December 3, 2018

The Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Re: California Independent System Operator Corporation
Docket No. ER19-___-000

Compliance with Order No. 841

Dear Secretary Bose:

The California Independent System Operator Corporation ("CAISO") submits this filing to comply with Order No. 841,[1] a final rule regarding electric storage participation in markets Operated by Regional Transmission Organizations ("RTOs") and Independent System Operators ("ISOs"). The Commission issued Order No. 841 to remove barriers to electric storage resources' participating in the capacity, energy, and ancillary service markets operated by RTO/ISOs.[2] The CAISO respectfully requests that the Commission accept this filing in compliance with the requirements of Order No. 841.

[1] *Electric Storage Participation in Markets Operated by Regional Transmission Operators and Independent System Operators,* 162 FERC ¶ 61,127 (2018) ("Order No. 841").

[2] The CAISO submits this filing pursuant to section 205 of the Federal Power Act, 16 U.S.C. § 824d. Capitalized terms not otherwise defined herein have the meanings set forth in 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.

I. Background

A. Order No. 841

Order No. 841 seeks to ensure that RTO/ISOs provide robust, fair models for electric storage resources[3] to participate in the wholesale energy markets.[4] Electric storage resources have unique physical and operational characteristics, including their ability to inject and receive energy from the grid. The Notice of Proposed Rulemaking ("NOPR") that culminated in Order No. 841 noted that some RTO/ISO tariffs have not kept pace with emerging technologies such as storage, and as a result these technologies have limited market opportunities in those regions.[5] Correspondingly, these RTO/ISO markets have limited ability to receive supply from these resources.[6]

To address these issues, Order No. 841 requires each RTO/ISO to revise its tariff to establish a participation model for electric storage resources if it has not already done so.[7] The participation model must (1) ensure that a storage resource is eligible to provide all capacity, energy, and ancillary services that it is technically capable of providing; (2) ensure that a storage resource can be dispatched and can set the wholesale market clearing price as both a wholesale seller and wholesale buyer; (3) account for the physical and operational characteristics of storage resources through bidding parameters or other means; and (4) establish a minimum size requirement for participation that does not exceed 100 kW.[8] Additionally, each RTO/ISO must specify that the price for sale of electric energy from the wholesale markets to an electric storage resource that the resource then resells back to those markets must be set at the wholesale locational marginal price ("LMP").[9] The CAISO tariff and market design already satisfy the vast majority of Order No. 841's requirements.

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3 The Commission defines an electric storage resource as a resource capable of receiving electric energy from the grid and storing it for later injection of electric energy back to the grid. Order No. 841 at P 1 n. 1. The NOPR notes: "These resources may include, but are not limited to, electric storage resources, distributed generation, thermal storage, and electric vehicles and their supply equipment." *Electric Storage Participation in Markets Operated by Regional Transmission Operators and Independent System Operators,* Notice of Proposed Rulemaking, FERC Stats. & Regs. ¶ 37,718 (2016) ("NOPR") at P 1 n. 2.

4 NOPR at P 1 n. 3.

5 NOPR at P 2.

6 *Id*.

7 Order No. 841 at PP 3-4.

8 *Id*.

9 *Id*.

B. The CAISO's Efforts on Electric Storage Participation

Under California Assembly Bills 2514 and 2868, the California Public Utilities Commission ("CPUC") has directed California investor-owned utilities to procure nearly 2,000 MW of energy storage (excluding pumped hydro storage) by 2020.[10] The total procurement target reflects three categories requiring at least 700 MW of energy storage interconnected to the transmission system, 925 MW interconnected to the distribution system, and 200 MW behind retail customers' meters.

The CAISO continues to incorporate the resources procured as a result of this procurement directive. In 2016 the CAISO generator interconnection queue had 36 interconnection requests for energy storage, comprising 3,093 MW.[11] Today the CAISO queue has 116 interconnection requests for energy storage comprising 23,139 MW. Over 200 MW of greenfield energy storage projects have interconnected to the CAISO transmission system since 2016, and even more storage has interconnected to the distribution grid. Both distribution connected resources and transmission interconnected resources are able to participate in the CAISO's markets.

In 2011 the CAISO established its "non-generator resource," or "NGR" model for storage resources, which is the CAISO's equivalent to Order No. 841's electric storage resource participation model. The CAISO developed the framework for the NGR model in response to the directives of Commission Order Nos. 719 and 890[12] to facilitate the provision of ancillary services by resources capable of both injecting and withdrawing energy.[13] Since then the CAISO has continued to tailor market rules and participation models to the unique aspects of storage, including implementing enhancements designed for storage resources connected both to the transmission system and the distribution system, aggregated and stand-alone resources, and small and large storage resources.

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[10] *See* California Energy Commission, "Energy Storage – Tracking Progress," *available at* http://www.energy.ca.gov/renewables/tracking_progress/documents/energy_storage.pdf.

[11] https://www.caiso.com/planning/Pages/GeneratorInterconnection/Default.aspx. Note that these figures include "hybrid" interconnection requests that can include other technology types, such as solar and storage or wind and storage.

[12] *Wholesale Competition in Regions with Organized Electric Markets,* 125 FERC ¶ 61,071 (2008) (Order No. 719"); *Preventing Undue Discrimination and Preference in Transmission Service,* 18 C.F.R. Parts 25 and 37 (Feb. 16, 2007); *order on re'hrg,* 121 FERC ¶ 61,297; and *order on re'hrg. and clarification,* 123 FERC ¶ 61,299 ("Order No. 890").

[13] *California Independent System Operator Corp.*, 132 FERC ¶ 61,211 (2010). The NGR model is the principal means by which energy storage resources participate in the CAISO markets. This model allows these resources to operate continuously across an operating range that includes both negative and positive generation (*i.e.*, charging and discharging). This model also recognizes that NGRs have MWh constraints that limit the amount of energy they can store and produce.

In 2014 the CAISO conducted three stakeholder initiatives regarding energy storage. First, the CAISO conducted an energy storage interconnection initiative to examine potential issues with energy storage resources' interconnecting to the CAISO controlled grid.[14] This initiative ultimately concluded that the CAISO's existing interconnection rules and study processes could accommodate energy storage resources, and the CAISO added guidance for storage resources on several topics in its business practice manuals ("BPMs"). Second, the CAISO conducted a distributed energy resource provider initiative to allow small distributed energy resources—including energy storage resources—to aggregate into consolidated resources to meet the CAISO's minimum capacity requirement of 0.5 MW. These revisions allowed smaller resources to participate in the wholesale market.[15] Third, collaborating with the CPUC and the California Energy Commission, the CAISO completed the California Energy Storage Roadmap, which outlines ways to (1) expand revenue opportunities for energy storage resources, (2) lower costs of integrating and connecting to the grid, and (3) streamline and elucidate policies to increase market participation.[16]

In 2015 the CAISO began the first phase of its Energy Storage and Distributed Energy Resource ("ESDER") initiative, which sought to solve the CAISO-related issues identified in the California Energy Storage Roadmap and solicit additional suggestions from stakeholders on storage-related issues. The first phase focused on the NGR model, demand response enhancements, and clarifications on the rules for "multiple-use applications," namely resources capable of both providing service to end-use customers and the wholesale electricity markets.[17] The Commission approved the CAISO's initial ESDER reforms in 2016.[18]

In 2016 the CAISO began phase two of its ESDER initiative. Phase two implemented more demand response performance evaluation methodologies to capture unique storage and load types, and clarified station power settlement treatment for storage resources. The Commission approved the CAISO's phase two reforms in 2018.[19]

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[14] Documents related to the energy storage interconnection initiative are available at http://www.caiso.com/informed/Pages/StakeholderProcesses/CompletedClosedStakeholderInitiatives/EnergyStorageInterconnection.aspx.

[15] *California Independent System Operator Corp.*, 155 FERC ¶ 61,229 (2016).

[16] Documents related to the Energy Storage Roadmap are available at https://www.caiso.com/Documents/Advancing-MaximizingValueofEnergyStorageTechnology_CaliforniaRoadmap.pdf.

[17] The examination of multiple-use application rules did not result in tariff revisions.

[18] *California Independent System Operator Corp.*, 156 FERC ¶ 61,110 (2016).

[19] *California Independent System Operator Corp.*, Letter Order approving tariff revisions, Docket No. ER18-2242-000 (October 24, 2018).

In 2017, the CAISO began phase three of the ESDER initiative, which will culminate in a tariff amendment proposing further enhancements next year.[20] Phase three focused on (1) modeling demand response limitations, (2) creating a load shift product that includes dispatchable consumption for energy storage located behind the retail meter, and (3) tailoring a participation model for electric vehicle charging in the CAISO markets.[21] The CAISO also has continued to work closely with CPUC staff on developing a usable framework for multiple use applications in California.

In addition, the CAISO has worked with the Commission on national energy storage and distributed energy resource reforms. The CAISO has participated on numerous technical conferences, participated in several calls and meetings with Commission staff, and has submitted many comments on Commission storage proceedings, including Order No. 841.

II. Compliance with Order No. 841

The CAISO has already implemented the vast majority of the mandates in Order No. 841. This section therefore largely describes how the CAISO's existing tariff complies with the requirements of Order No. 841 (following the order in which they appear in the final rule). Where the CAISO does not already comply with Order No. 841, the CAISO describes how it proposes in this filing to revise its tariff to comply. The CAISO notes it requested clarification, or rehearing in the alternative, on three issues in Order No. 841: (1) whether scheduling coordinators can directly meter storage resources; (2) whether RTO/ISOs must forego settling storage resources for charging where the retail utility refuses to provide wholesale treatment; and (3) whether charging pursuant to economic dispatch provides a grid service such that RTO/ISOs should not assess transmission charges.[22] The CAISO's compliance filing is consistent with the relief it has requested in its motion for clarification. If the Commission accepts this compliance filing, the CAISO's clarification/rehearing request will be moot, and the Commission need not address it.

A. Definition of Electric Storage Resource

Order No. 841 defines an electric storage resource as "a resource capable of receiving electric energy from the grid and storing it for later injection of electric energy

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20 *Id.*

21 *See* CAISO Draft Final Proposal on ESDER Phase 3, *available at* http://www.caiso.com/Documents/DraftFinalProposal-EnergyStorage-DistributedEnergyResourcesPhase3.pdf.

22 *Electric Storage Participation in Markets Operating by RTOs and ISOs*, Docket Nos. RM16-23 and AD16-20, "Motion for Clarification and, in the Alternative, Rehearing of the CAISO," (March 19, 2018).

back onto the grid."[23] The Commission states this definition is agnostic to the point of interconnection and intended to cover storage resources regardless of their technology (*e.g.*, batteries, flywheels, compressed air, and pumped-hydro).[24] Order No. 841 does not create a compliance requirement for RTO/ISOs to implement this definition. The CAISO nevertheless notes that its tariff and participation models already conform to the Commission's intent. As explained below, resources capable of receiving, storing, and later injecting energy onto the grid—regardless of interconnection level or technology—participate in the CAISO markets today in a manner consistent with Order No. 841.

B. Participation Model for Electric Storage Resources

1. Participation Model

Order No. 841 requires each RTO/ISO to "include a participation model consisting of market rules that, recognizing the physical and operational characteristics of electric storage resources, facilitates their participation in the RTO/ISO markets."[25] The Commission notes this rule "does not preclude an RTO/ISO from structuring its markets based on the technical requirements that a resource must meet to provide needed services. It simply requires that each RTO/ISO establish a participation model that ensures eligibility to participate in the RTO/ISO markets in a way that recognizes the physical and operational characteristics of electric storage resources."[26] Similarly, the Commission clarifies that "where an RTO/ISO already has a separate participation model that electric storage resources may use . . . we are not requiring the RTO/ISO to consolidate that participation model with the participation model for electric storage resources . . . ."[27] Likewise, storage resources do not have to use a storage participation model where, for example, they prefer demand response models.[28]

The CAISO's existing tariff and practices comply with these requirements. Most of the CAISO's participation models are not technology specific. For example, the majority of CAISO generators use the generic "Participating Generator" model. Different technology and fuel types may enter different master file parameters for modeling, forecasting, ramping, and dispatch purposes, but the CAISO markets do not distinguish among Participating Generators for settlement, bid-cost recovery, or the ability to set the marginal price.

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23 Order No. 841 at P 29.

24 *Id*.

25 Order No. 841 at P 51.

26 *Id*.

27 Order No. 841 at P 55.

28 *Id*.

Because of the unique aspects of storage and load-based resources, the CAISO has developed three other participation models used primarily by resources capable of receiving energy from the grid, storing it, and later injecting energy back: NGRs, Pumped Storage Hydro Units, and Demand Response providers. These models capture the unique aspects of these resources without discriminating against what they have in common with Participating Generators and other models, such as their ability to provide energy, ancillary services, and set the marginal price. The CAISO explains each model below.

First, the primary model for common storage technologies like lithium-ion and sodium sulfur batteries storage resources is the NGR model, which the CAISO designed specifically for storage. Order No. 841 expressly cites the CAISO's NGR model as an example of the participation model for resources with unique physical and operational characteristics that warrant distinctive treatment.[29] The CAISO tariff defines NGRs as "Resources that operate as either Generation or Load and that can be dispatched to any operating level within their entire capacity range but are also constrained by a MWh limit to (1) generate Energy, (2) curtail the consumption of Energy in the case of demand response, or (3) consume Energy."[30] The NGR model recognizes that a resource can operate seamlessly across a resource's entire operating range. With electric storage resources, this operating range can reflect both charging and discharging configurations. Battery storage is a resource which can discharge energy in one interval as positive generation and consume energy in the next interval as "negative generation." Current battery chemistries and storage control systems have demonstrated these resources can move nearly instantaneously between positive and negative generation, have fast ramping rates, and can be controlled with high precision and performance accuracy. Although storage technology is an ideal candidate for the NGR model, the model also may benefit other energy constrained resources such as dispatchable demand response or microgrids with limited ability to generate or consume energy continuously for wholesale market participation purposes.

NGRs also may elect to use the CAISO's Regulation Energy Management functionality, which allows NGRs to bid their capacity more efficiently in the CAISO's day-ahead regulation markets.[31] NGRs that select this option can only participate in the CAISO's regulation markets. Under this functionality, the CAISO uses a real-time energy offset to help these resources manage the continuous energy requirements for providing regulation service. Resource owners can opt into or out of the NGR Regulation Energy Management functionality by updating their master file data.[32] The CAISO reviews, approves, and incorporates all master file changes between five and

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29 Order No. 841 at P 3 n. 7.

30 Appendix A to the CAISO tariff.

31 Section 8.4.1.2 of the CAISO tariff.

32 *Id*.

eleven business days from submission.[33]

Second, the CAISO has a distinct participation model for Pumped-Storage Hydro Units, which are hydroelectric dams capable of producing electricity and pumping water between reservoirs at different elevations to store such water for the production of electricity.[34] This model reflects the unique physical and market characteristics of pumped storage: Pumped-Storage Hydro Units can operate in the mode of Generating Unit or Participating Load and can submit bid components for both modes. Besides the start-up cost components and the minimum load cost components (associated with operating in generating mode), Pumped-Storage Hydro Units submit additional bid components to reflect their shut-down costs, pumping levels, and hourly pumping costs.[35]

Third, energy storage resources—particularly those located behind a retail customer meter and smaller resources that wish to aggregate into a resource—may participate in energy and ancillary service markets by providing load curtailment (*i.e.*, demand response) as Proxy Demand Resources or Reliability Demand Response Resources.[36] These resources can be transmission-connected, distribution-connected, or behind a retail meter.[37] A proxy demand resource is essentially a traditional type of demand response resource; whereas a reliability demand response resource is dispatched only when the CAISO's system is near or in a system emergency.[38] Both models may use the CAISO's five performance methodologies to calculate their demand response energy measurement, which is the ultimate quantity of performance reported for settlement.[39] These methodologies comprise the 10-in-10 day-matching methodology, the 5-in-10 day-matching, the control group methodology, the weather-

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33 Section 30.7.3.2 of the CAISO tariff.

34 *Id*.

35 *See* Section 5.1.1.2.4 of the CAISO BPM for Market Instruments.

36 Sections 4.13 and 30.6 of the CAISO tariff.

37 The load resources may participate from all three locations. Storage resources participating under a demand response model would be located behind the retail meter. Storage resources interconnected directly to the transmission or distribution grid would use the other models discussed herein.

38 *See California Independent System Operator Corp.*, 144 FERC ¶ 61,047 at PP 8 *et seq.* (2013) (explaining a reliability demand response resource); *see also* Section 4.13.5 of the CAISO tariff (outlining the characteristics of proxy demand resources and reliability demand response resources).

39 Appendix A to the CAISO tariff defines Demand Response Energy Measurement as "The resulting Energy quantity calculated by comparing the applicable performance evaluation methodology of a Proxy Demand Resource or Reliability Demand Response Resource against its actual underlying performance for a Demand Response Event."

matching methodology, and the metering generator output methodology.[40] All methodologies require historic performance data to compare the performance at the time of dispatch to typical use.

The metering generator output methodology is especially relevant to storage participation because it examines both load and behind-the-meter generation, which typically comes from batteries. Through a required sub-meter, the metering generator output methodology allows resources to separate and isolate the demand curtailment from load reduction itself and the demand curtailment from the production of the behind-the-meter generation. The CAISO can then measure the demand response resource's performance based on either the load only, the generation only, or both according to the resource's configuration and elections.[41]

The CAISO also offers distributed resources—including storage resources—the ability to aggregate into a single virtual resource to meet the CAISO's minimum capacity requirements. The CAISO tariff refers to these as Distributed Energy Resource Aggregations.[42] These aggregations can participate in the CAISO markets as NGRs.

Consistent with Order No. 841, the CAISO has structured its markets and participation models based on the technical requirements that a resource must meet to provide needed services. The models discussed above ensure that the CAISO has accounted for storage resources' unique characteristics, and provide significant flexibility for different storage resources to optimize their performance depending on those characteristics. The Commission should continue to find these models satisfy Order No. 841's requirements.[43] The CAISO notes that Order No. 841 expressly identified the NGR model as potentially a best practice.[44]

2. Qualification Criteria

Order No. 841 requires each RTO/ISO to "define in its tariff the criteria that a resource must meet to use the participation model for electric storage resources," and that "these criteria must be based on the physical and operational characteristics of electric storage resources" rather than their type of storage technology.[45]

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40 *See California Independent System Operator Corp.*, Tariff Amendment, Docket No. ER18-242-000 (August 17, 2018) (explaining these methodologies in detail); *California Independent System Operator Corp.*, 156 FERC ¶ 61,110 (2016); Sections 4.13.4 and 11.6 of the CAISO tariff.

41 *See California Independent System Operator Corp.*, 156 FERC ¶ 61,110 at P 5 (2016).

42 *See* Section 4.17 of the CAISO tariff.

43 Order No. 841 at P 3 n. 7.

44 *Id*.

45 Order No. 841 at P 61.

The CAISO already complies with Order No. 841's requirement to have a participation model tailored to storage. The qualification criteria for models available to storage resources are based on resources' physical and operational characteristics. Specifically, to qualify as an NGR, the resources simply must be able to "operate as either Generation or Load and that can be dispatched to any operating level within their entire capacity range but are also constrained by a MWh limit to (1) generate Energy, (2) curtail the consumption of Energy in the case of demand response, or (3) consume Energy."[46] The only other qualification criteria is that an NGR execute a Participating Generator Agreement and a Participating Load Agreement (discussed below).[47] The NGR qualification criteria is thus based on physical and operational characteristics rather than fuel type of technology.

The CAISO's participation models also recognize that different storage resources have different physical and operational characteristics such that they benefit from a tailored participation model. For this reason the CAISO also has the Pumped-Storage Hydro Unit model, which recognizes (1) these resources can operate in the mode of Generating Unit or Participating Load and can submit bid components for both modes, and (2) they need to reflect their unique shut-down casts, pumping levels, and pumping costs through bids.[48] The CAISO tariff has no qualification criteria for this model beyond the capability to produce electricity and the ability to pump water between reservoirs at different elevations to store such water for the production of electricity.[49] These requirements reflect that only these resources must reflect their unique costs related to pumping.

The CAISO also has criteria to qualify as a demand response resource; however, these criteria are well-established and not the primary participation model for storage. The only unique requirement for storage resources using a demand response resource model pertains to those resources that elect to use the metering generator output methodology and want to be settled for their energy supply in lieu of or besides their load curtailment.[50] Such resources must have a separate meter on the storage resource in addition to their retail load meter.[51] This arrangement typically comprises a sub-meter on a battery behind the retail meter. This separate meter enables the

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46 Appendix A to the CAISO tariff.

47 Section 4.6 of the CAISO tariff, as proposed to be amended below.

48 *See* Section 5.1.1.2.4 of the CAISO BPM for Market Instruments.

49 Appendix A to the CAISO tariff.

50 This does not mean the CAISO double-counts the energy supply that enables the load curtailment. The opposite is true. The sub-meter allows the resource to separate and be settled upon its load curtailment independent of the behind-the-meter generation (*e.g.*, by turning off appliances), and upon the behind-the-meter generation itself above typical use. *See* Sections 4.13.4.2, 11.6.2, and 11.6.3 of the CAISO tariff.

51 *See* Section 11.6.3 of the CAISO tariff. (Also applies to resources with a generation-only resource behind the meter; not only storage.)

resource to isolate its energy production from its onsite load for metering and settlement purposes.

The CAISO's qualification criteria are based on unique operational characteristics that must be reflected in the market optimization process for both resource and market efficiency. They are neither onerous nor based on characteristics that are unreasonable or irrelevant to the grid and market. The Commission should approve these criteria as compliant with Order No. 841.

3. Electric Storage Participation Agreements

Order No. 841 requires each RTO/ISO to explain whether storage resources will use new or existing agreements, and whether particular existing market rules apply to resources participating under the storage participation model.[52] The CAISO's current tariff includes rules for storage resources to enter into market participation agreements.[53] The CAISO tariff provides for using existing market participation agreements depending on the storage resource type and participation model selected by the resource. For example, owners or operators of pumped hydro storage resources execute both a participating generator agreement and a participating load agreement.[54] Owners or operators of storage resources participating as proxy demand response must be represented by a demand response provider that has entered into a demand response provider agreement.[55] Owners or operators of NGRs must execute both a participating generator agreement and a participating load agreement.[56] These agreements bind electric storage resources to existing terms and conditions of the CAISO tariff that apply to the participation model the resource elects to use. The CAISO requests that the Commission find its existing market participation agreements for electric storage resources comply with the requirements of Order No. 841.

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[52] Order No. 841 at P 68.

[53] *See e.g.* Section 4.6 of the CAISO tariff, which states in part: "The CAISO shall not accept Bids from Scheduling Coordinators relating to Generation from a Non-Generator Resource unless the resource owner or operator undertakes in writing, by entering into a Participating Generator Agreement and Participating Load Agreement, to comply with all applicable provisions of this CAISO Tariff as they may be amended from time to time…."

[54] Sections 4.6 and 4.7 of the CAISO tariff. The Participating Generator Agreement is Appendix B.2 to the CAISO tariff. The Participating Load Agreement is Appendix B.4 to the CAISO tariff.

[55] CAISO tariff section 4.13.1.

[56] CASIO tariff sections 4.6 and 8.4.1.2 relating to non-generator resources electing to use Regulation Energy Management functionality.

C. Eligibility to Participate in RTO/ISO Markets

1. Capacity, Energy, and Ancillary Services Markets

Order No. 841 requires each RTO/ISO to "establish market rules so that a resource using the participation model for electric storage resources is eligible to provide all capacity, energy, and ancillary services that it is technically capable of providing, including services that the RTOs/ISOs do not procure through an organized market."[57]

The CAISO's tariff does not designate certain generator resource types or participation models as ineligible to provide capacity, energy, or ancillary services. The CAISO tariff instead includes general, technology-neutral rules for participating in its energy and ancillary services markets based upon the technical requirements those services require.[58] Generally, supply resources (which would include storage) must be able to comply with all CAISO operating dispatches,[59] provide telemetry,[60] and have a scheduling coordinator.[61]

The CAISO tariff also includes rules for resources that participate as resource adequacy resources (*e.g.*, must-offer obligations, resource adequacy availability incentive mechanism).[62] These rules do not exclude resources from participation based on their resource type or participation model.

To provide ancillary services, resources must meet the general eligibility requirements in Appendix K to the CAISO tariff (depending on the specific ancillary services offered).[63] These eligibility rules are technology-agnostic. For example, all resources seeking to provide ancillary services must meet the same continuous energy requirements (and they may de-rate their capacity to do so). Resources seeking to provide regulation up and down have a 60-minute requirement in the day-ahead market and a 30-minute requirement in the real-time market.[64] All resources seeking to provide

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57 Order No. 841 at P 76.

58 *See* Appendix K to the CAISO tariff (listing eligibility requirements to provide ancillary services).

59 Section 4.6.1.1 of the CAISO tariff.

60 Section 7.6.1 of the CAISO tariff.

61 Section 4.6 of the CAISO tariff.

62 *See* Section 40.4 of the CAISO tariff (listing eligibility requirements to provide resource adequacy).

63 *See* Appendix K to the CAISO tariff, Part A (Regulation), Part B (Spinning Reserve), and Part C (Non-spinning Reserve).

64 Resources with MWh constraints may more efficiently satisfy the continuous energy requirements for regulation up and regulation down in the day-ahead market if they elect to use Regulation Energy Management functionality. For example, a resource with the capability to provide 20 MW for 15 minutes

spinning and non-spinning reserve must offer real power within ten minutes and be capable of maintaining that output for 30 minutes.[65] Likewise, resources seeking to provide black start capacity must be capable of meeting technical criteria set forth in the CAISO tariff, regardless of resource type.[66]

Storage resources using the NGR or Pumped-Storage Hydro Unit model are eligible to provide all capacity, energy, and ancillary services they can technically provide. Similarly, storage resources are also eligible to provide other services the CAISO procures on behalf of its market (*e.g.,* capacity procured through the CAISO's backstop capacity procurement mechanism) provided they satisfy the basic, technology-agnostic, requirements for those services. The Commission has approved all of the basic requirements for these services as just and reasonable, and they have not proven a barrier to storage resource participation in the CAISO markets. The Commission should approve the CAISO's existing requirements as compliant with Order No. 841.

2. Ability to De-rate Capacity

Order No. 841 requires RTO/ISOs to allow storage resources to "de-rate" their capacity to meet minimum run-time requirements.[67] Doing so will not be considered physical withholding where the de-rating is "for true and verifiable technical reasons pertaining to the market rules for providing various services."[68] Storage resources are *not* required to de-rate their capacity.[69]

The CAISO allows all supply resources to de-rate their capacity, including resources using the NGR and Pumped-Storage Hydro Unit models. As Order No. 841 contemplates, NGRs can elect to de-rate their capacity to meet resource adequacy and ancillary service run-time requirements.[70] Order No. 841 expressly cites the CAISO

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would normally only be able to offer 5 MW of capacity into the CAISO's regulation market. With the use of a real-time energy offset, the CAISO's Regulation Energy Management functionality permits this resources to bid its full 20 MW of capacity into the CAIS)'s day-ahead market for regulation.

65 Section B.1.4 of Appendix K to the CAISO tariff.

66 *See* Appendix D to the CAISO tariff (listing eligibility requirements to be a black start unit).

67 Order No. 841 at P 94 ("this requirement would allow a 10MW/20MWh electric storage resource to offer 5MW of capacity into a capacity market with a 4-hour minimum run-time because that is the maximum output that the resource can sustain for the duration of the minimum run-time. Absent the opportunity to de-rate its capacity, the 10MW/20MWh electric storage resource would not be able to participate in that capacity market, despite its ability to reliably provide 5MW of capacity for the duration of the minimum run-time").

68 Order No. 841 at P 96.

69 Order No. 841 at P 97.

70 As explained above, the NGR regulation energy management model allows NGRs to *avoid* de-rating their capacity. A resource with the capability to provide 20 MW for 15 minutes would normally only be able to offer 5 MW of capacity into the CAISO's regulation market. With the use of a real-time energy

model as an example consistent with the Commission's mandate.[71] The Commission should therefore find the CAISO complies with Order No. 841.

D. Participating as Supply and Demand

1. Participating as a Wholesale Seller or Buyer

Order No. 841 requires RTO/ISOs to "ensure that a resource using the participation model for electric storage resources can be dispatched as supply and demand and can set the wholesale market clearing price as both a wholesale seller and wholesale buyer, consistent with rules that govern the conditions under which a resource can set the wholesale price."[72] Consistent with this requirement, the Commission specifies that:

1. Resources using the participation model for electric storage resources be able to set the price in the capacity markets, where applicable;

2. RTO/ISOs must accept wholesale bids from resources using the participation model for electric storage resources to buy energy; and

3. Resources using the participation model for electric storage resources must be allowed to participate in the RTO/ISO markets as price takers, consistent with the existing rules for self-scheduled resources.[73]

For purposes of market participation, the CAISO tariff does not distinguish among resource types or participation models, except where it is efficient to do so for the resource or market efficiency (as explained in Section II.B.1, above). Nothing precludes resources using storage participation models (1) from being dispatched as supply and demand, (2) from setting the wholesale market clearing price as a buyer or a seller, (3) from submitting wholesale bids to buy energy, or (4) from submitting self-schedules to participate as price takers. In other words, these resources can participate fully in the CAISO's markets provided they meet the basic, technology-agnostic requirements applicable to each market product.

The NGR model reflects storage resources' ability to discharge energy in one interval as positive generation and consume energy in the next interval as demand or "negative generation." NGRs submit bids and participate in the CAISO markets just as

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offset, the CAISO's regulation energy management functionality permits this resources to bid its full 20 MW of capacity into the CAISO's day-ahead market for regulation.

71 Order No. 841 at P 101.

72 Order No. 841 at P 142.

73 *Id*.

participating generators, except that NGRs have a Pmin below zero and additional bidding parameters to reflect their unique charging and discharging abilities and constraints. NGRs can be dispatched as supply or demand, set the marginal price, self-schedule, and otherwise participate fully in the CAISO markets. The CAISO notes that *electing* to participate in the NGR regulation energy management program cannot self-schedule, but only because they have elected to forego participating in the energy market altogether to provide regulation constantly. Such resources could elect to be standard NGRs through the master file modification process.[74]

Likewise, the Pumped-Storage Hydro Unit reflects the unique physical and market characteristics of pumped storage: Pumped-Storage Hydro Units can operate in the mode of Generating Unit or Participating Load and can submit bid components for both modes. These resources can be dispatched as supply and demand, set wholesale market clearing prices, and submit bids and self-schedules.

The CAISO offers no forward/centralized capacity auction, and as such, requirement (1) is inapplicable. The Commission should accordingly find that the CAISO complies with Order No. 841.

2. Preventing Conflicting Dispatch Instructions

Order No. 841 requires each RTO/ISO to "have in place market rules that prevent conflicting dispatch signals in the same market interval in order to avoid any operational uncertainties or reliability concerns that could arise."[75] To mitigate the potential occurrence of conflicting dispatch instructions, the Commission also requires each RTO/ISO to either (1) demonstrate that its market design will not allow for conflicting supply offers and demand bids from the same resource for the same market interval or (2) modify its market rules to prevent conflicting supply offers and demand bids from the same resource for the same market interval.[76]

Order No. 841 cites the CAISO's NGR model and its use of a single bid curve as a potential best practice in complying with this requirement. The Commission states:

> "[A]llowing electric storage resources to represent their full economic range (both charging and discharging) in a single bid could avoid concerns with conflicting dispatch signals and give electric storage resources the flexibility to participate as supply, demand, or both through one bid."[77]

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74 Section 30.7.3.2 of the CAISO tariff.

75 Order No. 841 at P 162.

76 *Id.*

77 Order No. 841 at P 163.

The Commission should find that the NGR model continues to comply with Order No. 841 because it avoid conflicting dispatch signals.

The CAISO's Pumped-Storage Hydro Unit model is different than the NGR model, but also complies with Order No. 841. Pumped-Storage Hydro Units do not submit both demand and supply in a single bid curve like NGRs. Instead, Pumped-Storage Hydro Units can submit a supply bid, pumping bid, or both for the same interval. If a Pumped-Storage Hydro Unit submits both bids, the CAISO's market optimization process will only dispatch one—whichever is more economic in that interval while respecting the unit's operating constraints—to avoid conflicting dispatch signals. The CAISO notes that Pumped-Storage Hydro Units have participated in the CAISO markets since the CAISO's inception. The Commission should therefore find that both the NGR and the Pumped-Storage Hydro Unit models comply with Order No. 841.

3. Make-whole Payments

Order No. 841 requires that the participation model for storage resources "must allow make-whole payments when a resource is dispatched as load and the wholesale price is higher than the resource's bid price and when it is dispatched as supply and the wholesale price is lower than the resource's offer price."[78] In other words, storage resources must be "held harmless for manual dispatch by being eligible for make-whole payments."[79] Likewise, the Commission requires storage resources "to be eligible for make-whole payments when acting as a supply resource consistent with the rules governing the eligibility of other supply resources to receive make-whole payments."[80] The Commission's objective is for storage resources to be treated like other dispatchable resources when grid operators use them to address reliability concerns through manual dispatch.[81]

The CAISO's processes for bid cost recovery and make-whole payments do not distinguish among participation models. Regarding bid-cost recovery for resources bidding to provide supply, the CAISO tariff states:

> For purposes of determining the Unrecovered Bid Cost Uplift Payments[82] for each Bid Cost Recovery Eligible Resource as determined in Section 11.8.5 and the allocation of Unrecovered Bid Cost Uplift Payments for

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78 Order No. 841 at P 174.

79 *Id*.

80 Order No. 841 at P 177.

81 *Id*.

82 Appendix A to the CAISO tariff defines Unrecovered Bid Cost Uplift Payments as "A payment made to Scheduling Coordinators for any Bid Costs in the IFM, RUC, and RTM not recovered by IFM, RUC, or RTM Market Revenues as provided in Section 11.8.5" of the CAISO tariff.

> each Settlement Interval, the CAISO shall sequentially calculate the Bid Costs, . . . as the algebraic difference between the respective . . . Bid Cost and the . . . Market Revenues as further described below in this Section 11.8.[83]

The CAISO also has a limited make-whole remedy when price corrections result in prices that are not consistent with bid costs. The CASO tariff states:

> If the CAISO corrects an LMP in the upward direction . . . that impacts Demand in the Day-Ahead Market and the FMM such that either a portion of or the entire cleared CAISO Demand or export Economic Bid curve becomes uneconomic, then the CAISO will calculate and apply the Price Correction Derived LMP . . . .[84]

As these examples illustrate, the CAISO's bid cost recovery and make-whole provisions are based on bids and prices; not participation models. Resources participating as NGRs or Pumped-Storage Hydro Units are treated like other supply and demand resources subject to manual dispatch or real-time price differences. Under the CAISO's Commission-approved tariff, NGRs do not recover pumping costs or pump shut-down costs because they are not pumping resources.[85] Likewise, NGRs do not recover transition costs because they are not gas fired multi-stage resources. NGRs are also ineligible for bid costs associated with start-up and minimum load because the CAISO participation model for NGR treats them as if they are always operational. NGRs are eligible to recover energy bid, residual unit commitment, or ancillary service bid costs.[86] NGRs also may qualify for opportunity cost adders, although NGRs can reflect all costs in energy bids within the current market horizon.[87] The Commission

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83 Section 11.8 of the CAISO tariff.

84 Section 11.21.1 of the CAISO tariff.

85 *California Independent System Operator Corp.*, 137 FERC ¶ 61,165 at PP 13, 32 (2011).

86 Section 11.8 of the CAISO tariff.

87 In phase three of the CAISO's commitment cost enhancements initiative ("CCE3"), the CAISO explored whether storage resources had limits that would be eligible for a start-up, run hour or MWh opportunity costs. Only limits that cannot be optimized in the CAISO markets are eligible for and opportunity cost adder. Because any limits that storage resources have can be incorporated within the CAISO market horizon, NGR resources do not have opportunity cost- eligible limits. The CAISO stated in its policy paper: "All resource characteristics for storage resources are included in the NGR model and are within the market horizon, therefore those limitations would not need an opportunity cost. The topic of how to model or manage limitations of storage resources which extend beyond the market horizon has been teed up as a potential topic for ESDER Phase 2. Under CCE3, the ISO is not explicitly excluding storage resources from registering and potentially qualifying for an opportunity cost after the needed discussions have been concluded; the ISO is stating that at this time, due to the points noted above, storage resources would not need an opportunity cost reflected in commitment cost bids." *See* CCE3 Draft Final Proposal, available at http://www.caiso.com/Documents/DraftFinalProposal-CommitmentCostEnhancementsPhase3.pdf.

should therefore find that the CAISO treats storage resources equitably with other supply and demand resources in providing make-whole payments for price differences and manual dispatch.

E. Physical and Operational Characteristics

1. Incorporating Bidding Parameters

Order No. 841 requires an RTO/ISO to demonstrate "how its proposed or existing tariff provisions account for the specific physical and operational characteristics of electric storage resources . . . ."[88] The Commission recognizes that "there may be other means of accounting for the physical and operational characteristics of electric storage resources than bidding parameters."[89] Likewise, the Commission recognizes that "not all of these physical and operational characteristics are applicable to all electric storage resources, particularly when a resource is managing its own state of charge and when the resource is providing multiple services."[90] Order No. 841 allows RTO/ISOs to propose where it is mandatory or discretionary for resources to submit information regarding physical and operational characteristics.

As described below, scheduling coordinators provide the CAISO a combination of biddable parameters and master file parameters to account for the physical and operational characteristics of their resources. The CAISO has worked with the storage community and stakeholders for several years to ensure that the NGR model and the Pumped-Storage Hydro Unit model reflect the unique physical and operational characteristics of storage.

2. State of Charge

Order No. 841 requires RTO/ISOs to account for storage resources' state of charge, minimum state of charge, maximum state of charge, minimum charge limit, and maximum charge limit.[91] Order No. 841 also provides each RTO/ISO "the flexibility to propose telemetry requirements for such resources in their compliance filings."[92]

The CAISO accounts for storage resources' state of charge and charging constraints. The CAISO offers storage resources the flexibility to manage their state of charge on their own (through bidding), or to have the CAISO market optimization

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88 Order No. 841 at PP 190-191.

89 *Id*.

90 Order No. 841 at P 212.

91 Order No. 841 at P 211.

92 Order No. 841 at P 214.

process manage the resource's state of charge and charging limits (through bidding and master file parameters). The CAISO requires NGRs to submit the same bid components as other resources seeking to supply energy, demand, or ancillary services (depending on what the NGR seeks to provide in that interval). The CAISO *allows* NGRs to include their state of charge in their bid.[93] If NGRs do not provide their state of charge, the CAISO uses the resource's previous state of charge. NGRs providing ancillary services must provide telemetry every four seconds to the CAISO that includes, *inter alia*, the resource's state of charge and maximum instantaneous ability to produce or consume energy.[94] The CAISO *allows* NGRs to include MWh constraints—including minimum state of charge, maximum state of charge, minimum charge limit, and maximum charge limit—as master file parameters. If the NGR elects to provide the CAISO these constraints, then the CAISO market optimization process respects them just as it respects Pmin, Pmax, and ramp rates for conventional generators.[95] The CAISO does not *require* NGRs to submit these constraints if the NGR prefers to self-manage its state of charge and charge/discharge limits. At any point an NGR could modify its elections through the CAISO master file modification process.[96] The Commission approved the CAISO's state of charge market rules in 2016.[97]

Likewise, Pumped-Storage Hydro Units may submit equivalents to state of charge and charging limits as separate bid components. These components comprise the unit's pumping level, and its maximum and minimum daily energy limits for both their pumping (charging) and generation (discharging) functions over the operating day.[98] Again, where such components are not included in a bid, the CAISO market optimization process will default to the unit's previous level while respecting master file parameters.

The CAISO's participation models account for storage resources' state of charge, minimum state of charge, maximum state of charge, minimum charge limit, and maximum charge limit. The Commission should find that the CAISO complies with Order No. 841.

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93 Section 30.5.6 of the CAISO tariff.

94 Section A.1.2.2.4 of Appendix K to the CAISO tariff; Section 27.9 of the CAISO tariff

95 Section 27.9 of the CAISO tariff.

96 Section 30.7.3.2 of the CAISO tariff.

97 *California Independent System Operator Corp.*, 156 FERC ¶ 61,110 (2016).

98 "Energy Limit," Appendix A to the CAISO tariff; Section 30.5.2.2

3. Charge and Run Times

Order No. 841 requires RTO/ISOs to account for storage resources' minimum charge time, maximum charge time, minimum run time, and maximum run time.[99] The Commission determined it necessary to account for these characteristics because—like for conventional generation—"it may only be economic for the resource to operate if it is guaranteed to do so for minimum amount of time."[100] The Commission stated that unlike for conventional generation, "it is physically impossible for an electric storage resource to charge or discharge energy for longer than their state of charge would allow."[101]

Many storage resources have physical run time and charge time constraints. On the other hand, many storage resources do not have physical run time or charge time constraints beyond their capacity and state of charge limits. The CAISO has therefore tailored its storage models to account for resources' different charge and run time constraints. This is consistent with the flexibility provided by the Commission to maintain separate models instead of trying to consolidate them into a one-size-fits all storage model.[102]

The CAISO carefully explored charging management with stakeholders in the first phase of its ESDER initiative. Because of that initiative, storage resources electing to use the NGR model may manage their charging and discharging run times through the optional state of charge parameters enumerated above, minimum and maximum continuous energy limits, and their bid curve. Order No. 841 explains that the CAISO's NGR bid curve allows electric storage resources to represent their full economic range (both charging and discharging) in a single bid, "which gives the resource "the flexibility to participate as supply, demand, or both through one bid."[103] If an NGR has economic costs or benefits driving a need to continue to charge or discharge, it can include them in its bid curve, subject to any applicable bid cap. This enables the CAISO to evaluate NGRs' need to continue to charge or discharge in the market and not as an out-of-market constraint. Storage resources still have physical constraints on their charging and discharging. The CAISO therefore allows NGRs to submit the MWh constraints enumerated above and maximum continuous energy limits (in MWh). These additional optional parameters allow for the CAISO market optimization process to manage charging time and discharging time constraints, or allow the resources to self-manage those constraints.

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99 Order No. 841 at P 220.

100 Order No. 841 at P 221.

101 *Id*.

102 Order No. 841 at PP 52; 55.

103 Order No. 841 at P 163.

Pumped-Storage Hydro Units' "charging" and "discharging" functions do not depend on the instantaneous movement of electrons, but on the mechanical pumping and flow of water. Order No. 841 cites to pumped-hydro resources as the example type of storage resource that needs charge time and run time limits to account for slow transition speeds, similar to multi-stage generators.[104] To address this issue, the CAISO allows Pumped-Storage Hydro Units to submit master file parameters specifying their "minimum run time"[105] and "minimum down time" for both their pumping function and their generating function.[106] Where resources have submitted these parameters, the CAISO market optimization process will respect how long Pumped-Storage Hydro Units must "charge," "discharge," or stay offline across continuous intervals.

The CAISO and its stakeholders have gone to great efforts to ensure that the CAISO markets capture storage resources' unique physical and operation constraints for charging time and discharging time, while providing the resources the flexibility to manage their charging and discharging through bidding alone or through bidding and optional master file parameters. The Commission should find that the CAISO's practices comply with Order No. 841.

4. Additional Characteristics

Order No. 841 requires RTO/ISOs to account for storage resources' minimum discharge limit, minimum charge limit, discharge ramp rate, and charge ramp rate.[107] The CAISO accounts for these characteristics using analogous master file parameters for conventional supply and demand resources. Order No. 841 defines "minimum discharge limit" as "the minimum MW output level that the resource can inject onto the grid," and "minimum charge limit" as "the minimum MW level that the resource can receive from the grid."[108] The CAISO allows all supply and demand participation models—including NGR and Pumped-Storage Hydro—to submit a "Pmin" or Minimum Load value.[109] For resources providing supply, the CAISO tariff defines Minimum Load

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104 Order No. 841 at P 222.

105 Appendix A to the CAISO tariff defines Minimum Run Time as "The minimum amount of time that a Generating Unit must stay on-line after being started-up prior to being Shut-Down, due to physical operating constraints," and Minimum Down Time as "The minimum amount of time that a Generating Unit must stay off-line after being Shut-Down, due to physical operating constraints."

106 *See* Section B.5 of the CAISO's Business Practice Manual for Market Instruments.

107 Order No. 841 at P 229.

108 Order No. 841 at P 231.

109 The CAISO notes that "Pmin" is the most common term to define this parameter because many say "Minimum Load" to refer to "Minimum Load Costs," which is a separate bid parameter for units with commitment costs that NGRs generally do not submit. Appendix A to the CAISO tariff, however defines Pmin as "Minimum Load."

as "the minimum sustained operating level at which it can operate at a continuous sustained level, as defined in the Master File."[110] For resources providing demand, the CAISO defines this value as "the operating level at reduced consumption pursuant to a Dispatch Instruction,"[111] meaning the minimum demand possible. Because NGRs are defined as "Resources that operate as either Generation or Load and that can be dispatched to any operating level within their entire capacity range but are also constrained by a MWh limit,"[112] they can submit Minimum Load values in the CAISO master file for both charging and discharging. Pumped-Storage Hydro Units likewise can submit Minimum Load values for both their pumping function and generating function.

Similarly, the CAISO accounts for ramping rates for NGRs just as it does for conventional generators. NGRs can submit Ramp Rates as bid components and as master file parameters.[113] Where the resource has submitted a master file parameter but includes no ramp rate as a bid component, the CAISO market optimization process will default to the master file parameter.[114] Resources may submit specific Ramp Rates to indicate their Operational Ramp Rate (for supply), Regulation Ramp Rate (for Regulation), and Operating Reserve Ramp Rate (for Spin and Non-spin).[115] To reflect that NGRs' ramp rates can go below 0 MW when discharging, the CAISO allows NGRs to submit two segments for their ramp rates—one for discharging (above 0) and one for charging (below 0).[116]

Ramping can be especially complex for Pumped-Storage Hydro Units. To address this complexity, the CAISO allows Pumped-Storage Hydro Units to submit the same bid components and master file parameters described for NGRs (for their pumping function and generating function), and an additional master file parameter called the Pump Ramping Conversion Factor. The CAISO defines the Pump Ramping Conversion Factor as "A Master File entry submitted by Scheduling Coordinators that allows the Scheduling Coordinator to indicate the ratio of Energy expended to pump water into storage that can be used to produce Energy."[117] A zero percent Pump Ramping Conversion Factor implies that no amount of energy production capability is produced because of pumping water, such that there is no energy available in the

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110 "Minimum Load," Appendix A to the CAISO tariff.

111 *Id*.

112 "Non-Generator Resource," Appendix A to the CAISO tariff.

113 Sections 30.5.2.2 and 30.5.2.3 of the CAISO tariff. Formatting details and mechanics of operational ramp rates are set forth in Section 30.7.7 of the CAISO tariff.

114 "Ramp Rate," Appendix A to the CAISO tariff.

115 *Id*.; Section 30.5.2.7 of the CAISO tariff.

116 *See* Exhibit 4-3 of the CAISO's BPM for Market Instruments.

117 "Pump Ramping Conversion Factor," Appendix A to the CAISO tariff.

CAISO markets.[118] A hundred percent Pump Ramping Conversion Factor indicates all the energy expended to pump water is available for generation in the CAISO markets. Resources may adjust this factor as needed to account for their ramp rate to pump.[119]

The CAISO affords storage resources great flexibility in choosing bid components or master file parameters or both to account for their charging rates and ramping rates. The Commission should therefore find that the CAISO complies with Order No. 841.

F. State of Charge Management

Order No. 841 requires RTO/ISOs to allow storage resources to manage the state of charge of their resources.[120] Mindful of the CAISO's optional NGR regulation energy management functionality, the Commission notes that providing resources this flexibility does not preclude additional participation models where the RTO/ISO manages the state of charge because the model is designed exclusively to provide frequency regulation. Where a wholesale service, such as regulation, "requires a resource providing that service to follow a dispatch signal . . ., an electric storage resource that is managing its own state of charge would still be required to follow such a dispatch signal" like other resources.[121]

As explained in Section II.E.2, above, the CAISO allows storage resources to manage their state of charge through optional bid components and master file parameters. Consistent with Order No. 841, where a CAISO resource receives an award and dispatch but diverges from its dispatch signal to manage its state of charge (or for any reason), it will be subject to imbalance energy and settled based upon the nodal LMP.[122]

Order No. 841 expressly notes that the CAISO's NGR regulation energy management functionality manages storage resources' state of charge when providing frequency response exclusively.[123] The Commission states that such models should be optional such that a storage resource may manage its own state of charge if it elects to

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118 *Id*.

119 *Id*.; Section 4.6.4 of the CAISO tariff.

120 Order No. 841 at P 251. A resource self-managing its state of charge "will be subject to any applicable penalties for deviating from a dispatch schedule to the extent that the resource deviates from the dispatch schedule in managing its state of charge." *Id*. at P 253.

121 *Id*.

122 *See* Sections 11.5.1 and 34.20 of the CAISO tariff.

123 Order No. 841 at P 254.

do so.[124] The Commission clarifies, however, that where the resource has the option to allow the RTO/ISO to manage its state of charge—like for the NGR regulation energy management model—the storage resource is the "default manager" of its state of charge.[125] The CAISO complies with these optionality requirements. For these reasons and those explained in Section II.E.2, above, the Commission should find that the CAISO complies with Order No. 841 in allowing storage resources to manage their state of charge.

G. Minimum Size Requirement

Order No. 841 requires RTO/ISOs to "include a participation model for electric storage resources that establishes a minimum size requirement for participation in the RTO/ISO markets that does not exceed 100 kW."[126] The Commission clarifies this minimum size requirements "includes all minimum capacity requirements, minimum offer to sell requirements, and minimum bid to buy requirements,"[127] but that "an RTO/ISO could allow offer and/or bid quantities smaller than 100 kW, as CAISO indicates it does."[128]

The CAISO currently requires all participating generators—including storage resources—to have a minimum capacity of 500 kW (which also can reflect aggregated resources).[129] To comply with Order No. 841, the CAISO proposes to revise this requirement such that storage resources must have a minimum capacity of 100 kW to qualify as participating generators.[130] Order No. 841 recognizes that the CAISO's other participating and bidding requirements are smaller: The CAISO has no minimum requirement for participating loads, and its minimum bid for all resources is 10 kWh.[131] With the CAISO's proposed revision, the Commission should find that the CAISO complies with Order No. 841.

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124 *Id*.

125 *Id*.

126 Order No. 841 at P 270.

127 *Id*.

128 Order No. 841 at P 276.

129 *See* "Participating Generator," Appendix A to the CAISO tariff; Section 4.6.3.2 of the CAISO tariff. Demand response resources already have a minimum size requirement of 100 kW.

130 Proposed Section 4.6.3.2 of the CAISO tariff; Proposed "Participating Generator," Appendix A to the CAISO tariff.

131 Order No. 841 at P 276.

H. Charging Energy

1. Price

Order No. 841 requires the sale of energy from RTO/ISOs to storage resources for later resale (or to provide ancillary services) be at the wholesale, nodal LMP.[132] The Commission clarifies this requirement applies regardless of whether the resource is using the participation model for storage resources or another model.[133] The Commission also states that when an electric storage resource is charging to resell energy at a later time, its behavior is similar to other load-serving entities, and that applicable transmission charges should apply.[134] However, the Commission states that transmission charges should not apply when a storage resource is dispatched by an RTO/ISO "to consume electricity to provide a service in the RTO/ISO markets (such as frequency regulation or a downward ramping service)."[135] The Commission states that

> this would be consistent with the treatment afforded traditional generation resources that provide ancillary services, because they are not charged for their impacts on the transmission system when they reduce their output to provide a service such as frequency regulation down. Therefore, we find that electric storage resources should not be charged transmission charges when they are dispatched by an RTO/ISO to provide a service because (1) their physical impacts on the bulk power system are comparable to traditional generators providing the same service and (2) assessing transmission charges when they are dispatched to provide a service would create a disincentive for them to provide the service.[136]

Regardless of technology or participation model, the CAISO uses the wholesale nodal LMP to price sales of energy and ancillary services to storage resources.[137] The CAISO thus already complies with Order No. 841's directive on pricing. The CAISO accounts for NGR charging as "negative generation" rather than load or demand. The Commission has identified this accounting as a best practice, noting, "the negative-generation practice in CAISO may allow transmission providers to better account for the

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132 Order No. 841 at P 294-6.

133 *Id*.

134 Order No. 841 at P 297.

135 Order No. 841 at P 298.

136 *Id*.

137 *See* Section 27.1 and Appendix C of the CAISO tariff (which does not distinguish among source or resource types for pricing).

transitions of electric storage resources between generation and load . . . ."[138] Because the CAISO accounts for storage resources' charging as negative generation, the CAISO does not assess Transmission Access Charges ("TAC") to charging. The CAISO developed this approach through a stakeholder initiative in 2014.[139] Stakeholders—including the CAISO's load-serving entities—unanimously determined that it is inappropriate to assess TAC to charging when the purpose of charging is to store electricity for later resale into the wholesale electricity market. In its stakeholder comments, Pacific Gas & Electric Company ("PG&E") stated: "PG&E agrees with the CAISO that charging energy for NGR resources should be settled at the locational marginal price, not be assessed TAC or measured demand uplifts, and that station power should be treated the same way for a storage device as for a conventional generator."[140] Southern California Edison Company ("SCE") also agreed: "SCE supports the use of the NGR model for storage, including not allocating TAC to storage while charging, and exempting uplift charges associated with Measured Demand."[141]

The CAISO believes that this practice is consistent with Order No. 841. The Commission stated that storage resources should not be assessed a transmission charge "when they are dispatched to provide a service," as doing so "would create a disincentive for them to provide the service."[142] Storage resources can provide a critical reliability service when they charge. As the CAISO explained in its motion for clarification:

> Charging, when it is economic to do so as instructed by the RTO/ISO to help balance the system, is a critically important "service" storage resources provide the grid. Unlike load-serving entities with firm load and little to no ability to curb or curtail demand, storage resources can charge during periods of excess generation and low prices, thereby shifting demand and combatting over-generation, providing ramping flexibility, addressing negative prices, and mitigating potential reliability issues in systems like the CAISO that operate with a high degree of supply and

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138 *Reform of Generator Interconnection Procedures and Agreements*, 82 F.R. 4464-01, 157 FERC ¶ 61,212 at PP 226-230 (2017).

139 Documents related to the Energy Storage Interconnection initiative are available at http://www.caiso.com/informed/Pages/StakeholderProcesses/CompletedClosedStakeholderInitiatives/EnergyStorageInterconnection.aspx.

140 Comments of PG&E on the Draft Final Proposal to the Energy Storage Interconnection initiative, available at http://www.caiso.com/Documents/PGEComments-EnergyStorageInterconnection-DraftFinalProposal.pdf.

141 Comments of SCE on the Draft Final Proposal to the Energy Storage Interconnection initiative, available at http://www.caiso.com/Documents/SCEComments-EnergyStorageInterconnection-DraftFinalProposal.pdf.

142 Order No. 841 at P

> demand variability.[143] Requiring RTO/ISOs to assess transmission charges on storage devices when charging could blunt storage resources' market effectiveness and financial viability.[144]

In other words, charging during periods of low prices, or to be able to discharge during periods of high prices, is the most important "service" storage resources provide. This type of dispatchable demand greatly mitigates the "duck curve" issues the CAISO regularly faces, mitigating the reliability risks presented by a significant evening ramp and reducing the curtailments and negative pricing necessitated by oversupply.

Moreover, requiring RTO/ISOs to assess transmission charges on storage devices will force storage resources to include those costs when they submit bids, thus affecting energy market prices. This requirement would contravene prior Commission precedent. For example, when the Commission approved the CAISO's NGR model, it approved as just and reasonable the CAISO's proposal to treat NGRs' demand as negative generation, which would not incur transmission charges.[145]

Historically, the CAISO has assessed TAC to the pumping load of Pumped-Hydro Storage Units. The CAISO proposes to forego doing so to align the CAISO's treatment with NGR resource charging, and for the same reasons as explained in the CAISO's request for clarification on this issue.[146] Charging during periods of high supply and low demand is a critical reliability service that mitigates system ramping challenges and helps avoid negative pricing and curtailment during oversupply, two issues becoming more pervasive in the CAISO. Consistent with the CAISO's requested clarifications and proposed revisions, the Commission should find that the CAISO complies with Order No. 841.

2. Metering and Accounting

Order No. 841 requires each RTO/ISO to "directly meter electric storage resources, so all the energy entering and exiting the resources is measured by that meter."[147] The Commission recognizes, however, that some resources may be subject

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143 *See*, e.g., U.S. Energy Information Administration, "California wholesale electricity prices are higher at the beginning and end of the day," *available at*: https://www.eia.gov/todayinenergy/detail.php?id=32172 (July 24, 2017); *see also* http://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf.

144 *Electric Storage Participation in Markets Operating by RTOs and ISOs*, Docket Nos. RM16-23 and AD16-20, "Motion for Clarification and, in the Alternative, Rehearing of the CAISO," pp. 11-12 (March 19, 2018).

145 *California Independent System Operator Corp.*, 132 ¶ 61,211 (2010).

146 Proposed Section 26.1 of the CAISO tariff.

147 Order No. 841 at P 322.

to other metering requirements that could be used in lieu of a direct metering requirement, and will therefore review alternative proposals.[148]

Order No. 841 expressly notes that the CAISO has two example practices "of how it has achieved market rules that accurately account for wholesale and retail activities by using direct metering."[149] As the CAISO explained in its comprehensive Metering Rules Enhancement initiative—which the Commission approved as just and reasonable[150] —the CAISO obtains settlement quality meter data from two types of market participants: CAISO metered entities ("CAISOMEs") and scheduling coordinator metered entities ("SCMEs").[151] For CAISOMEs, the CAISO directly polls the meters, and the CAISO performs the validation, estimation, and editing procedures to produce settlement quality meter data. For SCMEs, the scheduling coordinator directly polls the meters, performs the validation, estimation, and editing procedures, and submits the resulting settlement quality meter data to the CAISO. In the past, the CAISO required participating generators (including storage resources) to be CAISOMEs directly polled by the CAISO. To provide greater flexibility to entities that participate in the CAISO markets, the Commission approved as just and reasonable the CAISO's proposal to allow generators and other resources to be an SCME or a CAISOME.[152] New resources choosing to be SCMEs can forego the higher upfront costs associated with being a CAISOME. Resources participating in other markets also can participate in the CAISO markets without modifying their existing meters. This change gave generators the same metering flexibility afforded to other suppliers of energy and ancillary services—demand response resources, distributed energy resources, and external resources—to ensure a level playing field. To be sure, all of these resources still are directly metered—the principal difference is simply who reads the meter and performs the validation, estimation, and editing procedures.

For storage resources—regardless of participation model—it can be particularly useful to be an SCME. As the Commission recognizes elsewhere in Order No. 841, unlike traditional generators storage resources have much more complex accounting issues, such as distinguishing between charging energy and station power. Behind-the-meter resources likewise can alternate among providing wholesale, distribution, and retail services. A scheduling coordinator easily can work with the RTO/ISO and the local distribution company to ensure that a storage resource complies with all applicable metering standards. It can then meter and account for which capacity, energy, and

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148 *Id*.

149 Order No. 841 at P 323.

150 *California Independent System Operator Corp.*, Letter Order Approving Tariff Revisions, Docket No. ER17-949-000 (March 31, 2017).

151 *See* Appendix A to the CAISO tariff.

152 *California Independent System Operator Corp.*, Letter Order Approving Tariff Revisions, Docket No. ER17-949-000 (March 31, 2017).

demand are settled by whom and for how much.

Consistent with the CAISO's request for clarification that storage resources can be directly metered as CAISOMEs *or* SCMEs—like all other resources in the CAISO—the Commission should find that the CAISO complies with Order No. 841's requirement that all storage resources be directly metered.

Additionally, Order No. 841 requires RTO/ISOs to "prevent resources using the participation model for electric storage resources from paying twice for the same charging energy."[153] The Commission explains that where the host distribution utility is unable—due to a lack of the necessary metering infrastructure and accounting practices—or unwilling to net out any energy purchases associated with a resource using the participation model for electric storage resources' wholesale charging activities from the host customer's retail bill, the RTO/ISO would be prevented from charging that resource using the participation model for electric storage resources electric wholesale rates for the charging energy for which it is already paying retail rates.[154]

A majority of the CAISO's customer- and distribution-sited storage resources participate under the CAISO's demand response model using the metering generator output methodology specifically designed for storage resources. As explained in detail above, the CAISO's metering generator output methodology allows these storage resources to establish baselines for both their typical load curtailment (independent of offsetting energy), their storage resource's typical output (independent of load curtailment), or both, and then to be settled on performance in response to dispatch that exceeds these baselines.[155] Consistent with Order No. 841, the CAISO does not charge such resources for their charging because the distribution utility already has done so at a retail rate. The CAISO only awards these resources at wholesale for their response to dispatch. This response can come in the form of traditional load curtailment, using a storage resource to produce energy, or both simultaneously. Because these resources use a sub-meter in addition to their retail meter, the CAISO can account for all responses to dispatch independently to account for the resource's total performance. The Commission should find that this participation model complies with Order No. 841 for the reasons set forth herein and in the CAISO's request for clarification, or in the alternative, rehearing.

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153 Order No. 841 at P 326.

154 *Id*.

155 *See* Sections 4.13.4 and 11.6 of the CAISO tariff; *California Independent System Operator Corp.*, 156 FERC ¶ 61,110 (2016).

III. Effective Date

Consistent with Order No. 841, the CAISO requests an effective date of December 3, 2019.[156]

IV. Communications

Pursuant to Rule 203(b)(3) of the Commission's Rules of Practice and Procedure,[157] the CAISO requests that all correspondence, pleadings, and other communications regarding this filing should be directed to following:

Roger E. Collanton
General Counsel
Sidney L. Mannheim
Assistant General Counsel
William H. Weaver
Senior Counsel
California Independent System
Operator Corporation
250 Outcropping Way
Folsom, CA 95630
Tel: (916) 351-4400
Fax: (916) 608-7222
E-mail: bweaver@caiso.com

V. Service

The CAISO has served copies of this filing on the California Public Utilities Commission, the California Energy Commission, and all parties with scheduling coordinator agreements under the CAISO tariff. In addition, the CAISO has posted a copy of the filing on the CAISO website.

VI. Contents of Filing

Besides this transmittal letter, this filing includes these attachments:

Attachment A	Clean CAISO tariff sheets incorporating this tariff amendment; and
Attachment B	Red-lined document showing the revisions in this tariff amendment.

156 Order No. 841 at P 348.

157 18 C.F.R. § 385.203(b)(3).

VII. Conclusion

The CAISO has developed participation models for electric storage to participate in its markets. These models provide significant flexibility for electric storage resources and account for their unique technical operational characteristics. The CAISO will continue to explore market rules to enhance the efficient participation by electric storage in its markets. The CAISO tariff, as modified by this compliance filing, meets the requirements of Order No. 841. For this reason, the CAISO respectfully requests that the Commission accept this filing in compliance with the requirements of Order No. 841.

Respectfully submitted,

/s/ William H. Weaver

Roger E. Collanton
General Counsel
Sidney L. Mannheim
Assistant General Counsel
William H. Weaver
Senior Counsel

Counsel for the California Independent
System Operator Corporation

Attachment A – Clean Tariff

Compliance with Order No. 841

California Independent System Operator Corporation

4.6.3 Requirements for Certain Participating Generators

* * * * *

4.6.3.2 Exemption for Generating Units Less Than One (1) MW

A Generator with a Generating Unit directly connected to a Distribution System will be exempt from compliance with this Section 4.6 and Section 10.1.3 in relation to that Generating Unit provided that (i) the rated capacity of the Generating Unit is less than one (1) MW, and (ii) the Generator does not use the Generating Unit to participate in the CAISO Markets. This exemption in no way affects the calculation of or any obligation to pay the appropriate charges or to comply with all the other applicable Sections of this CAISO Tariff. A Generating Unit with a rated capacity of less than 500 kW, unless the Generating Unit is (a) participating in an aggregation agreement approved by the CAISO or (b) a storage resource with a rated capacity of 100 kW or more, is not eligible to participate in the CAISO Markets and the Generator is not a Participating Generator for that Generating Unit.

With regard to any Generating Unit directly connected to a UDC system, a Participating Generator shall comply with applicable UDC tariffs, interconnection requirements and generation agreements. With regard to a Participating Generator's Generating Units directly connected to a UDC system, the CAISO and the UDC will coordinate to develop procedures to avoid conflicting CAISO and UDC operational directives. With regard to Regulatory Must-Take Generation, the CAISO will honor applicable terms and conditions of existing agreements, including Existing QF Contracts, as specified in Section 4.6.3.2. Qualifying Facilities that are not Regulatory Must-Take Generation subject to an Existing QF Contract shall comply with the requirements applicable to Participating Generators, as specified in Section 4.6.3.3.

* * * * *

26. Transmission Rates and Charges

26.1 Access Charges

(a) In General. All Market Participants withdrawing Energy from the CAISO Controlled Grid shall pay Access Charges in accordance with this Section 26.1 and Appendix F, Schedule 3, except (1) as provided in Section 4.1 of Appendix I (Station Power Protocol)

and (2) for storage resources, including Non-Generator Resources and Pumped-Storage Hydro Units, withdrawing Energy for later resale to the CAISO Markets or to provide Ancillary Services. The Access Charge shall comprise two components, which together shall be designed to recover each Participating TO's or Approved Project Sponsor's Transmission Revenue Requirement. The first component shall be the annual authorized revenue requirement, as approved by FERC, associated with (1) the transmission facilities and Entitlements turned over to the Operational Control of the CAISO by a Participating TO or (2) transmission facilities that are not yet in operation, but approved under Section 24, and assigned to an Approved Project Sponsor. The second component shall be based on the Transmission Revenue Balancing Account (TRBA), which shall be designed to flow through the Participating TO's Transmission Revenue Credits calculated in accordance with Section 5 of the TO Tariff and other credits identified in Sections 6 and 8 of Schedule 3 of Appendix F of the CAISO Tariff.
The Access Charges shall be paid by any UDC or MSS Operator that is serving Gross Load in a PTO Service Territory, and shall consist, where applicable, of a Regional Access Charge, and a Local Access Charge. The Regional Access Charge and the Local Access Charges shall each comprise two components, which together shall be designed to recover each Participating TO's Regional Transmission Revenue Requirement and Local Transmission Revenue Requirement, as applicable. The Regional Access Charge and the Local Access Charge for the applicable Participating TO shall be paid by each UDC and MSS Operator based on its Gross Load in the PTO Service Territory.

* * * * *

Appendix A

Master Definition Supplement

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- Participating Generator

A Generator or other seller of Energy or Ancillary Services through a Scheduling Coordinator over the CAISO Controlled Grid (1) from a Generating Unit with a rated capacity of 1 MW or greater, (2) from a Generating Unit with a rated capacity of 500 kW up to 1 MW for which the Generator elects to be a Participating Generator, (3) from a storage resource with a rated capacity of 100 kW or greater, or (4) from a Generating Unit providing Ancillary Services or submitting Energy Bids through an aggregation arrangement approved by the CAISO, which has undertaken to be bound by the terms of the CAISO Tariff, in the case of a Generator through a Participating Generator Agreement, Net Scheduled PGA, or Pseudo-Tie Participating Generator Agreement.

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Attachment B – Marked Tariff Records

Compliance with Order No. 841

California Independent System Operator Corporation

4.6.3 Requirements for Certain Participating Generators

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* * * * *

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Appendix A

Master Definition Supplement

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