

177 FERC ¶ 61,051  
UNITED STATES OF AMERICA  
FEDERAL ENERGY REGULATORY COMMISSION

Before Commissioners: Richard Glick, Chairman;  
James P. Danly, Allison Clements,  
and Mark C. Christie.

California Independent System Operator Corporation      Docket No. ER21-2779-000

ORDER ACCEPTING TARIFF REVISIONS

(Issued October 26, 2021)

1. On August 27, 2021, the California Independent System Operator Corporation (CAISO) filed, pursuant to section 205 of the Federal Power Act,<sup>1</sup> proposed revisions to its Open Access Transmission Tariff (Tariff) designed to optimize the performance of storage and demand response resources and improve CAISO's markets, as part of the fourth phase of CAISO's energy storage and distributed energy resources (ESDER) stakeholder initiative. Specifically, CAISO proposes three distinct Tariff revisions: (1) creating biddable state of charge parameters for energy storage; (2) applying market power mitigation to energy storage; and (3) enabling demand response resources to specify maximum daily run times. As discussed below, we accept the proposed Tariff revisions, effective as of the actual implementation date, subject to CAISO notifying the Commission of the actual implementation date within five days of that date.

**I. Background and Proposal**

2. CAISO explains that its ESDER initiative began in 2015 and aimed to solicit suggestions from stakeholders on issues related to energy storage, distributed resources, demand response, and behind-the-meter resources. CAISO states that this instant filing represents the final set of Tariff revisions under ESDER's fourth phase.

3. CAISO requests that the Commission issue an order by October 26, 2021 accepting the proposed Tariff revisions effective no later than December 1, 2021, subject to confirmation by CAISO within five business days of the actual effective date. According to CAISO, implementing the proposed Tariff revisions would require

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<sup>1</sup> 16 U.S.C. § 824d.

substantial software enhancements, and the requested order and effective date timeframe will provide CAISO and market participants sufficient time to implement the changes.<sup>2</sup>

**A. Biddable State of Charge Parameters**

4. CAISO explains that energy storage resources generally use CAISO's non-generator resources (NGR) model,<sup>3</sup> which recognizes a resource's ability to receive negative dispatches to charge and tracks the resource's state of charge.<sup>4</sup> CAISO states that storage owners and scheduling coordinators have requested additional functions to help effectively manage state of charge for energy storage resources, particularly in the real-time market.

5. CAISO explains that while the day-ahead market optimizes resources across the entire operating day, the real-time market dispatches resources based on system supply and demand conditions and prices available in a shorter temporal horizon.<sup>5</sup> CAISO explains that while dispatching an energy storage resource to meet real-time load may be economically efficient in the short-term, it can affect the resource's ability to meet its day-ahead schedule over the remainder of the day.<sup>6</sup> According to CAISO, energy storage resources can currently utilize self-schedules to help manage the state of charge to meet their obligations, but is difficult due to the time lag between market execution and

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<sup>2</sup> CAISO August 27, 2021 Filing at 1–2, 14 (Transmittal). CAISO states its tentative plan to implement the Tariff revisions on November 1, 2021, but desires flexibility regarding the implementation date in case of any delay.

<sup>3</sup> The CAISO Tariff contains several ways through which other types of energy storage resources can participate in CAISO's market, including the Participating Load model and Proxy Demand Response-Load Shift Resource model. *See* CAISO, CAISO eTariff, OATT § 30.5.

<sup>4</sup> CAISO defines "state of charge" as the energy available to CAISO markets from a non-generator resource or storage device. *See id.* app. A – Master Definition Supplement.

<sup>5</sup> Transmittal at 3.

<sup>6</sup> CAISO notes that currently, energy storage resources can utilize self-schedules to help manage state of charge to meet these obligations; however, CAISO adds, doing so can be difficult due to lag between market execution and bid submission deadlines. Moreover, CAISO argues, this practice limits CAISO's ability to dispatch the resource throughout the operating hour during which it self-schedules. *Id.*

submission deadlines; and, CAISO notes that using self-schedules limits CAISO's ability to dispatch the resource throughout the operating hour for which it self-schedules.<sup>7</sup>

6. CAISO proposes to allow scheduling coordinators for NGRs to submit end-of-hour state of charge parameters for energy storage resources in the real-time market to manage the resources' use throughout the day. CAISO explains that these parameters will provide its market optimization software with a storage resource's desired state of charge level at the end of the real-time market trading hour. Under the proposal, scheduling coordinators may submit either specific MWh values or a minimum/maximum MWh range for NGRs.<sup>8</sup> CAISO notes that in submitting these targets, scheduling coordinators must ensure consistency with the resource's master file characteristics, resource adequacy obligations, and ancillary service obligations.<sup>9</sup>

7. Additionally, CAISO notes that the parameter would operate similar to a self-schedule—except that the market optimization software will dispatch the resource to reach the end-of-hour MWh value, or state of charge range, giving precedence to the state of charge target over the resource's energy bid. Therefore, according to CAISO, the optimization would dispatch the storage resource economically or uneconomically relative to the real-time price, to achieve the scheduling coordinator's end-of-hour state of charge. CAISO further notes that CAISO cannot guarantee the dispatch software will meet the targeted end-of-hour state of charge range for resources providing energy and ancillary services.<sup>10</sup>

8. CAISO also proposes to make energy storage resources ineligible for bid cost recovery of real-time market revenue shortfalls in: an hour where a resource has an end-of-hour state of charge parameter in its bid; in the immediately preceding hour; and in the hour preceding a self-schedule. CAISO states that this aspect of the proposal is intended

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<sup>7</sup> A self-schedule is a bid component that indicates the quantities (in MWhs) with no specification of a price that a Scheduling Coordinator is submitting to the CAISO, which indicates that the Scheduling Coordinator is a Price Taker, Regulatory Must-Run Generation, or Regulatory Must-Take Generation, which includes ETC and TOR Self-Schedules, Self-Schedules for Converted Rights, and Variable Energy Resource Self-Schedules. *See* CAISO, CAISO eTariff, OATT, app. A – Master Definition Supplement.

<sup>8</sup> Proposed CAISO Tariff § 30.5.6.1; Transmittal at 3 n.10, 3.

<sup>9</sup> Transmittal at 4.

<sup>10</sup> *Id.*

to address concerns about over-recovery or gaming.<sup>11</sup> CAISO explains that because a scheduling coordinator's state of charge target will take precedence over the energy storage resource's economic energy bid, the market software might dispatch the energy storage resource uneconomically to achieve its state of charge target. CAISO states that its proposal will ensure that resources will bear the cost of uneconomic dispatch. CAISO notes that due to the real-time market's scheduling horizon, energy storage resources could receive dispatches even where their bids would not have merited awards in both the target hour and the hour preceding it.<sup>12</sup>

## **B. Market Power Mitigation and Energy Storage**

9. CAISO states that the second set of Tariff revisions is designed to incorporate energy storage resources into CAISO's market power mitigation framework. CAISO explains that, while energy storage resources have been exempt from market power mitigation to date, it currently has over 1,000 MW of energy storage resources in its markets and anticipates close to 2,000 MW by the end of the year. In addition, CAISO states that energy storage resources are operating differently in CAISO markets than they have in the past: whereas they generally provided regulation to maintain system frequency rather than energy previously, CAISO has observed that energy storage resources have increasingly been charging and discharging in response to energy prices (and tend to discharge most of their energy during the net demand peak).<sup>13</sup> CAISO states that, because of the increasing volume of energy storage resources in its markets and the importance of meeting load during the net demand peak, it is prudent to remove the blanket exemption for energy storage resources from the market power mitigation process.

10. CAISO proposes to remove tariff language that exempts NGRs from the market power mitigation process and add language that would subject energy storage resources to its day-ahead and real-time market power mitigation processes.<sup>14</sup> Accordingly, if CAISO detects the potential exercise of market power, it will replace the energy storage resource's energy bid with a default energy bid representing the storage resource's marginal energy costs. To that end, CAISO proposes to create a new methodology for

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<sup>11</sup> Proposed CAISO Tariff §§ 30.5.6.1, 11.6.6; Transmittal at 5 (noting that the proposal affects energy settlements only, not ancillary services).

<sup>12</sup> Transmittal at 5.

<sup>13</sup> *Id.* at 6–8.

<sup>14</sup> Proposed CAISO Tariff §§ 31.2, 34.1.5.

calculating default energy bids specific to energy storage resources.<sup>15</sup> CAISO explains that marginal energy costs for energy storage resources have unique characteristics compared to the existing resource types—including a limited energy supply window, high cost variability, high flexibility, and relatively low ramping constraints—all of which are better captured using a tailored default bid option.<sup>16</sup> CAISO also proposes to exempt energy storage resources smaller than five MW from the market mitigation process, as they are unlikely to be capable of exercising market power.

11. CAISO explains that the new default energy bid would account for an energy storage resource's PMin, Pmax, run times, and other charging and discharging parameters registered in the master file.<sup>17</sup> The energy storage resource option will calculate the default energy bid by selecting the maximum of: (1) the sum of the expected energy costs and variable energy storage operation costs in the real-time market; and (2) the energy storage resource's opportunity costs.<sup>18</sup> The calculation is completed by adding 10% to the value. To calculate the Default Energy Bid, CAISO will use the Pmin, Pmax, run times, and other charging and discharging parameters registered in the master file.

12. To calculate the energy storage resource's expected energy cost, CAISO proposes to use the average cost to procure the amount of energy needed to charge, such that the resource can discharge completely, accounting for the resource's charging duration and round-trip efficiency, and excluding losses, during the lowest-priced continuous block of time during a given operating day. To calculate this component in the day-ahead market, CAISO proposes to use the average locational marginal price of energy based upon the final energy bids at the relevant pricing node; and in the real-time market, CAISO proposes to use the average real-time price of energy during the lowest priced hours

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<sup>15</sup> CAISO currently provides several methodologies to calculate default energy bids, including a variable cost option for gas-fired and non-gas-fired resources, a locational marginal price option, a negotiated rate option, and a hydroelectric default energy bid. Transmittal at 8.

<sup>16</sup> CAISO states that energy storage resources can also use CAISO's existing options if they believe those default energy bids will better represent their costs. *Id.* at 9.

<sup>17</sup> Proposed CAISO Tariff § 39.7.18. Pmax represents the maximum normal capability of a generating unit, as measured at the point of interconnection or point of delivery. Pmin represents the registered minimum load. *See* CAISO, CAISO eTariff, OATT, app. A – Master Definition Supplement.

<sup>18</sup> Transmittal at 9–10.

based on the locational marginal price of energy from the day-ahead market at the relevant pricing node.<sup>19</sup>

13. CAISO explains that the proposed variable storage operation cost component for an energy storage resource represents the costs of operating the resource beyond its daily cycling range (submitted by the scheduling coordinator in \$/MWh), as a resource's cycling depth and frequency have the greatest impact on its lifetime usability and degradation. CAISO states it will validate the energy storage operation cost based on the resource's manufacturer warranty, available data, and supporting documentation submitted by the scheduling coordinator. CAISO also clarifies that this cost component does not vary between the day-ahead and real-time markets.<sup>20</sup>

14. Finally, CAISO outlines its methodology to model the opportunity costs for energy storage resources in the real-time market. CAISO explains that an energy storage resource could be dispatched to discharge during lower-priced intervals (rather than higher-priced intervals when it would prefer to discharge) and need to recharge before being able to provide energy again. To avoid being discharged before the optimal time, CAISO states that a resource with limited availability should have an opportunity cost included in its default energy bid; the opportunity cost includes the value to the resource from not running during a particular interval and saving stored energy for discharge at a later time when prices are higher. To calculate this opportunity cost component, CAISO proposes to use the lowest energy price during the highest priced period over which the resource could have discharged based on the locational marginal price from the integrated forward market at the relevant PNode on the trading day.<sup>21</sup>

15. CAISO states that it developed the default energy bid for energy storage resources in close consultation with stakeholders, the CAISO Department of Market Monitoring (DMM), and CAISO Market Surveillance Committee, and asserts that it is an accurate reflection of the marginal energy costs for energy storage resources, ensuring that such resources will remain competitive if the market power mitigation process mitigates their bids (i.e., substitutes the resource's economic bid with a Default Energy Bid). CAISO reiterates that scheduling coordinators may still elect to use CAISO's existing default

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<sup>19</sup> CAISO notes that both of these would be constrained to not be below \$0/MWh. *Id.* at 10 n.40, 10.

<sup>20</sup> *Id.* at 11.

<sup>21</sup> *Id.*

energy bid options—the variable cost option, LMP option, or negotiated option—if they prefer.<sup>22</sup>

### C. Daily Run Times for Demand Response Resources

16. CAISO explains that demand response providers currently do not have any optional master file or bidding parameters that allow them to manage daily run time maximums, and they instead rely on careful bidding and scheduling strategies to avoid being dispatched outside their constraints. Additionally, CAISO explains that certain demand response resources have constraints limiting the number of sustained responses from their registered minimum loads (Pmin, which is 0 MW for many such resources). CAISO states that without a maximum daily run parameter, demand response resources may receive too many dispatches in an operating day, preventing them from providing demand response when needed.<sup>23</sup>

17. To alleviate these complexities, CAISO first proposes to allow scheduling coordinators to submit an optional master file parameter reflecting the maximum daily run time for the demand response resource in the operating day.<sup>24</sup> CAISO explains that this parameter will help ensure demand response resources receive dispatches within their limitations, and will limit dispatches issued to demand response resources with Pmins of 0 MW. Second, CAISO proposes to require a demand response resource be at least one MW in capacity to qualify for this option, stating that this is a critical threshold to avoid market system performance degradation. CAISO states the one MW threshold will minimize the known risk to market performance and prioritize demand response resources that are most beneficial to market efficiency and reliability.

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<sup>22</sup> Proposed CAISO Tariff § 39.7.1. This provision would allow preference ranking for default energy bids. If data were unavailable to CAISO, it will proceed to the next ranked option; if the scheduling coordinator does not provide a ranking, CAISO will default to the variable bid option, and then the LMP option. Transmittal at 12 n.44, 12.

<sup>23</sup> Transmittal at 13. CAISO notes that many demand response resources have Pmins of 0 MW, reflecting the smallest discrete load reduction possible. Upon being dispatched to this minimum, the resource is capable of being dispatched in real-time up to its Pmax; however, registering a Pmin of 0 MW may result in CAISO's optimization software dispatching the demand response resource to 0 MW.

<sup>24</sup> Proposed CAISO Tariff § 4.13.3. This includes proxy demand resources and reliability demand resources. CAISO also proposes to account for maximum daily run times as optional master file parameters rather than bidding parameters.

## II. Notice of Filing and Responsive Pleadings

18. Notice of CAISO's filing was published in the *Federal Register*, 86 Fed. Reg. 49,319 (Sept. 2, 2021), with interventions and protests due on or before September 17, 2021. Timely motions to intervene were filed by NRG Power Marketing LLC; Southern California Edison Company; Vistra Corp.; Boston Energy Trading and Marketing LLC; the Cities of Anaheim, Azusa, Banning, Colton, Pasadena, and Riverside, California; and the City of Santa Clara, California. California Department of Water Resources State Water Project (SWP) and DMM filed timely motions to intervene and comments.

### Comments

19. SWP states that it supports CAISO's efforts to accommodate energy storage and demand response resources into the wholesale energy market. SWP explains that in the current CAISO market design, SWP's ability to provide real-time bids to increase or decrease load is limited and that it hopes to continue working collaboratively with CAISO to identify ways that will facilitate SWP demand response resources to better respond to ramping needs by shifting demand during critical ramping periods when water conditions permit. SWP requests that the Commission accept CAISO's filing.<sup>25</sup>

20. DMM supports CAISO's proposed Tariff revisions but recommends that CAISO monitor the effects of implementing these changes and consider further enhancements to several elements of the revisions. First, regarding CAISO's biddable state of charge parameters, DMM states that it believes that the proposed end-of-hour state of charge revision should provide energy storage resources with an additional, effective tool to help energy storage resources manage their state of charge in real time. DMM also expresses support for CAISO's proposed bid cost recovery rules for energy storage resources in the hour preceding a self-schedule, because they would largely mitigate potential gaming opportunities when self-scheduling is used. However, DMM notes that CAISO's proposal could result in under-recovery of bid costs in hours where an end-of-hour state of charge constraint may not have impacted a resource's dispatch. DMM suggests that CAISO monitor the implementation of its proposed market power mitigation rules, and potentially consider more flexible bid cost recovery eligibility rules when the end-of-hour state of charge parameter is used.<sup>26</sup>

21. DMM also states that CAISO's proposal could help prevent large swings in resource schedules between real-time market runs and increase the likelihood that end-of-hour state of charge targets will remain feasible through the real-time market. However, DMM is concerned that CAISO's proposed implementation of the end-of-hour state of

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<sup>25</sup> SWP September 17, 2021 Comments at 4.

<sup>26</sup> DMM September 17, 2021 Comments at 2–3.



charge parameter could restrict the flexibility of energy storage resources. Specifically, DMM explains that when the parameter is used, CAISO's proposal would enforce end-of-horizon state of charge constraints in the 5-minute market to put resources on trajectory to meet 15-minute market schedules (by setting end-of-horizon state of charge constraints equal to the state of charge levels derived from the 15-minute intervals). DMM explains that the parameter might therefore limit a resource's ability to deviate from 15-minute market advisory schedules, even when such movement would be beneficial to the market without reducing the resource's ability to meet its end-of-hour state of charge targets.<sup>27</sup> DMM states that although it ultimately supports CAISO's general approach to maintaining alignment between 15- and five-minute markets when end-of-hour state of charge parameters are used as constraints in the market software, it recommends that CAISO monitor the impacts of end-of-horizon constraints on resource dispatches during implementation and testing.<sup>28</sup>

22. DMM supports CAISO's market power mitigation proposal, stating that it will be increasingly important that energy storage resources in uncompetitive locations be subject to energy bid mitigation. Similarly, DMM supports CAISO's proposed energy storage default energy bid for use in market power mitigation. DMM posits that the proposed energy storage default energy bid might be a conservative approach, as it includes a number of simplifications that may overestimate the cost of energy storage resources. Nevertheless, DMM states that it is an incremental improvement to the current market design and suggests that CAISO monitor its implementation and consider necessary future refinements.<sup>29</sup>

23. Finally, DMM supports CAISO's proposal to allow demand response resources to submit a maximum daily run time parameter, because CAISO entities have indicated that this parameter would better reflect the design of demand response programs. Although DMM supports CAISO's proposal, it expresses some concern that demand response resources providing resource adequacy could use the maximum daily run time parameter to limit resource availability. Therefore, DMM suggests that CAISO monitor use of the

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<sup>27</sup> *Id.* at 5–6. DMM states that the specific details regarding implementation of the end-of-hour state of charge feature and interactions between the 15- and 5-minute markets were discussed in the CAISO policy development process and the CAISO's final proposal, and cites DMM comments to CAISO's ESDER phase 4 stakeholder process. *Id.* at 5 n.5.

<sup>28</sup> *Id.* at 3–7.

<sup>29</sup> *Id.* at 7–8.

parameter and consider whether availability limitations effectuated by this parameter should factor into resource adequacy availability incentives in the future.<sup>30</sup>

### III. Discussion

#### A. Procedural Matters

24. Pursuant to Rule 214 of the Commission's Rules of Practice and Procedure, 18 C.F.R. § 385.214 (2020), the timely, unopposed motions to intervene serve to make the entities that filed them parties to this proceeding.

#### B. Commission Determination

25. We find that CAISO's proposed Tariff revisions are just and reasonable measures that will enhance participation in the CAISO markets by energy storage resources and demand response resources, and we therefore accept them, subject to CAISO notifying the Commission of the actual implementation date within five days of that date.<sup>31</sup>

26. First, we find just and reasonable CAISO's proposal to allow energy storage resources to specify target end-of-hour state of charge levels in the real-time market. We agree that such a provision will provide energy storage resources with an additional and tailored tool to help them manage state of charge in real-time. As CAISO points out, energy storage resources are flexible and able to respond on short notice in the real-time market. Although dispatching an energy storage resource to serve real-time loads may be economically efficient in the short-term, doing so may be inefficient over a longer time horizon as it could affect the resource's ability to meet its day-ahead schedule over the rest of the day if it is fully or significantly discharged. Accordingly, the proposed end-of-hour state of charge bid parameter for energy storage resources will likely result in more efficient use of storages resources throughout the operating day. We also agree with CAISO that utilizing self-schedules to achieve a desired state of charge is challenging given the lag between real-time bid submission deadlines and real-time market execution. Therefore, we find that the option to specify end-of-hour state of charge levels would allow energy storage resources to more effectively manage their resources.

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<sup>30</sup> *Id.* at 8–9.

<sup>31</sup> CAISO states that it anticipates implementation of the revisions on November 1, 2021, but requests that the Commission allow it to provide notification within five business days of the actual effective date, no later than December 1, 2021. Accordingly, the eTariff records submitted by CAISO contain an effective date of 12/31/9998. CAISO must submit a filing to confirm the actual effective date using Type of Filing Code 150 – Report.

27. DMM states that it supports CAISO's proposal, but expresses concern that CAISO's implementation of the end-of-hour state of charge parameter could restrict the flexibility of energy storage resources by limiting their ability to deviate from 15-minute market advisory schedules, even when such movement would be beneficial to the market and in circumstances where deviating from the 15-minute market would not impact their ability to meet end-of-hour state of charge targets. However, we find that CAISO's proposal is just and reasonable, as it will enhance the bidding flexibility that energy storage resources are provided under the current Tariff (allowing these resources more operational flexibility to maintain their state of charge more effectively) and enhance their availability during tight system conditions or high demand. DMM suggests that CAISO should monitor implementation of this parameter, and consider setting end-of-horizon state of charge constraints to minimum or maximum state of charge values instead of exact state of charge values derived from the 15-minute market, so that there would be some degree of flexibility built into the system. While we find that CAISO's proposal is just and reasonable, we encourage CAISO to monitor the effect of both the bid parameter and end-of-horizon constraints on resource dispatches and consider possible refinements to this framework, if warranted.

28. We also accept CAISO's proposal to make energy storage resources ineligible for bid cost recovery of real-time market revenue shortfalls in: the hour the resource submits an end-of-hour state of charge bid parameter; the hour preceding an end-of-hour state of charge bid; and the hour preceding a self-schedule. We agree that this limitation will address concerns regarding over-recovery and gaming, and that a resource should bear the cost of an uneconomic dispatch if it arises from CAISO respecting that resource's preferred end-of-hour state of charge target. DMM states that CAISO's proposal for both the end-of-hour and preceding hour might be too conservative and suggests that CAISO monitor the implementation of this parameter and consider more flexible bid cost recovery eligibility rules in future proposals. While we find the instant proposal just and reasonable for the reasons described herein, we nonetheless encourage CAISO to monitor and gauge the impacts of the bid cost recovery provisions to energy storage resource settlements.

29. In addition, we accept CAISO's proposal to apply market power mitigation measures to energy storage resources of five MW or more. As CAISO notes, energy storage resources charge and discharge in response to energy prices and tend to discharge most of their energy during the net demand peak. As energy storage resources play an increasingly significant role on the CAISO system, it is imperative that CAISO ensure competitive participation by these resources and have a mechanism to mitigate any potential exercise of market power. Replacing a resource's energy bid with a default energy bid is a just and reasonable mitigation strategy when the potential to exercise market power is identified, as the default energy bid represents an estimate of the resource's marginal energy costs. We also accept CAISO's proposal for calculating the new default energy bid option for energy storage resources because this proposal

recognizes the unique characteristics of these resources. Though we find that CAISO's mechanism proposed here is just and reasonable and provides targeted flexibility by introducing an energy storage-specific option, we recognize that this proposal represents an initial step in the complex modeling of energy storage resource costs and thus required certain assumptions and simplifications. Accordingly, we encourage CAISO to continue to study and, if merited, refine default energy bids for energy storage resources.

30. Finally, we also find just and reasonable CAISO's proposal to establish an option for a demand response resource to submit a maximum daily run time parameter in its master file. Given the inherent limitations in how long a demand response resource can curtail demand, the option to establish maximum run times will allow such a resource to better represent its operating characteristics. We acknowledge CAISO's observation that including this parameter adds complexity to the market optimization. Under the circumstances, we find that it is reasonable to limit the availability of this parameter to demand response resources at least one MW in capacity (i.e., that demonstrate that their Pmax is one MW or greater).

The Commission orders:

CAISO's proposed Tariff revisions are hereby accepted, as discussed in the body of this order, subject to CAISO notifying the Commission of the actual implementation date within five days of that date.

By the Commission.

( S E A L )

Debbie-Anne A. Reese,  
Deputy Secretary.