforts in the RTOs/ISOs to define Effective Load Carrying Capability for hybrid resources?

Please see the CAISO's response to question 22.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document upon each party listed on the official service list for this proceeding, in accordance with the requirements of Rule 2010 of the Commission's Rules of Practice and Procedure (18 C.F.R. § 385.2010).

Dated at Folsom, California on this 24th of September, 2020.

/s/ Jacqueline Meredith

Jacqueline Meredith