162 FERC ¶ 61,127
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

18 CFR Part 35
[Docket Nos. RM16-23-000; AD16-20-000; Order No. 841]

Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators

(Issued February 15, 2018)

AGENCY: Federal Energy Regulatory Commission.

ACTION: Final rule.

SUMMARY: The Federal Energy Regulatory Commission (Commission) is amending its regulations under the Federal Power Act (FPA) to remove barriers to the participation of electric storage resources in the capacity, energy, and ancillary service markets operated by Regional Transmission Organizations (RTO) and Independent System Operators (ISO) (RTO/ISO markets). Specifically, we require each RTO and ISO to revise its tariff to establish 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. The participation model must (1) ensure that a resource using the participation model is eligible to provide all capacity, energy, and ancillary services that the resource is technically capable of providing in the RTO/ISO markets; (2) ensure that a resource using the participation model can be dispatched and can set the wholesale market clearing price as both a wholesale seller and wholesale buyer consistent with existing market rules that govern when a resource can set

the wholesale price; (3) account for the physical and operational characteristics of electric storage resources through bidding parameters or other means; and (4) establish a minimum size requirement for participation in the RTO/ISO markets that does not exceed 100 kW. Additionally, each RTO/ISO must specify that the sale of electric energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets must be at the wholesale locational marginal price. We are taking this action pursuant to our legal authority under section 206 of the FPA to ensure that RTO/ISO tariffs are just and reasonable.

In the Notice of Proposed Rulemaking (NOPR), the Commission also proposed reforms related to distributed energy resource aggregations. While we continue to believe that removing barriers to distributed energy resource aggregations in the RTO/ISO markets is important, we have determined that more information is needed with respect to those proposals; therefore, we will not take final action on the proposed distributed energy resource aggregation reforms in this proceeding. Instead, the Commission will continue to explore the proposed distributed energy resource aggregation reforms under Docket No. RM18-9-000. To that end, concurrent with this Final Rule, a Notice of Technical Conference is being issued in Docket No. RM18-9-000 with questions related to the participation of distributed energy resource aggregations in the RTO/ISO markets so that we can gather additional information to help us determine what action to take on the distributed energy resource aggregation reforms proposed in the NOPR. All comments filed in response to the NOPR in this proceeding will be incorporated by reference into Docket No. RM18-9-000, and any further comments

regarding the proposed distributed energy resource aggregation reforms, including comments regarding the technical conference, should be filed henceforth in Docket No. RM18-9-000.

EFFECTIVE DATE: This rule will become effective **[INSERT DATE 90 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].**

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SUPPLEMENTARY INFORMATION:

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators	Docket Nos. RM16-23-000
Electric Storage Participation in Regions with Organized Wholesale Electric Markets	AD16-20-000

ORDER NO. 841

FINAL RULE

TABLE OF CONTENTS

Paragraph Numbers

162 FERC ¶ 61,127
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Before Commissioners: Kevin J. McIntyre, Chairman;
Cheryl A. LaFleur, Neil Chatterjee,
Robert F. Powelson, and Richard Glick.

Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators	Docket Nos. RM16-23-000
Electric Storage Participation in Regions with Organized Wholesale Electric Markets	AD16-20-000

ORDER NO. 841

FINAL RULE

(Issued February 15, 2018)

I. Introduction

1. In this Final Rule, the Federal Energy Regulatory Commission (Commission) is adopting reforms to remove barriers to the participation of electric storage resources[1] in the Regional Transmission Organization and Independent System Operator markets (RTO/ISO markets).[2] For the reasons discussed below, we find that existing RTO/ISO

[1] We define 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. *See infra* PP 29-36.

[2] For purposes of this Final Rule, we define RTO/ISO markets as the capacity, energy, and ancillary services markets operated by the RTOs and ISOs. We note that, in the Notice of Proposed Rulemaking in this proceeding, the Commission used "organized wholesale electric markets" and included that term in the proposed regulatory text. *See Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators*, Notice of Proposed Rulemaking,

market rules are unjust and unreasonable in light of barriers that they present to the participation of electric storage resources in the RTO/ISO markets, thereby reducing competition and failing to ensure just and reasonable rates. To help ensure that the RTO/ISO markets produce just and reasonable rates, pursuant to the Commission's legal authority under Federal Power Act (FPA) section 206,[3] the Commission modifies section 35.28 of its regulations[4] to require each RTO/ISO to revise its tariff to establish market rules that, recognizing the physical and operational characteristics of electric storage resources, facilitate their participation in the RTO/ISO markets, as discussed further below.

2. As the Commission explained in the NOPR, barriers to the participation of new technologies, such as many types of electric storage resources, in the RTO/ISO markets can emerge when the rules governing participation in those markets are designed for traditional resources and in effect limit the services that emerging technologies can provide.[5] For instance, electric storage resources in MISO that want to sell services other than frequency regulation would not have bidding parameters for electric storage

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FERC Stats. & Regs. ¶ 32,718 (2016) (NOPR). We find that using "RTO/ISO markets" is sufficient to describe the markets at issue in this Final Rule and therefore will no longer use "organized wholesale electric markets" here or include that term in the regulatory text.

[3] 16 U.S.C. § 824e (2012).

[4] 18 CFR § 35.28 (2017).

[5] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 2.

resources available to them and it is unclear if or how they would be eligible to purchase energy from the MISO market.[6] Where such conditions exist, resources that are technically capable of providing services are precluded from competing with resources that are already participating in the RTO/ISO markets. This restriction on competition can reduce the efficiency of the RTO/ISO markets, potentially leading an RTO/ISO to dispatch more expensive resources to meet its system needs. By removing barriers to the participation of electric storage resources in the RTO/ISO markets, our actions in this Final Rule will enhance competition and, in turn, help to ensure that the RTO/ISO markets produce just and reasonable rates. Furthermore, due to electric storage resources' unique physical and operational characteristics—including their ability to both inject energy into the grid and receive energy from it—our actions here will help support the resilience of the bulk power system.

3. To address barriers to the participation of electric storage resources in the RTO/ISO markets, in this Final Rule, we require each RTO/ISO to revise its tariff to establish 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. The RTOs/ISOs generally have a set of tariff provisions that apply to all market participants. In addition, the RTOs/ISOs create tariff provisions for specific types of resources when those resources have unique physical and operational

[6] *See* MISO Data Request Response, Docket No. AD16-20-000, at 14, 17 (filed May 16, 2016) (MISO Data Request Response).

characteristics or other attributes that warrant distinctive treatment from other market participants.[7] These distinct tariff provisions that are created for a particular type of resource are what we refer to in this Final Rule as a participation model. Accordingly, the participation model for electric storage resources that we require in this Final Rule is a set of tariff provisions that will help facilitate the participation of electric storage resources in the RTO/ISO markets.

4. For each RTO/ISO, the tariff provisions for the participation model for electric storage resources must (1) ensure 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 in the RTO/ISO markets; (2) ensure that a resource using the participation model for electric storage resources can be dispatched and can set the wholesale market clearing price as both a wholesale seller and wholesale buyer consistent with existing market rules that govern when a resource can set the wholesale price; (3) account for the physical and operational characteristics of

[7] As examples of RTO/ISO participation models, we point to Non-Generator Resources in CAISO, Alternative Technology Regulation Resources in ISO-NE, Generation Resources in MISO, Energy Limited Resources in NYISO, Economic Load Response resources in PJM, and Variable Energy Resources in SPP. *See* CAISO Data Request Response, Docket No. AD16-20-000, at 2 (filed May 16, 2016) (CAISO Data Request Response); ISO-NE Data Request Response, Docket No. AD16-20-000, at 3 (filed May 16, 2016) (ISO-NE Data Request Response); MISO Data Request Response at 4; NYISO Data Request Response, Docket No. AD16-20-000, at 2-3 (filed May 16, 2016) (NYISO Data Request Response); PJM Data Request Response, Docket No. AD16-20-000, at 5 (PJM Data Request Response); SPP Data Request Response, Docket No. AD16-20-000, at 3 (filed May 16, 2016) (SPP Data Request Response).

electric storage resources through bidding parameters or other means; and (4) establish a minimum size requirement for participation in the RTO/ISO markets that does not exceed 100 kW. Additionally, each RTO/ISO must specify that the sale of electric energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets must be at the wholesale locational marginal price (LMP).

5. In the NOPR, the Commission also proposed reforms related to distributed energy resource aggregations.[8] While we continue to believe removing barriers to distributed energy resource aggregations in the RTO/ISO markets is important, we have determined that more information is needed with respect to those proposals; therefore, we will not take final action on the proposed distributed energy resource aggregation reforms in this proceeding.[9] Instead, the Commission will continue to explore the proposed distributed energy resource aggregation reforms under Docket No. RM18-9-000. To that end, concurrent with this Final Rule, a Notice of Technical Conference is being issued in Docket No. RM18-9-000 with questions related to the participation of distributed energy resource aggregations in the RTO/ISO markets so that we can gather additional information to help us determine what action to take on the distributed energy resource aggregation reforms proposed in the NOPR.[10] All comments filed in response to the

[8] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at PP 1-16, 103-158.

[9] We clarify that the reforms adopted here regarding electric storage resources represent final agency action subject to rehearing and appeal.

[10] Notice of Technical Conference, Docket No. RM18-9-000 (Feb. 15, 2018).

NOPR in this proceeding will be incorporated by reference into Docket No. RM18-9-000, and any further comments regarding the proposed distributed energy resource aggregation reforms, including comments regarding the technical conference, should be filed henceforth in Docket No. RM18-9-000.[11]

6. As discussed further below, each RTO/ISO must file the tariff changes needed to implement the requirements of this Final Rule within 270 days of the publication date of this Final Rule in the Federal Register. We will allow each RTO/ISO a further 365 days from that date to implement the tariff provisions.

II. Background

7. Electric storage resources have unique physical and operational characteristics, namely their ability to both inject energy to the grid and receive energy from it. Certain electric storage resources, such as pumped-hydro resources,[12] have been participating in the RTO/ISO markets for many years, and, as the RTOs/ISOs have gained experience with these resources, the RTOs/ISOs have found new ways to facilitate the participation

[11] Further comments regarding the proposed distributed energy resource aggregation reforms should no longer be filed in Docket No. RM16-23-000.

[12] Pumped-hydro storage projects move water between two reservoirs located at different elevations (i.e., an upper and lower reservoir) to store energy and generate electricity. *See* https://www.ferc.gov/industries/hydropower/gen-info/licensing/pump-storage.asp.

of pumped-hydro resources.[13] More recently, other types of electric storage resources, such as batteries and flywheels, are participating in the RTO/ISO markets.[14]

8. As the capabilities of electric storage resources improve and their costs decline to the point that they may be competitive with existing resources,[15] the Commission has become concerned that these resources face barriers that limit their participation in the RTO/ISO markets. To further examine this issue, the Commission hosted a panel to discuss electric storage resources at its November 19, 2015 open meeting. Subsequently, on April 11, 2016, Commission staff issued data requests to each of the six RTOs/ISOs seeking information about the rules in the RTO/ISO markets that affect the participation of electric storage resources.[16] Concurrently, Commission staff issued a request for

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[13] *See, e.g.*, *ISO New England Inc.*, Docket Nos. ER16-954-000 and ER16-954-001 (March 22, 2016) (delegated letter order).

[14] *Midwest Indep. Trans. Sys. Operator, Inc.*, 129 FERC ¶ 61,303 (2009); NYISO Services Tariff, section 2.12 (defining "Limited Energy Storage Resource" as "[a] Generator authorized to offer Regulation Service only and characterized by limited Energy storage, that is, the inability to sustain continuous operation at maximum Energy withdrawal or maximum Energy injection for a minimum period of one hour"); PJM Operating Agreement, Schedule 1, section 1.3 (defining an "Energy Storage Resource" as "[a] flywheel or battery storage facility solely used for short term storage and injection of energy at a later time to participate in the PJM energy and/or ancillary services markets as a Market Seller.")

[15] *See, e.g.*, Lazard's Levelized Cost of Storage Analysis – Version 3.0 (Nov. 2017), available at https://www.lazard.com/media/450338/lazard-levelized-cost-of-storage-version-30.pdf.

[16] Specifically, Commission staff requested information related to (1) the eligibility of electric storage resources to participate in the capacity, energy, and ancillary service markets in the RTOs/ISOs; (2) the technical qualification and performance requirements for market participants; (3) the bidding parameters for different types of

comments, seeking information from interested persons on whether barriers exist to the participation of electric storage resources in the RTO/ISO markets that may potentially lead to unjust and unreasonable wholesale rates. In addition to the responses from the RTOs/ISOs, Commission staff received 44 comments.

9. On November 17, 2016, the Commission issued the NOPR in this proceeding, proposing to amend its regulations under the FPA to remove barriers to the participation of electric storage resources in the RTO/ISO markets. The Commission received 109 comments on the NOPR proposals from a diverse set of stakeholders.[17]

III. Need for Reform

10. In the NOPR, the Commission stated that its proposal in this proceeding is a continuation of efforts pursuant to its authority under the FPA to ensure that the RTO/ISO tariffs and market rules produce just and reasonable rates, terms and conditions of service.[18] Specifically, the Commission noted that it has observed that

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resources; (4) opportunities for distribution-level and aggregated electric storage resources to participate in the RTO/ISO markets; (5) the treatment of electric storage resources when they are receiving electricity for later injection to the grid; and (6) any forthcoming rule changes or other stakeholder initiatives that may affect the participation of electric storage resources in the RTO/ISO markets.

[17] *See* Appendix A for a list of entities that submitted comments and the shortened names used throughout this Final Rule to describe those entities.

[18] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 9 (citing *Integration of Variable Energy Resources*, Order No. 764, FERC Stats. & Regs. ¶ 31,331, *order on reh'g*, Order No. 764-A, 141 FERC ¶ 61,232 (2012), *order on reh'g*, Order No. 764-B, 144 FERC ¶ 61,222 (2013); *Wholesale Competition in Regions with Organized Electric Markets*, Order No. 719, FERC Stats. & Regs. ¶ 31,281 (2008), *order on reh'g*, Order No. 719-A,

market rules designed for traditional resources can create barriers to entry for emerging technologies. The Commission explained that it was proposing to require the RTOs/ISOs to address barriers to the participation of electric storage resources in the RTO/ISO markets.[19]

11. The Commission acknowledged in the NOPR that electric storage resources are already providing energy and ancillary services in some RTO/ISO markets.[20] However, the Commission explained that these resources must often use existing participation models designed for traditional generation or load resources that do not recognize electric storage resources' unique physical and operational characteristics and their capability to provide capacity, energy, and ancillary services in the RTO/ISO markets.[21] Even where the RTOs/ISOs have established distinct participation models for electric storage resources, the Commission stated that those models limit the services that electric storage resources may provide[22] or are designed for electric storage resources

FERC Stats. & Regs. ¶ 31,292 (2009), *order on reh'g*, Order No. 719-B, 129 FERC ¶ 61,252 (2009)).

[19] *See id*. P 10.

[20] *See id*. P 11.

[21] *See id*. PP 11-12.

[22] *See id.* P 11 (citing *Midwest Indep. Trans. Sys. Operator, Inc.*, 129 FERC ¶ 61,303 at PP 40, 64; MISO FERC Electric Tariff, section 1.S (Stored Energy Resources); NYISO Services Tariff, section 2.12 (defining Limited Energy Storage Resource as a "Generator authorized to offer Regulation Service only and characterized by limited Energy storage, that is, the inability to sustain continuous operation at maximum Energy withdrawal or maximum Energy injection for a minimum period of

with very specific characteristics (such as pumped-hydro facilities or resources with a maximum run-time that is less than one hour). The Commission also noted that existing RTO/ISO tariffs generally limit smaller electric storage resources to participating in the RTO/ISO markets as demand response resources, which can restrict these electric storage resources' ability to employ their full operational range, prohibit them from injecting power onto the grid, and preclude them from providing certain services that they are technically capable of providing (such as operating reserves).

12. Thus, the Commission preliminarily found that current tariffs that do not recognize the operational characteristics of electric storage resources limit the participation of electric storage resources in the RTO/ISO markets and result in inefficient use of these resources.[23] As a result, the Commission stated that the RTOs/ISOs may not efficiently dispatch resources, including electric storage resources, thereby reducing competition in the RTO/ISO markets. The Commission stated that limiting the services an electric storage resource is eligible to provide and limiting the efficiency with which it is dispatched to provide services could also inhibit developers' incentives to design their electric storage resources to provide all capacity, energy, and ancillary services that these resources could otherwise provide, further reducing competition in the RTO/ISO

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one hour.")). The Commission noted that NYISO limits Limited Energy Storage Resources to providing regulation service only and Demand Side Resources and Generators that can sustain operation for longer than one hour are not eligible to be Limited Energy Storage Resources. *Id*. (citing NYISO Data Request Response at 3-4).

[23] *See id*. P 12.

markets. The Commission stated that effective integration of electric storage resources into the RTO/ISO markets would enhance competition and, in turn, help to ensure that these markets produce just and reasonable rates.

A. Comments

13. In response to the NOPR, commenters elaborate on the degree to which, and how, existing RTO/ISO market rules pose barriers to the participation of electric storage resources in the RTO/ISO markets and the impact of those barriers.[24] For example, Advanced Energy Economy and GridWise state that RTO/ISO tariffs often lack participation models that allow for participation by advanced energy technologies, apply unnecessary and burdensome technical requirements originally developed for traditional generation technologies, or impose performance requirements that arbitrarily exclude advanced technologies.

14. Alevo, Eagle Crest, Massachusetts State Entities, and NYISO Indicated Transmission Owners claim that RTO/ISO market rules hinder the full participation of electric storage resources by failing to recognize these resources' unique operating characteristics and requiring them to use market rules designed for other types of resources, such as generation.[25] For example, Massachusetts State Entities explain that, in ISO-NE, electric storage resources have to use participation models for pumped-hydro

[24] *See* Advanced Energy Economy Comments at 14-15; GridWise Comments at 3.

[25] *See* Alevo Comments at 4-6; Eagle Crest Comments at 5; Massachusetts State Entities Comments at 13-14; NYISO Indicated Transmission Owners Comments at 3.

resources, which do not take advantage of the flexibility of newer electric storage technologies.

15. A few commenters emphasize that making market rules technology neutral will remove barriers to entry for electric storage resources. For example, several commenters argue that market design should be technology neutral to ensure equal access to markets[26] and to reduce long-term investment risk associated with developing electric storage resources.[27] Microgrid Resources Coalition shares the Commission's concerns that the varying participation models among RTOs/ISOs limit market opportunities for new technologies.[28]

16. While commenters addressed concerns with specific aspects of the NOPR proposals, most commenters, including the RTOs/ISOs, generally agree that the Commission should act to remove barriers to the participation of electric storage resources in the RTO/ISO markets.[29] Further, commenters state that allowing electric storage resources

[26] *See* AES Companies Comments at 14; Alevo Comments at 7-8; EEI Comments at 6-7; Efficient Holdings Comments at 2, 5; ELCON Comments at 2-4; GridWise Comments at 3; Tesla/SolarCity Comments at 10-11.

[27] *See* Massachusetts State Entities Comments at 9.

[28] *See* Microgrid Resources Coalition Comments at 2.

[29] *See, e.g.,* Advanced Energy Economy Comments at 1, 3-6, 8-17; American Petroleum Institute Comments at 2; APPA/NRECA Comments at 1-2; EEI Comments at 2-4; EPRI Comments at 2; EPSA/PJM Power Providers Comments at 3, 6-9, 11-12; Energy Storage Association Comments at 3-5; IRC Comments at 2; NARUC Comments at 3; National Hydropower Association Comments at 2-4; TAPS Comments at 1.

to fully participate in the RTO/ISO markets could create more reliable and resilient electric markets and could provide energy security, fuel diversity, and valuable fast-responding capability to the RTO/ISO markets.[30] CAISO explains that there is no reason to exclude an electric storage resource from providing an existing wholesale electric service if that resource has the technical capabilities required to do so.[31]

17. Some commenters note that implementation of the reforms proposed in the NOPR could improve competition and/or efficiency in the RTO/ISO markets and provide other system benefits.[32] More specifically, Energy Storage Association contends that the benefits from participation of electric storage resources in the RTO/ISO markets include avoided capacity payments, lower peak prices, reduced need for traditional generators to cycle, facilitating effective ramp management, avoiding generator start-up and shut-down costs, and absorbing over-generation. Dominion argues that recognizing the characteristics of electric storage resources can lead to more efficient dispatch and utilization of resources. In addition, City of New York, Energy Storage Association,

[30] *See, e.g.*, IRC Comments at 2; ISO-NE Comments at 1, 4; NYISO Comments at 2; SPP Comments at 1-2.

[31] *See* CAISO Comments at 3.

[32] *See, e.g.*, Dominion Comments at 4-5; Energy Storage Association Comments at 4 (citing Massachusetts Department of Energy Resources, *State-of-Charge: Massachusetts Energy Storage Initiative Study* (Sept. 2016), available at http://www.mass.gov/eea/docs/doer/state-of-charge-report.pdf); Imperial Irrigation District Comments at 6; IRC Comments at 2; ISO-NE Comments at 1; Starwood Energy Comments at 3; TechNet Comments at 1; Telsa/SolarCity Comments at 1.

NYISO, Sunrun, and Tesla/SolarCity suggest that the NOPR reforms will lead to lower costs for consumers,[33] while Silicon Valley Leadership Group and Starwood Energy state that use of electric storage resources will reduce greenhouse gas emissions.[34] Institute for Policy Integrity explains that new storage technologies can reduce dependence on expensive transmission infrastructure.[35] Commenters also argue that electric storage resources can improve grid "resiliency" in the event of a significant weather emergency.[36]

18. EPSA/PJM Power Providers argue that, because there are many unanswered questions (such as the cost of software changes), the Commission should not develop generic requirements for the RTOs/ISOs in a final rule without a clear record that such specification will not constrain any particular region.[37]

B. Commission Determination

19. For the reasons discussed below, we find that existing RTO/ISO market rules are unjust and unreasonable in light of barriers that they present to the participation of

[33] *See* City of New York Comments at 4; Energy Storage Association Comments at 4; NYISO Comments at 2; Sunrun Comments at 1; Tesla/SolarCity Comments at 2, 5.

[34] *See* Silicon Valley Leadership Group Comments at 1; Starwood Energy Comments at 3.

[35] *See* Institute for Policy Integrity Comments at 3.

[36] *See* Advanced Energy Economy Comments at 3; Institute for Policy Integrity Comments at 3; IRC Comments at 2; Massachusetts State Entities Comments at 17; SPP Comments at 2.

[37] EPSA/PJM Power Providers Comments at 12-13.

electric storage resources in the RTO/ISO markets, thereby reducing competition and failing to ensure just and reasonable rates. Specifically, RTO/ISO market rules that limit the services that electric storage resources are technically capable of providing may create barriers to the participation of electric storage resources in the RTO/ISO markets. Barriers also exist in the RTOs/ISOs that have already adopted market rules that provide for the participation of electric storage resources because these participation models were often designed for electric storage resources with very specific characteristics (such as pumped-hydro resources or other electric storage resources with a maximum run-time that is less than one hour), thus limiting electric storage resources from providing the full range of services they are technically capable of providing.

20. These barriers adversely affect competition in the RTO/ISO markets by limiting the participation of resources that are technically capable of providing services in those markets. Moreover, these barriers reduce competition and market efficiency by inhibiting developers' incentives to design their electric storage resources to provide all capacity, energy, and ancillary services that these resources could otherwise provide. We find that better integration of electric storage resources into the RTO/ISO markets is necessary to enhance competition and, in turn, help to ensure that these markets produce just and reasonable rates. Accordingly, as discussed further below, we require each RTO/ISO to revise its tariffs to remove barriers to the participation of electric storage resources in the RTO/ISO markets.

21. While we agree with EPSA/PJM Power Providers that it is necessary to provide each RTO/ISO with flexibility in the manner it incorporates certain aspects of these

reforms into its tariff as explained below, we find that the record in this proceeding provides sufficient basis for requiring the generic requirements discussed herein.

IV. Discussion

A. Definition of Electric Storage Resource

1. NOPR Proposal

22. For the purpose of defining the set of resources for which an RTO/ISO must create a participation model, in the NOPR, the Commission proposed to define an electric storage resource as "a resource capable of receiving electric energy from the grid and storing it for later injection of electricity back to the grid regardless of where the resource is located on the electrical system."[38] The Commission stated that these resources include all types of electric storage technologies, regardless of their size, storage medium (e.g., batteries, flywheels, compressed air, pumped-hydro, etc.), or whether the resource is located on the interstate grid or on a distribution system.

2. Comments

23. The comments received on the proposed definition of electric storage resources generally ask the Commission to modify or clarify the definition but disagree on how the Commission should do so. Some commenters ask the Commission to modify or clarify the definition of electric storage resource to broaden its application. For example, they raise concerns with how the Commission's proposed definition treats behind-the-meter

[38] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 10.

resources. First, Energy Storage Association argues that the NOPR definition only applies to resources connected directly to the transmission or distribution system and, therefore, asks the Commission to extend these reforms to behind-the-meter electric storage resources that net inject energy to the grid.[39] Second, some commenters ask that the Commission extend the NOPR reforms to behind-the-meter resources that do not inject power back to the grid.[40] Advanced Microgrid Solutions and Stem note that the definition of an electric storage resource in the NOPR implies that all such resources will inject electricity back to the grid. However, Advanced Microgrid Solutions and Stem argue that behind-the-meter electric storage resources can provide value to the grid even when they do not inject electricity to the grid. Advanced Microgrid Solutions and Stem thus ask the Commission to clarify that behind-the-meter electric storage resources that do not inject electricity back to the grid can use the participation model for electric storage resources to participate in the RTO/ISO markets.

24. Advanced Energy Economy expresses a related concern, arguing that the Commission's proposed definition of an electric storage resource does not capture all energy storage technologies, such as thermal and kinetic storage; storage co-located with generation resources (including variable resources) on the transmission grid; and other types of technologies that can perform an energy storage function but may not physically

[39] *See* Energy Storage Association Comments at 7, 21-22.

[40] *See* Advanced Energy Economy Comments at 18-20; Advanced Microgrid Solutions Comments at 10; Stem Comments at 6.

export electricity to the wholesale grid. Advanced Energy Economy suggests that the Commission remedy this concern by revising the definition of an electric storage resource to include all storage technologies that are capable of converting electric energy into stored energy and later supplying electric energy (either back to the grid or to a host customer or site).

25. In contrast, other commenters recommend that the Commission narrow its proposed definition of an electric storage resource.[41] Robert Borlick urges the Commission to limit the application of its proposed reforms to those electric storage resources that directly connect to transmission systems controlled by RTOs/ISOs, citing potential adverse impacts of distribution-interconnected resources on power systems. Xcel Energy Services also suggests that the proposed reforms should apply only to electric storage resources connected to the transmission system. While TAPS strongly supports facilitating the participation of transmission-interconnected storage and believes that distribution-interconnected storage could yield benefits to the RTO/ISO markets, it cautions that distribution-interconnected storage should comply with distribution utility tariffs and rates for delivery of energy between the transmission system and the resource's point of interconnection to the distribution system (including provisions related to losses and other terms and conditions of service), both for the resource's sales

[41] *See* Robert Borlick Comments at 2; Xcel Energy Services Comments at 3-4.

to the RTO/ISO markets *and* the resource's purchases of energy from the RTO/ISO markets.[42]

26. Several commenters address the implications of the proposed definition for state and federal jurisdiction. Connecticut State Entities state that they welcome the Commission's efforts to fully provide resources access to wholesale electric markets without changing existing state and federal jurisdiction.[43] Some commenters express concerns regarding the jurisdictional implications of including electric storage resources connected at the distribution level in the definition of an electric storage resource.[44] NARUC asserts that state authority must remain intact under any final rule. Organization of MISO States supports the NOPR on the condition that state and other regulatory jurisdiction is maintained. APPA/NRECA, Maryland and New Jersey Commissions, MISO Transmission Owners, and NYISO Indicated Transmission Owners state that RTO/ISO market rules and Commission policy must maintain the ability of state and local authorities to regulate existing and future electric storage resources that interconnect at the distribution level or behind a customer meter and provide retail- or distribution-level services without the Commission considering such action as a barrier

[42] *See* TAPS Comments at 28-29.

[43] *See* Connecticut State Entities Comments at 7.

[44] *See* APPA/NRECA Comments at 3-4; Maryland and New Jersey Commissions Comments at 3; Massachusetts State Entities Comments at 9; MISO Transmission Owners Comments at 6; NARUC Comments at 4; NYISO Indicated Transmission Owners Comments at 4; Organization of MISO States Comments at 1-2.

to participation in wholesale markets. This request includes Commission confirmation of state jurisdiction over matters such as distribution system design, interconnection to the distribution system, distribution system operations, distribution power quality, the ability of electric storage resources to participate in programs at the distribution level, and distribution system costs. APPA/NRECA believe that the NOPR confines the proposed reforms to the RTO/ISO markets and urge the Commission to reject requests to expand the scope of this final rule beyond that limited scope.

27. DTE Electric/Consumers Energy and MISO Transmission Owners assert that the Commission should allow states to decide whether electric storage resources in their state that are located on the distribution system or behind a retail meter are permitted to participate in the RTO/ISO markets through the electric storage resource participation model proposed in the NOPR.[45] Massachusetts Municipal Electric asks the Commission to clarify that its proposed reforms will enable, but not compel, electric storage resources located behind the meter to participate in the RTO/ISO markets.[46]

28. In contrast, Genbright argues that the Commission must not only assert primary jurisdiction over electric storage resources' sales of services in the RTO/ISO markets but also ensure that RTOs/ISOs do not rely on *ad hoc* interpretations of retail rules and

[45] *See* DTE Electric/Consumers Energy Comments at 7; MISO Transmission Owners Comments at 4, 7.

[46] *See* Massachusetts Municipal Electric Comments at 2.

regulations to erect barriers to the participation of electric storage resources in those markets.[47]

3. Commission Determination

29. Consistent with the NOPR proposal, in this Final Rule, we revise section 35.38(b) of the Commission's regulations to define 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." We find that removing the phrase "regardless of where the resource is located on the electrical system" from the NOPR proposal and instead clarifying where an electric storage resources may be located does not change the applicability of the definition and will also provide a more adaptable definition for other Commission actions.[48] We clarify that this definition is intended to cover electric storage resources capable of receiving electric energy from the grid and storing it for later injection of electric energy back to the grid, regardless of their storage medium (e.g., batteries, flywheels, compressed air, and pumped-hydro). Additionally, consistent with the NOPR proposal, we clarify that electric storage resources located on the interstate transmission system, on a distribution system, or behind the meter fall under this definition, subject to the additional clarifications provided below. By including all

[47] *See* Genbright Comments at 3-4.

[48] *See, e.g., Essential Reliability Services and the Evolving Bulk-Power System—Primary Frequency Response*, Final Rule, *Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators*, 162 FERC ¶ 61,128 (2018), Notice of Proposed Rulemaking, FERC Stats. & Regs. ¶ 32,718, Notice of Inquiry, FERC Stats. & Regs. ¶ 35,576 (2016).

electric storage technologies, and by allowing resources that are interconnected to the transmission system, distribution system, or behind the meter to use the participation model for electric storage resources, we are ensuring that the market rules will not be designed for any particular electric storage technology.

30. We observe that an electric storage resource that injects electric energy back to the grid for purposes of participating in an RTO/ISO market engages in a sale of electric energy at wholesale in interstate commerce.[49] As a result, such an electric storage resource must fulfill certain responsibilities set forth in the FPA and the Commission's rules and regulations.[50]

31. We disagree with commenters who assert that the definition of an electric storage resource should be limited to those electric storage resources that are interconnected to the transmission system. Electric storage resources interconnected to the distribution system are already participating in the RTO/ISO markets,[51] and they should continue to

[49] We note that injections of electric energy back to the grid do not necessarily trigger the Commission's jurisdiction. *See Sun Edison LLC*, 129 FERC ¶ 61,146 (2009), *reh'g granted on other grounds*, 131 FERC ¶ 61,213 (2010) (the Commission's jurisdiction would arise only when a facility operating under a state net metering program produces more power than it consumes over the relevant netting period); *MidAmerican Energy Co.*, 94 FERC ¶ 61,340 (2001).

[50] Examples of such responsibilities include filing rates under FPA section 205 (potentially including obtaining market-based rate authority); submitting FPA sections 203 and 204 filings related to corporate mergers and other activities; and fulfilling FPA section 301 accounting obligations and FPA section 305(b) interlocking directorate obligations. *See* 16 U.S.C. §§ 824b, 824c, 824d, 825, 825d(b).

[51] *See, e.g., PJM Interconnection L.L.C.*, 149 FERC ¶ 61,185 (2014), *order on reh'g*, 151 FERC ¶ 61,231 (2015).

be able to do so. Such a limitation also would be inconsistent with the participation of other types of resources because various types of traditional generation and demand-side resources that are not connected directly to the transmission system currently participate in the RTO/ISO markets.

32. Some commenters argue that the Commission should broaden its definition of an electric storage resource to apply to behind-the-meter resources that do not inject electricity onto the grid. We decline to do so. Through this Final Rule, we seek to ensure that RTO/ISO market rules account for the unique physical and operational characteristic of electric storage resources, namely their bidirectional capability to both inject energy to the grid and receive energy from it. Expanding the definition of an electric storage resource to include behind-the-meter resources that do not inject electric energy onto the grid would not advance this purpose because they would not be injecting electric energy back to the grid. In addition, we have previously found that behind-the-meter resources that do not inject electric energy onto the grid are considered demand response.[52] There are existing participation models for demand response that already have well-established rules that are in some cases unique to demand response and we do not want the requirements of this Final Rule to disrupt or otherwise conflict with those rules.[53]

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[52] *See ISO New England Inc.*, 138 FERC ¶ 61,042, at PP 76-86, *reh'g denied*, 139 FERC ¶ 61,116, at PP 10-12, 26-31 (2012).

[53] Participation by demand response resources in an RTO/ISO market does not involve a sale of electric energy at wholesale in interstate commerce. *See*

33. We also clarify that, by "capable of … later injection of electric energy back to the grid," we mean that the electric storage resource is both physically designed and configured to inject electric energy back onto the grid and, as relevant, is contractually permitted to do so (e.g., per the interconnection agreement between an electric storage resource that is interconnected on a distribution system or behind-the-meter with the distribution utility to which it is interconnected). Consequently, the definition of an electric storage resource excludes a resource that is either (1) physically incapable of injecting electric energy back onto the grid due to its design or configuration or (2) contractually barred from injecting electric energy back onto the grid.

34. While we decline in this Final Rule to expand the definition of an electric storage resource to include behind-the-meter resources that do not inject electric energy onto the grid, we note that the definition in this Final Rule establishes the minimum set of resources that each RTO/ISO must consider when developing an electric storage resource participation model to comply with this Final Rule. It does not preclude any RTO/ISO from proposing a broader definition for electric storage resources through a separate FPA section 205 filing.[54]

EnergyConnect, Inc., 130 FERC ¶ 61,031, at P 30 (2010); *see also FERC v. Elec. Power Supply Ass'n*, 136 S.Ct. 760 (2016) (RTO/ISO rules governing participation of demand response resources in the RTO/ISO markets are practices that directly affect rates in those markets.).

[54] *See* 16 U.S.C. § 824d. We acknowledge that the definition of an electric storage resource that we adopt in this Final Rule may differ from existing, Commission-accepted practices. For example, in CAISO, a stand-alone electric storage resource or an aggregation of behind-the-meter electric storage resources that cannot or does not inject

35. Further, this Final Rule requires each RTO/ISO to implement market rules applicable to electric storage resources, as defined herein, that voluntarily seek to participate in the RTO/ISO markets; this Final Rule does not require electric storage resources to participate in those markets. The Commission has exclusive jurisdiction over the wholesale markets and the criteria for participation in those markets, including the wholesale market rules for participation of resources connected at or below distribution-level voltages.[55] We also understand that numerous resources connected to the distribution system participate in the RTO/ISO markets today.[56] Under these circumstances, we are not persuaded to grant the MISO Transmission Owners' and DTE Electric/Consumers Energy's request that the Commission allow states to decide whether electric storage resources in their state that are located behind a retail meter or on the

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electric energy back to the grid is able to use CAISO's participation model for electric storage resources (the Non-Generator Resource model). *See California Indep. Sys. Operator Corp.*, 132 FERC ¶ 61,211 (2010). This Final Rule does not require each RTO/ISO to limit the applicability of its existing participation models to electric storage resources as they are defined in this Final Rule or prevent them from arguing on compliance why its Commission-accepted tariff complies with the requirements of this Final Rule.

[55] *See FERC v. Elec. Power Supply Ass'n*, 136 S.Ct. 760 (2016); *see also Advanced Energy Economy*, 161 FERC ¶ 61,245, at PP 59-60 (2017).

[56] *See, e.g., Southern California Edison Co.*, Docket No. ER10-1356-000 (2010) (accepting Southern California Edison's Wholesale Distribution Access Tariff); *PJM Interconnection, L.L.C.*, Docket No. ER11-3148-000 (May 13, 2011) (delegated letter order) (accepting Wholesale Market Participation Agreement among PJM, CleanLight Power, L.L.C. and Public Service Electric and Gas Company); PJM Manual 14C, § 1.3 (discussing requirements of Wholesale Market Participation Agreements).

distribution system are permitted to participate in the RTO/ISO markets through the electric storage resource participation model.

36. That said, we emphasize the ongoing, vital role of the states with respect to the development and operation of electric storage resources. Such state responsibilities include, among other things, retail services and matters related to the distribution system, including design, operations, power quality, reliability, and system costs. We add that nothing in this Final Rule is intended to affect or implicate the responsibilities of distribution utilities to maintain the safety and the reliability of the distribution system or their use of electric storage resources on their systems.

B. Creation of a Participation Model for Electric Storage Resources

1. Participation Model for Electric Storage Resources

a. NOPR Proposal

37. In the NOPR, the Commission proposed to require each RTO/ISO to revise its tariff to include a participation model consisting of market rules that, recognizing the physical and operational characteristics of electric storage resources, facilitates their participation in RTO/ISO markets.[57] The Commission further proposed that the electric storage resource participation model satisfy certain requirements to accommodate the physical and operational characteristics of electric storage resources.[58]

[57] *See* NOPR, FERC Stats. & Regs.¶32,718 at P 26.

[58] *See id*. P 28.

b. Comments

38. Many commenters support the Commission's proposal to require each RTO/ISO to create a participation model for electric storage resources.[59] These commenters agree that there is a need to recognize the physical, technical and operational characteristics of electric storage resources,[60] remove artificial barriers to electric storage resource participation in the RTO/ISO markets,[61] and allow electric storage resources to be adequately and fairly compensated for the services they provide.[62] Commenters argue that these reforms will provide system and consumer benefits[63] (including increased

[59] *See, e.g.*, Advanced Microgrid Solutions Comments at 3; AES Companies Comments at 5, 14; Brookfield Renewable Comments at 2; CAISO Comments at 3-4; EEI Comments at 3-4; Energy Storage Association Comments at 1, 4-5; EPSA/PJM Power Providers Comments at 4, 11; Massachusetts State Entities Comments at 13-14; NYISO Comments at 5.

[60] *See, e.g.*, Advanced Energy Economy Comments at 22-24; AES Companies Comments at 3; APPA/NRECA Comments at 11; CAISO Comments at 3; City of New York Comments at 3; Research Scientists Comments at 2.

[61] *See, e.g.*, City of New York Comments at 3; Energy Storage Association Comments at 5; Exelon Comments at 4; NYISO Indicated Transmission Owners Comments at 2-3.

[62] *See, e.g.*, Dominion Comments at 4-5; Massachusetts Municipal Electric Comments at 2; NYISO Indicated Transmission Owners Comments at 2-3.

[63] *See, e.g.*, Alevo Comments at 4-6; NESCOE Comments at 3; Ohio Commission Comments at 4.

competition and lower costs to consumers,[64] efficiency,[65] and system reliability benefits[66]) and will improve air quality.[67]

39. Some commenters, however, condition their support for the Commission's proposed electric storage resource participation model.[68] For example, EEI expresses support contingent on the proposed participation model ensuring adequate reliability, not causing undue discrimination to other market participants, and addressing cost allocation and double recovery. Similarly, Exelon emphasizes that the Commission should avoid approving tariff changes that may have a detrimental effect on reliability, safety, or markets. Xcel Energy Services supports the participation model if it is feasible and cost-effective. According to EPSA/PJM Power Providers, any initiatives or rules to facilitate participation of electric storage resources in the RTO/ISO markets must be compatible with, and support, the extensive system of conventional resources that make up the backbone of the bulk power system and implementation of a participation model for

[64] *See, e.g.*, Beacon Power Comments at 2, 6; City of New York Comments at 3-4; EPRI Comments at 2; NESCOE Comments at 3; Union of Concerned Scientists Comments at 7.

[65] *See* EPRI Comments at 8-9; NESCOE Comments at 5.

[66] *See, e.g.*, EPRI Comments at 2; Institute for Policy Integrity Comments at 4; NESCOE Comments at 5.

[67] *See* City of New York Comments at 3-4.

[68] *See, e.g.*, EEI Comments at 4-6; EPSA/PJM Power Providers Comments at 3-4; Exelon Comments at 5-6, 12; Xcel Energy Services Comments at 14-15.

electric storage resources must preserve efficient operational and investment signals for all resources.

40. Whether or not they support the Commission's proposal to require each RTO/ISO to establish a participation model for electric storage resources, many commenters caution against granting undue preference in the markets to electric storage resources.[69] For example, Independent Energy Producers Association argues that the electric storage resource participation model should impose comparable performance obligations (such as penalties for non-performance, schedule deviations, and replacement obligations) to those required of other resources participating in the RTO/ISO markets. Similarly, several commenters contend that the Commission should focus on the technical requirements of the electric system and remain neutral about how or from which technology services are provided.[70] For example, Massachusetts State Entities urge the Commission to ensure that participation is not limited based on type, vintage, ownership, business model, or other criteria unrelated to how well a particular resource satisfies the physical and operational parameters of a defined electric market or service.

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[69] *See, e.g.,* Avangrid Comments at 5; EEI Comments at 5; ELCON Comments at 3; EPSA/PJM Power Providers Comments at 4, 7-8; Exelon Comments at 2, 12; Independent Energy Producers Association Comments at 4; New York Utility Intervention Unit Comments at 3.

[70] *See, e.g.,* American Petroleum Institute Comments at 2-4; EEI Comments at 6-7; EPSA/PJM Power Providers Comments at 7-8; Massachusetts State Entities Comments at 8-9; MISO Transmission Owners Comments at 7; PJM Market Monitor Comments at 2-3, 4-5.

41. Commenters also address whether the Commission should provide regional flexibility for each RTO/ISO to comply with the rule by proposing requirements that accommodate electric storage resources that comport to their unique circumstances. Several commenters contend that regional flexibility is appropriate, with EEI, EPSA/PJM Power Providers, and Exelon noting that the proposed electric storage resource participation model provides such flexibility.[71] Connecticut State Entities suggest that the Commission should create threshold standards for all RTOs/ISOs but allow regional variations for cost allocation and rate design.[72]

42. Other commenters argue that the Commission should defer to the RTOs/ISOs to develop the detailed participation rules that take into account the unique needs of each market.[73]

43. For example, ISO-NE urges the Commission to avoid a one-size-fits-all approach. Specifically, ISO-NE is concerned that (1) the focus on participation models and market participant types rather than on services is inconsistent with its core market design objective of technology neutrality and (2) the rulemaking could require ISO-NE to fundamentally change this technology-neutral approach to the detriment of its markets.

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[71] *See, e.g.*, APPA/NRECA Comments at 11; EEI Comments at 4; EPSA/PJM Power Providers Comments at 11-12; Exelon Comments at 2; NESCOE Comments at 2-3, 9.

[72] *See* Connecticut State Entities Comments at 6.

[73] *See, e.g.*, Duke Energy Comments at 3; ISO-NE Comments at 10-14; MISO Comments at 2; National Hydropower Association Comments at 4.

ISO-NE argues that adopting participation models could allow resource owners to engage in participation model "shopping," a form of tariff rule arbitrage.

44. Given these concerns, ISO-NE asks the Commission to provide only general guidance to RTOs/ISOs, requiring them to (1) examine the requirements associated with providing each wholesale service in their markets and (2) assess whether and how to revise those requirements to better accommodate the participation of electric storage resources. ISO-NE also asks the Commission to clarify that RTOs/ISOs are not required to adopt a specific participation model construct but instead may propose to incorporate the participation of electric storage resources in their markets in a manner consistent with the RTO's/ISO's existing market constructs.

45. Similarly, while NESCOE supports the intent of the NOPR, it observes that further information is required on whether each RTO/ISO could modify its existing participation model(s) to address any barrier to the participation of electric storage resources in the RTO/ISO markets, rather than being required to create a new participation model.[74] TeMix also questions the need for a new participation model for electric storage resources, arguing that such a participation model will only add to the complexity of the RTO/ISO markets.[75] TeMix instead proposes that the Commission encourage reform of retail energy and distribution tariffs and require the RTOs/ISOs to frequently post

[74] *See* NESCOE Comments at 2, 5.

[75] *See* TeMix Comments at 2-3, 4-5.

wholesale bids and offers at the retail/wholesale interface to better allow retail customers to respond to the wholesale price of electricity.

46. Some commenters request that the Commission establish detailed requirements for a participation model for electric storage resources.[76] For example, Energy Storage Association argues that prescriptive requirements for the proposed electric storage resource participation model are necessary to ensure that the participation model is adequately defined. Starwood Energy requests that the Commission require uniform participation models across all of the RTOs/ISOs to ensure that all electric storage resources have the same opportunity to fully participate in the RTO/ISO markets, including the capacity markets, regardless of the region in which they are located. EPRI suggests that the definition of a participation model include, in addition to a set of tariff provisions, the set of software provisions required to represent the physical and operational characteristics of the particular resource.[77]

47. Several commenters suggest that the participation model for electric storage resources should account for the physical and operational differences among electric storage technologies because different electric storage resources (such as pumped-hydro) have different operating characteristics, provide different services, and are not intended

[76] *See* Energy Storage Association Comments at 8; Starwood Energy Comments at 7.

[77] *See* EPRI Comments at 2-3.

to serve the same roles within the electric grid.[78] EPRI suggests that, given the current form of the day-ahead and real-time energy markets, there may need to be two participation models for electric storage resources.[79] EPRI explains that one participation model would be for resources whose transition time from charge to discharge, or vice versa, exceeds the market interval (e.g., pumped-hydro and compressed-air) with the operational mode of these resources determined by the RTO's/ISO's security constrained unit commitment model. EPRI further explains that the second participation model would be for resources that transition from charge to discharge, or vice versa, within the market interval (e.g., batteries and flywheels). EPRI states that it is likely these resources can be online and responsive at zero power output, and therefore do not need to be committed to a particular mode of operation, and can be dispatched as an injector or withdrawer of power.

48. Other commenters discuss the need to distinguish between electric storage resources based on their point of interconnection with the grid.[80] Organization of MISO States recommends that electric storage resource participation models differentiate between transmission-interconnected electric storage resources and distribution-interconnected

[78] *See, e.g.*, Brookfield Renewable Comments at 3; Dominion Comments at 4-5; DTE Electric/Consumers Energy Comments at 4-5; National Hydropower Association Comments at 4; NYPA Comments at 5; San Diego Water Comments at 12-13, 15.

[79] *See* EPRI Comments at 7-8.

[80] *See* Organization of MISO States Comments at 3; Stem Comments at 2-3; TeMix Comments at 3.

electric storage resources due to the interplay and potential overlap between wholesale and retail rates for energy use of retail customers. Stem suggests that, in developing their electric storage resource participation models, RTOs/ISOs should distinguish between behind-the-meter and front-of-the-meter electric storage resources, as well as single site and aggregated resources, to ensure that each resource is being used to its full technical capabilities and behind-the-meter resources are not precluded from the most efficient use cases.

49. Two RTOs/ISOs request clarifications with respect to the Commission's proposal to require them to establish a participation model for electric storage resources.[81] ISO-NE and PJM want to ensure that the requirement that they establish a participation model for electric storage resources does not preclude electric storage resources participating in their markets from using other participation models (such as demand response or Alternative Technology Regulation Resource). PJM also argues that its current rules for electric storage resources should be carried forward because it allows electric storage resources to provide all services that they are capable of providing in a manner comparable to generation resources of similar size and with similar operational characteristics.

[81] *See* ISO-NE Comments at 29-30; PJM Comments at 6, 9, 11.

50. Finally, several commenters share information on existing RTO/ISO initiatives to remove barriers to the participation of electric storage resources in their markets.[82] California Commission notes that, in CAISO, most of the NOPR proposals are either already in place or under development.[83] Stem suggests that CAISO's current models, while incomplete, are the best place to start when designing a participation model for electric storage resources.[84]

c. Commission Determination

51. In this Final Rule, we adopt the NOPR proposal and add section 35.28(g)(9)(i) to the Commission's regulations to require each RTO/ISO to revise its tariff 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. We find that requiring each RTO/ISO to create a participation model that recognizes the unique characteristics of electric storage resources will help eliminate barriers to their participation in the RTO/ISO markets, which will enhance competition and, in turn, help to ensure that these markets produce just and reasonable rates.

52. In response to concerns that the creation of a participation model for electric storage resources may undermine market designs that are based on services provided rather than

[82] *See, e.g.*, NYISO Comments at 4; MISO Comments at 3.

[83] *See* California Commission Comments at 3.

[84] *See* Stem Comments at 2-3.

resource type, we find that this Final 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. As such, this Final Rule does not grant undue preference to electric storage resources as a group or to specific electric storage technologies; rather, it removes barriers to their participation, enhancing competition among all resources that are technically capable of providing wholesale services. As noted above, resources that use the participation model required by this Final Rule must fulfill certain responsibilities set forth in the FPA and the Commission's rules and regulations.[85] Additionally, resources that use this participation model will be compensated for the wholesale services they provide in the same manner as other resources that provide these services.

53. With respect to commenters' arguments concerning regional flexibility in implementation, we find that this Final Rule strikes the appropriate balance between allowing each RTO/ISO to adopt market rules that complement its unique market design and providing sufficiently detailed requirements to ensure that each RTO/ISO eliminates barriers to electric storage resource participation in its markets. Specifically, this Final Rule does not adopt prescriptive, uniform market rules to which each RTO/ISO must adhere. Instead, the regulations establish minimum requirements (for, among other

[85] *See supra* P 30.

things, bidding parameters and resource size) that each RTO/ISO must meet when proposing market rules to comply with this Final Rule, permitting each RTO/ISO to propose market rules that comply with these minimum requirements in the way that best suits its individual market design.[86] We therefore decline to adopt additional or more prescriptive requirements for the participation model at this time.

54. We are not convinced that separate participation models are necessary for different types of electric storage resources (e.g., slower, faster, or aggregated) because we believe that the physical differences between electric storage resources can be represented by complying with the requirements for bidding parameters that are discussed below and that a single participation model can be designed to be flexible enough to accommodate any type of electric storage resource. However, to the extent an RTO/ISO seeks to include in its tariff additional market rules that accommodate electric storage resources with specific physical and operational characteristics, the RTO/ISO may propose such revisions to its tariff through a separate FPA section 205 filing.[87]

55. We agree with CAISO that electric storage resources currently participate in the

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[86] For example, we acknowledge that it may be necessary in some markets to create market rules that differentiate between electric storage resources interconnected to the grid at different points (i.e., at the transmission system, the distribution system, or behind-the-meter). Such differences could include different metering and accounting practices for certain electric storage resources, as discussed in the Metering and Accounting Practices for Charging Energy section. *See infra* P 317.

[87] *See* 16 U.S.C. § 824d.

RTO/ISO markets in a variety of ways and may use a variety of existing participation models. We clarify that, where an RTO/ISO already has a separate participation model that electric storage resources may use (such as participation models for pumped-hydro resources or demand response), we are not requiring the RTO/ISO to consolidate that participation model with the participation model for electric storage resources required by this Final Rule. However, to the extent an RTO/ISO modifies existing participation models to comply with this Final Rule, it must ensure that those resulting participation models are available for all types of electric storage resources and comply with all of the other requirements set forth in this Final Rule.

56. While the participation model for electric storage resources should be designed to facilitate the participation of all types of electric storage technologies, we do not require all electric storage resources to use that participation model. To that end, we clarify that this Final Rule does not preclude electric storage resources from continuing to participate in demand response programs, as Alternative Technology Regulation Resources in ISO-NE, or under other participation models in any RTO/ISO in which they are eligible to participate. However, we clarify that, under section 35.28(g)(9) of the Commission's regulations, section 35.28(g)(9)(i) applies to resources using the participation model for electric storage resources and section 35.28(g)(9)(ii) applies to all electric storage resources that fall under the definition established in this Final Rule. Therefore, electric storage resources that may elect not to use the participation model for electric storage resources would still be able to pay the wholesale LMP for the electric energy they purchase from the RTO/ISO markets and then resell back to those markets.

2. Qualification Criteria for the Participation Model for Electric Storage Resources

a. NOPR Proposal

57. To ensure that the proposed participation model for electric storage resources will facilitate the participation of both existing and future electric storage resource technologies in the RTO/ISO markets, the Commission proposed that each RTO/ISO define the criteria in its tariff that a resource must meet to qualify to use the participation model for electric storage resources (i.e., qualification criteria).[88] The Commission stated that these qualification criteria must be based on the physical and operational attributes of electric storage resources, must not limit participation to any particular type of electric storage resource or other technology, and must ensure that the RTO/ISO is able to dispatch a resource in a way that recognizes its physical constraints and optimizes its benefits to the RTO/ISO. The Commission invited comment on whether it should establish qualification criteria that each RTO/ISO must adopt and, if so, what specific criteria the Commission should require. The Commission explained that it was not proposing to limit the use of the electric storage resource participation model to electric storage resources as defined in the NOPR, acknowledging that there may be other types of resources whose physical and operational characteristics could qualify under the proposed participation model.[89]

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[88] *See* NOPR, FERC Stat. & Regs. ¶ 32,718 at P 29.

[89] *See id*. P 30.

b. Comments

58. While several commenters support providing each RTO/ISO with flexibility to propose appropriate qualification criteria on compliance with this Final Rule,[90] a few commenters suggest that the Commission require each RTO/ISO to propose qualification criteria that meet certain standards.[91] For example, Exelon, Imperial Irrigation District, and Magnum assert that qualification criteria should not limit participation to certain types of electric storage resources. Imperial Irrigation District argues that the qualification criteria for a resource to use the electric storage resource participation model should not be more specific than the physical and operational attributes cited in the NOPR (i.e., the ability to both charge and discharge energy). EPRI states that, if an RTO/ISO adopts two different participation models for electric storage resources, one for slower responding resources and one for faster responding resources, then that RTO/ISO may need to establish different qualification criteria for each electric storage resource participation model.

59. Both MISO and SPP point to existing qualification criteria for providing certain services in their markets that they argue should apply to resources that use the electric

[90] *See, e.g.*, AES Companies Comments at 15-16; Bonneville Comments at 4; CAISO Comments at 4-5; MISO Comments at 9-10; NESCOE Comments at 9; PG&E Comments at 7; SoCal Edison Comments at 15-16.

[91] *See, e.g.*, EPRI Comments at 7-8; Exelon Comments at 4; Imperial Irrigation District Comments at 6-7; Magnum Comments at 8.

storage resource participation model to provide those services.[92] MISO notes that, for certain services, a resource must be able to sustain provision of the service for the minimum amount of time (e.g., contingency reserves have a 90-minute replenishment time and capacity resources must be capable of providing four hours of continuous energy). SPP makes similar arguments, noting that some products like regulation may have shorter output sustainability requirements than other products like energy.

60. In addition to qualification criteria, Fluidic argues that RTOs/ISOs should modify their protocols and procedures to include a uniform accrediting process for determining the capacity of an electric storage resource for participation in their markets.[93]

c. Commission Determination

61. To implement the new requirement in section 35.28(g)(9)(i) of the Commission's regulations for a participation model for electric storage resources, in this Final Rule, we adopt the NOPR proposal to require each RTO/ISO to define in its tariff the criteria that a resource must meet to use the participation model for electric storage resources (i.e., qualification criteria). As proposed in the NOPR, these criteria must be based on the physical and operational characteristics of electric storage resources, such as their ability to both receive and inject electric energy, must not limit participation under the electric storage resource participation model to any particular type of electric storage resource or other technology and must ensure that the RTO/ISO is able to dispatch a

[92] *See* MISO Comments at 9-10; SPP Comments at 4.

[93] *See* Fluidic Comments at 4.

resource in a way that recognizes its physical and operational characteristics and optimizes its benefits to the RTO/ISO. We find that such criteria are necessary to ensure that the electric storage resource participation model will accommodate both existing and future technologies.

62. Because the qualification criteria must not limit participation to any particular technology and instead will be based on the physical and operational characteristics of electric storage resources, these criteria will allow new electric storage resource technologies to participate in the RTO/ISO markets without the need for additional tariff revisions to explicitly permit their participation. This focus on the physical and operational characteristics of electric storage resources rather than the specific technology in use will remove barriers to entry for existing and future technologies, which will enhance competition in the RTO/ISO markets and, in turn, help to ensure that these markets produce just and reasonable rates. In addition, requiring each RTO/ISO to define in its tariff qualification criteria will provide greater certainty about which resources will be eligible to use the electric storage resource participation model in each RTO/ISO.

63. Also, as proposed in the NOPR, we provide each RTO/ISO with flexibility to propose qualification criteria that best suit its proposed participation model for electric storage resources. We decline to adopt Imperial Irrigation District's suggestion to specify that the qualification criteria for a resource to use the electric storage resource participation model should be limited to the physical and operational characteristics cited in the definition proposed in the NOPR (i.e., the ability to both charge and discharge

energy). We agree that the qualification criteria should not present barriers to the participation of any electric storage resource in the RTO/ISO markets. As long as any qualification criteria that the RTOs/ISOs propose do not create such barriers and are inclusive of, at a minimum, those resources set forth under the definition of electric storage resources in this NOPR, then we do not find that it is necessary to place additional limitations on any qualification criteria that the RTOs/ISOs may propose in response to this Final Rule.

64. In response to Fluidic, we clarify that the qualification criteria should not include a uniform accrediting process to determine the capacity of an electric storage resource. As discussed in the Eligibility to Provide all Capacity, Energy, and Ancillary Services section,[94] we understand that, like all other market participants, resources using the participation model for electric storage resources will be subject to testing procedures to determine their technical ability to provide a particular service and that this testing will be done based on the capacity that the resource wants to offer into the RTO/ISO markets.

65. With respect to MISO's and SPP's comments, we note that, based on our understanding, the requirements that MISO and SPP characterize as qualification criteria are technical requirements to provide a particular wholesale service. Such technical requirements should not be used as qualification criteria to determine whether a resource may use the participation model for electric storage resources. Rather, MISO and SPP would continue to use these requirements to determine whether individual resources

[94] *See infra* P 80.

using the participation model for electric storage resources are eligible to provide specific services.

3. Relationship between Electric Storage Resource Participation Model and Existing Market Rules

a. NOPR Proposal

66. In the NOPR, the Commission proposed that each RTO/ISO propose any necessary additions or modifications to its existing tariff provisions to specify: (1) whether resources that qualify to use the participation model for electric storage resources will participate in the RTO/ISO markets through existing or new market participation agreements; and (2) whether particular existing market rules apply to resources participating under the electric storage resource participation model.[95]

b. Comments

67. CAISO supports the NOPR proposal.[96] In contrast, ISO-NE requests that the Commission omit any specific directive about market participation agreements from a final rule.[97] ISO-NE notes that, in New England, all market participants use the same Market Participation Service Agreement regardless of resource type, and it does not interpret the NOPR to preclude its continued use of a single agreement. SPP remains silent as to whether it supports the NOPR proposal but states that it will modify both its

[95] *See* NOPR, FERC Stats. & Regs. ¶32,718 at P 31.

[96] *See* CAISO Comments at 5.

[97] *See* ISO-NE Comments at 56.

tariff and market protocols to accommodate the participation of electric storage resources, noting that it will structure any new rules consistent with SPP balancing authority needs and requirements, while providing as much flexibility and opportunity for the participation of electric storage resources as possible.[98]

c. Commission Determination

68. To implement the new requirement in section 35.28(g)(9)(i) of the Commission's regulations for a participation model for electric storage resources, in this Final Rule, we adopt the NOPR proposal to require each RTO/ISO to propose any necessary additions or modifications to its existing tariff provisions to specify: (1) whether resources that qualify to use the participation model for electric storage resources will participate in the RTO/ISO markets through existing or new market participation agreements and (2) whether particular existing market rules apply to resources participating under the electric storage resource participation model. We find that these requirements are necessary to provide certainty to resources using the electric storage resource participation model about the market rules that will govern their participation in each RTO/ISO market, thus removing barriers to their participation.

69. With respect to ISO-NE's concern that the RTOs/ISOs should not be precluded from using a single market participation agreement for all market participants, we clarify that this Final Rule allows the use of one or more existing agreements so long as the agreement(s) complies with the terms of this Final Rule.

[98] *See* SPP Comments at 5.

C. Eligibility of Electric Storage Resources to Participate in the RTO/ISO Markets

1. Eligibility to Provide all Capacity, Energy, and Ancillary Services

a. NOPR Proposal

70. In the NOPR, the Commission proposed to require each RTO/ISO to modify its tariff to establish a participation model consisting of market rules for electric storage resources under which a participating resource is eligible to provide any capacity, energy, and ancillary service that it is technically capable of providing in the RTO/ISO markets.[99] The Commission also proposed that electric storage resources should be eligible, as part of the participation model, to provide services that the RTOs/ISOs do not procure through a market mechanism, such as blackstart service, primary frequency response service, and reactive power service, if they are technically capable. The Commission specified that, where compensation for these services exists, electric storage resources should also receive such compensation commensurate with the service provided.

[99] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 48.

b. Comments

71. Many commenters generally support the NOPR proposal.[100] In particular, several commenters support the NOPR proposal that electric storage resources, if technically capable, must be eligible to provide services that the RTOs/ISOs do not procure through a market mechanism, such as blackstart service, primary frequency response service, and reactive power service.[101] However, APPA/NRECA suggest that the Commission give each RTO/ISO flexibility to demonstrate on compliance the extent to which an electric storage resource may not be technically capable of providing a given service reliably, efficiently, and cost-effectively.[102]

72. Several of the RTOs/ISOs explain their ongoing efforts to improve the opportunities for electric storage resources to participate in their markets.[103] MISO states that the NOPR proposal aligns with its tariff, which classifies resources based on their technical capabilities, including any technical limitations that they have. Moreover, MISO states that it is exploring the potential to enhance the opportunities for electric storage resources to participate in its markets, noting, however, that implementing such

[100] *See, e.g.*, Advanced Energy Economy Comments at 23-25; American Petroleum Institute Comments at 3; EEI Comments at 6; Mensah Comments at 2; MISO Comments at 4; National Hydropower Association Comments at 7.

[101] *See, e.g.*, Advanced Energy Economy Comments at 29; APPA/NRECA Comments at 12-13; Exelon Comments at 6; National Hydropower Association Comments at 7; Xcel Energy Services Comments at 21.

[102] *See* APPA/NRECA Comments at 13.

[103] *See* CAISO Comments at 5-6; MISO Comments at 4-6; NYISO Comments at 5-6; SPP Comments at 7.

enhancements may require significant changes to its settlement systems and software. NYISO explains that, to ensure that its market rules are fully accessible to new electric storage technologies, it is working with stakeholders on a comprehensive review and reform of the rules related to electric storage resource participation in its markets.

73. CAISO points out that electric storage resources participating in CAISO's market have the opportunity to provide energy and ancillary services, including those that CAISO may procure outside of its market processes, if they meet the technical criteria to do so. Likewise, SPP notes that electric storage resources may provide non-market based services such as blackstart service and reactive power service if they meet the relevant technical requirements.

74. While ISO-NE states that it will revise its market rules in compliance with a final rule in this proceeding to eliminate barriers to the participation of electric storage resources in their markets, and SPP states that, prior to the issuance of the NOPR, it was planning to do so,[104] they each request clarification of the NOPR proposal that a resource using the electric storage resource participation model must be eligible to provide any capacity, energy, and ancillary service that it is technically capable of providing. According to ISO-NE, electric storage resources should not receive different treatment than other technology types. ISO-NE and SPP thus ask the Commission to clarify that an electric storage resource must be eligible to provide a service only if it meets the same

[104] *See* ISO-NE Comments at 14-15; SPP Comments at 3-4, 6-7.

requisite performance requirements to provide that service that apply to all other resources.

75. Energy Storage Association contends that it is imperative that RTOs/ISOs establish a process for resources to demonstrate that they are technically capable of providing a specific service.[105] Energy Storage Association asserts that such a process must be transparent and documented to create more certainty for new resources and to ensure that all resources that are technically capable of providing a particular service can do so.

c. Commission Determination

76. In this Final Rule, we adopt the NOPR proposal and add section 35.28(g)(9)(i)(a) to the Commission's regulations to require 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. To provide clarity, we add the phrase "technically capable of providing" to the regulatory text we proposed in the NOPR. To be eligible to provide capacity, energy, and ancillary services, a resource using the participation model for electric storage resources will still need to meet the technical requirements for any of the services that it wants to provide. We recognize that the RTOs/ISOs have ongoing efforts to enhance opportunities for electric storage resources to participate in their markets and encourage

[105] *See* Energy Storage Association Comments at 10-11.

each RTO/ISO to build upon these efforts when developing tariff revisions to comply with this Final Rule.

77. In response to ISO-NE, we clarify that each RTO/ISO is required to revise its tariff to allow a resource using the electric storage resource participation model to be eligible to provide a service only if that resource is technically capable of doing so. To the extent that an RTO/ISO has developed a standard set of technical requirements that all resources must meet to provide a given service, those requirements would also apply to a resource using the electric storage resource participation model if it wants to provide that service.

In response to ISO-NE and SPP, we clarify that "technically capable" of providing a service means that a resource can meet all of the technical, operational, and/or performance requirements that are necessary to reliably provide that service. For example, these requirements may include a minimum run-time to provide energy or the ability to respond to automatic generation control to provide frequency regulation. While we are clarifying the definition of "technically capable" here, we note that we are not considering in this proceeding the requirements that determine whether resources are technically capable of providing individual wholesale services.[106]

[106] To the extent that an RTO/ISO seeks to revise its tariff provisions setting forth the technical requirements for providing any specific wholesale service, the RTO/ISO may propose such revisions to its tariff through a separate FPA section 205 filing. *See* 16 U.S.C. § 824d.

78. We decline to adopt APPA/NRECA's suggestion that the Commission give each RTO/ISO flexibility to demonstrate on compliance the extent to which an electric storage resource may not be technically capable of providing a given service reliably, efficiently, and cost-effectively. Each individual electric storage resource must still meet the technical requirements of providing any specific service, which would be determined by the RTO/ISO on a case-by-case basis.

79. As part of the requirement that each RTO/ISO develop a participation model for electric storage resources that allows electric storage resources to be eligible to provide services in all of its capacity, energy, and ancillary service markets, we also require that such participation model allow electric storage resources to be eligible to provide services that the RTOs/ISOs do not procure through an organized market mechanism (such as blackstart service, primary frequency response service, and reactive power service) if they are technically capable of providing those services. As noted above, we are not requiring each RTO/ISO to revise or revisit the technical requirements or compensation provisions of those markets.

80. We will not require the RTOs/ISOs to establish new processes through which a resource using the participation model for electric storage resources can demonstrate that it is technically capable of providing a specific service in their markets. The RTOs/ISOs already have technical requirements and testing procedures in place to ensure that market participants can provide the particular services that they seek to provide. We expect that these requirements and procedures will apply to resources using the electric storage resource participation model, just as they do to all other resources. However, as part of

developing a participation model for electric storage resources, we encourage each RTO/ISO to consider whether any modifications or additions to the existing technical requirements, testing protocols, or other qualification procedures are necessary to facilitate the participation of electric storage resources in its markets.

2. Ability to De-Rate Capacity to Meet Minimum Run-Time Requirements

a. NOPR Proposal

81. In the NOPR, the Commission proposed to require each RTO/ISO to revise its tariff to clarify that an electric storage resource may de-rate its capacity to meet minimum run-time requirements to provide capacity or other services.[107] In RTOs/ISOs with capacity markets, the Commission proposed that the de-rated capacity value for electric storage resources be consistent with the quantity of energy that must be offered into the day-ahead energy market for resources with capacity obligations.

b. Comments

82. Many commenters generally support the proposal to require each RTO/ISO to revise its tariff to clarify that an electric storage resource may de-rate its capacity to meet minimum run-time requirements to provide capacity or other services.[108] Additionally,

[107] *See* NOPR, FERC Stats. & Regs. ¶32,718 at P 49.

[108] *See, e.g.*, AES Companies Comments at 16; Avangrid Comments at 5; City of New York Comments at 6-7; Energy Storage Association Comments at 8; Minnesota Energy Storage Alliance Comments at 3; MISO Comments at 12; NESCOE Comments at 10-11; NRG Comments at 14-15; R Street Institute Comments at 5; Xcel Energy Services Comments at 21.

while many commenters either support or do not oppose the NOPR proposal, multiple entities request that the Commission clarify the proposal or raise specific issues about the proposal and its interaction with the RTO/ISO markets.

83. Multiple commenters raised issues surrounding performance requirements for electric storage resources in the RTO/ISO markets.[109] NRG agrees that the final rule should allow flexibility to de-rate in capacity markets but argues that the Commission should clarify that electric storage resources participating in capacity markets must meet the same performance metrics and criteria as other resources. American Petroleum Institute similarly supports allowing electric storage resources to de-rate to meet their capacity requirements but asserts that this should not affect the ability of these resources to participate in energy and ancillary services markets up to their nominal capacity. American Petroleum Institute also contends that electric storage resources should be subject to the same penalties for non-performance as generators and demand response.

84. Some entities raise issues about the interaction of the Commission's de-rating proposal with resource obligations.[110] Both Avangrid and EEI seek clarification that the proposal is intended to ensure that the resource's de-rate is consistent with obligations that the resource has in organized wholesale markets. AES Companies note that, because some electric storage resources may only provide wholesale services when there

[109] *See, e.g.*, AES Companies Comments at 17; American Petroleum Institute Comments at 7-8; NRG Comments at 15.

[110] *See, e.g.*, Avangrid Comments at 5; EEI Comments at 7; Xcel Energy Services Comments at 21-22.

is excess available after serving retail load, their nameplate capacity may not be the same as the capacity available for wholesale services and would need to be reduced by the capacity reserved for providing retail services. Xcel Energy Services agrees that resources must reserve sufficient capacity to meet any applicable capacity obligations, but it also notes that there are regional differences in how capacity obligations are treated (e.g., CAISO does not "count" storage capacity, while other RTOs/ISOs have a four-hour run-time requirement).

85. Energy Storage Association raises concerns regarding the Commission's proposal that the de-rated capacity value for an electric storage resource should be consistent with the quantity of energy that must be offered into the day-ahead energy market for resources with capacity obligations.[111] Energy Storage Association asserts that, because some RTOs/ISOs explicitly exempt electric storage resources from a day-ahead energy market must-offer obligation, there would not be a basis for determining a storage resource's capacity value. Instead, Energy Storage Association recommends that RTOs/ISOs assign electric storage resources a capacity value based on the quantity of energy that they can discharge continuously over the minimum run-time set by the RTO/ISO. SPP also supports the ability to de-rate the maximum capacity of an electric storage resource in order to qualify for provision of other products but requests that the Commission find that a storage resource de-rating its capacity to meet minimum run-

[111] *See* Energy Storage Association Comments at 8-9.

time requirements is not physical withholding.[112]

86. Several other commenters consider the interaction between the Commission's de-rating proposal and market power issues.[113] For example, EEI asserts that the RTO/ISO or market monitor would need to verify minimum run-times and parameters to ensure that there is a reasonable basis for the de-rate. Exelon agrees that electric storage resources should be treated the same as generators providing capacity, which can de-rate, and states that the market monitor can investigate a market participant if there is a concern about an exercise of market power. NYISO also raises general concerns about market power issues, asking the Commission to consider the potential market power implications of allowing a resource to hold back energy through its offer, even if its intent is to discharge the energy at a later time.

87. Other commenters consider whether electric storage resources need to de-rate in all circumstances.[114] For example, California Energy Storage Alliance asks the Commission to confirm that shorter-duration electric storage resources should be eligible to participate in the markets and provide services, when reasonable, without de-rating. California Energy Storage Alliance argues that each RTO/ISO should make determinations regarding de-rating capacity based on market needs. CAISO contends

[112] *See* SPP Comments at 7.

[113] *See, e.g.*, EEI Comments at 7; Exelon Comments at 7; NYISO Comments at 7.

[114] *See, e.g.*, CAISO Comments at 6; California Energy Storage Alliance Comments at 10-11.

that the Commission should not require any specific outage rules for electric storage resources and that the general outage management rules that apply to all other resources in individual RTO/ISO markets should also apply to electric storage resources.

88. EPRI raises concerns about the effectiveness of the Commission's proposal. EPRI asserts that the Commission's de-rating proposal is potentially an improved approximation of an electric storage resource's capacity value.[115] However, EPRI states that the proposal may not be entirely accurate because it assumes that an electric storage resource would contribute less than its maximum capacity to provide energy across the entire four-hour minimum duration required for providing capacity in many RTOs/ISOs. EPRI asserts that, during periods where the RTO/ISO requires maximum capacity, an electric storage resource with a two-hour duration at maximum discharge may exhaust all energy production during the first two hours. EPRI argues that the Commission's proposal also does not guarantee that an electric storage resource will have full energy levels when the maximum capacity period begins. EPRI contends that, where the load typically peaks during just one hour of the highest load days, an electric storage resource with less than the minimum duration requirement of the capacity market may actually be providing greater capacity value than the proposed de-rated value. EPRI asserts that, depending on the ability of an electric storage resource to provide capacity when its duration of energy storage is less than the minimum duration requirement of the capacity market, must-offer rules for the day-ahead energy market must be fairly determined.

[115] *See* EPRI Comments at 12-13.

EPRI adds that the hours which an electric storage resource must bid as an injector of energy per day and how much capacity it must bid for those days must be determined. EPRI adds that those rules should be consistent with other principles of must-offer rules for capacity providers and ensure that they lead to the electric storage resource's ability to perform during critical peak conditions.

89. Several commenters consider whether reforms beyond the Commission's proposal are needed. For example, some commenters argue for either exempting electric storage resources from minimum run-time requirements in some circumstances or developing new capacity products with shorter minimum run-time requirements.[116] Alevo argues that the Commission should require each RTO/ISO to have additional capacity market products that better reflect the capabilities of electric storage resources because minimum run-time requirements present a barrier to electric storage resource participation in capacity markets. R Street Institute states that capacity products and performance requirements may not be well-suited to extracting the full economic value of electric storage resources for resource adequacy purposes. R Street Institute states that these rules can create barriers to capacity market participation for electric storage resources but, at the same time, relaxing them too aggressively may raise reliability concerns. R Street Institute further explains that it may be useful for capacity constructs to distinguish between short- and long-duration resource needs. R Street Institute encourages the Commission to seek additional detailed comments on

[116] *See, e.g.*, Alevo Comments at 8; R Street Institute Comments at 5.

methodologies for electric storage resources to participate in capacity markets, stating that reforms may be best left to individual RTO/ISO compliance filings or individual RTO/ISO proceedings.

90. NextEra asserts that, in most RTOs/ISOs, reserve product commitment requirements systematically discriminate against electric storage resources by restricting their ability to offer their full capacity into the market and that de-rating capacity to meet existing requirements diminishes the value of electric storage resources and arbitrarily restricts competition.[117] In contrast, EPRI contends that each RTO/ISO should perform additional analysis to provide guidance on the amount of capacity that can be relied upon from limited-duration electric storage resources for particular services in each market.[118]

91. A few commenters address the must-offer requirements that are often associated with a resource's capacity supply obligation.[119] Energy Storage Association argues that electric storage resources should be exempt from, or otherwise allowed to manage, must-offer obligations. Advanced Energy Economy argues that must-offer requirements fail to account for the physical and operational characteristics of electric storage resources and arbitrarily exclude them from providing wholesale services that they are technically capable of providing. Advanced Energy Economy asserts that must-offer requirements

[117] *See* NextEra Comments at 7.

[118] *See* EPRI Comments at 12-13.

[119] *See, e.g.*, Advanced Energy Economy Comments at 25-26, 28-29; AES Companies Comments at 16-17; Energy Storage Association Comments at 6, 12.

were developed to prevent the exercise of market power and electric storage resources have no incentive or ability to exercise market power.

92. AES Companies claim that it may be necessary to modify RTO/ISO must-offer requirements to allow electric storage resources to participate in capacity markets while also providing non-dispatched services (such as primary frequency response and voltage control). AES Companies add that most must-offer requirements apply to a capacity resource during all dispatch intervals, even though specific services may only be needed for a set number of hours in a day.

c. Commission Determination

93. To implement section 35.28(g)(9)(i)(a) of the Commission's regulations, in this Final Rule, we adopt the NOPR proposal, as modified and clarified below, to require each RTO/ISO to revise its tariff to allow electric storage resources to de-rate their capacity to meet minimum run-time requirements. We find that allowing resources using the participation model for electric storage resources to de-rate their capacity to meet minimum run-time requirements to provide capacity or other services will help to ensure that electric storage resources are eligible to provide all services that they are technically capable of providing by taking into account their physical and operational characteristics, while still maintaining the quality and reliability of services they seek to provide. For example, 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.

94. We also clarify several aspects of the NOPR proposal in response to commenters. In response to NRG, we clarify that this Final Rule does not exempt electric storage resources that participate in RTO/ISO capacity markets from meeting the performance metrics and criteria that apply to all other resources that participate in those markets. In fact, along with other requirements in this Final Rule that require an RTO's/ISO's participation model for electric storage resources to account for the physical and operational characteristics of electric storage resources,[120] allowing electric storage resources to de-rate their capacity to meet minimum run-time requirements should make it possible for energy-limited electric storage resources to satisfy relevant performance metrics in the RTO/ISO markets. In response to American Petroleum Institute, we clarify that this Final Rule does not exempt an electric storage resource that is participating in RTO/ISO capacity markets from any applicable penalties for non-performance.

95. In response to SPP, we clarify that an electric storage resource de-rating its capacity to provide capacity or other services is not engaging in physical withholding if it is de-rating to meet minimum run-time requirements. In the case of an electric storage

[120] *See, e.g.*, Physical and Operational Characteristics of Electric Storage Resources and State of Charge Management sections, *infra* PP 186-190, 246-252.

resource that de-rates its capacity to meet minimum run-time requirements, this resource would be de-rating its capacity for true and verifiable technical reasons pertaining to the market rules for providing various services. However, as the Commission has previously explained, physical withholding may include a market participant declaring that an electric facility has been de-rated, forced out of service, or otherwise been made unavailable for technical reasons that are unrelated to physical or legitimate commercial issues or that cannot be verified.[121] Thus, we find that each RTO/ISO may request that its market monitor verify whether an electric storage resource de-rated its capacity to meet a minimum run-time requirement to ensure that these resources are not engaging in physical withholding, as defined by the Commission.

96. Additionally, while commenters do not specifically describe any market power concerns outside the context of physical withholding, to the extent that market power concerns arise as a result of electric storage resources de-rating capacity to provide capacity or other services, each RTO/ISO may consider whether it is appropriate to

[121] *See Sw. Power Pool, Inc.*, 141 FERC ¶ 61,048, at P 451 (2012), *order on reh'g*, 142 FERC ¶ 61,205 (2013). Other examples of physical withholding that the Commission has identified, which we do not believe apply to de-rating to meet minimum run-time requirements, include: (1) refusing to provide offers or schedules for an electric facility when it is required to offer into the market when it would otherwise have been in the economic interest to do so without market power; (2) operating a generation resource in real time to produce an output level that is less than dispatch targets; (3) de-rating a transmission facility or interface for technical reasons that are not true or verifiable; (4) operating a transmission facility in a manner that is not economic and that causes a binding transmission constraint or binding reserve zone constraint or local reliability issue; and (5) declaring that the capability of resources to provide energy or operating reserves is reduced for reasons that are not true or verifiable. *Id*.

update and/or apply existing market power mitigation processes to electric storage resources to alleviate market power concerns.

In response to California Energy Storage Alliance, we agree that electric storage resources may provide services in the RTO/ISO markets without de-rating so long as they meet the requirements to provide the particular service that they seek to provide. We also clarify that this Final Rule does not require any specific outage rules for electric storage resources.

97. Further, upon consideration of the comments, we clarify the part of the NOPR proposal stating that the de-rated capacity value for electric storage resources should be consistent with the quantity of energy that must be offered into the day-ahead energy market for resources with capacity obligations. Several commenters suggest that there may be reasons why the de-rated capacity value for electric storage resources might not be consistent with the quantity of energy that must be offered into the day-ahead energy market. For example, an electric storage resource may choose to de-rate to reflect its capacity interconnection rights; to reserve capacity for providing retail services; or because system operators may need the full capacity of electric storage resources based on real-time system conditions.[122] We find these points compelling. We also agree with Xcel Energy Services that the rules governing must-offer quantities vary between RTOs/ISOs and with Energy Storage Association that where electric storage resources

[122] *See, e.g.*, AES Companies Comments at 16-17; Avangrid Comments at 5; Energy Storage Association Comments at 8-9; EPRI Comments at 12-13.

do not have a must-offer obligation the de-rated quantity cannot be tied to such an obligation. We therefore provide each RTO/ISO flexibility either to use its existing rules for must-offer quantities or to modify its existing rules as necessary to reflect the physical and operational characteristics of electric storage resources. However, in response to Avangrid and EEI, we clarify that, if an electric storage resource elects to de-rate its capacity, it must not de-rate its capacity below any capacity obligations it has assumed, such as any applicable must-offer requirement. We also agree with Energy Storage Association that the de-rated quantity should be based on the quantity of energy that an electric storage resource can discharge continuously over the minimum run-time set by the RTO/ISO.

98. In response to those commenters suggesting that the RTO/ISO resource adequacy constructs provide accommodations for electric storage resources, we will not require the RTOs/ISOs to make specific changes to minimum run-time or must-offer requirements associated with providing capacity. While we agree with commenters that some of the requirements to participate in the resource adequacy constructs of the RTOs/ISOs may limit the ability of electric storage resources to participate, there is significant variation in how each RTO/ISO approaches resource adequacy. Thus, we do not believe it is appropriate to establish one standard approach to this issue in the RTO/ISO markets. However, we do find that it is important for electric storage resources that can provide value in those resource adequacy constructs to be eligible to participate. Therefore, in the interest of preserving flexibility for the RTOs/ISOs to address this issue given their unique resource adequacy constructs, we require each RTO/ISO to demonstrate on

compliance with this Final Rule that its existing market rules provide a means for electric storage resources to provide capacity. If an RTO/ISO does not have existing tariff provisions that enable electric storage resources to provide capacity, such as the RTO/ISO tariff provisions described below, we require the RTO/ISO to propose such rules on compliance with this Final Rule.

99. To provide guidance for this requirement, we note that several of the RTOs/ISOs already have developed rules that allow energy-limited resources to provide capacity. Some of these market rules explicitly facilitate the participation of electric storage resources. For example, NYISO has an Energy Limited Resource model that facilitates the participation of electric storage resources in the capacity market by limiting their commitments to one four-hour interval per day, while CAISO requires that flexible resource adequacy resources be available only during peak hours. Other RTOs/ISOs rely on opportunity costs in incremental energy offer reference levels, allowing for a resource to reflect its energy-limited nature through high offers in the energy market that make it unlikely to be dispatched. For example, ISO-NE's tariff allows opportunity costs included in an incremental energy reference level based on costs associated with complying with emissions limits, water storage limits, and other operating permits that limit production of energy.[123] While some of these market rules may apply to resources using the participation model for electric storage resources, we require each RTO/ISO to demonstrate how such rules are applicable to resources using the participation model for

[123] ISO-NE Tariff, Market Rule 1, Appendix A, § III.A.7.5.1.

electric storage resources on compliance with this Final Rule.

3. Energy Schedule Requirement for Provision of Ancillary Services

a. NOPR Request for Comments

100. In the NOPR, the Commission stated that electric storage resources tend to be capable of faster start-up times and higher ramp rates than traditional synchronous generators and are therefore able to provide ramping, spinning, and regulating reserve services without already being online and running.[124] However, the Commission acknowledged that the RTOs/ISOs that co-optimize energy and ancillary services dispatch and pricing may condition eligibility to provide ancillary services on having an energy schedule.[125] The Commission therefore sought comment on whether the requirement to have an energy schedule to provide ancillary services could be adjusted so that electric storage resources and other technically-capable resources could participate in the ancillary service markets independent of offering energy to the RTO/ISO.

101. Specifically, the Commission sought comment on whether dispatch and pricing of energy and ancillary services would be internally consistent if a resource were not required to offer to provide energy in order to offer to provide ancillary services. Further, the Commission sought comment on whether the capability of resources to provide an ancillary service absent an energy schedule can be determined in the regular performance

[124] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 50.

[125] *See id*. P 51.

tests that the RTO/ISO conducts and whether a resource's start-up time and ramp capability are generally represented in bidding parameters and would adequately guarantee the resource's ability to provide other services absent energy market participation. Finally, the Commission sought comment on the extent of software changes necessary to factor the elimination of such an energy schedule requirement into the RTO/ISO co-optimization models.

b. Comments

102. A number of commenters agree that the RTOs/ ISOs should base a market participant's eligibility to provide a particular ancillary service on its ability to provide services when called upon, rather than whether it is online and synchronized to the grid.[126] They argue that the requirement to have an energy schedule to provide ancillary services is no longer technically necessary. For example, Advanced Energy Economy and Efficient Holdings state that electric storage resources are able to provide services such as primary frequency response, even while they are charging and unable to supply energy. Altametric and Energy Storage Association explain that an electric storage resource's start-up time and ramp capability are generally represented in bidding parameters, adequately guaranteeing the resource's ability to provide other services absent energy market participation. Altametric adds that an RTO/ISO can validate a

[126] *See, e.g.*, Advanced Energy Economy Comments at 26-27; Altametric Comments at 6; Beacon Power Comments at 3-4; Efficient Holdings Comments at 13-14; Energy Storage Association Comments at 10, 12-13; NRG Comments at 15-16; Pacific Gas & Electric Comments at 8.

resource's ability to provide ancillary services through its regular performance, while Energy Storage Association, NRG, and Pacific Gas & Electric contend that periodic performance testing is sufficient. Beacon Power notes that regulation resources are already required to undergo performance testing in PJM, with no requirement that they participate in the energy market.

103. A few commenters address the benefits of removing any requirement to have an energy schedule to provide ancillary services.[127] Specifically, Efficient Holdings, Energy Storage Association, and Magnum argue that removing any such requirement would eliminate a barrier to some electric storage resources' ability to provide ancillary services because they are energy-limited, increasing competition. Similarly, Starwood Energy states that electric storage resources should be allowed to participate in the ancillary service markets regardless of whether they offer energy to the RTO/ISO.

104. Energy Storage Association and Research Scientists opine that it is feasible for RTOs/ISOs to remove any requirement to have an energy schedule to provide ancillary services.[128] Energy Storage Association and Research Scientists argue that, even if an electric storage resource is allowed to provide ancillary services without an energy schedule, dispatch and pricing of energy and ancillary services can be co-optimized and will be internally consistent. However, Research Scientists also note that whether an

[127] *See., e.g.*, Efficient Holdings Comments at 13-14; Energy Storage Association Comments at 12; Magnum Comments at 10; Starwood Energy Comments at 6.

[128] *See* Energy Storage Association Comments at 12-13; Research Scientists Comments at 5-6.

electric storage resource offers to provide energy may influence market outcomes, as an energy offer represents a resource's opportunity cost of providing ancillary services under the market clearing optimization algorithm. Energy Storage Association adds that, just as some resources currently provide only energy, RTOs/ISOs can manage resources that provide only ancillary services because they will receive enough information about electric storage resources' capability to provide ancillary services through their bidding parameters and through regular performance tests.

105. In contrast, EPSA/PJM Power Providers and NRG contend that, if the Commission requires each RTO/ISO to remove any requirement that a resource have an energy schedule to provide ancillary services, the Commission should require each resource that seeks to provide ancillary services to provide economic offers into the energy market.[129] They argue that such offers are necessary to allow for the co-optimization of energy and ancillary services markets and to price the provision of ancillary services.

106. While not opining on whether the Commission should require each RTO/ISO to remove any requirement to have an energy schedule to provide ancillary services from its tariff, MISO Transmission Owners comment on the ability of resources to provide ancillary services without an energy schedule.[130] MISO Transmission Owners claim that whether a resource can provide ancillary services without an energy schedule depends on the particular electric storage technology, the service being offered, and the ability of the

[129] *See* EPSA/PJM Power Providers Comments at 17; NRG Comments at 15-16.

[130] *See* MISO Transmission Owners Comments at 9.

resource to respond within the timeframe established for that service. Similarly, EPRI and Research Scientists assert that electric storage resources that transition from charge to discharge slowly (e.g., pumped-hydro resources) are unlikely to be able to provide certain ancillary services without an energy schedule, while electric storage resources that transition from charge to discharge and change operating levels quickly can.[131]

107. While Xcel Energy Services agrees that resources do not necessarily need to be synchronized to the grid to provide ancillary services, it argues that RTOs/ISOs must establish response time requirements to ensure that all resources provide those services within an adequate timeframe.[132] Xcel Energy Services further notes that to provide some services, such as voltage support, resources do not need to submit an energy offer. Xcel Energy Services concludes that the larger issue is the capability of co-optimization software to evaluate the option between dispatching an electric storage resource to charge or discharge.

108. MISO, PJM, and SPP do not opine on whether the Commission should require each RTO/ISO to remove any requirement that a resource have an energy schedule to provide ancillary services, although MISO and SPP present considerations for the Commission to evaluate should it move forward on this issue, each discuss the feasibility of removing

[131] *See* EPRI Comments at 14-15; Research Scientists Comments at 5.

[132] *See* Xcel Energy Services Comments at 22.

any such requirement for some services.[133] For example, PJM notes that it already allows market participants to offer to provide ancillary services without a corresponding energy offer and that no further software changes are needed to effectuate this outcome.[134] Likewise, MISO notes that, under its Stored Energy Resource model, the Stored Energy Resource submits regulation offers but not energy offers, illustrating the potential for resources to provide ancillary services without an energy schedule. SPP states that it allows a resource that is not online or synchronized to provide supplemental reserves. SPP also explains that a resource that is not qualified to provide energy can participate in the regulation market; however, that resource would not be eligible to set the price in the energy market, and its output could not be substituted for contingency reserves.

109. While MISO agrees that electric storage resources that can start rapidly should not be required to be online and synchronized to provide ancillary services, it contends that an RTO must review and address its system limitations to ensure that it can handle such resources' fast start and ramp capabilities before removing any such requirement. According to MISO, reflecting an electric storage resource's start-up time and ramp capabilities in the clearing engine is feasible but would require extensive system and software changes. For an electric storage resource that is managing its own state of charge, MISO states that it would need the resource's energy schedule and dispatch range

[133] *See* MISO Comments at 12-14; PJM Comments at 17; SPP Comments at 8-9.

[134] *But see* NextEra Comments at 7, n.8 (asserting that this option is only available in PJM for regulation service).

to ensure that it dispatches the resource to provide ancillary services within that resource's physical limits. MISO further contends, however, that if it were managing an electric storage resource's state of charge, it would need to receive offers for all ancillary services that the resource seeks to provide and that, absent an energy offer, the optimization model would need to assume that the resource is a price taker in the energy market if that maximizes its profit from providing ancillary services.

110. SPP asserts that any change to an energy schedule requirement for providing spinning reserve needs to involve the North American Electric Reliability Corporation (NERC) because NERC defines spinning reserves as a resource that is synchronized and spinning.

111. AES Companies argue that, rather than adopting any prescriptive requirement in a final rule, the Commission should allow each RTO/ISO to determine whether it can remove or modify any tariff provision or business practice that requires a resource to have an energy offer or schedule to provide a specific ancillary service, given their differing operational characteristics and needs.[135] That said, AES Companies note that some RTOs/ISOs permit demand response resources to provide certain ancillary services without providing energy and that it is important to remove barriers to the provision of essential reliability services. AES Companies also mention that periodic testing of resources is sufficient to determine their ability to provide ancillary services but that testing and measurement procedures may vary by technology.

[135] *See* AES Companies Comments at 17-19.

112. R Street Institute asserts that, unless they have a must-offer energy obligation, electric storage resources should not have to submit an energy schedule to participate in ancillary service markets.[136] However, R Street Institute contends that, before requiring each RTO/ISO to remove any requirement that a resource must have an energy schedule to provide ancillary services, the Commission should weigh the costs of any software changes necessary to implement such a requirement against its projected benefits.

113. CAISO, ISO-NE, and NYISO state that the Commission should not require each RTO/ISO to remove any requirement that a resource have an energy offer or schedule to provide ancillary services.[137] They state that their markets cannot accommodate resources that seek to provide ancillary services without offering energy as well. Specifically, they contend that all other resource types must submit an energy offer or schedule to provide ancillary services because it is necessary to allow them to co-optimize their energy and ancillary services markets. They argue that, without such a requirement, an RTO/ISO may dispatch a resource to provide ancillary services when it would have been more economically efficient to dispatch the resource to provide energy or may not be able to determine which resource(s) that have cleared as reserves it would be most economically efficient to dispatch for energy when contingencies arise. They

[136] *See* R Street Institute Comments at 4.

[137] *See* CAISO Comments at 7-8; ISO-NE Comments at 15-17; NYISO Comments at 7-9.

contend that removing this requirement would therefore decrease overall market efficiency, increasing costs to consumers and uplift costs.

114. In terms of the technical difficulties of removing the requirement that a resource have an energy schedule to provide ancillary services, EPRI notes that some RTOs/ISOs require zero-cost offers for certain ancillary services in the real-time market.[138] EPRI states that prices for these ancillary services are based on the opportunity costs that the marginal ancillary service provider incurs to provide ancillary services instead of energy. Energy Storage Association and EPRI contend that, without providing an energy offer, an electric storage resource will not have a lost opportunity cost.[139] EPRI notes that therefore the electric storage resource will not be able to set the price at a non-zero value when it is the marginal resource providing ancillary services.

115. Guannan He argues that there is no need for the Commission to require each RTO/ISO to remove any requirement that a resource have an energy schedule to provide ancillary services if electric storage resources specify through their energy schedules when they are online or offline.[140]

116. While Advanced Energy Economy and Electric Vehicle R&D Group argue that the Commission should require each RTO/ISO to remove any requirement that an electric

[138] *See* EPRI Comments at 15.

[139] *See* Energy Storage Association Comments at 12; EPRI Comments at 15;

[140] *See* Guannan He Comments at 1-2.

storage resource have an energy schedule to provide ancillary services, they state that, if the Commission decides to retain the requirement, the Commission should make certain clarifications in the final rule or require each RTO/ISO to revise its existing market rules with respect to the provision of ancillary services.[141] Specifically, Advanced Energy Economy argues that the Commission should require each RTO/ISO to revise its tariff to allow an electric storage resource to account for its charge and discharge parameters. In addition, Advanced Energy Economy states that the Commission should provide assurances that an electric storage resource that manages its state of charge through energy offers will not be mitigated or deemed engaged in withholding. Electric Vehicle R&D Group argues that electric storage resources should be allowed to set their energy schedule to zero or a small negative number to compensate for losses.

c. Commission Determination

117. Upon consideration of the comments, we will not require each RTO/ISO to modify rules requiring resources to have an energy schedule to participate in the ancillary service markets. While some electric storage resources may be technically capable of providing ancillary services without an energy schedule and could represent those capabilities in their bidding parameters and performance tests, we are persuaded by commenters that requiring the RTOs/ISOs to adjust the requirement to have an energy schedule to provide ancillary services could result in less efficient dispatch, potentially

[141] *See* Advanced Energy Economy Comments at 27; Electric Vehicle R&D Group Comments at 1.

increasing costs. Moreover, we recognize the importance of co-optimization in clearing and dispatch software and appreciate that the RTOs/ISOs have developed different, individual approaches to co-optimizing their energy and ancillary service markets. Upon consideration of the comments, we do not find, on a generic basis, that a requirement to have an energy schedule to participate in the ancillary service markets is necessarily an unreasonable requirement for the participation of electric storage resources in those markets because such a requirement may be necessary to support economically efficient dispatch within a particular RTO/ISO market.

118. However, we agree with commenters that some fast-responding electric storage resources are technically capable of providing ancillary services without an energy schedule. We also acknowledge that some RTO/ISO market rules already allow resources to provide some ancillary services, namely regulation, without the requirement to participate in the energy market. Such opportunities for participation in certain ancillary service markets without an energy schedule suggest that there may be instances (i.e., for certain ancillary services in certain RTO/ISO markets) in which allowing a resource to provide an ancillary service without an energy schedule may enhance market efficiency. Therefore, we encourage each RTO/ISO to consider whether fast-responding electric storage resources may be able to provide certain ancillary services in its markets without an energy schedule.

4. NERC Definitions

a. NOPR Request for Comment

119. In the NOPR, the Commission noted that it appears that some of the Glossary of Terms definitions used in NERC reliability standards were created for synchronous generation.[142] Therefore, the Commission sought comment on whether and to what extent the Commission-approved NERC Glossary of Terms and associated reliability standards or regional reliability requirements may create barriers to the participation of electric storage resources or other non-synchronous technologies in the RTO/ISO markets.

b. Comments

120. Several commenters argue that the NERC reliability standards and regional reliability requirements do not present a barrier to electric storage resources participating in wholesale electric markets.[143] Both AES Companies and EEI note, however, that modifications to the reliability standards may be appropriate in the future. NERC argues that its reliability standards are technology neutral and provide the responsible entity, usually the balancing authority, with flexibility to meet their performance-based requirements.[144] Furthermore, Imperial Irrigation District and NERC point to an

[142] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 52.

[143] *See* AES Companies Comments at 24; CAISO Comments at 8; EEI Comments at 8; NERC Comments at 2.

[144] *See* NERC Comments at 4-5.

interpretation of regional Reliability Standard BAL-002-WECC-2 that acknowledges that non-traditional resources, including electric storage resources, are capable of meeting the operating reserves-spinning requirement of the regional standard.[145]

121. Other commenters contend that it may be appropriate to revise the NERC Glossary of Terms to ensure that the definitions reflect the physical and operational characteristics of electric storage resources and other non-synchronous technologies.[146] NESCOE contends that certain definitions in the NERC Glossary of Terms may limit electric storage resources' participation in the reserves markets, while Massachusetts State Entities assert that Northeast Power Coordinating Council rules, which Massachusetts State Entities do not specifically identify, may prohibit inverter-based resources, including electric storage resources, from providing spinning reserves. Exelon notes that the NERC definitions were written before the development of electric storage resources and if those definitions or reliability standards are being read to exclude certain resources, then those definitions or reliability standards should be carefully reviewed to determine whether the exclusionary language is necessary for purposes of reliability.

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[145] *See* Imperial Irrigation District Comments at 4; NERC Comments at 6 (citing *N. Am. Elec. Reliability Corp.*, Docket No. RD17-3-000 (Jan. 24, 2017) (delegated letter order)).

[146] *See, e.g.*, ELCON Comments at 5, 9-10 (citing the NOPR's summary of comments that asserted, for example, that the NERC Glossary's definitions of Spinning Reserves and Operating Reserve-Spinning may be barriers to non-synchronous resources seeking to provide reserve products; *see, e.g.*, NOPR, FERC Stats. & Regs. ¶ 32,718 at P 44); EPRI Comments at 15-16; Exelon Comments at 7-8; Massachusetts State Entities Comments at 15-16; MISO Comments at 14; National Hydropower Association Comments at 8; NYISO Comments at 7; Tesla/SolarCity Comments at 12-14.

122. Tesla/SolarCity suggest that (1) NERC should modify the definitions of ancillary services in its Glossary of Terms to eliminate any apparent requirement that ancillary service providers must be "generation" or "synchronized;" (2) in its compliance filing, each RTO/ISO should identify any reliability standards that prevent it from making Commission-directed tariff changes to accommodate electric storage resource participation; and (3) the Commission should make clear in the final rule that reliability standards that were developed for or favor conventional generators without technical justification must be changed to allow the participation of all resources unless there are technical limitations.

123. EPRI discusses the following potential revision to the NERC Glossary of Terms. While EPRI notes that the NERC definition of Operating Reserve-Spinning includes the phrase "generation synchronized to the system," according to EPRI, resources providing spinning/synchronized reserves do not necessarily need to be synchronous resources but rather must be able to respond as soon as they are directed to do so. EPRI states that it would be useful to discuss this clarification with NERC and industry. SPP also notes that a spinning reserve product, by definition, means the resource must be synchronized and spinning.[147]

c. Commission Determination

124. Upon consideration of the comments, we find that the Commission-approved NERC reliability standards, the associated Glossary of Terms, and regional reliability standards

[147] *See* SPP Comments at 8.

do not create barriers to the participation of electric storage resources or other non-synchronous technologies in the RTO/ISO markets. We find persuasive NERC's argument that its reliability standards are technology neutral and provide electric storage resources with flexibility to meet their performance-based requirements. Moreover, no commenter has demonstrated that the NERC Glossary of Terms and associated reliability standards or regional reliability requirements preclude electric storage resources or other non-synchronous technologies from providing the services that they are technically capable of providing in the RTO/ISO markets.

D. Participation in the RTO/ISO Markets as Supply and Demand

1. Eligibility to Participate as a Wholesale Seller and Wholesale Buyer

a. NOPR Proposal

125. In the NOPR, the Commission proposed to require each RTO/ISO to revise its tariff to ensure that electric storage resources can be dispatched and can set the wholesale market clearing price as both a wholesale seller and wholesale buyer, consistent with existing rules that govern when a resource can set the wholesale price.[148] The Commission also proposed that, for a resource using the proposed participation model for electric storage resources to be able to set prices in the RTO/ISO markets as either a wholesale seller or a wholesale buyer, it must be available to the RTO/ISO as a

[148] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 81.

dispatchable resource.[149] This proposal included the requirements that the RTOs/ISOs accept wholesale bids from electric storage resources to buy energy so that the economic preferences of electric storage resources are fully integrated into the market, the electric storage resource can set the price as a load resource where market rules allow, and the electric storage resource can be available to the RTO/ISO as a dispatchable demand asset.[150] The Commission noted that these requirements must not prohibit electric storage resources from participating in the RTO/ISO markets as price takers, consistent with the existing rules for self-scheduled load resources. The Commission also proposed that resources using the participation model for electric storage resources be able to set the price in the capacity markets, where applicable.

126. Finally, the Commission sought comment on whether any existing RTO/ISO rules may unnecessarily limit the ability of resources using the participation model for electric storage resources to set prices in the RTO/ISO markets.[151]

b. Comments

i. Wholesale Seller/Wholesale Buyer

127. Numerous commenters agree with the Commission's proposal to require each RTO/ISO to permit electric storage resources to be able to be dispatched as both supply

[149] *See id*. P 84.

[150] *See id*. P 81.

[151] *See id*. P 84.

and demand and to set wholesale market clearing prices as both a wholesale seller and wholesale buyer.[152] Commenters state that this proposal appropriately recognizes the full bidirectional value of electric storage resources, their fast response times, and limited energy and allows for greater grid efficiency, greater competition, and downward pressure on wholesale prices and system costs.[153] Institute for Policy Integrity also argues that such participation could reduce peak energy costs by replacing inefficient thermal units, reduce price volatility by shifting load from peak to off-peak, improve overall reliability on the electric grid, and reduce the need for cost-intensive investment in electric transmission infrastructure.

128. Tesla/SolarCity add that, as more variable energy resources come online, the value of having dispatchable loads capable of setting market prices will become greater and this feature of the market will become increasingly valuable.[154] Research Scientists agree that the economic preferences of energy storage resources should be reflected in the market clearing as both load and supply, in line with other load resources in the

[152] *See, e.g.*, Efficient Holdings Comments at 17; Imperial Irrigation District Comments at 10-11; National Hydropower Association Comments at 9; NYPA Comments at 11; R Street Institute Comments at 6; Tesla/SolarCity Comments at 15.

[153] *See, e.g.*, Avangrid Comments at 7; Energy Storage Association Comments at 6-7, 17, 18; Imperial Irrigation District Comments at 11; Institute for Policy Integrity Comments at 3-4; SPP Comments at 13.

[154] *See* Tesla/SolarCity Comments at 15.

grid.[155] Magnum supports the ability of electric storage resources to participate as a dispatchable load but not if it precludes the generation function of its technology from participating in market opportunities because the two functions can occur simultaneously.[156]

129. Several RTOs/ISOs, including CAISO, ISO-NE, NYISO, and SPP, also express general support for the Commission's proposals.[157] MISO agrees that a resource optimized through the market clearing process should be allowed to set wholesale prices but states that determining the rules and conditions under which electric storage resources should be cleared and optimized in the markets will require significant time and resources.[158]

130. MISO Transmission Owners caution that state laws may affect an electric storage resource's status as a seller or buyer, arguing that states and distribution utilities should retain authority to manage this aspect of electric storage resources in their areas.[159] MISO Transmission Owners also assert that it is technologically challenging to enforce a requirement for a behind-the-meter electric storage resource to buy electricity at

[155] *See* Research Scientists Comments at 8.

[156] *See* Magnum Comments at 13.

[157] *See* CAISO Comments at 13; ISO-NE Comments at 21; NYISO Comments at 10; SPP Comments at 13.

[158] *See* MISO Comments at 7.

[159] *See* MISO Transmission Owners Comments at 11-12.

wholesale. Xcel Energy Services conditions its support upon resources being dedicated wholesale resources that do not have the ability to arbitrage wholesale and retail rates.[160] EEI supports the proposal on the condition that the Commission clarify that an electric storage resource bidding into the wholesale markets that is interconnected to the transmission system must charge at wholesale rates, while an electric storage resource interconnected to the distribution system must pay any applicable charges under state jurisdictional tariffs for its use of state jurisdictional facilities.[161]

131. While Open Access Technology conditionally supports the NOPR proposal, it requests that the Commission clarify whether a storage resource in charging mode is considered as negative demand response (i.e., load increase instead of load reduction).[162]

132. Several commenters state that electric storage resources should have the same ability as other resources to self-schedule within the requirements of the RTO/ISO and participate in the RTO/ISO markets as a price taker.[163] Energy Storage Association further recommends that the Commission clarify that the option to self-schedule should apply to storage resources both as buyers and as sellers and not just as "load resources."

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[160] *See* Xcel Energy Services Comments at 23.

[161] *See* EEI Comments at 12.

[162] *See* Open Access Technology Comments at 2.

[163] *See, e.g.*, APPA/NRECA Comments at 15-16; Avangrid Comments at 7; Energy Storage Association Comments at 18; NYISO Comments at 10; Tesla/SolarCity Comments at 15.

APPA/NRECA contend that, if electric storage resources are not permitted to participate as price takers on the same basis as any other self-scheduled resource, it will create a disincentive to load serving entity investment and utilization of electric storage resources, which will undermine the Commission's goals.

133. Dominion asserts that, in order to improve price transparency, the Commission should consider allowing a pumped-hydro resource to submit its dispatch cost to the RTO while preserving its right to self-schedule in the real-time market.[164] While MISO Transmission Owners generally support the Commission's proposal to allow electric storage resources to participate as a wholesale buyer and seller, they state that it is important to consider any unintended consequences regarding an electric storage resource owner's ability to self-schedule the unit if needed to meet load demand conditions and maintain power quality and reliability.[165] NYISO points out that self-schedule offers will not allow the resource to participate as a supply and demand resource simultaneously because self-schedule offers indicate the resource's desired schedule.[166] AES Companies argue that the Commission should not require the RTOs/ISOs to allow electric storage resources to be price takers; rather, this should be an RTO/ISO-specific decision because the markets are different and the decision to self-

[164] *See* Dominion Comments at 6.

[165] *See* MISO Transmission Owners Comments at 11.

[166] *See* NYISO Comments at 10.

schedule may have unintended consequences and could skew market results.[167]

ii. Dispatchability

134. Some commenters support the Commission's proposal that an electric storage resource must be available to the RTO/ISO as a dispatchable resource to set prices in the RTO/ISO markets.[168] EPRI asserts that, assuming an energy storage resource is dispatchable with a range of output, it should have no limitations to setting the price as either a wholesale seller or a wholesale buyer when it is marginal.

135. SPP states that, while any resource type may set the price for any product that the resource is qualified to provide and offers to provide in the market, the resource must be dispatchable and must have available range to provide the system's marginal MW.[169]

iii. Limitations on Price Setting

136. Generally, the RTOs/ISOs do not believe that their rules limit the ability of an electric storage resource to set prices.[170] SPP adds that, other than dispatchability and range requirements described in the preceding section, it does not have restrictions that would unnecessarily limit the ability of any resource type, including electric storage resources, to set price. MISO states that it is unaware of any rules that limit the ability of

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[167] *See* AES Companies Comments at 25.

[168] *See, e.g.*, EPRI Comments at 24; Imperial Irrigation District Comments at 11; Starwood Energy Comments at 6.

[169] *See* SPP Comments at 15.

[170] *See, e.g.*, ISO-NE Comments at 21; MISO Comments at 18; PJM Comments at 18; SPP Comments at 15.

pumped-hydro resources to set prices in its markets. MISO also states that stored energy resources provide only regulation and are price-takers for energy. MISO recommends studying the basic participation model(s) for electric storage resources in more detail before identifying any necessary adjustments to an RTO/ISO market's price-setting rules.

137. SoCal Edison and Xcel Energy Services state that they are not aware of any RTO/ISO rules that would unnecessarily limit the ability of storage resources to set market prices, except in some cases where RTO market software does not allow a resource at minimum output to set price.[171]

138. Some commenters argue that electric storage resources should be allowed to set prices if they meet certain requirements, including the minimum requirements for each service.[172] PJM Market Monitor argues that storage resources should be eligible to set price on the basis of dispatch if the storage resource meets all other relevant requirements and has the necessary telemetry and metering. Dominion supports the ability for electric storage resources to set prices in the energy market when applicable if (1) the current day-ahead market pricing rules applicable to pumped-hydro optimization are preserved and (2) the Commission directs each RTO/ISO to create a methodology to

[171] *See* SoCal Edison Comments at 17; Xcel Energy Services Comments at 23.

[172] *See, e.g.*, Dominion Comments at 6; NYPA Comments at 11; PJM Market Monitor Comments at 7.

calculate accurate real-time offers and in situations where electric storage resources designate themselves dispatchable.

139. AES Companies assert that the individual RTOs/ISOs and their stakeholders should decide whether and how electric storage resources may set prices in the capacity markets because the capacity constructs in each differ.[173] Avangrid contends that electric storage resources should be able to set the capacity clearing price.[174] However, Avangrid notes that capacity constructs that are based on real-time performance (such as ISO-NE's Pay for Performance and PJM's Capacity Performance) may need to guard against the ability of electric storage resources to switch from generation to load during a capacity emergency because it could exacerbate the need for generating capacity. Avangrid suggests that these resources could be subjected to more severe penalties than a generator that performs less than its capacity commitment to guard against such concerns. Relatedly, SPP asks the Commission to clarify the effects on scarcity pricing when an electric storage resource moves its capacity instantly from charging to discharging, eliminating any scarcity.[175]

c. Commission Determination

140. In this Final Rule, we adopt the NOPR proposal and add section 35.28(g)(9)(i)(b) to the Commission's regulations to require each RTO/ISO to revise its tariff to ensure that a

[173] *See* AES Companies Comments at 25.

[174] *See* Avangrid Comments at 8.

[175] *See* SPP Comments at 14.

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. Consistent with the NOPR proposal, we find that, for a resource using the proposed participation model for electric storage resources to be able to set prices in the RTO/ISO markets as either a wholesale seller or a wholesale buyer, it must be available to the RTO/ISO as a dispatchable resource. Also, consistent with the NOPR, we require that (1) resources using the participation model for electric storage resources be able to set the price in the capacity markets, where applicable; (2) RTOs/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.

141. Improving electric storage resources' opportunity to participate as both wholesale sellers of services and wholesale buyers of energy will improve market efficiency and, in turn, competition, by allowing the RTO/ISO to dispatch these resources in accordance with their most economically efficient use (i.e., as supply when the market clearing price for energy is higher than their offer and as demand when the market clearing price is lower than their bid). Additionally, allowing electric storage resources to participate in the RTO/ISO markets as dispatchable load will allow these resources to set the market clearing price under certain circumstances, thus better reflecting the value of the marginal resource and ensuring that electric storage resources are dispatched in

accordance with the highest value service that they are capable of providing during a set market interval. A wide range of commenters, including most RTOs/ISOs, generally support this requirement as one that will increase economic efficiency to the benefit of both electric storage resources and the RTO/ISO markets in which they will more fully be able to participate.

142. We reject AES Companies' assertion that an RTO/ISO must decide whether to allow electric storage resources to be price takers. None of the RTOs/ISOs have indicated that this need exists. We also find that AES Companies have not provided support for their assertion that the decision to self-schedule may have unintended consequences and could skew market results. To ensure consistent treatment in the RTO/ISO markets, we find that electric storage resources must maintain the same ability to self-schedule their resource as other market participants.

143. In response to EEI's, MISO Transmission Owners', and Xcel Energy Services' jurisdictional concerns, we find that the Commission has authority to require the RTOs/ISOs to permit any resource using the participation model for electric storage resources participating in the RTO/ISO markets to buy energy from those markets, consistent with the rules related to wholesale purchasers of energy in each RTO/ISO. As discussed in the Price for Charging Energy section below,[176] we find that the sale of electric energy from the grid that is used to charge electric storage resources for later resale into the energy or ancillary service markets constitutes a sale for resale.

[176] *See infra* P 289.

Therefore, to better facilitate these wholesale purchases and improve economic efficiency in the RTO/ISO markets, it is reasonable for the RTOs/ISOs to allow electric storage resources to choose to participate in the RTO/ISO markets as both supply and demand. This approach maximizes the ability of electric storage resources to participate as wholesale sellers and wholesale buyers in RTO/ISO markets, which will enhance competition and, in turn, helps to ensure these markets produce just and reasonable rates. Additionally, we note that we address EEI's concern about an electric storage resource's use of the distribution system in the Price for Charging Energy section below.[177]

144. We disagree with SPP that there is a need to clarify in this Final Rule the effects on scarcity pricing when an electric storage resource moves its capacity instantly from charging to discharging. Scarcity pricing rules vary between RTOs/ISOs and we do not have information on the record to consider a generic clarification for all RTOs/ISOs, nor do we find clarification is necessary to ensure that the reforms in this Final Rule are just and reasonable and can be implemented. In response to Avangrid, we find that it is not appropriate to require stricter penalties for electric storage resources during capacity emergencies. Avangrid has not shown why electric storage resources should be subject to stricter penalties than other resources. While we are not establishing a requirement for resources using the participation model for electric storage resources to pay stricter penalties during capacity emergencies, we note that each RTO/ISO is free to evaluate the

[177] *See infra* P 296.

potential impacts of electric storage resources during scarcity events and propose in a separate FPA section 205 filing[178] any market rules that it believes are necessary to account for the unique physical and operational characteristics of electric storage resources.

145. We also reject MISO's recommendation to study in more detail the basic participation model(s) for electric storage resources before identifying any necessary adjustments to an RTO/ISO market's price-setting rules. We believe that the flexibility that we provide each RTO/ISO to implement this Final Rule renders moot MISO's assertion that more study is necessary.

146. In response to Energy Storage Association's recommendation that the option to self-schedule should apply to electric storage resources both as buyers and as sellers, we clarify that the ability of electric storage resources to participate as price takers will not be limited to their participation as load. Electric storage resources should also be able to self-schedule when they participate in the RTO/ISO markets as a supply resource consistent with rules governing how other resources self-schedule. This requirement helps to ensure that electric storage resources are treated consistently with the ability of self-scheduled load resources and traditional generation resources to participate in the RTO/ISO markets.

147. Additionally, in response to Dominion's concerns regarding the ability of electric storage resources to set prices in the energy market, particularly as it relates to pumped-

[178] *See* 16 U.S.C. § 824d.

hydro resources and the preservation of existing rules related to their optimization, we clarify that we are not requiring the RTOs/ISOs to change their participation models for pumped-hydro resources in response to this Final Rule. However, we require each RTO/ISO to establish means by which all electric storage resources, including pumped-hydro resources, can participate as wholesale sellers and wholesale buyers in the RTO/ISO markets using a participation model for electric storage resources. This requirement ensures that the RTO/ISO markets value the participation of all electric storage resources as both supply and demand.

148. Additionally, in response to Open Access Technology, we clarify that we do not consider electric storage resources in charging mode to be negative demand response. This Final Rule requires an electric storage resource to be eligible to participate in the RTO/ISO markets as a wholesale buyer and for each RTO/ISO to be able to dispatch them as such. Such a mechanism would entail participation in the energy markets, not the provision of a new service, recognizing that electric storage resources may also be dispatched to consume electricity when they are providing certain ancillary services (such as frequency regulation).

2. Mechanisms to Prevent Conflicting Dispatch Instructions

a. NOPR Request for Comments

149. In the NOPR, the Commission preliminarily concluded that the proposed requirement to participate as a supply and demand resource simultaneously (i.e., submit bids to buy and offers to sell during the same market interval) is necessary to maximize

the value that electric storage resources can provide in the RTO/ISO markets, allowing the markets to identify whether it is more economic to dispatch an electric storage resource as supply or demand during a given market interval.[179] The Commission stated that it expected that, through its bidding strategy, a resource using the electric storage resource participation model would be able to prevent any conflicting dispatch signals to itself. However, the Commission sought comment on whether there should be a mechanism that identifies bids and offers coming from the same resource to ensure the price for the offer to sell is not lower than the price for the bid to buy during the same market interval so that an RTO/ISO does not accept both the offer and bid of a resource using the electric storage resource participation model for that interval.

b. Comments

150. Regarding the issue of preventing conflicting dispatch signals, AES Companies, Efficient Holdings, and PJM Market Monitor agree with the Commission that a resource using the electric storage resource participation model would be able to prevent any conflicting dispatch signals itself through a bidding strategy and fuel management plan.[180]

151. In contrast, Bonneville, Imperial Irrigation District, and NRG argue that the Commission should not rely on an electric storage resource's bidding strategy to prevent

[179] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 83.

[180] *See* AES Companies Comments at 26; Efficient Holdings Comments at 17; PJM Market Monitor Comments at 8.

conflicting dispatch signals to itself and argue that a screening mechanism in RTO/ISO software would be a more robust approach than relying on rational bids and offers coming from the same resource.[181] Xcel Energy Services agrees but seeks assurance that any RTO/ISO mechanism to prevent such conflicts would work and not create unintended consequences for market dispatch of the resource.[182] EPRI states that an RTO/ISO can likely put a fairly straightforward constraint within its security-constrained unit commitment or security-constrained economic dispatch model to prevent conflicting dispatch signals.[183] R Street Institute and Research Scientists believe that building logical checks into the market clearing software could avoid this problem.[184]

152. Avangrid, Imperial Irrigation District, and SoCal Edison agree with the Commission that the RTOs/ISOs should not allow an electric storage resource to submit a buy bid that is higher than its sell offer in the same market interval because there is no economic reason to do so.[185] Imperial Irrigation District and NRG argue that RTO/ISO software should ensure that, when an electric storage resource submits both supply and demand

[181] *See* Bonneville Comments at 5; Imperial Irrigation District Comments at 11; NRG Comments at 14.

[182] *See* Xcel Energy Services Comments at 23.

[183] *See* EPRI Comments at 23-24.

[184] *See* R Street Institute Comments at 6; Research Scientists Comments at 8-9.

[185] *See* Avangrid Comments at 8; Imperial Irrigation District Comments at 11; SoCal Edison Comments at 17.

bids, the offer to sell is not lower than the price for the bid to buy during a single market interval.[186] SoCal Edison is also concerned that there may be an incentive for an electric storage resource to submit conflicting bids and offers in markets that allow some form of uplift payments.

153. CAISO states that its Non-Generator Resource participation model, which was designed with electric storage resources in mind, allows Non-Generator Resources to submit an economic bid that spans a negative to positive capacity range.[187] CAISO explains that this single bid curve avoids conflicting dispatch. MISO similarly states that it has a method for Demand Response Resources – Type II that could be implemented for electric storage resources to allow a smooth dispatch range between a negative minimum limit and a positive maximum limit.[188]

154. SPP agrees that the coordination of a single asset as both load and generation is important, stating that both the mechanism utilized and the rules should ensure that the offers for use as load and generation would be monotonically increasing.[189] However, SPP notes that non-LMP components (e.g., start-up costs) may need specific consideration to avoid a situation where such costs are not considered in dispatch. ISO-

[186] *See* Imperial Irrigation District Comments at 11; NRG Comments at 14.

[187] *See* CAISO Comments at 14.

[188] *See* MISO Comments at 17.

[189] *See* SPP Comments at 15.

NE does not believe any mechanism is necessary to avoid conflicting dispatch instructions, noting that to avoid this problem, starting in December 2018, it plans to use a single dispatch signal that reflects the net supply and demand dispatch.[190] ISO-NE adds that the Commission should not be overly prescriptive in this area, instead allowing each RTO/ISO to address these sorts of issues as necessary. NYISO requests that offers for simultaneous participation as supply and demand include an incremental cost construct that allows an electric storage resource's offer price for demand to be less than its offer price for supply and gives each RTO/ISO flexibility to determine an offer construct that best fits its software design.[191]

155. Consistent with the single bid curve approach suggested by some RTOs/ISOs, Energy Storage Association, and NextEra request that the Commission direct RTOs/ISOs to permit electric storage resources to enter an energy bid curve with price/quantity pairs for providing and withdrawing energy (bidding different quantities of positive or negative MW for different energy prices) in both day-ahead and real-time markets.[192]

156. Ohio Commission recommends that the market monitors review all buy bids and sell offers to confirm that a resource is appropriately providing a marginal cost-based bid

[190] *See* ISO-NE Comments at 22.

[191] *See* NYISO Comments at 10.

[192] *See* Energy Storage Association Comments at 17-18; NextEra Comments at 10, n.14.

and not exercising market power.[193] While EEI is not aware of this issue currently, it claims that it could arise as new technologies buy and sell in the same interval; therefore, it suggests that the Commission discuss this issue at a technical conference to determine if adequate monitoring mechanisms exist.[194]

157. Efficient Holdings, Energy Storage Association, and NYPA support requiring electric storage resources to participate simultaneously as generation and load to maximize the value they can provide and provide the RTO/ISO with more flexibility to operate its system.[195] Efficient Holdings contends that simultaneous buy and sell offers allow storage operators to absorb extra power when prices are low, thus lowering operators' fuel costs and adding greater flexibility to market operations and optimizing energy costs.

158. While Energy Storage Association argues that electric storage resources should be permitted to participate in the RTO/ISO markets simultaneously as generation and load, it argues that they should not have to register as, or be modeled as, two separate resources (i.e., generation and load) because it would limit the flexibility of scheduling and dispatching the storage resource in several ways.[196] Energy Storage Association

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[193] *See* Ohio Commission Comments at 8.

[194] *See* EEI Comments at 13.

[195] *See* Efficient Holdings Comments at 17; Energy Storage Association Comments at 18; NYPA Comments at 9.

[196] *See* Energy Storage Association Comments at 13, 18.

asserts that this would generally (1) only allow a resource to inject or withdraw energy on a bidding interval (i.e., hourly) basis, rather than allowing switching between buying and selling energy on a dispatch interval (i.e., five-minute) basis; and (2) include transition time for switching from one mode of operation to another, which newer electric storage resources do not require. Energy Storage Association believes that an electric storage resource should be able to both withdraw energy from, and provide energy to, the grid and switch between states from one (five-minute) dispatch interval to the next, so it can be dispatched seamlessly across its full range (i.e., from positive to negative). Energy Storage Association contends that permitting resources to indicate their willingness to charge or discharge based on 5-minute pricing will allow RTOs/ISOs to more fully utilize the unique capabilities of electric storage resources.

159. In contrast, AES Companies argue that there is no reason to restrict an electric storage resource from both buying and selling in the same market interval because some electric storage technologies allow the resource owner to operate separate nodes independently.[197] Tesla/SolarCity argue that, while it is very likely that many electric storage resources will participate both as demand and supply resources in the same intervals during most times, the Commission should not require this because there are no efficiency gains and some optionality will be lost.[198]

[197] *See* AES Companies Comments at 25-26.

[198] *See* Tesla/SolarCity Comments at 16.

c. Commission Determination

160. While we find that simultaneous participation of resources using the participation model for electric storage resources as supply and demand may enable more efficient use of those resources, we also find that each RTO/ISO must 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. In addition, while we agree with commenters that conflicting dispatch instructions will be prevented if market participants accurately represent their economic preferences in their bids, we find that relying on the expected behavior of market participants is not sufficient to alleviate the related operational concerns. Therefore, to mitigate the potential occurrence of conflicting dispatch instructions and to implement the new requirement in section 35.28(g)(9)(i)(b) of the Commission's regulations, on compliance to this Final Rule, we require 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.

161. Several approaches could address conflicting dispatch. We agree with commenters that allowing 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. However, while we agree this approach could be effective at mitigating conflicting dispatch signals, there may be other reasonable

approaches compatible with existing market designs in other RTOs/ISOs to prevent conflicting dispatch. For example, we agree with Bonneville, Imperial Irrigation District, and NRG that a screening mechanism in RTO/ISO software could also prevent conflicting dispatch. We also agree with NYISO that a cost construct that ensures that the price of offers to sell are not lower than the price for bids to buy may be reasonable. Therefore, we will not require a specific approach in this Final Rule but require that the approach chosen by each RTO/ISO mitigates the possibility of conflicting dispatch instructions. However, we disagree with the Ohio Commission that it could be the responsibility of the market monitors to review bids to address conflicting dispatch and clarify that the RTO/ISO is responsible for preventing conflicting dispatch.

162. In response to the comment suggesting resources using the participation model for electric storage resources should be able to enter an energy bid curve providing and withdrawing energy in both day-ahead and real-time markets, we clarify that resources using the participation model for electric storage resources should be able to submit offers to sell and bids to buy energy consistent with the opportunities available to other market participants in both the day-ahead and real-time markets. We also find a technical conference, as recommended by EEI, is unnecessary at this time given the existence of viable solutions to this issue identified by other commenters and given the flexibility that we provide each RTO/ISO and other market participants to address this issue.

163. Lastly, we clarify that, while each RTO/ISO should allow resources using the participation model for electric storage resources to participate as supply and demand

simultaneously (i.e., submit bids to buy and offers to sell during the same market interval), the RTOs/ISOs should not require resources using the participation model for electric storage resources to participate as supply and demand simultaneously.

3. Make-Whole Payments

a. NOPR Request for Comments

164. In the NOPR, the Commission noted that a resource using the proposed participation model for electric storage resources that elects to submit an economic bid as a wholesale buyer and participate as a dispatchable demand resource would still be able to self-schedule its charging and be a price taker.[199] However, the Commission noted that it is possible that the RTO/ISO could dispatch an electric storage resource as load when the wholesale price for energy is above the price of their bid to buy (a circumstance under which they would lose the opportunity to earn greater revenues as a supply resource). Therefore, to help alleviate any potential financial risk to electric storage resources when being dispatched as a demand resource, the Commission sought comments on whether the proposed participation model for electric storage resources should allow make-whole payments when a resource participating under this participation model is dispatched as load and the price of energy is higher than the resource's bid price.

[199] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 85.

b. Comments

165. Several commenters support allowing make-whole payments when an electric storage resource is dispatched as load and the price of energy is higher than the resource's bid price.[200] Avangrid, EEI, and ISO-NE state that electric storage resources should be treated comparably to other resources with regard to make-whole payments.[201] Avangrid states that, if the RTO/ISO uses electric storage resources as both generation and load, the reasoning for make-whole payments exists in either direction. California Energy Storage Alliance asks the Commission to require all electric storage participation models to include the ability to recover commitment costs and receive make-whole payments.[202] Trans Bay asks the Commission to clarify that the NOPR does not preclude electric storage resources from receiving any non-market payments, including make-whole payments.[203] While American Petroleum Institute does not oppose make-whole payments in principle, it argues these payments should not subsidize some technologies by mitigating the higher downside risk that should be managed by the owners of those resources.[204]

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[200] *See, e.g.*, CAISO Comments at 15; NRG Comments at 19; SoCal Edison Comments at 17-18; Tesla/SolarCity Comments at 17.

[201] *See* Avangrid Comments at 8; EEI Comments at 13; ISO-NE Comments at 21-22.

[202] *See* California Energy Storage Alliance Comments at 11.

[203] *See* Trans Bay Comments at 4.

[204] *See* American Petroleum Institute Comments at 6.

166. Several commenters suggest that the Commission should not set specific requirements for make-whole payments in this final rule but should provide the RTOs/ISOs flexibility to establish rules for make-whole payments, if appropriate.[205] Six Cities state that, if the Commission allows RTOs/ISOs to propose make-whole payments for electric storage resources, such payments should only be allowed in limited circumstances to prevent any undue preference for electric storage resources. Six Cities assert, if make-whole payments are allowed, they should be analogous to criteria for bid cost recovery within CAISO or other analogous payments.

167. Several commenters raise concerns about the complexity of requiring make-whole payments.[206] MISO requests that the Commission hold a series of technical conferences to address significant design and compensation issues. SoCal Edison contends that make-whole payments need to work in conjunction with other mechanisms (such as market power mitigation, temporal and product revenue netting, and specific bidding rules). Xcel Energy Services states that make-whole payments require further consideration to ensure electric storage resources are treated comparably to other resources and to avoid unnecessary uplift charges.

168. Some commenters assert that make-whole payments are not necessary in certain

[205] *See* MISO Transmission Owners Comments at 12; Six Cities Comments at 7-8 (citing CAISO Tariff at §11.8); SoCal Edison Comments at 18.

[206] *See* MISO Comments at 18-19; SoCal Edison Comments at 18; Xcel Energy Services Comments at 18.

circumstances.[207] ELCON and PJM reason that make-whole payments are not necessary for electric storage resources when they are dispatched as load and the price of energy is higher than the resource's bid price. Similarly, Electric Vehicle R&D Group states that make-whole payments do not seem necessary. ELCON believes that the resource should bear the financial risk of uneconomic dispatch.

169. Similar to how self-committed resources may not be able to receive make-whole payments for start-up costs, EPRI cautions that each RTO/ISO should consider whether certain costs should be eligible for make-whole payments when an electric storage resource self-manages its state-of-charge.[208] MISO contends that the potential appropriateness of make-whole payments may depend on whether the state of charge is managed by an electric storage resource or optimized by the RTO.[209] NYPA argues that, if the system operator is given state of charge control over a storage resource, RTO/ISO tariffs must compensate the resource if and when it is dispatched out of economic merit order.[210] NYPA asserts that this compensation should apply to: (1) electric storage resources that are dispatched as load when the wholesale price for energy is above the

[207] *See* ELCON Comments at 5-6; Electric Vehicle R&D Group Comments at 1; PJM Comments at 18-19.

[208] *See* EPRI Comments at 26.

[209] *See* MISO Comments at 18-19.

[210] *See* NYPA Comments at 12.

price of their bid to buy and (2) resources withheld from generating when their energy offer is infra-marginal.

170. Other commenters believe that the Commission should not require the RTO/ISO to provide make-whole payments to electric storage resources because they should be able to self-manage in a way that eliminates the need for make-whole payments and achieves better price formation.[211] Acknowledging that make-whole payments are one potential solution to mitigate potential financial shortfalls, AES Companies contend that changes to the optimization price determination and the granting of flexibility for electric storage resources to manage their fuel use is preferable to make-whole payments. PJM Market Monitor similarly argues that market participants should decide when it is economic to buy and sell rather than create rules through which the market operator could dispatch a storage resource in a way inconsistent with its economics and then compensate it through an uplift payment.

171. Given that PJM does not dispatch load increases, it explains that, before engaging in this practice, it would need to consult with stakeholders to analyze whether the benefits would justify the costs.[212] NYISO discourages creating price protections for electric storage resources when they are scheduled as demand because such treatment would not be comparable to the treatment of other resources that are scheduled as demand, noting

[211] *See* AES Companies Comments at 28; PJM Market Monitor Comments at 8.

[212] *See* PJM Comments at 18.

that regional flexibility will provide the RTOs/ISOs with the opportunity to treat resources comparably.[213]

c. Commission Determination

172. Given the unique capability of electric storage resources to serve as both a supply of, and demand for, energy and to implement the new requirement in section 35.28(g)(9)(i)(b) of the Commission's regulations that resources using the participation model for electric storage resources be able to be dispatched and set the wholesale market clearing price as both a wholesale seller and wholesale buyer, we find that the participation model for electric 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. Therefore, as part of this Final Rule, we require each RTO/ISO to revise its tariff to ensure that resources available for manual dispatch as a wholesale buyer and wholesale seller under the participation model for electric storage resources are held harmless for manual dispatch by being eligible for make-whole payments. Any such make-whole payments must be consistent with the rules for make-whole payments for other dispatchable resources. This requirement is necessary to ensure that electric storage resources are treated like dispatchable resources that participate in the RTO/ISO markets. Because the rules for make-whole payments vary by RTO/ISO and there are inherent complexities in implementing this requirement, we

[213] *See* NYISO Comments at 10.

will not require a specific method of make-whole payments. Instead, each RTO/ISO will have the flexibility to establish a methodology under which resources using the participation model for electric storage resources can receive make-whole payments.

173. Recognizing that comprehensive market design changes could be necessary to implement this requirement, we believe that the compliance deadline and implementation schedule set forth in the Compliance Requirements section[214] should provide sufficient time for the each RTO/ISO to work with its stakeholders to establish the necessary market rules for make-whole payments. In addition, given the time provided for each RTO/ISO to work with its stakeholders on this issue, we decline to hold the technical conferences requested by MISO.

174. We disagree with commenters who suggest that make-whole payments are not necessary because electric storage resources should bear the risk of uneconomic dispatch. Modeling, software, and certain other limitations are inherent in the complexity of the electric system and the tools available to maintain reliable operations. Uplift, or make-whole, payments may be needed to ensure that resources committed and dispatched out-of-market are able to recover their operating costs. Electric storage resources participating in the RTO/ISO markets are subject to the same system conditions as other resources that may cause them to be dispatched out-of-market and unable to recover their operating costs. Therefore, resources using the electric storage resource participation model should be able to receive the same make-whole payments

[214] *See infra* P 343.

that other resources receive to remedy the problem. Not offering make-whole payments to resources using the electric storage resource participation model could create a barrier to their participation in the RTO/ISO markets and be inconsistent with the treatment of other market participants.

175. Additionally, while the NOPR did not propose a requirement regarding make-whole payments for resources using the participation model for electric storage resources that are manually dispatched as supply, we agree with commenters' concerns that, if a resource using the participation model for electric storage resources is available to be used by the RTO/ISO as both a supply and demand resource, then the RTO/ISO should provide make-whole payments for the resource in both directions. Therefore, we require each RTO/ISO to modify its tariff to allow a resource using the participation model for electric 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. This requirement will further ensure that resources using the participation model for electric storage resources are treated like other dispatchable resources in the RTO/ISO markets and help make resources using the participation model for electric storage resources available to grid operators to address any reliability concerns through manual dispatch. As for NYPA's suggestion to make electric storage resources whole when they are withheld from generating when their energy offer is infra-marginal, we find that such payments should only be provided to resources using the participation model for electric storage resources to the extent that such payments are already provided to other market participants.

176. Regarding state-of-charge management, we agree with commenters that, if the market participant is controlling its resource, and it has not been dispatched uneconomically by the RTO/ISO, then it would not be appropriate for the resource using the participation model for electric storage resources to receive make-whole payments. Similar to other market participants, make-whole payments should only be available to resources using the electric storage resource participation model if the system operator dispatches that resource in a way that is inconsistent with its bids to buy and offers to sell energy. We agree with commenters that self-management could be a means to minimize make-whole payments. As discussed in the State of Charge Management section,[215] in this Final Rule, we require each RTO/ISO to allow electric storage resources to self-manage their state of charge. However, to the extent that an RTO/ISO manually dispatches a resource using the participation model for electric storage resources, that resource must be able to recover their costs consistent with the manner in which other market participants are able to recover their costs if the RTO/ISO dispatches them uneconomically.

177. In response to NYISO and PJM, we note that one of the requirements of this Final Rule is that each RTO/ISO have the ability to dispatch electric storage resources as load.[216] Therefore, in response to PJM, it is necessary for each RTO/ISO to establish a methodology under which resources using the participation model for electric storage

[215] *See infra* P 248.

[216] *See supra* P 140.

resources that participate as load are able to receive make-whole payments. Additionally, in response to NYISO, because electric storage resources must be able to be dispatched as load, their eligibility to receive make-whole payments when dispatched as load would need to be consistent with other dispatchable resources but would not need to be consistent with the eligibility of other load resources that are not dispatchable by the RTO/ISO.

E. Physical and Operational Characteristics of Electric Storage Resources

1. Requirement to Incorporate Bidding Parameters as Part of the Electric Storage Resource Participation Model

a. NOPR Proposal

178. In the NOPR, the Commission proposed to require each RTO/ISO to revise its tariff to include a participation model for electric storage resources that incorporates bidding parameters that reflect and account for the physical and operational characteristics of electric storage resources.[217] Specifically, the Commission proposed that the RTOs/ISOs establish state of charge, upper charge limit, lower charge limit, maximum energy charge rate, and maximum energy discharge rate as bidding parameters for the participation model for electric storage resources that participating resources must submit, as applicable.[218] The Commission also proposed that the participation model for

[217] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 66.

[218] *See id*. P 67.

electric storage resources include the following bidding parameters that market participants may submit, at their discretion, for their resource based on its physical constraints or desired operation: minimum charge time, maximum charge time, minimum run time, and maximum run time.[219]

b. Comments

179. Several commenters support the NOPR proposal to require each RTO/ISO to establish bidding parameters that reflect and account for the physical and operational characteristics of electric storage resources because they assert it will support efficient procurement of resources in the RTO/ISO markets and reduce system costs.[220]

180. Other commenters support the NOPR proposal, subject to clarification.[221] EPRI contends that the definitions of the bidding parameters proposed in the NOPR are ambiguous and asks the Commission to explicitly define them. Beacon Power asks the Commission to ensure that, when implementing the proposed bidding parameters, the RTOs/ISOs do not impose any arbitrary requirements that limit electric storage resources' participation in their markets (such as a minimum time period over which energy must be dispatchable continuously at full capacity).

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[219] *See id*. P 68.

[220] *See, e.g.*, Advanced Energy Economy Comments at 24-25; Energy Storage Association Comments at 14; IRC Comments at 5; MISO Comments at 6; NESCOE Comments at 11; NYISO Comments at 9; Ohio Commission Comments at 7; Starwood Energy Comments at 5.

[221] *See* Beacon Power Comments at 5; EPRI Comments at 16-17.

181. Several commenters do not necessarily oppose the NOPR proposal that each RTO/ISO incorporate certain bidding parameters into its participation model for electric storage resources but request that the Commission grant each RTO/ISO flexibility on compliance with respect to the bidding parameters that it ultimately adopts.[222] NYISO, Pacific Gas & Electric, and PJM ask the Commission to give each RTO/ISO flexibility to develop bidding parameters that are tailored to its market and reliability needs and to determine how to best use those bidding parameters in its market. Magnum agrees and further contends that the Commission should not mandate that each RTO/ISO adopt bidding parameters for specific types of electric storage resources. Connecticut State Entities argue that bidding parameters should not be so prescriptive as to determine prematurely which electric storage resource technologies to deploy. Connecticut State Entities claim that overly prescriptive bidding parameters would constrain load-serving entities' ability to adopt least-cost solutions.

APPA/NRECA also argue for flexibility, stating that the Commission should allow each RTO/ISO to demonstrate on compliance that the proposed minimum bidding requirements would harm the participation of electric storage resources in its markets and to propose a superior alternative.[223] Similarly, Imperial Irrigation District asks the Commission to allow an RTO/ISO to decline to adopt a bidding parameter if it can

[222] *See* Connecticut State Entities Comments at 6; Magnum Comments at 10-11; NYISO Comments at 9; PJM Comments at 10; Pacific Gas & Electric Comments at 9.

[223] *See* APPA/NRECA Comments at 14-15.

demonstrate that it would be unnecessary or impractical.[224] R Street Institute states that, while the required and optional bidding parameters are reasonable, each RTO/ISO should incorporate the proposed optional bidding parameters in its software only if justified by forward cost/benefit analysis.[225]

182. Some commenters argue that certain of the physical and operational characteristics that the Commission proposed as bidding parameters in the NOPR are better represented through other means.[226] For example, ISO-NE argues that it is a misnomer to characterize state of charge as a bidding parameter because it is a physical characteristic that constantly changes in real time. Likewise, CAISO, IRC, and Pacific Gas & Electric assert that certain electric storage resource-specific characteristics (such as charging and discharging rates, charge limits, and minimum charge times) are physical characteristics that should be static and not subject to change through a resource's offer or bid. Pacific Gas & Electric notes that it may be better to include such physical and operational characteristics in each resource's data file, while CAISO suggests that they may be accounted for through other means besides bidding parameters.

[224] *See* Imperial Irrigation District Comments at 9.

[225] *See* R Street Institute Comments at 5.

[226] *See* CAISO Comments at 10-11; IRC Comments at 5; ISO-NE Comments at 18; Pacific Gas & Electric Comments at 10.

183. A few commenters oppose any requirement that each RTO/ISO incorporate bidding parameters into its participation model for electric storage resources.[227] AES Companies contend that the proposed bidding parameters may artificially limit the performance of some electric storage technologies, while MISO Transmission Owners argue that they have the potential to limit the services that a resource can provide. AES Companies and MISO Transmission Owners argue that, in place of the NOPR proposal, the Commission should require each RTO/ISO to determine the parameters and data requirements necessary for it to efficiently dispatch a resource given the services offered and then set performance-based standards for each service. Both AES Companies and MISO Transmission Owners further suggest that each RTO/ISO should include these technology-specific bidding parameters in its business practice manuals rather than its tariff.

184. In addition, DER/Storage Developers contend that bidding parameters should be flexible and differ for different services.[228] DTE Electric/Consumers Energy assert that the proposed bidding parameters are not clear, may not be applicable to all resource types, and may not take full advantage of the value of the existing pumped-hydro resources. Therefore, DTE Electric/Consumers Energy asks the Commission to allow

[227] *See* AES Companies Comments at 5-6; MISO Transmission Owners Comments at 10-11.

[228] *See* DER/Storage Developers Comments at 4-5.

each RTO/ISO to work with its stakeholders to develop bidding parameters that accommodate all electric storage resources or hold a technical conference on the issue.

185. A few commenters opine on the ability of resources using the electric storage resource participation model to update their bidding parameters as those values change.[229] Energy Storage Association states that the Commission should require each RTO/ISO to allow a resource using the electric storage resource participation model to submit the state-of-charge bidding parameter in both the day-ahead and real-time markets. According to Energy Storage Association, allowing a resource using the electric storage resource participation model to update its state-of-charge bidding parameter in the real-time market will provide the RTO/ISO with better information about such a resource's limitations and availability in the next market interval. DER/Storage Developers contend that electric storage resources should be able to adjust their bidding parameters hourly to account for their state of charge. Similarly, Tesla/SolarCity assert that, to maintain feasibility of schedules and increase asset value, electric storage resources should be able to change their bidding parameters as their state of charge changes.

c. Commission Determination

186. Upon consideration of the comments, we will modify the NOPR proposal in this Final Rule to provide greater flexibility for each RTO/ISO to demonstrate that its

[229] *See* DER/Storage Developers Comments at 5; Energy Storage Association Comments at 15; Tesla/SolarCity Comments at 14-15.

participation model for electric storage resources accounts for the physical and operational characteristics of electric storage resources. As the Commission stated in the NOPR, requiring each RTO/ISO to revise its tariff to include a participation model for electric storage resources that incorporates bidding parameters that account for the physical and operational characteristics of electric storage resources will allow such resources to provide all of the services that they are technically capable of providing and allow the RTOs/ISOs to procure these services more efficiently.[230] We continue to believe that the lack of any means of accounting for the physical and operational characteristics of electric storage resources could present barriers to the participation of these resources in the RTO/ISO markets, limiting competition and thereby potentially rendering the resulting rates unjust and unreasonable.

187. We are persuaded, however, by commenters' arguments that there may be other means of accounting for the physical and operational characteristics of electric storage resources than bidding parameters. For example, some of the bidding parameters that the Commission proposed in the NOPR may account for physical characteristics that do not change over time, such that an electric storage resource could report that information when registering as a market participant in an RTO/ISO without updating that information continually through its bidding parameters. However, we note that it may only be possible to represent some of the physical and operational characteristics (such as a forecasted State of Charge) through bidding parameters. Furthermore, we agree

[230] *See* NOPR, FERC Stats. and Regs. ¶ 32,718 at P 66.

with commenters that greater regional flexibility than the Commission proposed in the NOPR is appropriate; different RTOs/ISOs may be able to more effectively account for the physical and operational characteristics of electric storage resources through different mechanisms given their unique market designs.

Therefore, we add section 35.28(g)(9)(i)(c) to the Commission's regulations to require each RTO/ISO to have tariff provisions providing a participation model for electric storage resources that accounts for the physical and operational characteristics of electric storage resources through bidding parameters or other means. In its compliance filing, each RTO/ISO must demonstrate how its proposed or existing tariff provisions account for the specific physical and operational characteristics of electric storage resources described below. We find that this requirement will improve the ability of electric storage resources to provide all of the services that they are technically capable of providing and allow the RTOs/ISOs to procure these services more efficiently, which will enhance competition and, in turn, help to ensure that the RTO/ISO markets produce just and reasonable rates.

188. Additionally, as discussed in further detail below, we will not require the RTOs/ISOs to make the submission of any information by the resource owner/operator mandatory. Instead, we provide flexibility to each RTO/ISO to determine whether it is mandatory for resources using the participation model for electric storage resources to submit information regarding their physical and operational characteristics, or whether resources using the participation model for electric storage resources should be allowed to submit such information at their discretion. This flexibility will allow each RTO/ISO

to accept information from resources using the participation model for electric storage resources consistent with how it accepts information from other market participants. It also may help prevent resources using the participation model for electric storage resources from having to submit information that is not applicable given their physical, operational, or commercial circumstances.

189. With respect to commenters' request that the RTOs/ISOs should allow electric storage resources to update their bidding parameters, we find that, to the extent that an RTO/ISO adopts bidding parameters to account for the physical and operational characteristics set forth in this Final Rule, it must permit a resource using the participation model for electric storage resources to submit those bidding parameters in both the day-ahead and the real-time markets. To efficiently dispatch its system, an RTO/ISO must have accurate information about the physical and operational characteristics of the resources participating in its markets. Allowing a resource using the participation model for electric storage resources to provide updated information through any applicable bidding parameters, consistent with the opportunities that other market participants have to do so, will help to ensure that each RTO/ISO has the information necessary to efficiently dispatch its system, fully accounting for the physical and operational capabilities of the resources using the participation model for electric storage resources participating in its markets.

190. In the following subsections, we set forth the physical and operational characteristics for which each RTO's/ISO's participation model for electric storage resources must account, whether through bidding parameters or other means. We

discuss these physical and operational characteristics in terms of the bidding parameters proposed in the NOPR, making clarifications as necessary. First, we discuss the physical and operational characteristics of electric storage resources associated with the bidding parameters that the Commission proposed a resource using an electric storage resource participation model must submit to the RTO/ISO, which were identified as the mandatory bidding parameters, including state of charge, upper and lower charge limits, and maximum charge and discharge rates. Second, we discuss the physical and operational characteristics of electric storage resources associated with the bidding parameters that the Commission proposed a resource using an electric storage resource participation model could submit to the RTO/ISO at the resource's discretion, which were identified as the optional bidding parameters, including maximum and minimum charge time and maximum and minimum run time. Finally, we address the physical and operational characteristics for which each RTO's/ISO's participation model for electric storage resources must account that are not associated with any bidding parameter proposed in the NOPR but instead were suggested by commenters and we believe are appropriate to adopt here.

2. State of Charge, Upper and Lower Charge Limits, and Maximum Charge and Discharge Rates

a. NOPR Proposal

In the NOPR, the Commission proposed that each RTO/ISO establish the following bidding parameters for the participation model for electric storage resources that participating resources must submit, as applicable: state of charge, upper charge limit,

lower charge limit, maximum energy charge rate, and maximum energy discharge rate.[231] The Commission explained that the state-of-charge bidding parameter would allow resources using the participation model for electric storage resources to identify their forecasted state of charge at the end of a market interval, as defined by the RTO/ISO, while the upper and lower charge limits would prevent the operator from trying to give too much energy to or take too much energy from the resource. The Commission further stated that it expected that the state of charge would be telemetered in real time when the RTO/ISO is managing the state of charge so that the upper and lower charge limits are not exceeded. However, the Commission did not propose any specific telemetry requirements. Finally, the Commission explained that the maximum energy charge rate and maximum energy discharge rate would be used to indicate how quickly the resource can receive energy from or inject it back to the grid.

b. Comments

191. The Commission received a number of comments on the NOPR proposal requiring each RTO/ISO to establish state of charge, upper and lower charge limit, and maximum energy charge and discharge rate as mandatory bidding parameters for resources using the electric storage resource participation model. Below, we present the comments received with respect to three groups of the proposed bidding parameters: (1) State of Charge, (2) Upper and Lower Charge Limit, and (3) Maximum Energy Charge and Discharge Rate.

[231] *See id*. P 67.

i. State of Charge

192. Several commenters support the proposed requirement that each RTO/ISO adopt a state-of-charge bidding parameter.[232] Advanced Energy Economy claims that many RTOs/ISOs do not have tariff provisions in place to account for the state of charge of electric storage resources, despite the fact that it is a defining characteristic of such resources.

193. Other commenters argue that the Commission should modify the NOPR proposal so that a resource using the electric storage resource participation model is not required to submit information for the state-of-charge bidding parameter to the RTO/ISO, at least under certain circumstances.[233] Specifically, CAISO, Energy Storage Association, NextEra, and NYPA ask the Commission to clarify that an electric storage resource is only required to use the state of charge bidding parameter if the resource owner has opted for the RTO/ISO to manage its state of charge. They argue that an electric storage resource that opts to manage its own state of charge would do so through its bidding strategy rather than the RTO/ISO market processes and that it is therefore unnecessary for such a resource to submit its state of charge to the RTO/ISO as a bidding parameter. SPP asserts that, to dispatch and clear the appropriate amount of resources, it must know

[232] *See, e.g.*, Advanced Energy Economy Comments at 24-25; Massachusetts State Entities Comments at 15; NESCOE Comments at 11; Ohio Commission Comments at 7; Tesla/SolarCity Comments at 14.

[233] *See* CAISO Comments at 11-12; Energy Storage Association Comments at 14-15; NextEra Comments at 9; NYPA Comments at 9.

the real-time state of charge for an electric storage resource for which it is managing state of charge.[234] However, SPP states that it does not require information on the state of charge of electric storage resources that are self-managing their state of charge.

194. While stating that it supports the NOPR proposal directing RTOs/ISOs to institute new electric storage resource-related bidding parameters, Energy Storage Association also explains that requiring electric storage resources that provide both retail and wholesale services to use the proposed bidding parameters could adversely affect their capability to provide retail service.[235] California Energy Storage Alliance and Stem contend that certain bidding parameters, including state of charge, may be difficult or infeasible for some electric storage resources to provide.[236] Thus, California Energy Storage Alliance, National Hydropower Association, and Stem argue that it should be optional for an electric storage resource to provide its state of charge to the RTO/ISO.[237]

195. Pacific Gas & Electric supports the inclusion of a bidding parameter that a resource

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[234] *See* SPP Comments at 10.

[235] *See* Energy Storage Association Comments at 14. Energy Storage Association's statement applies equally to the proposed Upper and Lower Charge Limit and Maximum Energy Charge and Discharge Rate bidding parameters.

[236] *See* California Energy Storage Alliance Comments at 6-7; Stem Comments at 15-16.

[237] *See* California Energy Storage Alliance Comments at 6-7; National Hydropower Association Comments at 8-9; Stem Comments at 15-16. California Energy Storage Alliance's and Stem's statements apply equally to the proposed Upper and Lower Charge Limit and Maximum Energy Charge and Discharge Rate bidding parameters.

using the electric storage resource participation model can use in the day-ahead markets to indicate its state of charge at the beginning of the operating day.[238] However, Pacific Gas & Electric opposes any requirement for each RTO/ISO to adopt an hourly or real-time state-of-charge bidding parameter. Pacific Gas & Electric claims that such a requirement could enable market manipulation by allowing resources to indicate that they are unavailable to provide energy to the market without reporting an outage. To the extent that a resource using the electric storage resource participation model desires to update its state of charge more frequently, Pacific Gas & Electric contends that it should manage its own state of charge through its market bidding.

196. ISO-NE opposes the NOPR proposal for a State of Charge bidding parameter and argues that it is a misnomer to characterize state of charge as a bidding parameter because it is a physical characteristic that constantly changes in real time.[239] Thus, ISO-NE asserts that the Commission should not require state of charge as a day-ahead or real-time bidding parameter, nor require any optimization of this type of parameter in the day-ahead or real-time energy market. ISO-NE contends that, instead, the Commission should allow RTOs/ISOs to develop methods to acquire communication of a resource's current state of charge, use the state of charge data, and potentially require market participants to manage their state of charge using their energy market supply offers and

[238] *See* Pacific Gas & Electric Comments at 8-9.

[239] *See* ISO-NE Comments at 18.

demand bids.

197. AES Companies explain that, for certain electric storage technologies, dispatching the resource based on a state-of-charge or upper or lower charge limit bidding parameter could lead to its under-utilization.[240] AES Companies add that the proposed state-of-charge bidding parameter does not reflect the availability of the resource or the sophisticated software used to optimize the resource's useful life. Moreover, AES Companies assert that, if a resource is deployed in a manner that violates its optimal state of charge management, then the associated costs should be included in market offers and the decision to offer must be at the asset owner's discretion.

198. Research Scientists explain that, to make use of the full flexibility of electric storage resources, a fixed state-of-charge target may not be ideal because it limits the dispatch flexibility in real-time operations.[241] Research Scientists argue that state-of-charge range is a better strategy to enable the use of an electric storage resource to address unexpected system deviations in real time.

199. In addition, a few commenters, including those that support the NOPR proposal, take issue with the Commission's statement that the state-of-charge bidding parameter will allow resources using the participation model for electric storage resources to identify their forecasted state of charge at the end of a market interval.[242] Beacon Power

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[240] *See* AES Companies Comments at 20-22.

[241] *See* Research Scientists Comments at 7.

[242] *See* Beacon Power Comments at 6; Pacific Gas & Electric Comments at 9.

contends that any state-of-charge bidding parameters should reflect an actual state of charge at any point in time, rather than a forecasted state of charge, which would be difficult for the resource or RTO/ISO to predict. Pacific Gas & Electric argues that allowing an electric storage resource to target a particular state of charge at the end of a market interval could enable manipulation in circumstances in which the RTO/ISO is managing a resource's state of charge because the RTO/ISO would have to dispatch the resource as necessary to achieve its specified state of charge regardless of whether such dispatch were economic.

200. Energy Storage Association clarifies that CAISO's tariff allows electric storage resources to submit a forecasted starting state-of-charge value for the day-ahead market, not for the end of a market interval.[243] NextEra agrees and asks the Commission to clarify that the state-of-charge bidding parameter is not limited to the resource owner's forecasted state of charge at the end of the market interval.[244] Similarly, Research Scientists request clarification on whether the state-of-charge bidding parameter provides an electric storage resource's desired state of charge at the beginning or end of a market interval.[245] EPRI clarifies that it understands that the state of charge is the level

[243] *See* Energy Storage Association Comments at 14-15.

[244] *See* NextEra Comments at 9.

[245] *See* Research Scientists Comments at 7.

of energy that an electric storage resource has available at present or anticipates to have at the start of the market interval.[246]

201. Finally, several commenters opine on the Commission's statement in the NOPR that, when the RTO/ISO is managing the state of charge, it expects that the state of charge would be telemetered in real time.[247] ISO-NE states that an electric storage resource's state of charge should be telemetered in real time, arguing that this data is essential for reliable and efficient system operation. IRC agrees that electric storage resources should provide information about their state of charge to the RTO/ISO, stating that the state of charge must be telemetered to the RTO/ISO in real time if other resources are required to be telemetered. Xcel Energy Services argues that RTOs/ISOs should have the capability to monitor state of charge so that they can verify that an electric storage resource could provide ancillary services if called upon to do so. Beacon Power asserts that an electric storage resource (whether or not the RTO/ISO is managing its state of charge) should be required to notify the RTO/ISO of its state of charge on a timely basis.

202. In contrast, Energy Storage Association also contends that the Commission should require each RTO/ISO to institute a capability to continually monitor an electric storage resource's state of charge but should only perform such monitoring when an electric

[246] *See* EPRI Comments at 17.

[247] *See* Beacon Power Comments at 6; IRC Comments at 5; ISO-NE Comments at 18; Xcel Energy Services Comments at 19.

storage resource submits its state of charge as a bidding parameter.[248] Energy Storage Association contends that monitoring such a resource's state of charge will allow the RTO/ISO to better optimize the scheduling and dispatch of the resource.

ii. Upper and Lower Charge Limit

203. ISO-NE, Massachusetts State Entities, and NESCOE support the proposed requirement that each RTO/ISO establish upper charge limit and lower charge limit as bidding parameters for resources using the electric storage resource participation model.[249] NYPA supports the proposed bidding parameters conditional on the Commission clarifying in this Final Rule that an electric storage resource managing its own state of charge is not required to submit information on its upper and lower charge limit.[250] EPRI states that it interprets the upper charge limit as the maximum amount of power the electric storage resource can withdraw at any given instant and the lower charge limit as the minimum amount of power the electric storage resource can withdraw at any instant in time.[251]

[248] *See* Energy Storage Association Comments at 15-16.

[249] *See* ISO-NE Comments at 17; Massachusetts State Entities Comments at 15; NESCOE Comments at 11.

[250] *See* NYPA Comments at 9.

[251] *See* EPRI Comments at 17.

iii. Maximum Energy Charge and Discharge Rate

204. Several commenters support the proposed requirement that each RTO/ISO establish maximum energy charge rate and maximum energy discharge rate as bidding parameters for the participation model for electric storage resources.[252] However, NextEra also states that electric storage resources can have different charge and discharge rates depending on their current state of charge and thus requests that the Commission clarify that it does not propose to require a single, static charge or discharge rate for an electric storage resource's entire operating range.[253] NYPA and Pacific Gas & Electric argue that maximum charge and discharge rates should be optional bidding parameters, at least when an electric storage resource is managing its own state of charge.[254]

205. Finally, EPRI requests clarification of the Commission's definitions for maximum energy charge and discharge rate.[255] EPRI notes that it understands that "maximum energy charge rate" is the speed at which an electric storage resource can change its withdrawn power amount. EPRI also states that it understands that "maximum energy discharge rate" is the speed at which an electric storage resource can change its injected power amount, which is identical to the current ramp rates that generators provide.

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[252] *See, e.g.*, IRC Comments at 5-6; ISO-NE Comments at 17; Massachusetts State Entities Comments at 15; NESCOE Comments at 11; NextEra Comments at 9; Ohio Commission Comments at 7.

[253] *See* NextEra Comments at 10.

[254] *See* NYPA Comments at 9; Pacific Gas & Electric Comments at 9.

[255] *See* EPRI Comments at 17.

c. Commission Determination

206. To implement the new requirement in section 35.28(g)(9)(i)(c) of the Commission's regulations, in this Final Rule, we adopt the NOPR proposal, with the modifications discussed below, to require each RTO/ISO to revise its tariff to include a participation model for electric storage resources that accounts for the following physical and operational characteristics of such resources: State of Charge, Minimum State of Charge, Maximum State of Charge, Minimum Charge Limit and Maximum Charge Limit. As discussed above in the Requirement to Incorporate Bidding Parameters as Part of the Electric Storage Resource Participation Model section,[256] each RTO's/ISO's participation model for electric storage resources must account for these physical and operational characteristics, whether through bidding parameters or other means. To the extent that an RTO/ISO proposes to comply with this requirement through its existing bidding parameters or other existing market mechanisms, it must demonstrate in its compliance filing how its existing market rules already account for these characteristics of electric storage resources.

207. Upon consideration of the comments, however, we will modify the proposed requirement that a resource using an RTO's/ISO's participation model for electric storage resources must submit information concerning these physical and operational characteristics to the RTO/ISO. As commenters state, not all of these physical and operational characteristics are applicable to all electric storage resources, particularly

[256] *See supra* P 0.

when a resource is managing its own state of charge and when the resource is providing multiple services. We agree that the physical and operational characteristics adopted in this Final Rule may need to acknowledge commercial obligations in addition to physical and operational limitations. Thus, we find that an RTO/ISO should have flexibility in how a resource using a participation model for electric storage resources will be allowed to represent its physical, operational, and commercial circumstances. This flexibility will allow an RTO/ISO to determine, consistent with how it treats other resources, whether it is mandatory for resources using the participation model for electric storage resources to submit information regarding these physical and operational characteristics, or whether resources using the participation model for electric storage resources should be allowed to submit this information at their discretion.

208. In addition, we clarify the meaning of these proposed physical and operational characteristics of electric storage resources, as commenters request. First, we clarify that State of Charge represents the amount of energy stored in proportion to the limit on the amount of energy that can be stored, typically expressed as a percentage. Moreover, we agree with EPRI and other commenters that the State of Charge as a bidding parameter is the level of energy that an electric storage resource is anticipated to have available at the *start* of the market interval rather than the end. As noted above in the Requirement to Incorporate Bidding Parameters as Part of the Electric Storage Resource Participation Model section,[257] we require each RTO/ISO to allow a resource using the participation

[257] *See supra* P 189.

model for electric storage resources to submit its State of Charge in both day-ahead and real-time markets. We find that this requirement will provide the RTOs/ISOs with more accurate market information regarding the resource's actual state of charge and prevent the RTO/ISO from needing to make assumptions about the state of charge of an electric storage resource, which is particularly important if the resource did not receive an award in the previous market interval. Moreover, it provides the electric storage resource owner/operator with a usable bidding parameter to reflect the actual operating conditions of the resource, providing more certainty to the RTO/ISO about the capabilities of the resource.

209. Additionally, while the NOPR indicated the Commission's expectation that the state of charge of a resource using the electric storage resource participation model would be telemetered in real time when the RTO/ISO manages that resource's state of charge, as discussed further below, we provide each RTO/ISO the flexibility to propose telemetry requirements for such resources in their compliance filings. This flexibility will allow the RTOs/ISOs to implement the requirements of this Final Rule consistent with the telemetry requirements for different services and other market participants in each RTO/ISO. For example, telemetry may be necessary if an electric storage resource is

participating exclusively in the frequency regulation market but less important if that resource is providing capacity or energy to the RTOs/ISOs.

210. Second, we clarify that the upper and lower charge limits discussed in the NOPR represent the minimum and maximum state of charge of an electric storage resource.

Because they are state of charge values, we will refer to these values in this Final Rule as the Maximum and Minimum State of Charge. More specifically, the Maximum State of Charge represents the state of charge that should not be exceeded (i.e., gone above) when the electric storage resource is receiving electric energy from the grid, while the Minimum State of Charge represents the state of charge that should not be exceeded (i.e., gone below) when an electric storage resource is injecting electric energy onto the grid. These values will allow a resource using the participation model for electric storage resources to place limits on the degree to which the RTO/ISO can charge or discharge the resource, ensuring that it is operated within its design limitations and preventing excessive wear and tear. These values may be either static values based on manufacturer specifications or dynamic values depending on the operational characteristics of the resource (e.g., if it is providing multiple services and needs to reserve part of its state of charge for another service).

211. Finally, we clarify that the maximum charge and discharge rates discussed in the NOPR represent the operating limits of an electric storage resource. As such, we refer to them in this Final Rule as Maximum Charge Limit and Maximum Discharge Limit. Specifically, we clarify that the Maximum Charge Limit for a resource using the electric storage resource participation model is the maximum MW quantity of electric energy that it can receive from the grid, and the Maximum Discharge Limit is the maximum MW quantity that the resource can inject onto the grid. The Maximum Discharge Limit is analogous to, and could potentially be represented by, the economic maximum that traditional generation resources can generally submit with their offers. Having both a

Maximum Charge Limit and Maximum Discharge Limit ensures that RTO/ISO modeling and dispatch can account for the capabilities of resources using the participation model for electric storage resources to both receive and inject electric energy in accordance with their maximum physical capabilities in both directions.

3. Minimum Charge Time, Maximum Charge Time, Minimum Run Time, and Maximum Run Time

a. NOPR Proposal

212. In the NOPR, the Commission proposed to require that each RTO/ISO include in its participation model for electric storage resources the following bidding parameters that market participants may submit, at their discretion, for their resource based on its physical constraints or desired operation: minimum charge time, maximum charge time, minimum run time, and maximum run time.[258]

b. Comments

213. Energy Storage Association, NESCOE, Open Access Technology, and SPP support the NOPR proposal.[259] Specifically, Energy Storage Association and NESCOE contend that establishing these optional bidding parameters that reflect the physical and operational characteristics of electric storage resources may allow RTOs/ISOs to more

[258] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 68. The Commission acknowledged that some of these optional bidding parameters may not be necessary for resources participating under the proposed participation model for electric storage resources that provide certain information to the RTO/ISO through telemetry. *Id*. n.130.

[259] *See* Energy Storage Association Comments at 14; NESCOE Comments at 11-12; Open Access Technology Comments at 2; SPP Comments at 12.

efficiently dispatch all of the resources (including electric storage resources) that participate in their markets, thereby reducing system costs. Magnum supports the NOPR proposal given that the proposed bidding parameters are optional for resources using the electric storage resource participation model to submit; however, Magnum argues that these requirements should not require an electric storage resource to be a "must run" facility.[260]

214. CAISO and ISO-NE oppose the NOPR proposal.[261] CAISO does not agree that minimum charge time, maximum charge time, minimum run time, and maximum run time should be bidding parameters because (1) they represent the physical characteristics of a particular electric storage resource and (2)other resources (such as pumped-hydro resources) are not permitted to change their physical operating characteristics through a bid. According to ISO-NE, these bidding parameters are not necessary for all electric storage resources to participate in the RTO/ISO markets nor to clear these markets or operate the power system. ISO-NE adds that these additional bidding parameters may increase the complexity of implementing the final rule's requirements but provide little value. Thus, ISO-NE requests that the Commission allow each RTO/ISO to determine whether and how to implement these parameters in the future based on their experience working with different types of electric storage technologies.

[260] Magnum Comments at 12.

[261] *See* CAISO Comments at 10-11; ISO-NE Comments at 19.

c. Commission Determination

215. To implement the new requirement in section 35.28(g)(9)(i)(c) of the Commission's regulations, in this Final Rule, we modify the NOPR proposal, with the clarification provided below, to require each RTO/ISO to revise its tariff to include a participation model for electric storage resources that accounts for the following physical and operational characteristics of such resources: Minimum Charge Time, Maximum Charge Time, Minimum Run Time, and Maximum Run Time. As discussed above in the Requirement to Incorporate Bidding Parameters as Part of the Electric Storage Resource Participation Model section,[262] each RTO's/ISO's participation model for electric storage resources must account for these physical and operational characteristics, whether through bidding parameters or other means. We do not adopt the component of the NOPR proposal to require the RTO/ISO to allow market participants to submit this information at their discretion. Instead, consistent with the discussion above, we provide flexibility to each RTO/ISO to determine, consistent with how it treats other resources, whether it is mandatory for resources using the participation model for electric storage resources to submit information regarding these physical and operational characteristics, or whether resources using the participation model for electric storage resources should be allowed to submit this information at their discretion. Additionally, to the extent that an RTO/ISO proposes to comply with this requirement through its existing bidding parameters or other existing market mechanisms, it must demonstrate in its compliance

[262] *See supra* P 0.

filing how its existing market rules account for these characteristics of electric storage resources.

216. We find that it is necessary for a resource using an RTO's/ISO's participation model for electric storage resources to be able to provide information concerning these physical and operational characteristics to the RTO/ISO because, like traditional generation resources, it may only be economic for the resource to operate if it is guaranteed to do so for minimum amount of time. Additionally, unlike traditional generation resources, it is physically impossible for an electric storage resource to charge or discharge energy for longer than their state of charge would allow.

217. However, we clarify the NOPR proposal, further explaining the meaning of these physical and operational characteristics. First, we clarify that Minimum Charge Time represents the shortest duration that a resource using the participation model for electric storage resources is able to be dispatched by the RTO/ISO to receive electric energy from the grid. For example, it may only be possible for resources with slower transition speeds (such as pumped-hydro resources) to receive electric energy from the grid if it can do so for some minimum period of time (e.g., for one hour). Minimum Charge Time is similar to the Minimum Run Time for traditional generation resources but represents the minimum time the resource can receive electric energy from the grid, rather than provide electric energy to the grid.

218. We further clarify that Maximum Charge Time represents the maximum duration that a resource using the participation model for electric storage resources is able to be dispatched by the RTO/ISO to receive electric energy from the grid (e.g., for four hours).

If the RTO/ISO is not managing the state of charge of the electric storage resource in real time, then this parameter will prevent it from dispatching the resource to charge for a duration that would exceed the resource's Maximum State of Charge. It also provides useful information about how long the electric storage resource can be relied upon to receive energy from the grid if the system operator needs to dispatch it to do so.

219. Finally, we clarify that Minimum Run Time and Maximum Run Time are the minimum and maximum amounts of time that a resource using the participation model for electric storage resources is able to discharge electric energy. Maximum Run Time reflects the maximum amount of time that a resource using the participation model for electric storage resources is able to inject electric energy to the grid due to physical or operational constraints, such as its state of charge or potential obligations to provide other services. Similarly, Minimum Run Time allows the resource to identify the minimum amount of time the resource is physically able to discharge electric energy onto the grid. Minimum Run Time already exists in the RTOs/ISOs to prevent excessive wear and tear on traditional generation resources due to starting and stopping a resource too frequently and to ensure they are able to recover the costs of starting. To the extent that an RTO/ISO already accounts for this characteristic of the participation model for electric storage resources through its existing bidding parameters or other means, it must demonstrate in its compliance filing how its existing market rules do so.

4. Additional Physical and Operational Characteristics

a. Comments

220. In addition to the bidding parameters that the Commission proposed in the NOPR, a number of commenters identify physical and operational characteristics that they argue the Commission should also require each RTO/ISO to incorporate into its participation model for electric storage resources.[263] For example, EPRI contends that, to the extent that the Upper and Lower Charge Limit bidding parameters proposed in the NOPR do not represent the maximum and minimum amount of energy that an electric storage resource can store, the Commission should adopt additional bidding parameters in the final rule to capture this information. According to EPRI, this information is necessary for an RTO/ISO to manage an electric storage resource's state of charge within that resource's limits.

221. Several commenters support the concept of a bidding parameter(s) that reflects the time that an electric storage resource needs to transition from charging to discharging and from discharging to charging. NYPA asserts that an electric storage resource may also need a bidding parameter that reflects any ramp rate for those transitions. Relatedly, EPRI explains that energy storage resources that cannot transition from charging to discharging (and vice versa) instantaneously may require minimum charge level as a bidding parameter. EPRI further explains that software models may also require that the

[263] *See* EPRI Comments at 7-8, 17-18; NRG Comments at 9, 15; NYPA Comments at 9; Pacific Gas & Electric Comments at 9.

values for maximum energy charge and discharge rates (ramp rates) bidding parameters to be the same for these resources.

222. Some commenters propose bidding parameters to reflect any limits on an electric storage resource's operations.[264] California Energy Storage Alliance and Pacific Gas & Electric suggest that the Commission could adopt through-put limit as a bidding parameter. California Energy Storage Alliance claims that such a bidding parameter is necessary because cycling multiple times a day can cause excessive wear and tear to electric storage resources. NYISO Indicated Transmission Owners suggest maximum and minimum allowable charge and maximum daily charging and discharging cycles as bidding parameters. NYPA argues that bidding parameters should reflect the unique operating costs of electric storage resources (such as wear and tear, lost opportunity costs, and efficiency losses). Research Scientists assert that, to contribute to their economic viability, bidding parameters for most electrochemical energy storage technologies should represent their power limits, efficiency/losses, and degradation.

223. Other commenters propose various additional bidding parameters, including charge and discharge price, maximum consumption for dispatch asset-related demand, minimum time between discharge cycles for demand response resources,[265] minimum

[264] *See* California Energy Storage Alliance Comments at 13; NYISO Indicated Transmission Owners Comments at 6; NYPA Comments at 9-10; Pacific Gas & Electric Comments at 9; Research Scientists Comments at 6-7.

[265] *See* NYISO Indicated Transmission Owners Comments at 6.

energy charge and discharge rate, self-discharge rate,[266] round-trip efficiency (i.e., the ratio of how much energy is lost from charge to discharge),[267] and separate ramp rates for energy and reserves,[268] as well as bidding parameters that reflect electric storage resources' ability to respond to transients with automatic voltage regulation, power system stability, and generator droop.[269]

b. Commission Determination

224. Upon consideration of the comments, and to implement the new requirement in section 35.28(g)(9)(i)(c) of the Commission's regulations, we require each RTO/ISO to revise its tariff to incorporate a participation model for electric storage resources that accounts for the following physical and operational characteristics that were not proposed in the NOPR: Minimum Discharge Limit, Minimum Charge Limit, Discharge Ramp Rate, and Charge Ramp Rate. Each RTO's/ISO's participation model for electric storage resources must account for these physical and operational characteristics, whether through bidding parameters or other means. Consistent with the discussion above, we provide flexibility to each RTO/ISO to determine, consistent with how it treats other resources, whether it is mandatory for resources using the participation model for electric storage resources to submit information regarding these physical and

[266] *See* Pacific Gas & Electric Comments at 9.

[267] *See* EPRI Comments at 17-18.

[268] *See* Dominion Comments at 6-7.

[269] *See* Magnum Comments at 11.

operational characteristics, or whether resources using the participation model for electric storage resources should be allowed to submit this information at their discretion. To the extent that an RTO/ISO proposes to comply with this requirement through its existing bidding parameters or other existing market mechanisms, it must demonstrate in its compliance filing how its existing market rules account for these characteristics of electric storage resources.

225. We find that requiring each RTO's/ISO's electric storage resource participation model to account for these physical and operational characteristics is necessary to improve the ability of electric storage resources to provide all of the services that they are technically capable of providing and to allow the RTOs/ISOs to procure these services more efficiently, which will enhance competition and, in turn, help to ensure that the RTO/ISO markets produce just and reasonable rates.

226. First, we are persuaded by EPRI's suggestion that some electric storage resources may need to identify their minimum operating limits when they are charging or discharging. Specifically, an electric storage resource may need to identify its Minimum Discharge Limit, which represents the minimum MW output level that the resource can inject onto the grid, and its Minimum Charge Limit, which represents the minimum MW level that the resource can receive from the grid.

227. Like traditional generation resources, some electric storage resources may not be able to inject energy onto the grid below a minimum MW output level due to the physical capabilities of individual turbines or the power electronic of the system. Also like traditional generators, we find that resources using the participation model for

electric storage resources should be able to represent such a minimum value in the RTO/ISO markets. Because electric storage resources are also able to receive electric energy from the grid, there may be a Minimum Charge Limit in MWs that they are able to receive from the grid as well due to similar physical constraints of the resource or its power electronics.

228. Therefore, while the Commission did not propose in the NOPR to require each RTO's/ISO's electric storage resource participation model to account for the Minimum Charge Limit or Minimum Discharge Limit of a resource using the electric storage resource participation model, in this Final Rule, we require each RTO/ISO to revise its tariff to account for these physical characteristics as part of its participation model for electric storage resources.

229. In addition, we agree with EPRI that the speed at which electric storage resources can move from zero output to full output, or its Maximum Discharge Limit, is the same as the current ramp rates provided by traditional generation resources. However, we find that it is important to ensure that electric storage resources are able to represent this physical characteristic consistent with how other market participants are able to do so. Therefore, for purposes of this Final Rule, we refer to this parameter as the Discharge Ramp Rate and require each RTO/ISO to account for this physical characteristic in its participation model for electric storage resources by either making existing ramp rate parameters available to resources using the participation model for electric storage resources or by other means. The unique consideration for electric storage resources is their ability to both charge and discharge energy and to transition from one operational

state to the other. Therefore, in addition to a Discharge Ramp Rate, we require each RTO/ISO to account for a Charge Ramp Rate in its participation models for electric storage resources. The Charge Ramp Rate represents the speed at which an electric storage resource can move from zero output to fully charging, or the resource's Maximum Charge Limit. While electric storage resources are often designed to charge and discharge at the same speeds, that is not always the case, and there may be other physical or operational reasons that resources using the participation model for electric storage resources need to differentiate their Charge Ramp Rate from the Discharge Ramp Rate. Therefore, in this Final Rule, we require each RTO/ISO to revise its tariff to account for these characteristics as part of its participation model for electric storage resources.

230. We do not find it necessary to require each RTO/ISO to account for the other physical and operational characteristics of electric storage resources that commenters suggest in its participation model for electric storage resources. However, we recognize that, given the different market structures of the RTOs/ISOs, there may be additional physical and operational characteristics of electric storage resources that each RTO/ISO wishes to reflect in its participation model for such resources to allow it to more efficiently dispatch its system. Thus, we will allow each RTO/ISO to propose in its compliance filing bidding parameters or other means to account for physical and operational characteristics of electric storage resources besides those set forth in this Final Rule. To the extent that an RTO/ISO includes such a proposal in its compliance filing, the RTO/ISO must demonstrate that such bidding parameters or other mechanisms

do not impose barriers to the participation of electric storage resources in its markets.

5. Summary of Physical and Operational Characteristics of Electric Storage Resources

231. For ease of reference, the following chart summarizes the physical and operational characteristics of electric storage resources for which each RTO's/ISO's participation model for electric storage resources must account:

Physical or Operational Characteristic	Definition
State of Charge	State of Charge represents the amount of energy stored in proportion to the limit on the amount of energy that can be stored, typically expressed as a percentage. It represents the forecasted starting State of Charge for the market interval being offered into.
Maximum State of Charge	Maximum State of Charge represents a State of Charge value that should not be exceeded (i.e., gone above) when a resource using the participation model for electric storage resources is receiving electric energy from the grid (e.g., 95% State of Charge).
Minimum State of Charge	Minimum State of Charge represents a State of Charge value that should not be exceeded (i.e., gone below) when a resource using the participation model for electric storage resources is injecting electric energy to the grid (e.g., 5% State of Charge).
Maximum Charge Limit	Maximum Charge Limit represents the maximum MW quantity of electric energy that a resource using the participation model for electric storage resources can receive from the grid.
Maximum Discharge Limit	Maximum Discharge Limit represents the maximum MW quantity that a resource using the participation model for electric storage resources can inject to the grid.
Minimum Charge Time	Minimum Charge Time represents the shortest duration that a resource using the participation model for electric storage resources is able to be dispatched by the RTO/ISO to receive electric energy from the grid (e.g., one hour).
Maximum Charge Time	Maximum Charge Time represents the maximum duration that a resource using the participation model for electric storage resources is able to be dispatched by the RTO/ISO to receive

	electric energy from the grid (e.g., four hours).
Minimum Run Time	Minimum Run Time represents the minimum amount of time that a resource using the participation model for electric storage resources is able to inject electric energy to the grid (e.g., one hour).
Maximum Run Time	Maximum Run Time represents the maximum amount of time that a resource using the participation model for electric storage resources is able to inject electric energy to the grid (e.g., four hours).
Minimum Discharge Limit	The minimum MW output level that a resource using the participation model for electric storage resources can inject onto the grid.
Minimum Charge Limit	The minimum MW level that a resource using the participation model for electric storage resources can receive from the grid.
Discharge Ramp Rate	The speed at which a resource using the participation model for electric storage resources can move from zero output to its Maximum Discharge Limit.
Charge Ramp Rate	The speed at which a resource using the participation model for electric storage resources can move from zero output to its Maximum Charge Limit.

F. State of Charge Management

1. NOPR Proposal

232. In the NOPR, the Commission proposed to require each RTO/ISO to allow electric storage resources to self-manage their state of charge and upper and lower charge limits.[270] The Commission stated that an electric storage resource that self-manages its state of charge is subject to any penalties for deviating from a dispatch schedule to the extent the resource manages its state of charge by deviating from the dispatch schedule.[271] However, the Commission sought comment on whether there are conditions

[270] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 69.

[271] *See id*. P 70.

under which an RTO/ISO should not allow an electric storage resource to manage its state of charge and upper and lower charge limits.

2. Comments

233. Numerous commenters support the NOPR proposal to require each RTO/ISO to allow electric storage resources to self-manage their state of charge and upper and lower charge limits.[272] Some commenters assert that the proposal will allow for more efficient use of electric storage resources and will extend their useful lives.[273] Other commenters state that permitting an electric storage resource to manage its state of charge would allow the asset owner to optimize the operations of its resource.[274] Tesla/SolarCity point to CAISO's tariff for Non-Generator Resources to self-manage energy limits and state-of-charge in real time as a good model.[275]

234. Several commenters, however, urge the Commission to go farther than the NOPR

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[272] *See, e.g.*, Beacon Power Comments at 6; DTE Electric/Consumers Energy Comments at 4-5; EEI Comments at 10; Energy Storage Association Comments at 16-17; IRC Comments at 5; Microgrid Resources Coalition Comments at 7; NESCOE Comments at 11; Pacific Gas & Electric Comments at 8; Research Scientists Comments at 7-8.

[273] *See* AES Companies Comments at 22; Electric Vehicle R&D Group Comments at 1.

[274] *See* Avangrid Comments at 6; Energy Storage Association Comments at 16; Imperial Irrigation District Comments at 10; NRG Comments at 18; NYPA Comments at 10.

[275] *See* Tesla/SolarCity Comments at 14-15 (citing *California Indep. Sys. Operator Corp.*, 156 FERC ¶ 61,110 at P1).

proposal, stating that an electric storage resource should always, or almost always, be responsible for managing its own state of charge. Most RTOs/ISOs, PJM Market Monitor, and Xcel Energy Services argue that the RTO/ISO should not be responsible for managing an electric storage resource's state of charge.[276] For example, IRC argues that the RTOs/ISOs should only be responsible for following reasonable operating parameters provided by the electric storage resource owner.[277] Generally, commenters state that it would be challenging for the RTO/ISO to manage a storage resource's state of charge, RTOs/ISOs traditionally do not manage how resources participate in the market, RTOs/ISOs should not be put in the position of managing market risk for or making business judgments on behalf of market participants, and electric storage resources should manage their own state of charge through their market offers, updates to market offers, and decisions to remove their resource from market dispatch.[278]

235. Other commenters argue that, to the extent the Commission permits an RTO/ISO to manage an electric storage resource's state of charge, that RTO/ISO should be required to meet certain conditions.[279] For example, AES Companies argue the related software

[276] *See* IRC Comments at 5; ISO-NE Comments at 20; PJM Comments at 10; PJM Market Monitor Comments at 4.

[277] *See* IRC Comments at 5.

[278] *See* AES Companies Comments at 23; PJM Comments at 10; PJM Market Monitor Comments at 4; Xcel Energy Services Comments at 17-18.

[279] *See* AES Companies Comments at 23.

development and administrative costs of RTO/ISO management of a resource's state of charge should be allocated only to those resources requesting the state-of-charge management service from the RTO/ISO. In contrast, Microgrid Resources Coalition contends that, if an RTO/ISO seeks to manage the state of charge or readiness of an electric storage resource, it should compensate the resource for that privilege.[280] NRG asserts that to the extent an RTO/ISO manages an electric storage resource's state of charge, it will have to include complex bidding parameters to ensure that the resource could meet any retail obligations that it has assumed.[281] MISO Transmission Owners state that an RTO/ISO that manages an electric storage resource's state of charge must do so in accordance with the criteria that the resource owner establishes.[282]

236. Imperial Irrigation District asserts that the RTO/ISO should manage an electric storage resource's state of charge only if the resource owner agrees.[283] Relatedly, NYPA argues that, if an RTO/ISO is managing an electric storage resource's state of charge, that resource should be permitted to withdraw from RTO/ISO control without penalty if it believes it is under-recovering revenues due to the RTO's/ISO's directives.[284] NYPA

[280] *See* Microgrid Resources Coalition Comments at 7-8.

[281] *See* NRG Comments at 18.

[282] *See* MISO Transmission Owners Comments at 11.

[283] *See* Imperial Irrigation District Comments at 10.

[284] *See* NYPA Comments at 10-11.

contends that several RTOs/ISOs have considered or implemented performance incentive structures and including electric storage resources in those market designs could provide the proper market incentive for such resources to be available when they are most needed, instead of having the RTO/ISO manage a resource's state of charge.

237. Other commenters suggest that there are certain circumstances when RTO/ISO state of charge management is beneficial and that each RTO/ISO should be permitted to manage an electric storage resource's state of charge in certain circumstances.[285] SPP asserts that RTOs/ISOs should manage the state of charge of regulation resources but that electric storage resources that qualify to provide other services should manage their own states of charge.[286] CAISO notes that, under its existing market rules, it manages the state of charge for some electric storage resources and allows others to manage their own state of charge. Specifically, CAISO notes that, for resources that seek to provide regulation, it can optimize a resource's state of charge, allowing a resource to offer its full capacity as regulation consistent with continuous energy requirements for that service. ISO-NE states that it recognizes that it may be necessary at times for an RTO/ISO to posture resources, including electric storage resources, to ensure reliability.

238. EPRI states that it may be appropriate for the RTO/ISO to manage a storage

[285] *See* CAISO Comments at 10-11; EPRI Comments at 21-22 (citing https://ncreview.org/smart_grid/pjms-frequency-regulation-market-and-the-changing-nature-of-energy-storage-gtm-squared/45256); ISO-NE Comments at n.23; Research Scientists Comments at 7; SPP Comments at 11, 12.

[286] *See* SPP Comments at 11, 12.

resource's state of charge to ensure that sufficient regulating capability is available from the resource, noting that this has already occurred in some RTOs/ISOs. EPRI adds that RTO/ISO management of state of charge could lead to more efficient and more reliable operations and better mitigation of day-ahead forecast uncertainty because the RTO/ISO has better knowledge of system conditions. Research Scientists argue that, while it may be technically challenging to achieve, in principle, the RTO/ISO is in the best position to manage energy storage scheduling and state of charge in order to minimize system costs.

239. EEI and Exelon assert that, if an electric storage resource is used to address reliability-related transmission needs or relieve congestion as a transmission asset, the RTO/ISO must have functional control over dispatch, including the timing and amount of energy that may be injected into or withdrawn from the transmission system and the amount of energy that must be made available for injection or withdrawal at the direction of the RTO/ISO to fulfill the resource's transmission function.[287] Exelon states that the RTO/ISO could release control of the electric storage resource when it is not needed for such services, noting that the RTO/ISO may still have to determine the level of energy to be available at all times from resources that provide blackstart service. In contrast, AES Companies claim that, because advanced software is used to optimize a lithium array's life, state of charge should still be managed by the owner of a storage resource used as a transmission asset under the RTO's/ISO's functional control.[288]

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[287] See EEI Comments at 11; Exelon Comments at 8-9, n.4.

[288] *See* AES Companies Comments at 21.

240. EEI and Xcel Energy Services suggest that, given the lack of clarity about the proposal for state of charge management, a technical conference may be warranted to better explain the state of charge management concept and better ascertain the issues that need to be evaluated in determining how state of charge should be managed.[289] EEI states that this technical conference should address the management of multiple payment streams for electric storage resources that are both receiving cost-based rates and participating in the RTO/ISO markets because such a resource must be able to fulfill both the obligations that it assumes in the market and as a transmission asset. MISO also argues that further study is needed to comprehend the reliability and economic outcomes of different approaches to state-of-charge management for electric storage resources, noting that it must have an effective way to ensure that an electric storage resource managing its state of charge has enough stored energy to allow it to provide the services that it clears the market to provide.[290]

241. Altametric and Bonneville assert that an RTO/ISO may need to directly manage the state of charge and upper and lower charge limits of electric storage resources during an abnormal condition or system emergency to preserve system reliability.[291] Bonneville encourages the Commission to allow the RTOs/ISOs to identify these reliability-based conditions. City of New York contends that, while there may be limited circumstances

[289] *See* EEI Comments at 10-11; Xcel Energy Services Comments at 18.

[290] *See* MISO Comments at 15-16.

[291] *See* Altametric Comments at 6; Bonneville Comments at 5.

under which an RTO/ISO is better suited than the asset owner to manage an electric storage resource's state of charge and upper and lower charge limits, the scope of an RTO's/ISO's authority to do so should be established consistent with their limited experience with such resources, while changing over time as they gain additional experience.[292]

242. Some commenters argue that the Commission should require each RTO/ISO to offer state-of-charge management to electric storage resources.[293] NYISO Indicated Transmission Owners state that, because electric storage resources can be used to support local or bulk electric system reliability, the Commission should ensure that electric storage resource owners can voluntarily elect to cede control of their resources' state of charge to either an RTO/ISO or distribution utility. Dominion stresses the importance of pumped-hydro resources' ability to opt for PJM to optimize their pumping and dispatch in the day-ahead market when these facilities provide PJM with their starting and ending storage levels for the day, along with other resource-specific operating parameters and suggests expanding this ability to other electric storage resources.

243. To enable them to provide their full capabilities to the market in a continual manner, Energy Storage Association asks the Commission require each RTO/ISO to allow an

[292] *See* City of New York Comments at 7.

[293] *See* Dominion Comments at 5; NYISO Indicated Transmission Owners Comments at 6.

electric storage resource to opt to have the RTO/ISO manage its state of charge.[294] Energy Storage Association contends that, at a minimum, an active state-of-charge management mechanism should be available for electric storage resources providing services that need operational decisions faster than bidding intervals (e.g., frequency regulation) and state of charge cannot be predicted or managed through bidding alone. Energy Storage Association notes that CAISO, MISO, and NYISO offer state of charge management for electric storage resources providing frequency regulation service and argues that these practices should be expanded to all RTOs/ISOs and be available for resources of any duration, not just short-duration storage resources providing frequency regulation.

244. Xcel Energy Services contends that issues associated with managing state of charge may impact opportunity costs included in offers and raise concerns regarding economic withholding of resources from the market and market monitors may need to develop new monitoring tools and exhibit flexibility in evaluating offer opportunity costs when evaluating behavior of storage resources in the market.[295] R Street Institute posits that economic withholding may be difficult to detect, given that electric storage resources' offers reflect their opportunity costs (rather than physical marginal costs) and that these resources will likely supply energy when prices are high and the market is most

[294] *See* Energy Storage Association Comments at 6, 17, n.24.

[295] *See* Xcel Energy Services Comments at 18, n.27.

vulnerable to the exercise of market power.[296] R Street Institute explains that physical withholding detection will prove challenging due to the complexity and heterogeneity of physical characteristics of electric storage resources. Therefore, R Street Institute asks the Commission to seek comment on how electric storage resources may engage in economic or physical withholding.

245. With respect to the Commission's statement in the NOPR that an electric storage resource that self-manages its state of charge is subject to any penalties for deviating from a dispatch schedule to the extent the resource manages its state of charge by doing so, several commenters agree that, if an electric storage resource self-manages its state of charge and does not perform when obligated to do so, the resource should incur non-performance penalties.[297] EPRI asserts that potential penalties will help incentivize energy storage resources that self-manage their state of charge to ensure that their state-of-charge constraints are met. EPRI adds, however, that the RTO/ISO may not have sufficient information about whether an electric storage resource that is providing spinning/synchronized reserve can meet its obligation to provide energy unless the RTO/ISO must call on that resource, making it more difficult to penalize such a resource for noncompliance unless an event has occurred.

[296] *See* R Street Institute Comments at 6.

[297] *See, e.g.*, Energy Storage Association Comments at 17; EPRI Comments at 23; ISO-NE Comments at 20; Ohio Commission Comments at 7; Xcel Energy Services Comments at 22.

3. Commission Determination

246. Upon consideration of the comments, we agree with commenters that resource owners/operators using the participation model for electric storage resources must be able to manage the state of charge of their resources. Consistent with the NOPR, we find that each RTO/ISO must permit electric storage resources to manage their state of charge because it allows these resources to optimize their operations to provide all of the wholesale services that they are technically capable of providing, similar to the operational flexibility that traditional generation resources have to manage the wholesale services that they offer. We find that, while the RTOs/ISOs may be in a better position to effectively manage the state of charge for a resource using the participation model for electric storage resources that, for example, exclusively provides frequency regulation service, some electric storage resources may be able to provide multiple services or services to another entity outside of the RTO/ISO markets.

247. We therefore agree with commenters that resources using the participation model for electric storage resources must have the ability to self-manage their state of charge and it is often desirable to allow them to do so. Providing this flexibility will allow resource owners/operators to ensure their own Minimum and Maximum States of Charge are not violated,[298] which will help prevent excessive wear and tear on the resource and

[298] *See supra* P 210. Consistent with the changes in terminology adopted in the State of Charge, Upper and Lower Charge Limits, and Maximum Charge and Discharge Rates section, we are using the terms Maximum State of Charge and Minimum State of Charge instead of Upper Charge Limit and Lower Charge Limit.

help maintain its technical capabilities to provide services in the RTO/ISO markets. Additionally, depending on the telemetry rules adopted by each RTO/ISO, ensuring that a resource owner/operator is able to manage its own state of charge may also limit the need for the RTO/ISO to telemeter the resource in real time to ensure that the Minimum and Maximum States of Charge are not violated. For these reasons, we find that a sufficient record exists in this proceeding to make these determinations without the need for additional process or a technical conference, as some commenters propose.

248. Therefore, we require each RTO/ISO to allow resources using the participation model for electric storage resources to self-manage their state of charge. We also find here that a resource using the participation model for electric storage resources that self-manages 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.[299] We also clarify that, to the extent that the provision of a particular wholesale service, such as frequency regulation, requires a resource providing that service to follow a dispatch signal that has the effect of maintaining the resource's ability to provide the service, an electric storage resource that is managing its own state of charge would still be required to follow such a dispatch signal, just as all other resources providing that same service.

[299] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 70.

249. Additionally, we clarify that the RTOs/ISOs are not required as part of this Final Rule to manage the state of charge for resources using the participation model for electric storage resources.[300] However, if an RTO/ISO already has a mechanism to manage a resource's state of charge (such as regulation energy management in CAISO or pumped-hydro resource operation in PJM), then we require the RTO/ISO to make the use of such mechanism optional so that an electric storage resource owner/operator is able to manage its own state of charge if it elects to do so. Where an electric storage resource has the option to allow the RTO/ISO to manage its state of charge, we clarify that the electric storage resource is the default manager of the resource's state of charge.

250. In response to the concerns about the ability of the RTOs/ISOs to use electric storage resources to address any reliability challenges and to know that the resources have an adequate state of charge to perform the service to which they have committed, we note that the RTO/ISO should be able to dispatch a resources using the participation model for electric storage resources in the same manner as any other market participant. Nothing in this Final Rule precludes an RTO/ISO from establishing telemetry or other communication requirements necessary to determine the capabilities of the electric storage resource in real time. We believe that this flexibility will ensure sufficient visibility of a resource using the participation model for electric storage resources to

[300] We note that, while the RTOs/ISOs must permit resources to manage their own state of charge, the RTOs/ISOs may provide an option for the RTO/ISO to manage an electric storage resource's state of charge for any particular service or circumstance as they deem appropriate in their markets with consent of the electric storage resource.

safeguard operational reliability and market integrity. We reiterate that self-managing electric storage resources, just like all market participants, are subject to any non-performance penalties in the RTO/ISO tariff, thus incentivizing them to ensure that they have sufficient energy available to meet their obligations.

251. As for commenters' concerns about economic and physical withholding, we agree that the energy limitations of electric storage resources will need to be factored into their market offers and that misrepresenting those limitations could constitute manipulation if an electric storage resource has an obligation to participate in an RTO/ISO market. However, as discussed in the Ability to De-Rate Capacity to Meet Minimum Run-Time Requirements section above, in this Final Rule, we require each RTO/ISO to demonstrate how its existing market rules provide a means for energy-limited resources, including electric storage resources, to provide capacity.[301] This may include ways for energy-limited resources, such as electric storage resources, to represent their energy limitations through their offer prices, which, if allowed by the RTO/ISO, would not constitute economic withholding. Also, as discussed above, we find that electric storage resources de-rating to provide capacity or other services are not engaging in physical withholding if they are de-rating to meet minimum run-time requirements.

252. However, there may still be concerns that electric storage resources managing their own state of charge could be doing so inconsistent with the physical and operational characteristics of the resource, which may create a need to ensure those resources are not

[301] *See supra* P 98.

withholding services or otherwise violating its dispatch in a way inconsistent with its physical capabilities. Therefore, we note that, as with other resources, market monitors have the ability to review the bids from electric storage resources to detect economic or physical withholding. Additionally, if an RTO/ISO determines that additional rules are needed to ensure electric storage resources are not managing their state of charge in a way that could manipulate market outcomes through withholding, then the RTO/ISO could propose such rules in response to this Final Rule or through a separate FPA section 205 filing.[302]

G. Minimum Size Requirement

1. NOPR Proposal

253. In the NOPR, the Commission proposed to require each RTO/ISO to revise its tariff 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.[303]

[302] *See* 16 U.S.C. § 824d.

[303] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 94. The Commission used the term "minimum size requirement" to collectively describe minimum capacity requirements to qualify to use a given participation model, "minimum offer requirements" for offers to sell services in the RTO/ISO markets, and "minimum bid requirements" for bids to buy energy in these markets. *Id*. n.148.

2. Comments

254. Several commenters agree with the proposed 100 kW minimum size requirement for electric storage resources.[304] Many of these commenters argue that there is no justification for the minimum size requirement to be any higher. Minnesota Energy Storage Alliance asserts that large minimum size requirements have and continue to pose a barrier to electric storage resource development in Minnesota.[305] Energy Storage Association and Tesla/SolarCity note that most or all of the RTOs/ISOs currently allow at least some type of resource to participate in their markets at a size of 100 kW, including PJM, which allows participation by 100 kW electric storage resources.[306] Massachusetts State Entities and NESCOE state that the proposal would be technically feasible in ISO-NE and will not compromise the efficiency of market dispatch.[307] Massachusetts State Entities note that the 100kV threshold is consistent with the results of a pilot program in which ISO-NE reduced the minimum size requirement to participate in its frequency regulation market to 100 kW and found that resources smaller than one MW were technically capable of providing the service. However,

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[304] *See, e.g.*, Avangrid Comments at 8; Energy Storage Association Comments at 23; Massachusetts State Entities Comments at 16-17; NYISO Comments at 10; PJM Market Monitor Comments at 9; Tesla/SolarCity Comments at 17-18.

[305] *See* Minnesota Energy Storage Alliance Comments at 3-4.

[306] *See* Energy Storage Association Comments at 7, 23-24; Tesla/SolarCity Comments at 17-18.

[307] *See* NESCOE Comments at 12.

Tesla/SolarCity request that the Commission clarify that the 100 kW minimum size requirement applies not only to individual electric storage resources but also can be met through the aggregation of smaller electric storage resources.

255. Energy Storage Association asserts that electric storage resources less than 1 MW in size can provide the same services and the same flexibility, reliability, and cost reduction benefits as larger electric storage resources.[308] NYISO Indicated Transmission Owners do not oppose the NOPR proposal.[309]

256. Other commenters support the concept of a minimum size requirement but have reservations about the 100 kW value that the Commission proposed in the NOPR.[310] Eagle Crest agrees that a minimum size requirement is appropriate but takes no position with respect to what that requirement should be. Relatedly, Public Interest Organizations and R Street Institute contend that lowering the minimum size requirement will reduce barriers to the participation of electric storage resources but state that the NOPR proposal does not address the arbitrariness of choosing a particular minimum size. R Street Institute argues that no economic rational justifies the RTOs/ISOs adopting different minimum size requirements. While R Street Institute states that the NOPR correctly identifies the need to balance the benefits of lowering

[308] *See* Energy Storage Association Comments at 24.

[309] *See* NYISO Indicated Transmission Owners Comments at 7.

[310] *See* Eagle Crest Comments at 7; National Hydropower Association Comments at 9, n.9; Public Interest Organizations Comments at 18; R Street Institute Comments at 7.

minimum size requirements with the ability of market clearing software to model and dispatch smaller resources, it argues that it is unclear how the NOPR proposal balances these benefits and costs. While the National Hydropower Association notes that it is concerned with market participation limitations based on project size, it believes that the NOPR proposal is compatible with existing and future pumped-hydro resources interconnected to the transmission system.

257. Other commenters oppose the NOPR proposal.[311] CAISO explains that it requires resources to have a capacity of at least 500 kW to participate in its energy and ancillary service markets, while initial offer segments must be no less than 100 kW/kWh. While CAISO agrees with the Commission that its software could model or dispatch a resource with a capacity of 100 kW, CAISO is concerned that the 100 kW minimum size requirement would also apply to distributed energy resources and requiring CAISO to clear congestion on its grid with thousands of resources with capacities in the range of 100 kW will reduce the efficiency and performance of its market software. Therefore, CAISO asks the Commission to allow each RTO/ISO to set its minimum size requirement up to 500 kW for installed capacity, with a minimum offer requirement of up to 100 kW/kWh offered into the market and for the initial offer segment. CAISO states that a 500 kW minimum size requirement is consistent with the minimum size requirement that it applies to generators. CAISO further states that the Commission could direct each RTO/ISO to explain how electric storage resources smaller than 500

[311] *See* CAISO Comments at 16-19; ISO-NE Comments at 23.

kW may participate in their markets (e.g., through aggregation models or as demand response resources).

258. ISO-NE argues that imposing a 100 kW minimum size requirement could force it to change the minimum size requirement for all resources in its markets due to its product-based market design. ISO-NE asks the Commission to permit ISO-NE to work with transmission organizations and utility distribution companies in the regions to set minimum size requirements. ISO-NE contends that it must assess whether such an outcome would increase the costs or time needed for implementation. ISO-NE asserts that the proposed 100 kW minimum size requirement might increase costs and the time needed for implementation for the region's transmission organizations and distribution utilities because smaller resources are more likely to be interconnected to the distribution system and these transmission organizations and distribution utilities would have to install metering and adopt accounting procedures to measure the consumption and output of these resources.

259. AES Companies, EEI, MISO Transmission Owners, Pacific Gas & Electric, and SoCal Edison argue that the Commission should allow each RTO/ISO to establish its own minimum size requirements for electric storage resources based on its unique circumstances.[312] EEI argues that it could allow so many electric storage resources to participate in the RTO/ISO markets that the RTOs/ISOs will be unable to evaluate these

[312] *See* EEI Comments at 13-14; AES Companies Comments at 7, 28-29; MISO Transmission Owners Comments at 13-14; Pacific Gas & Electric Comments at 10-11; SoCal Edison Comments at 15-16.

resources, distribution utilities will be unable to model these resources and implement infrastructure upgrades, and the implementation costs incurred to facilitate their participation will exceed the benefits of that participation. While AES Companies support the concept of a minimum size requirement, they contend that 100 kW is significantly below the minimum size requirement for many distribution utilities and may be challenging for some of the RTOs/ISOs to implement (given their diverse operating characteristics and supporting software systems). Likewise, MISO Transmission Owners state that 100 kW is very low, especially for distribution utilities. Pacific Gas & Electric contends that the Commission should allow each RTO/ISO to establish different minimum size requirements for the different services that electric storage resources can provide (e.g., energy or ancillary services) and the different participation models that they can use to participate in the RTO/ISO market. Pacific Gas & Electric asserts that the appropriate minimum size requirement(s) may be based on the opportunities for aggregation of electric storage resources.

260. AES Companies, EEI, MISO Transmission Owners, and Pacific Gas & Electric contend that the minimum size requirement for an electric storage resource to participate in an RTO/ISO market should take into account the point at which electric storage resources will interconnect to the system (i.e., the transmission or distribution system) and how it will be operated relative to other generation interconnected to the distribution system.[313] AES Companies assert that the Commission does not have the authority to set

[313] *See* AES Companies Comments at 7, 28-29; EEI Comments at 14; MISO

minimum size requirements for distribution utilities and the 100 kW proposed minimum size requirement conflicts with existing state tariffs and operating principles. Thus, AES Companies and MISO Transmission Owners ask the Commission to allow each distribution utility (with its retail regulators) and each RTO/ISO (with its stakeholders) to establish its own minimum size requirement for distribution-interconnected and behind-the-meter electric storage resources and transmission-interconnected electric storage resources, respectively.

261. Alternatively, MISO Transmission Owners state that a one MW minimum size requirement is more practical and appropriate due to administrative and settlement burdens on the RTOs/ISOs, while a 500 kW minimum size requirement may be appropriate for supporting innovation in immature technologies and markets through pilot projects.[314] In contrast, while acknowledging that smaller electric storage resources can be aggregated to meet minimum size requirements, SoCal Edison argues that a one MW minimum size requirement may be too large because electric storage resources with a capacity of one MW or more that are interconnected to the distribution system could create operational challenges for distribution operators.[315] Altametric recommends a minimum power output size of 500 kW from no charge to full charge with a minimum

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Transmission Owners Comments at 13; Pacific Gas & Electric Comments at 11.

[314] *See* MISO Transmission Owners Comments at 13-14.

[315] *See* SoCal Edison Comments at 15.

limit of 100 kWh.[316] Xcel Energy Services contends that electric storage resources should have to meet the same minimum size requirements like other, larger resources.[317]

262. A few commenters raise the potential impact of the NOPR proposal on the software that RTOs/ISOs use to clear their markets.[318] MISO claims that a minimum size requirement that is too small could result in more very small electric storage resources participating in MISO's markets than its current operational and market systems and software may be capable of tracking, processing, and settling. Similarly, Pacific Gas & Electric and Xcel Energy Services suggest considering whether the market-clearing software is capable of managing the dispatch of many small resources when determining minimum size requirements. MISO warns that its market systems may require significant upgrades to accommodate the potentially large number of electric storage resources and the multiplicity of variables associated with their transactions. MISO also claims that its State Estimator (which it uses to track energy for real-time dispatch and performance measurement) may not have the ability to estimate the status of 100 kW resources. Minnesota Energy Storage Alliance states that, while it defers to the RTOs'/ISOs' comments on the software upgrades needed to implement the proposed minimum size requirement and the associated costs, it would like to see MISO modify

[316] *See* Altametric Comments at 7.

[317] *See* Xcel Energy Services Comments at 23.

[318] *See* Minnesota Energy Storage Alliance Comments at 4; MISO Comments at 8-9; Pacific Gas & Electric Comments at 11; Xcel Energy Services Comments at 23.

its markets to allow for the participation of smaller resources.

263. MISO Transmission Owners claim that any new rule would effectively direct investment in software and/or infrastructure upgrades over other priorities that have been established based on customer need and that the Commission must balance prioritization of electric storage resource participation against other important system improvements and maintenance.[319] MISO Transmission Owners assert that this concern is valid and timely because many distribution companies are implementing large-scale, advanced metering infrastructure deployment plans. Xcel Energy Services also argues that any administrative costs that result from the growth in the number of small resources participating in the RTO/ISO markets should be borne by those resources.[320] EPRI suggests further study on two issues: (1) whether RTO/ISO market-clearing software will be capable of identifying the optimal dispatch of resources within existing market timelines when there are more resources participating in the RTO/ISO markets and (2) whether small electric storage resources will be dispatched arbitrarily given that small resources that could reduce total production costs might not be dispatched, even though they would reduce production costs, because the market-clearing software has stopped looking for a better dispatch solution.[321]

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[319] *See* MISO Transmission Owners Comments at 14.

[320] *See* Xcel Energy Services Comments at 23.

[321] *See* EPRI Comments at 26-27.

264. Finally, Open Access Technology recommends that the Commission clarify the minimum size of a price-quantity pair that an electric storage resource can include in its offer because RTO/ISO market rules generally allow for an offer curve that consists of up to ten price-quantity pairs (i.e., whether an electric storage resource can submit a price-quantity pair for less than 100 kW in its offer).[322]

3. Commission Determination

265. In this Final Rule, we adopt the NOPR proposal and add section 35.28(g)(9)(i)(d) to the Commission's regulations to require each RTO/ISO to revise its tariff 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. This minimum size requirement includes all minimum capacity requirements, minimum offer to sell requirements, and minimum bid to buy requirements for resources participating in these markets under the participation model for electric storage resources.

266. Electric storage resources are generally smaller than traditional generation resources and are often in the 100 kW to 1 MW range.[323] In many cases, existing minimum size

[322] *See* Open Access Technology Comments at 3.

[323] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at nn.146-147 (citing Sandia Report at 29, Figure 19 (Positioning of Energy Storage Technologies); U.S. Department of Energy, *Grid Energy Storage* at 12 (Dec. 2013) (stating that most storage systems are in the 10 kW to 10 MW range, with the largest proportion of those resources in the 100 kW to 1 MW range)).

requirements were created prior the emergence of new, smaller resources such as electric storage resources that are technically capable of participating in the RTO/ISO markets. We find that RTO/ISO market rules may create barriers to electric storage resource participation in those markets based on minimum size requirements that may have been designed for different types of resources.[324] Therefore, as discussed below, we conclude that requiring the RTOs/ISOs to establish a minimum size requirement not to exceed 100 kW for the participation model for electric storage resources balances the benefits of increased competition with the potential need to update RTO/ISO market clearing software to effectively model and dispatch smaller resources.

267. While some commenters argue that RTO/ISO modeling and dispatch software may be unable to accommodate a large number of smaller resources, the record shows that all RTOs/ISOs are already accommodating the participation of smaller resources in their markets. For example, the record shows that all RTOs/ISOs already have the modeling and dispatch software capabilities to accommodate the participation of resources that are as small as 100 kW. Specifically, both PJM and SPP have a minimum size requirement of 100 kW for all resources, and all of the RTOs/ISOs have at least one participation model that allows resources as small as 100 kW to participate in their markets.[325] In response to ISO-NE's claim that its product-based market design does not permit such

[324] *See id*. P 86.

[325] *See* CAISO Data Request Response at 10-11; ISO-NE Data Request Response at 13-14; MISO Data Request Response at 10; NYISO Data Request Response at 9; PJM Data Request Response at 10; SPP Data Request Response at 5.

size requirements, we point to varying minimum size requirements for existing participation models in ISO-NE (e.g., 1 MW for generators and 100 kW for demand response).

268. Further, we are not persuaded by commenters who argue that different minimum size requirements may be needed based on the service being provided, the location and concentration of electric storage resources, or where the electric storage resources are interconnected. Commenters have failed to demonstrate how minimum size requirements should be varied based on the manner in which electric storage resources are operated or based on the location of these resources. Additionally, in response to commenters that suggest that the Commission does not have the authority to set minimum size requirements for distribution utilities, we clarify that we are not setting minimum size requirements for distribution utilities in this Final Rule. Rather, we are requiring each RTO/ISO to establish a minimum size requirement for resources participating in its markets. Therefore, we find that minimum size requirements do not need to be resource-specific or location-specific. We note that existing participation models in the RTOs/ISOs have standard minimum size requirements for all resources that elect to use them.

269. Moreover, in response to concerns about potential impacts on the distribution systems and related costs, we note that numerous 100 kW minimum size requirements already exist, and there are resources located on the distribution system that are already participating in the RTO/ISO markets. Establishing a standard minimum size requirement for resources using the participation model for electric storage resources

may potentially result in more resources on the distribution systems participating in the RTO/ISO markets. However, it does not change the responsibilities of the RTOs/ISOs or the distribution utilities, and it does not change the ability of distribution utilities to allocate any costs that they incur in operating and maintaining their respective power systems.

270. With respect to CAISO's and MISO's concern that they may need to upgrade their software to manage the potentially large number of resources using the participation model for electric storage resources under the proposed minimum size requirement, as discussed in the Compliance Requirements section,[326] we find that we are providing the RTOs/ISOs with adequate time to develop the requisite tariff language and update their modeling and dispatch software to comply with this Final Rule and are factoring into the effective date of this Final Rule the burden of implementing the requirements herein. We are not persuaded that more than 365 days after the RTOs/ISOs submit their compliance filings will be necessary to implement the reforms in this Final Rule. We are also not concerned about the potential availability of software solutions as multiple RTOs/ISOs already provide a minimum size requirement of 100 kW for all resources and have not expressed similar concerns regarding the minimum size requirement. While establishing a minimum size requirement of 100 kW for the participation model for electric storage resources will result in some smaller resources entering the markets in the near term, we do not expect an immediate influx of these smaller resources or any

[326] *See infra* P 343.

resulting inability to model and dispatch them. However, we recognize this finding is based on the fact that there are currently fewer 100 kW resources than there may be in the future. Therefore, in the future, we will consider requests to increase the minimum size requirement to the extent an RTO/ISO can show that it is experiencing difficulty calculating efficient market results and there is not a viable software solution for improving such calculations.

271. In response to Open Access Technology's request for clarification of the number of allowed price-quantity bid segments for a 100 kW resource using the participation model for electric storage resources, we reiterate our requirement that the minimum size requirement applies to all minimum capacity requirements, minimum offer to sell requirements, and minimum bid to buy requirements. We note that, under this requirement, an RTO/ISO could allow offer and/or bid quantities smaller than 100 kW, as CAISO indicates it does.[327] An RTO/ISO could also allow minimum offer and/or bid quantities equal to 100 kW, as PJM indicates it does.[328] However, this requirement would not permit an RTO/ISO to require a resource using the electric storage resource participation model to submit offer and/or bid quantities larger than 100 kW.

[327] CAISO states the minimum participation requirement for electric storage resource energy bids is 10 kW. CAISO Data Request Response at 16.

[328] PJM states the 100 kW is both the minimum capacity requirement and also the minimum incremental offer amount. PJM Data Request Response at 10 (citing PJM Tariff, Attachment DD, section 5.6).

H. Energy Used to Charge Electric Storage Resources

1. Price for Charging Energy

a. NOPR Proposal

272. In the NOPR, the Commission stated that it has found that the sale of energy from the grid that is used to charge electric storage resources for later resale into the energy or ancillary service markets constitutes a sale for resale in interstate commerce.[329] As such, the Commission stated that the just and reasonable rate for that wholesale sale of energy used to charge the electric storage resource is the RTO/ISO market's wholesale price for energy or LMP. The Commission thus proposed to require each RTO/ISO to revise its tariff to specify that the sale of energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets must be at the wholesale LMP.

b. Comments

273. Many commenters support the NOPR proposal that the sale of energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets must be at the wholesale LMP.[330] MISO notes that the proposed

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[329] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 100 (citing *Norton Energy Storage, L.L.C.*, 95 FERC ¶ 61,476, at 62,701-02 (2001) (*Norton Energy Storage*); *PJM Interconnection, L.L.C.*, 132 FERC ¶ 61,203 (2010)).

[330] *See, e.g.*, AES Companies Comments at 6, 8; American Petroleum Institute Comments at 12; APPA/NRECA Comments at 41; California Energy Storage Alliance Comments at 8; EEI Comments at 15; ELCON Comments at 6; ISO-NE Comments at 23-24; Mensah Comments at 2; NextEra Comments at 10; Ohio Commission Comments at 7; TAPS Comments at 28.

wholesale LMP requirement aligns with MISO's current market design for Stored Energy Resources and Demand Response Resources.[331] National Hydropower Association agrees with the NOPR's characterization of charging and discharging as wholesale transactions,[332] while NYISO Indicated Transmission Owners do not oppose the NOPR proposal.[333]

274. A few commenters support the NOPR proposal in principle but condition their support.[334] ISO-NE agrees with the general principle of paying LMP for charging energy that is later resold into the wholesale market; however, ISO-NE notes that implementing the NOPR proposal may be complicated and will depend on the participation of the region's transmission organizations and distribution utilities. While Alevo supports the NOPR proposal, it states that, because electric storage resources that are participating in ancillary service markets (such as the market for frequency regulation) are responding to the grid operator's needs, requiring them to settle energy to provide such services would be inappropriate and a barrier to their participation.

[331] *See* MISO Comments at 9.

[332] *See* National Hydropower Association Comments at 10.

[333] *See* NYISO Indicated Transmission Owners Comments at 7.

[334] *See* Alevo Comments at 10-11; ISO-NE Comments at 23-24.

275. Other commenters assert that certain electric storage resources should not be permitted to purchase charging energy at LMP unless they meet certain conditions.[335] According to Avangrid, NRG, and Pacific Gas & Electric, a behind-the-meter electric storage resource should not be eligible to pay LMP for its charging energy unless it has implemented the metering, accounting, and data protocols necessary to distinguish its wholesale and retail activities. NRG contends that, otherwise, a behind-the-meter electric storage resource should pay the retail rate for its charging energy.

276. Similarly, Xcel Energy Services goes farther, contending that, given the practical impossibility of determining what charging energy will be used to provide wholesale services and what charging energy will be used to provide retail services, the default rate for distributed electric storage resources should be the retail rate.[336] Xcel Energy Services further claims that, by paying the wholesale LMP, a distributed electric storage resource owner can bypass capacity and infrastructure costs, thus depriving the distribution utility of revenues to meet its obligation to serve.

277. APPA/NRECA, FirstLight, and TAPS argue that, instead of requiring RTOs/ISOs and distribution utilities to develop and administer elaborate metering and accounting schemes, which some argue may not be possible, storage resources must elect to

[335] *See* Avangrid Comments at 9; NRG Comments at 16-17; Pacific Gas & Electric Comments at 13.

[336] *See* Xcel Energy Services Comments at 13-14.

participate in either wholesale or retail markets, but not in both.[337] FirstLight adds that introducing the ability to toggle between retail and wholesale rates may create incentives to shift the liability of bad decisions in the wholesale market to the retail supplier by discharging to meet retail load.

278. Some commenters ask the Commission to clarify that the Commission's regulations will not require an electric storage resource that is participating in an RTO/ISO market to pay the wholesale LMP for the charging energy that it uses to provide wholesale services.[338] For example, Energy Storage Association asks the Commission to clarify that RTOs/ISOs may not compel electric storage resources providing wholesale services to purchase their charging energy from wholesale markets because they may be able to charge from a co-located generator. Similarly, AES Companies state that electric storage resources should be permitted to purchase charging energy for providing wholesale services from the wholesale markets and from other sources, such as generators not registered in an RTO/ISO. AES Companies also assert that electric storage resources should be permitted to self-supply from other assets (such as co-located behind-the-meter solar). AES Companies argue that flexibility in procurement will provide a more competitive framework for electric storage devices, which would

[337] *See* APPA/NRECA Comments at 42; FirstLight Comments at 12; TAPS Comments at 28.

[338] *See, e.g.*, AES Companies Comments at 7-9, 30; DER/Storage Developers Comments at 5; Energy Storage Association Comments at 7, 20; MISO Transmission Owners Comments at 15; Stem Comments at 10-11.

lower cost to consumers. MISO Transmission Owners contend that requiring electric storage resources to purchase the charging energy that they use to provide wholesale services would result in inequitable treatment because synchronous generators have the opportunity to buy fuels from many sources.

279. While Stem contends that all charging energy that an electric storage resource located in front of a retail meter is a sale for resale, it asserts that the only charging energy for a behind-the-meter electric storage resource that is a sale for resale is charging energy that it used to net inject energy back onto the grid.[339] Stem argues that a behind-the-meter electric storage resource should not have to pay the wholesale rate for any of its charging energy because the resource may then have to pay twice for its charging energy if the local distribution utility does not "net out" that charging energy from the host customer's retail bill.

280. In contrast, APPA/NRECA ask that the Commission require that electric storage resources pay wholesale LMP for all charging energy used to provide wholesale services.[340] APPA/NRECA argue that, otherwise, electric storage resources could engage in arbitrage between the volatile wholesale markets and regulated retail markets, likely shifting costs to the distribution utility's other customers. Similarly, NYISO contends that all energy that an electric storage resource consumes at a wholesale rate

[339] *See* Stem Comments at 11.

[340] *See* APPA/NRECA Comments at 42.

must be sold back to the grid at a wholesale rate.[341] Stem asks the Commission to clarify that all energy used to charge front-of-meter electric storage resource is a sale for resale and thus the resource must pay the wholesale LMP for energy withdrawn from the grid to charge the resource.[342]

281. Several commenters raise jurisdictional concerns with respect to the application of the NOPR proposal's requirement that the sale of energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets must be at the wholesale LMP to electric storage resources interconnected to the distribution system or located behind a retail customer's meter. Specifically, commenters argue that applying the NOPR proposal to such resources raises issues related to regulatory oversight and may interfere with the exclusive right of state regulators to set retail rates and terms of service.[343] EEI asserts that electric storage resources should charge at the retail rate when seeking to participate in the retail markets and requests that the Commission indicate that charging at LMP rates does not confer exclusive jurisdiction over electric storage resources to the Commission. IRC requests that the Commission work with the states to address jurisdiction issues given that it may be unclear whether charging energy will be used to provide wholesale or retail services when it is being

[341] *See* NYISO Comments at 10-11.

[342] *See* Stem Comments at 10.

[343] *See, e.g.*, AES Companies Comments at 7; EEI Comments at 12, 15; IRC Comments at 2-3; MISO Transmission Owners Comments at 15.

absorbed. MISO Transmission Owners recommend that any final rule recognize that state or localities have jurisdiction over rate setting and provide flexibility in the rates at which an electric storage resource that is interconnected to a distribution system may buy and sell electricity.

282. MISO Transmission Owners further contend that electric storage resources located behind the meter should pay any retail rate applicable to them under state law for charging energy.[344] Pacific Gas & Electric argues that the local regulatory authority must determine that an electric storage resource's consumption is not a retail transaction before that resource is eligible to pay LMP for that consumption.[345] AES Companies argue that the Commission does not have authority to require behind-the-meter resources under state jurisdiction (outside of retail choice states) to pay LMP.[346]

283. Microgrid Resources Coalition believes that LMP rates are the more economically efficient result for charging behind-the-meter resources but agrees that "retail rates are legally appropriate."[347] Specifically, Microgrid Resources Coalition contends that, in retail choice jurisdictions, large customers can typically arrange to pay LMP and a retail supplier could also agree to pass through to the customer the economic consequences of

[344] *See* MISO Transmission Owners Comments at 6, 14-15.

[345] *See* Pacific Gas & Electric Comments at 12.

[346] *See* AES Companies Comments at 6, 29.

[347] *See* Microgrid Resources Coalition Comments at 13.

a demand bid by the supplier on the customer's behalf. ELCON similarly states that an electric storage resource should be able to register as an energy service company in an applicable state and buy energy or capacity at the prevailing LMPs from an organized market and resell to direct access retail customers but that, without Commission regulation, concerns may arise regarding anti-competitive behavior and potential for double-recovery of costs.[348]

284. Several commenters address specific components of gross load for electric storage resources.[349] California Energy Storage Alliance, Energy Storage Association, and NextEra request that the Commission clarify that efficiency losses experienced between charging and discharging an electric storage resource should be settled at the wholesale LMP. In addition, California Energy Storage Alliance argues that loads that are unavoidable to the production or conversion of energy drawn from the grid or are integral to the optimal production or conversion of energy drawn from the grid represent efficiency losses and that these directly integrated loads should be counted as charging energy to provide wholesale services. Energy Storage Association and NextEra further state that some electric storage resources have thermal management components that are integral to, or internalized within, the storage medium and the sale of the energy that these systems use should be considered wholesale transactions and thus priced at LMP.

[348] *See* ELCON Comments at 7.

[349] *See* California Energy Storage Alliance Comments at 8-9; EEI Comments at 12; Energy Storage Association Comments at 7, 19-20, n.30; NextEra Comments at 10-11.

EEI suggests the Commission should discuss the definition of charging energy at a technical conference to determine whether all ancillary loads of a battery installation should be considered wholesale or only the specific load associated with charging the battery.

285. Other commenters disagree that electric storage resources should pay wholesale LMP for these energy uses.[350] IRC requests that the Commission work with states to address the jurisdictional issues surrounding injection and charging functions (such as energy losses, thermal regulation, and station power) to avoid future litigation. California Commission states that the energy consumption of behind-the-meter electric storage resources that will charge at a wholesale rate raises jurisdictional issues, particularly since station power is a retail service. Likewise, Six Cities and Xcel Energy Services assert that the sale of power purchased to operate generating facilities (i.e., station power) must be at retail rates. Six Cities argue that distribution utilities (subject to the oversight of their local regulatory authorities) should have the flexibility to identify measures needed to properly distinguish between station power and charging energy.

286. Several commenters are concerned about the NOPR proposal's potential financial impacts on distribution utilities.[351] EEI and NYISO Indicated Transmission Owners

[350] *See* California Commission Comments at 5; IRC Comments at 2-3 Six Cities Comments at 5 (citing *PJM Interconnection, L.L.C.*, 94 FERC ¶ 61,251, at 61,891 (2001)); Xcel Energy Services Comments at 12.

[351] *See* EEI Comments at 12, 14, 15; MISO Transmission Owners Comments at 7, 17; NYISO Indicated Transmission Owners Comments at 7-8; TAPS Comments at 29.

argue that resources located on distribution systems must pay any applicable charges covered under state jurisdictional tariffs in order to adequately reflect their use of, and cost to, state-jurisdictional facilities. Likewise, MISO Transmission Owners ask the Commission to clarify how utilities and ratepayers will be compensated for allowing electric storage resources to use the distribution system to provide wholesale services. TAPS requests that the Commission clarify that distribution-interconnected electric storage resources should be subject to distribution utility tariffs and rates for delivery of energy between the RTO grid and their point of interconnection to the distribution system. Six Cities request confirmation that distribution utilities or their local regulatory authorities retain jurisdiction to determine how to manage the cost, reliability, operational, and interconnection impacts to the distribution system of any electric storage resource.[352]

287. As a separate issue, Energy Storage Association and NextEra suggest that energy stored for re-delivery to the grid should not be subject to the transmission charges that apply to load.[353] NextEra explains that electric storage resources participating in the RTO/ISO markets are dispatched by the RTO/ISO for a wholesale service and the withdrawal of energy from the transmission network under RTO/ISO control is part the wholesale service, particularly with respect to regulation service. Similarly, NRG asks

[352] *See* Six Cities Comments at 3-4.

[353] *See* Energy Storage Association Comments at 7, 20; NextEra Comments at 11.

the Commission to clarify that an electric storage resource will receive and pay the applicable nodal LMP, and not the zonal price, for its wholesale transactions.[354] To the extent that the Commission finds that any transmission charges apply to electric storage resources, NextEra states that those charges should apply only to station power.

288. In contrast, Open Access Technology argues that, if the NOPR assumes that both consumption (when charging) and generation (when discharging) from an electric storage resource are measured at the wholesale pricing node upstream of the physical location of the storage resource in the distribution feeder, then the Commission should make this assumption explicit given the effect of distribution system losses on these measurements.[355] American Petroleum Institute also contends that the price signals that distribution-interconnected resources receive for wholesale market participation should account for congestion, losses, and voltage considerations on the distribution system, which current market models do not take into account.[356]

c. Commission Determination

289. In this Final Rule, we adopt the NOPR proposal and add section 35.28(g)(9)(ii) to the Commission's regulations to require that the sale of electric energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets be at the wholesale LMP. The Commission is modifying this provision to

[354] *See* NRG Comments at 16.

[355] *See* Open Access Technology Comments at 3.

[356] *See* American Petroleum Institute Comments at 13.

apply regardless of whether the electric storage resource is using the participation model for electric storage resources or another participation model to participate in the RTO/ISO markets, as long as the resource meets the definition of an electric storage resource set forth in this Final Rule. The Commission has found that the sale of energy from the grid that is used to charge electric storage resources for later resale into the energy or ancillary service markets constitutes a sale for resale in interstate commerce.[357] As such, the just and reasonable rate for that wholesale sale of energy used to charge that electric storage resource is the RTO/ISO market's wholesale LMP, regardless of whether the electric storage resource uses the participation model for electric storage resources.

290. In response to Alevo's concerns that the requirement may not be appropriate for

[357] *See Norton Energy Storage*, 95 FERC at 62,701-02 (citations omitted) ("[T]he use of compressed air as a medium for the storage of energy in an energy storage facility is a new technology. However, we find that a compressed air energy storage facility is analogous to a [pumped-hydro resource], in that compressed air is used in a conversion/storage cycle just as water is used in a [pumped-hydro resource] in the conversion/storage cycle…. [T]he Commission views the pumping energy not as being consumed, but rather as being converted and stored, as water in the upper reservoir, for later re-conversion … back to electric energy. It is this conversion/storage cycle that distinguishes energy storage facilities, whether [pumped-hydro resources] or compressed air energy storage facilities, from facilities that consume electricity (in the form of station power or otherwise). The fact that pumping energy or compression energy is not consumed means that the provision of such energy is not a sale for end use that this Commission cannot regulate. Rather, based on Norton's representations in its petition, we find that deliveries of compression energy to the Norton energy storage facility as part of energy exchange transactions employing the conversion/storage cycle are wholesale transactions subject to our exclusive authority under the FPA."). *See also PJM Interconnection, L.L.C.*, 132 FERC at 62,053 ("Like pumping energy and compression energy, the energy used to charge Energy Storage Resources will be stored for later delivery and not used for operating the electric equipment on the site of a generation facility or associated buildings as Station Power is used.").

electric storage resources that are participating in ancillary service markets, we reiterate that the sale of electric energy from the grid that is used to charge an electric storage resource for later resale into ancillary service markets constitutes a sale for resale in interstate commerce and therefore the just and reasonable rate is the wholesale LMP. Electric storage resources that are participating in RTO/ISO frequency regulation markets are already settled at wholesale LMP for their net energy at the end of a market interval, consistent with our requirements for charging energy here.

291. Additionally, in response to NRG's concern, we clarify that an electric storage resource's wholesale energy purchases should take place at the applicable nodal LMP, and not the zonal price. Using the applicable nodal LMP will prevent any potential arbitrage between nodal and zonal prices and allows for consistent evaluation of a resource's impacts on the energy, congestion, and loss components of LMP when it is both receiving and injecting energy.

292. We disagree with Energy Storage Association and NextEra that transmission charges that apply to load should not apply to electric storage resources. When an electric storage resource is charging to resell energy at a later time, then its behavior is similar to other load-serving entities, and we find that applicable transmission charges should apply. However, it may be possible for different transmission charges to apply to load resources located at a single node (such as pumped-hydro resources) that are paying a nodal price for energy and load resources that are located across multiple nodes (such as load-serving entities) that are paying a zonal price for energy. Therefore, to the extent that load resources located at a single node pay different transmission charges than load

resources located across multiple nodes, then we require each RTO/ISO to apply those transmission charges for single-node resources to electric storage resources that are located at a single pricing node, as long as, as discussed in the next paragraph, they are not being dispatched to provide an ancillary service by an RTO/ISO.

293. In response to the concern that transmission charges should not apply when an electric storage resources is dispatched by an RTO/ISO, we find that electric storage resources that are dispatched to consume electricity to provide a service in the RTO/ISO markets (such as frequency regulation or a downward ramping service) should not pay the same transmission charges as load during the provision of that service. We find 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.

294. In response to concerns about an electric storage resources being compelled to purchase all of its energy for future use from the RTO/ISO markets, we clarify that we impose no such requirement. Our finding regarding charging energy does not address payment of the retail rate for energy or charging a device off of co-located generation

resources, as suggested by commenters. Also, while this finding requires each RTO/ISO to allow electric storage resources to be able to pay the wholesale LMP for their charging energy, it does not address whether they can pay some other rate, such as a retail rate or charging off of co-located generation. Finally, like other market participants that purchase energy from the RTO/ISO markets, an electric storage resource that pays the wholesale LMP for charging energy may enter into bilateral financial transactions to hedge the purchase of that energy.

295. We disagree with commenters who argue that the requirement to pay LMP for charging energy should only apply to electric storage resources that are interconnected to the transmission system. As discussed above, this Final Rule applies to electric storage resources that are capable of receiving electric energy from the grid and storing it for later injection of electric energy back to the grid, irrespective of where the resource is interconnected. The sale of charging energy to an electric storage resource that the resource then resells into the RTO/ISO markets is a sale for resale in interstate commerce and thus subject to the Commission's jurisdiction.[358]

296. With respect to concerns about electric storage resources' use of the distribution system, we note that, in *PJM Interconnection L.L.C.*, the Commission permitted a distribution utility to assess a wholesale distribution charge to an electric storage

[358] *See Norton Energy Storage*, 95 FERC at 62,701-02; *see also PJM Interconnection*, L.L.C., 132 FERC ¶ 61,203 at P 7.

resource participating in the PJM markets.[359] Consistent with this precedent, we find that it may be appropriate, on a case-by-case basis, for distribution utilities to assess a charge on electric storage resources similar to those assessed to the market participant in that proceeding.

297. With respect to efficiency losses, consistent with *Norton Energy Storage*, we find that efficiency losses are charging energy and therefore not a component of station power load.[360] Accordingly, the charging energy lost to conversion inefficiencies should also be settled at the wholesale LMP as long as those efficiency losses are an unavoidable component of the conversion, storage, and discharge process that is used to resell energy back to the RTO/ISO markets and are not a component of what an RTO/ISO considers onsite load. With respect to directly integrated and other ancillary loads, we provide the RTOs/ISOs flexibility to determine whether they are a component of charging energy or a component of station power.

[359] *See PJM Interconnection L.L.C.*, 149 FERC ¶ 61,185 at P 12 (wholesale distribution charge that ComEd will assess to Energy Vault is a weighted average carrying charge that is applied on a case-by-case basis, depending on the distribution facilities expected to be used in providing wholesale distribution service), *order on reh'g*, 151 FERC ¶ 61,231 at PP 16-18.

[360] *See Norton Energy Storage*, L.L.C., 95 FERC at 62,702 (stating that "[t]he fact that pumping energy or compression energy is not consumed means that the provision of such energy is not a sale for end use that this Commission cannot regulate.").

2. Metering and Accounting Practices for Charging Energy

a. NOPR Proposal

298. In the NOPR, the Commission sought comment on whether metering and accounting practices designed to delineate between wholesale and retail activities would need to be established in the RTO/ISO tariffs to facilitate compliance with the proposed requirement that the sale of energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets must be at the wholesale LMP or whether it is possible to determine the end use for energy used to charge an electric storage resource under existing requirements.[361]

b. Comments

299. As discussed above, commenters agree that electric storage resources providing retail services should not charge at the wholesale rate and discharge to serve a retail customer,[362] and many commenters assert that metering and accounting practices designed to delineate between wholesale and retail activities are necessary to prevent such an outcome.[363] Stem contends that the energy used to charge a behind-the-meter electric storage resource is considered a sale for resale only up to the amount that is

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[361] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 102.

[362] *See, e.g.*, California Municipals Comments at 4; FirstLight Comments at 12; PJM Market Monitor Comments at 9; SoCal Edison Comments at 9, 13; TAPS Comments at 30-31; Tesla/SolarCity Comments at 19.

[363] *See, e.g.*, American Petroleum Institute Comments at 12-13; Mensah Comments at 2; MISO Comments at 19; Six Cities Comments at 4-5; SoCal Edison Comments at 9, 13; Tesla/SolarCity Comments at 19.

injected onto the grid for wholesale purposes, which requires each RTO/ISO to establish metering and accounting practices that separate wholesale from retail activity.[364] Independent Energy Producers Association argues that the Commission must address how to distinguish and measure wholesale and retail activities to ensure transparency in both markets and to prevent double-counting.[365] Electric Vehicle R&D Group asks the Commission to propose different methods for reconciliation of wholesale and retail activities for behind-the-meter electric storage resources, giving RTOs/ISOs options from which to choose.[366]

300. Some commenters encourage the Commission to provide flexibility to the RTOs/ISOs with respect to metering and accounting practices to distinguish wholesale and retail activities.[367] Pacific Gas & Electric recommends that the Commission provide each RTO/ISO with flexibility to establish hardware and software requirements for telemetry and metering that account for its system characteristics, market rules, and utility tariffs. Six Cities contend that distribution utilities or their local regulatory authorities should retain their own metering standards and technical requirements for resources interconnecting to the distribution system and any flexibility that the

[364] *See* Stem Comments at 10.

[365] *See* Independent Energy Producers Association Comments at 7.

[366] *See* Electric Vehicle R&D Group Comments at 1-2.

[367] *See* Pacific Gas & Electric Comments at 13; Six Cities Comments at 3.

Commission provides with respect to metering in the final rule should not compromise the accuracy of settlements or impose additional costs on the distribution system.

301. Minnesota Energy Storage Alliance contends that the Commission should not adopt explicit metering arrangements but instead should set forth requirements that metering solutions must meet to adequately delineate between wholesale and retail activities and allow the industry to develop those solutions at the lowest cost possible.[368] Minnesota Energy Storage Alliance states that it is necessary to establish adequate accounting process to track and verify costs associated with operating an electric storage resource that can delineate between wholesale and retail transactions. AES Companies argue that any criterion for accounting methodologies and data collection criterion for electric storage resources, including recognition of state jurisdiction, should be documented in the RTO/ISO business practice manuals rather than the tariff, so timely changes can occur as technology and regulation evolve.[369]

302. Many commenters are concerned, however, that requiring the establishment of metering and accounting practices designed to delineate between wholesale and retail activities raises jurisdictional issues.[370] CAISO argues that the Commission should permit RTOs/ISOs to develop the rules governing these practices in collaboration with

[368] *See* Minnesota Energy Storage Alliance Comments at 5-6.

[369] *See* AES Companies Comments at 30-31.

[370] *See* CAISO Comments at 20; MISO Comments at 19; PJM Comments at 7, 13-15.

their stakeholders to help prevent cross-jurisdictional disputes. MISO states that it is unclear to what extent MISO's current tariff and processes can make jurisdictional distinctions between wholesale and retail activities and that new rules are therefore necessary.

303. PJM believes that it is important for the Commission, working with the states, to provide guidance in the final rule on issues including, but not limited to, the rate treatment for energy used to charge behind-the-meter electric storage resources and for front-of-the meter electric storage resources that occasionally serve retail load through a separate connection to a retail customer and the ability of RTOs/ISOs to develop requirements associated with metering, visibility, and dispatchability of distributed electric storage resources. With respect to the issue of how to account for the energy used to charge an electric storage resource that is located in front of the retail meter but occasionally provides retail services, PJM recommends that the RTO/ISO track what energy is used for retail services (i.e., any net load), like RTOs/ISOs do today for station power. With respect to the issue of how to account for energy used to charge a behind-the-meter electric storage resource, PJM argues that RTOs/ISOs and their stakeholders should not be put in the position of resolving purely legal and regulatory issues.

304. Massachusetts State Entities question whether the NOPR appropriately addresses states' concerns regarding the ability of behind-the-meter storage resources to charge at a wholesale rate and discharge to serve a retail customer to avoid paying a retail rate.[371]

[371] *See* Massachusetts State Entities Comments at 10.

Massachusetts State Entities and NARUC ask the Commission to clarify the appropriate metering and accounting practices that can be used to delineate between wholesale and retail uses.[372] Massachusetts State Entities argue that the Commission should clarify whether an electric storage resource providing both wholesale and retail services must have separate metering both upstream and downstream of the resource. Open Access Technology similarly requests that the Commission clarify whether a storage resource in charging mode is expected to be separately metered and settled from the load of the premises in which it is located.[373] Relatedly, Organization of MISO States contends that, because state statutes may prohibit retail customers from purchasing energy directly from the wholesale market, a distribution-interconnected electric storage resource must have a

separate meter to participate in the wholesale market, unless a single meter is explicitly allowed by the relevant electric retail regulatory authority.[374]

305. A few commenters emphasize the importance of distribution utilities to the successful implementation of any metering and accounting practices.[375] ISO-NE states that it has no way to ensure compliance with a requirement that behind-the-meter sales for resale are metered and reported to ISO-NE for settlement without the cooperation of

[372] *See* Massachusetts State Entities Comments at 9-10; NARUC Comments at 7.

[373] *See* Open Access Technology Comments at 2.

[374] *See* Organization of MISO States Comments at 3-4.

[375] *See* ISO-NE Comments at 27; Mensah Comments at 2.

each distribution utility. Mensah argues that metering and accounting practices should be coordinated with the local distribution utility to avoid any duplicate metering requirements and to ensure proper accounting is performed based on the collection, availability, and sharing of metered data points at different intervals with all parties.

306. Some commenters are concerned that there may not be a feasible or practical way to delineate between wholesale and retail activities, especially when there are multiple devices and retail load behind the same meter.[376] MISO Transmission Owners argue that, when an electric storage resource is located behind a retail customer's electric meter, it may be impractical, prohibitively expensive, or even impossible to distinguish between use of the resource (i.e., charging and discharging) and the customer's other electric loads. FirstLight claims that an RTO/ISO cannot in practice distinguish between charging energy that will be used to provide a wholesale service and charging energy that will be used to provide a retail service, especially given that an electric storage resource may charge at different times and use its capacity to provide different services. Avangrid claims that, even if behind-the-meter retail load, distributed energy resources (including energy storage), and generation are separately metered, ownership and reconciliation of the data to produce results suitable for retail billing and wholesale settlement in a timely manner may be impractically complex and likely subject to both state and federal regulation.

[376] *See, e.g.*, Avangrid Comments at 15; FirstLight Comments at 9-12; MISO Transmission Owners Comments at 15-16; NARUC Comments at 7, n.18; TAPS Comments at 28.

307. Likewise, TAPS contends that for distribution-interconnected electric storage resources, even revenue-quality metering, might be insufficient to distinguish between the wholesale and retail activities of an electric storage resource behind the same meter as distributed generation and/or load.[377] TAPS further states that any accounting practices would have to track two separate energy level balances, one for wholesale activities and one for retail activities. According to TAPS, in each interval, discharge from the retail balance must be limited to the retail customer's consumption in that interval (or perhaps sales to the distribution utility) and discharge from the wholesale balance must be reconciled with sales to the RTO. Given these complexities, TAPS recommends that

electric storage resources should not be able to provide services at both wholesale and retail.

308. SoCal Edison asserts that current net metering configurations and accounting practices cannot separate which generation is used by the customer and which is offered for wholesale use and that it is insufficient to have a policy that prevents mixing wholesale and retail with instruction to RTOs/ISOs to develop the provisions as necessary.[378] Pacific Gas & Electric agrees that the needed metering and accounting

[377] *See* TAPS Comments at 31-32.

[378] *See* SoCal Edison Comments at 13.

requirements do not exist today, stating that RTOs/ISOs will have to develop such requirements with their local regulatory authorities.[379]

309. According to AES Companies, whether existing metering and accounting practices will allow an RTO/ISO to distinguish between wholesale and retail transactions depends on the RTO/ISO, the electric storage technology in question, and the state jurisdiction.[380] AES Companies contend that there are often state-mandated accounting procedures that involve more than the individual electric storage resource that render it impossible to separate parasitic load/charging (station power/state-of-charge management) when behind-the-meter and distribution-interconnected electric storage resources are selling excess capacity into the wholesale ancillary services markets. AES Companies add that, for older electric storage resources or those that are already in service, the operating software may not provide a sufficient level of detail to distinguish between wholesale and retail transactions.

310. In contrast, several commenters suggest that metering and accounting practices can be developed to discern between wholesale and retail activities.[381] Tesla/SolarCity recommend that the Commission specify that behind-the-meter resources participating in wholesale markets have appropriate metering that RTOs/ISOs can use for settlement

[379] *See* Pacific Gas & Electric Comments at 13.

[380] *See* AES Companies Comments at 30.

[381] *See, e.g.*, Energy Storage Association Comments at 22; Mensah Comments at 2; Minnesota Energy Storage Alliance Comments at 5-6; Tesla/SolarCity Comments at 19-20.

purpose to distinguish between wholesale energy uses and retail energy uses. Tesla/SolarCity point to CAISO's Metering Generation Output for Proxy Demand Resources as a good example that relies on direct metering and not synthetic baselines to distinguish between wholesale and retail applications for behind-the-meter energy storage resources.

311. CAISO explains its existing metering and accounting practices can distinguish between wholesale and retail activities.[382] CAISO notes that a behind-the-meter resource participating through its Non-Generator Resource model must separately meter its output and consumption and report that meter data to CAISO for settlement purposes, which is settled at the wholesale rate. CAISO adds that this meter data can be used to adjust the end-use customer meter data to ensure that it reflects only the end-use load. In contrast, CAISO notes that a behind-the-meter resource participating under CAISO's Proxy Demand Resource model only settles with CAISO for intervals in which it has submitted a bid and received a schedule or dispatch instruction to discharge energy to reduce load as a demand response resource, such that its energy consumption for charging is a portion of the end-use retail load.

312. ISO-NE argues that the Commission should require individual customers or resources that are directly settled in the wholesale market either as a load or a generator (or both as in the case of electric storage resource) to directly install revenue-quality

[382] *See* CAISO Comments at 20-21.

interval metering; otherwise, it will be unclear what energy the rest of the customers or resources in that meter domain (i.e., defined areas of a transmission or distribution owner's network for purposes of load measurement) have consumed.[383] For behind-the-meter resources, ISO-NE argues that submetering must be in place so that the distribution utility can report information to ISO-NE for settlement purposes and can itself determine net retail consumption for billing purposes. According to ISO-NE, the distribution utility must develop the necessary accounting practices and ensure that the appropriate metering is installed, tested, and routinely read to ensure that behind-the-meter electric storage resources are not charged at both the wholesale and retail rate for their charging energy and are not paid at both the wholesale and retail rate for discharging. ISO-NE emphasizes that the Commission should not adopt requirements that could result in a material potential for double charging or double paying electric storage resources and should acknowledge that affected distribution utilities must have the necessary infrastructure, standards, and practices to support wholesale settlements of behind-the-meter electric storage resources before it can address these concerns.

313. ISO-NE contends that an alternative approach to direct metering is allowing a customer with an electric storage resource or other distributed energy resource to participate directly in the wholesale market and be charged or credited at wholesale prices for its entire net load as measured from its retail delivery point. ISO-NE argues that the advantage of this approach is that only one meter, located at the customer's

[383] *See* ISO-NE Comments at 24-27, 29.

delivery point, is needed to measure net consumption; no sub-metering would be required. However, ISO-NE notes that, if this approach resulted in greater participation of distributed electric storage resources, it could require advanced metering infrastructure and software to manage settlement.

314. Other commenters state that direct metering is necessary to allow an RTO/ISO to distinguish between wholesale and retail services.[384] Although perhaps inadequate for distribution-interconnected electric storage resources, TAPS contends that revenue-quality metering will be needed. Maryland and New Jersey Commissions state that it is important to install specialized metering devices and telemetry to distinguish the intended uses of energy used to charge a behind-the-meter electric storage resource, which will help to ensure that these resources do not receive inappropriate compensation or avoid paying retail rates. PJM Market Monitor recommends that generation and storage facilities that seek to buy or sell at wholesale LMP locate in front of the retail meter and require them to have their own meters and telemetry that would link them to the RTO/ISO.

315. Some commenters comment on technical aspects of developing metering and accounting practices to distinguish between wholesale and retail activities.[385] IRC and ISO-NE contend that rules are needed to address circumstances in which the use of

[384] *See* Maryland and New Jersey Commissions Comments at 4; PJM Market Monitor Comments at 9; TAPS Comments at 30-31.

[385] *See* IRC Comments at 3; ISO-NE Comments at 27; Stem Comments at 10.

stored energy is unclear at the time of charging. Stem asks the Commission to affirm that metering and accounting practices established by the RTO/ISO for behind-the-meter electric storage resources that inject energy onto the grid would be for the sole purpose of proper settlement of wholesale sale of energy to electric storage resources without implications for a host customer's retail bill.

316. Duke Energy believes that the Commission should encourage RTOs/ISOs to develop measurement and verification requirements to examine a resource's performance against its scheduled output.[386] FirstLight suggests that the RTO/ISO may be able to correct problems after-the-fact with telemetered state of charge for each storage asset location.[387] Finally, Minnesota Energy Storage Alliance asks the Commission to contemplate the appropriateness of adapting the Uniform System of Accounts to handle costs associated with charging electricity used for retail services when those resources are also providing wholesale services, which the Commission declined to do under a SoCal Edison request for clarification under Order No. 784.[388]

c. Commission Determination

317. Upon consideration of the comments, and to help implement the new requirement in section 35.28(g)(9)(ii) of the Commission's regulations, we require each RTO/ISO to implement metering and accounting practices as needed to address the complexities of

[386] *See* Duke Energy Comments at 4.

[387] *See* FirstLight Comments at 12.

[388] *See* Minnesota Energy Storage Alliance Comments at 6.

implementing the requirement that the sale of electric energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets be at the wholesale LMP. To help accomplish this, we require each RTO/ISO to directly meter electric storage resources, so all the energy entering and exiting the resources is measured by that meter. However, we recognize some electric storage resources (such as those located on a distribution system or behind a customer meter) may be subject to other metering requirements that could be used in lieu of a direct metering requirement by an RTO/ISO. Therefore, the Commission will consider, in the individual RTO/ISO compliance filings, alternative proposals that may not entail direct metering but nonetheless address the complexities of implementing the requirement that the sale of electric energy from the RTO/ISO markets to a resource using the participation model for electric storage resources that the resource then resells back to those markets be at the wholesale LMP.

318. We are not persuaded by commenters who argue that developing metering practices that distinguish between wholesale and retail activity is impractically complex. CAISO provides two examples of how it has achieved market rules that accurately account for wholesale and retail activities by using direct metering. Additionally, retail metering infrastructure, which is subject to state jurisdiction, may be able to work in concert with the RTO/ISO requirements to lower the overall metering costs for electric storage resources. Therefore, we provide each RTO/ISO with the flexibility to propose in its compliance filing other reasonable metering solutions that may help reduce costs for developers.

319. Developing new accounting practices for electric storage resources in response to this requirement will be complex, but we nonetheless find that they are feasible to develop. We recognize that it may be beneficial for each RTO/ISO to coordinate accounting requirements in cooperation with the distribution utilities and relevant electric retail regulatory authorities in its footprint to help identify workable accounting solutions for distribution-interconnected or behind-the-meter electric storage resources to participate in the RTO/ISO markets. While the data obtained from directly metering a resource may be adequate to establish the necessary accounting practices, there may also be other reasonable approaches to address these concerns depending on local retail regulatory requirements, such as allowing the customer to be a direct wholesale market participant as suggested by ISO-NE. We also find that metering and accounting rules may need to differ based on whether the resource is located on the transmission system, the distribution system, or behind the meter. These unique considerations underscore the need to provide the RTOs/ISOs flexibility to comply with this requirement.

320. We are not persuaded by APPA/NRECA's and TAPS' suggestion that electric storage resources must choose to participate in either wholesale or retail markets due to the complexity of the metering and accounting practices. It is possible for electric storage resources that are selling retail services also to be technically capable of providing wholesale services, and it would adversely affect competition in the RTO/ISO markets if these technically capable resources were excluded from participation.

321. With respect to Stem's concerns regarding double payment for the same charging energy, we find that resources using the participation model for electric storage

resources should not be required to pay both the wholesale and retail price for the same charging energy because it would create market inefficiencies due to the double payment. Therefore, we require each RTO/ISO to prevent resources using the participation model for electric storage resources from paying twice for the same charging energy. To the extent that 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.

322. We decline Stem's request to clarify that metering and accounting practices established by the RTO/ISO for behind-the-meter electric storage resources that inject energy onto the grid would be for the sole purpose of proper settlement of wholesale sale of energy to electric storage resources without implications for a host customer's retail bill. We also decline Stem's request that metering and accounting practices established by the RTOs/ISOs be for the sole purpose of proper settlement of wholesale sale of energy. We recognize that each RTO/ISO may need to coordinate these metering and accounting practices with the distribution utilities and relevant electric retail regulatory authorities. Therefore, we will not place limitations on the extent to which the hardware being used to collect information or the information itself can be shared as this may help

reduce costs for the electric storage resources and burdens on RTOs/ISOs, distribution utilities, or relevant electric retail regulatory authorities.

323. With respect to Minnesota Energy Storage Alliance's request to modify the Uniform System of Accounts, we are not persuaded that it is necessary to address costs associated with charging energy used for retail-level services when those resources are also participating in the RTO/ISO markets. Account 555.1 Power Purchased for Storage Operations, which was created in Order No. 784,[389] already allows for the reporting of power purchased and stored for resale and any services provided by an electric storage resource, whether wholesale or retail, would be considered a resale.[390] Accordingly, to the extent that a given electric storage resource subject to the Uniform System of Accounts is approved by relevant authorities to provide both retail and wholesale services, the cost of the charging energy used for providing both retail and wholesale services can already be accommodated by Account 555.1.

I. Issues Outside the Scope of this Final Rule

1. Comments

324. Some commenters raise issues that were not addressed in the NOPR. Many raised issues with respect to compensation or cost recovery under a Policy Statement that the

[389] *Third-Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies*, Order No. 784, FERC Stats. & Regs. ¶ 31,349 (2013), *order on clarification*, Order No. 784-A, 146 FERC ¶ 61,114 (2014).

[390] *See* 18 CFR pt. 101.

Commission issued in January 2017.[391] Other commenters raised issues with respect to expanding the scope of the rule to apply to resources outside of the RTOs/ISOs;[392] whether to revise RTO/ISO interconnection procedures for electric storage resources;[393] price formation or additional services the Commission should require the RTOs/ISOs to develop;[394] market-based rates;[395] co-optimization models;[396] how the RTO/ISO dispute resolution processes apply to electric storage resources and other new market entrants;[397] whether to incorporate electric storage resources into transmission planning;[398] whether the RTOs/ISOs should modify their unit commitment or settlement periods[399] and other

[391] *See Utilization of Electric Storage Resources for Multiple Services When Receiving Cost-Based Rate Recovery*, 158 FERC ¶ 61,051 (2017). *See, e.g.*, APPA/NRECA Comments at 4-5; EPSA/PJM Power Providers Comments at 13-16; 10; FirstLight Comments at 1-2, 4-5; Pacific Gas & Electric Comments at 14.

[392] *See, e.g.*, AWEA Comments at 6; SEIA Comments at 13-15.

[393] *See, e.g.*, AWEA Comments at 8; Organization of MISO States Comments at 2-3; Power Applications Comments at 8.

[394] *See, e.g.*, Brookfield Renewable Comments at 2-4; NRG Comments at 19; NYISO Indicated Transmission Owners Comments at 4-5; Organization of MISO States Comments at 3; Tesla/SolarCity Comments at 8-10.

[395] *See* AWEA Comments at 6.

[396] *See* Mosaic Power Comments at 4.

[397] *See* SEIA Comments at 8-10.

[398] *See* National Hydropower Association Comments at 5-6.

[399] *See, e.g.*, AWEA Comments at 7; NextEra Comments at 7-8; Research Scientists Comments, Att. 2 at 280, Att. 12 at 290.

settlement rules;[400] RTO/ISO governance issues;[401] removing barriers to other types of resources;[402] varying compensation based on resource characteristics;[403] requiring the RTOs/ISOs to compensate resources for providing certain non-market services that they are not compensated for providing today;[404] addressing issues in specific RTO/ISO markets;[405] modifications to existing energy management systems communications infrastructure;[406] whether to allow shaping of capacity and energy offers to reflect a resource's capabilities;[407] the submission of multiple bid stacks;[408] and bids for dispatchable load coupled with offers for generation at a later time.[409]

[400] *See* Guannan He Comments at 1-4.

[401] *See* E4TheFuture Comments, Att. at 2.

[402] *See* AWEA Comments at 4-5.

[403] *See* Energy Storage Association Comments at 19, 27-28.

[404] *See, e.g.*, Advanced Energy Economy Comments at 29-31; AES Companies Comments at 16; National Hydropower Association Comments at 7-8; San Diego Water Comments at 3-4.

[405] *See* Advanced Microgrid Solutions Comments at 11-13; Advanced Rail Energy Storage Comments at 4-7; Advanced Energy Management Comments at 31-33.

[406] *See* Power Applications Comments at 8.

[407] *See* Fluidic Comments at 4-5.

[408] *See* California Energy Storage Alliance Comments at 12-13.

[409] *See* Eagle Crest Comments at 6.

325. Commenters also raise issues related to the reform of existing wholesale services to change their technical requirements and product definitions;[410] exploring whether the RTOs/ISOs are appropriately valuing market services (such as frequency regulation service);[411] and requiring a reverse demand response or load increase product.[412]

2. Commission Determination

326. We find that the NOPR did not propose reforms related to these issues raised by commenters. Therefore, these issues are outside the scope of this proceeding and will not be addressed here.

V. Compliance Requirements

A. NOPR Proposal

327. In the NOPR, the Commission proposed to require each RTO/ISO to submit a compliance filing to demonstrate that it satisfies the proposed requirements set forth in the Final Rule within six months of the date the Final Rule in this proceeding is published in the Federal Register.[413] The Commission stated that, while it believed that six months would be sufficient for each RTO/ISO to develop and submit its compliance

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[410] *See* Alevo Comments at 8-10; Energy Storage Association Comments at 9; NextEra Comments at 6-9; R Street Institute Comments at 5.

[411] *See, e.g.*, Brookfield Renewable Comments at 2-4; National Hydropower Association Comments at 7-8; NYPA Comments at 4-5; San Diego Water Comments at 3-4.

[412] *See* National Hydropower Association Comments at 11.

filing, it recognized that implementation of the reforms proposed therein could take more time due to the changes that may be necessary to each RTO's/ISO's modeling and dispatch software. Therefore, the Commission proposed to allow 12 months from the date of the compliance filing for implementation of the proposed reforms to become effective.

328. In the NOPR, the Commission sought comment from the RTOs/ISOs on the changes that would be required to implement the proposed participation model for electric storage resources and the associated costs as well as how those costs could be minimized.[414] The Commission sought comment on the time and resources that would be necessary for the RTOs/ISOs to incorporate these bidding parameters, including the optional bidding parameters, into their modeling and dispatch software.[415] The Commission sought comment on the proposed deadline for each RTO/ISO to submit its compliance filing, as well as the proposed deadline for each RTO's/ISO's implementation of the proposed reforms to become effective.[416] Specifically, the Commission sought comment on whether the proposed compliance and implementation timeline would allow sufficient time for each RTO/ISO to implement changes to its technological systems and business processes in response to a Final Rule. The Commission also sought comment on whether the RTOs/ISOs would require more or

[414] *See* NOPR, FERC Stats. & Regs. ¶ 32,718 at P 32.

[415] *See id*. P 71.

[416] *See id*. P 160.

less time to implement certain reforms versus others.

329. The Commission stated that, to the extent that any RTO/ISO believes that it already complies with any of the requirements adopted in a Final Rule in this proceeding, the RTO/ISO would be required to demonstrate how it complies in the filing due within six months of the date any Final Rule in this proceeding is published in the Federal Register.[417] The Commission also stated that the proposed implementation deadline would apply only to the extent that an RTO/ISO does not already comply with the reforms proposed in this NOPR.

B. Comments

330. A few commenters support the timeline proposed in the NOPR.[418] For example, Energy Storage Association and NRG support the Commission's proposed implementation timeline. Public Interest Organizations also support finalizing the proposed rules as scheduled but adds that, if more time is needed, the Commission should allow the RTOs/ISOs more time to develop their compliance filings.

331. Other commenters, such as the RTOs/ISOs, generally express concerns about the feasibility of the Commission's proposed timelines.[419] NYISO argues that the proposed

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[417] *See id*. P 161.

[418] *See* Energy Storage Association Comments at 26-27; NRG Comments at 21-22; Public Interest Organizations Comments at n.14

[419] ISO-NE Comments at 21; MISO Comments at 10; NYISO Comments at 21; PJM Comments at 17 (citing *PJM Interconnection, L.L.C.*, Order No. 825 Compliance Filing, Docket No. ER17-775-000, at 2 (Jan. 11, 2017)); SPP Comments at 5. PJM states

filing deadline of six months after a final rule and another six months for implementation do not appear to be feasible. Based on the comprehensive review of electric storage resource participation that NYISO is conducting in its own region, it asserts that the compliance deadline should not be before the end of 2018 and implementation should not be required until the end of 2021. MISO requests that the Commission give it time to understand the system impacts of various integration options, noting, for example, that changing the minimum size to 100 kW could tax systems beyond current capabilities. SPP points out that the proposed participation model for electric storage resources will require extensive changes to software, the tariff, and market protocols.

332. PJM and ISO-NE state that the timeline depends upon the magnitude of the required changes. PJM states that it can implement the necessary system changes in approximately 12 months at a cost of under $1 million if (1) the final rule is limited to changes in PJM's real-time energy market and to offers to sell energy and (2) if PJM does not need to manage electric storage resources' state of charge. However, PJM asserts that, if more extensive system changes are necessary to comply, the cost could be significantly higher and will likely take more time to implement. PJM also states that, given the timing of PJM's upcoming implementations of 5-minute settlements and hourly offers, it could not realistically begin working on the necessary system changes until at least early 2018. ISO-NE states that the changes contemplated in the NOPR are

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that it will propose an effective date for implementing hourly offers by March 6, 2017, which it expects to be sometime around November 1, 2017. PJM Comments at n.23 (citing *PJM Interconnection, L.L.C.*, 158 FERC ¶ 61,133, at P 126 (2017)).

substantial but that the time and resources needed to comply with the final rule depend on the specific final provisions. ISO-NE argues that, if the Commission accepts ISO-NE's suggestions to (1) only require implementation of state of charge in real time as an information communication requirement (for example, via telemetered information), (2) not require implementation of the proposed voluntary bidding parameters, and (3) require participants to manage their own bidding parameters (except when reliability needs dictate otherwise), then the implementation effort will be substantially shorter and easier.

333. Some commenters also point out that, in order to comply with the rule, the RTOs/ISOs will need to change more than just their market rules. For example, AES Companies, Energy Storage Association, and EPRI note that the RTOs/ISOs will need to make changes to their software.[420] AES Companies also note that RTOs/ISOs will have to adjust their business practice manuals to comply.

334. Multiple commenters argue that the Commission should take a phased approach to its proposed compliance and implementation timelines.[421] For example, NextEra suggests that the Commission finalize proposed reforms related to both the electric storage resource and distributed energy resource aggregation resources, while extending the distributed energy resource aggregation requirements to allow further time to work

[420] AES Companies Comments at 5, 14-15; Energy Storage Association Comments at n.8, 26-27; EPRI Comments 2-3.

[421] *See* FirstLight Comments at 14; MISO Comments at 11; NextEra Comments at 4-6.

through issues. NextEra states that the Commission could stage compliance deadlines with electric storage resource tariff revisions being submitted within six months of a final rule and aggregation tariff revisions being due 12 months after a final rule. NextEra asserts that, if the Commission determines additional consideration needs to be given to the aggregation-related issues, the Commission should finalize the storage related revisions now.

335. MISO suggests that the Commission allow RTOs/ISOs to integrate electric storage resources using a phased approach. MISO explains that electric storage resources can be accommodated in the short term through the RTO's/ISO's existing system or with relatively manageable modifications but argues that, in the long-term, the further integration of electric storage resources should be pursued through joint study of an RTO's/ISO's market design and system enhancements. FirstLight also argues that, because the proposal includes changes to RTO/ISO bidding, dispatch, pricing and settlement software, the Commission should allow each RTO/ISO to address the phasing of market development and implementation efforts related to any final rule.

336. Several other commenters argue that the Commission should allow the RTOs/ISOs to develop their own implementation schedules.[422] CAISO, IRC, NYISO Indicated Transmission Owners, and PJM argue that the Commission should permit each affected RTO/ISO to propose an implementation schedule for various aspects of the final rule.

[422] *See* CAISO Comments at 53; IRC Comments at 11-12; NYISO Indicated Transmission Owners Comments at 20; PJM Comments at 30.

CAISO states that it does not oppose the Commission setting a compliance and implementation timeframe but suggests that a better approach would be to direct the RTO/ISOs to establish independent timelines in their compliance filings. PJM states that allowing RTOs/ISOs to propose implementation schedules is preferable to the Commission setting firm deadlines that may lead to requests for waivers. IRC recommends that the final rule should require each RTO/ISO to file an implementation plan and schedule with the Commission within 180 days. IRC states that the implementation plan and schedule should be subject to notice and comment and not necessarily limited to 12 months.

337. NYISO Indicated Transmission Owners state that the Commission should not set unrealistic goals for the participation of distributed energy resource aggregations in wholesale markets before the grid has the needed technological capabilities.[423] Therefore, NYISO Indicated Transmission Owners oppose the Commission's proposal to make the compliance filing due in six months with full implementation 12 months thereafter. Instead, NYISO Indicated Transmission Owners request that each RTO/ISO be allowed to utilize the stakeholder process to establish a timeline for implementation.

338. Xcel Energy Services also expresses concerns that the implementation timeline is too aggressive, stating that that Commission should further evaluate whether the technological capability exists to fully implement the NOPR requirements and, if not,

[423] *See* NYISO Indicated Transmission Owners Comments at 20.

what timeline is needed to ensure that such functionality can be developed.[424] Xcel Energy Services contends that the requirements of the NOPR and the implementation timeline must be tailored to fit within achievable technological capabilities. Xcel Energy Services states that the RTOs/ISOs and their stakeholders should be permitted to propose alternate implementation timelines that allow higher priority regional projects to move forward before the software updates needed under the NOPR.

339. In contrast to other commenters, Advanced Microgrid Solutions argues that the proposed compliance and implementation timeline will take 18 months and therefore not promptly end unduly discriminatory rules and practices and will impose on-going burdens on the storage industry.[425] Advanced Microgrid Solutions argues that compliance plans should be filed within 90 days and specify the earliest possible implementation date for each compliance action.

340. Multiple entities discuss the proposed bidding parameters, including state of charge, in relation to the proposed timeline for compliance.[426] MISO states that managing state of charge would require costly investments and upgrades, noting that in some cases it may not be technically feasible for large volumes of electric storage resources. CAISO states that it will require at least 24 months to design and incorporate bidding parameters

[424] *See* Xcel Energy Services Comments at 16-17.

[425] *See* Advanced Microgrid Solutions Comments at 13.

[426] *See* AES Companies Comments at 23; CAISO Comments at 12; EPRI Comments at 12; MISO Comments at 10; Tesla/SolarCity Comments at 15.

that account for all physical operating parameters (such as state of charge) into its modeling and dispatch software, which would require stakeholder discussions, market design work, and implementation testing. CAISO further explains that this directive would be inconsistent with how CAISO models other resources in its markets and asks that the Commission direct RTOs/ISOs to account for the physical operating constraints of resource in their market modeling and dispatch software and require them to explain how they do so.

341. AES Companies similarly explain that time, resources, and capital costs can be minimized if all energy storage resources managed their own state of charge. EPRI notes that, assuming that the Commission does not require the RTOs/ISOs to manage state-of-charge of electric storage resources (which some already do), there would only be minimal changes to the bidding interface, market clearing, or settlement software. EPRI states that the large change absent RTOs/ISOs having to manage state of charge will be allowing electric storage resources to offer as an injector and withdrawer of energy in the same market interval but for the market clearing software to only allow acceptance of one or the other. Tesla/SolarCity state that bidding parameters should reflect storage resources state of charge and be included in the unit commitment and economic dispatch optimization algorithms of each RTO/ISO. Tesla/SolarCity believe that storage resources should manage their own state of charge or have the choice between relying on RTO/ISO estimates or self-managing. In contrast to other commenters, Tesla/SolarCity assert that the time and resources necessary to incorporate

these bidding parameters into the dispatch software should be minimal and are justified given the increased efficiency of markets and operations.

342. NEPOOL raises regional issues.[427] NEPOOL encourages the Commission to ensure that any final rule includes sufficient flexibility to allow the region to implement the requirements while also achieving the other regional priorities in ISO-NE's Work Plan for 2017-2018. Specifically, NEPOOL urges that the final rule take into account market rules that are currently being implemented in the region to eliminate barriers to the entry of electric storage resources into wholesale markets.

C. Commission Determination

343. Upon consideration of the comments, we find that it is reasonable to provide the RTOs/ISOs additional time to submit their proposed tariff revisions in response to the Final Rule, given that the changes could require significant work on the part of the RTOs/ISOs. We find that shorter timeframes proposed by commenters such as Advanced Microgrid Solutions would not provide the RTO/ISOs with sufficient time to implement the required reforms. Taking into account that the Commission is not implementing the distributed energy resource aggregation reforms at this time, we require each RTO/ISO to file the tariff changes needed to implement the requirements of this Final Rule within 270 days of the publication date of this Final Rule in the Federal

[427] *See* NEPOOL Comments at 5.

Register. We will continue to allow each RTO/ISO a further 365 days from that date to implement the tariff provisions.

344. We find that, given the modifications and clarifications to the NOPR we make in this Final Rule and the record in this proceeding in support of the reforms we finalize here, our implementation schedule is reasonable. Commenters highlight that managing state of charge will complicate or delay implementation, and we note that we are not requiring the RTOs/ISOs to manage state of charge. Further, some commenters also provide feedback on the implementation of the entire NOPR and indicate that implementing only the storage components would expedite compliance and implementation. We are not establishing any requirements for distributed energy resource aggregations as part of this Final Rule. Given the additional time we are providing for each RTO/ISO to file proposed tariff revisions to comply with this Final Rule, we believe that the compliance and implementation schedule that we establish in this Final Rule is appropriate. As a consequence, we are not persuaded that more than 365 days after the RTOs/ISOs are required to submit their proposed tariff revisions will be necessary to implement the reforms in this Final Rule; therefore, we decline to adopt commenters' other proposed recommendations, such as allowing the RTO/ISOs to develop their own implementation schedules. We disagree with Xcel Energy Services' argument that the Commission needs to further evaluate whether the technological capability exists to fully implement the NOPR requirements, especially as we are not finalizing in this Final Rule the distributed energy resource aggregation reforms proposed in the NOPR.

345. Additionally, we note that many of the RTOs/ISOs already have rules in place to enable the participation of electric storage resources in their markets. To the extent that an RTO/ISO proposes to comply with certain requirements of this Final Rule using existing market rules, it must demonstrate on compliance how its existing market rules meet the requirements of this Final Rule. We expect that the additional time that we are providing for the RTOs/ISOs to make their compliance filings, along with the ability of the RTOs/ISOs to use existing tariff provisions to demonstrate compliance with aspects of the Final Rule, will mean that the RTOs/ISOs can meet the deadlines that we are establishing here. Finally, we also note that, throughout this Final Rule, we are allowing regional flexibility to the extent possible. We believe that this flexibility will assist the RTOs/ISOs in meeting the compliance and implementation deadlines.

VI. Information Collection Statement

346. The collection of information contained in this Final Rule is being submitted to the Office of Management and Budget (OMB) for review under section 3507(d) of the Paperwork Reduction Act of 1995.[428] OMB's regulations,[429] in turn, require approval of certain information collection requirements imposed by agency rules. Upon approval of a collection(s) of information, OMB will assign an OMB control number and an expiration date. Respondents subject to the filing requirements of a rule will not be penalized for failing to respond to the collection of information unless the collection of

[428] *See* 44 U.S.C. § 3507(d).

[429] 5 CFR § 1320.

information displays a valid OMB control number.

Public Reporting Burden: In this Final Rule, we are not adopting any of the proposed reforms in the NOPR related to distributed energy resource aggregations and are modifying some of the requirements related to the participation model for electric storage resources. Thus, we are revising the estimated public reporting burden and cost from the NOPR[430] based on these changes. The estimated burden and cost for the requirements contained in this Final Rule follow.

[430] The burden estimates for the NOPR in Docket No. RM16-23-000 were submitted to OMB under FERC-516 (OMB Control No. 1902-0096, in ICR 201611-1902-005). There is another unrelated item affecting FERC-516 which will also be pending OMB review. Because only one item per OMB Control No. can be pending OMB review at a time, the reporting requirements in this Final Rule in RM16-23-000 will be submitted to OMB under a new collection number, FERC-516H.

FERC-516H, as implemented in the Final Rule in Docket No. RM16-23-000 [431]						
	Number of Respondents	Annual Number of Responses per Respondent	Total Number of Responses	Average Burden (Hours) & Cost Per Response	Total Annual Burden Hours & Total Annual Cost	Cost per Respondent ($)
	(1)	(2)	(1)×(2)=(3)	(4)	(3)×(4)=(5)	(5)÷(1)
One-Time Tariff Filing[432]	6[433]	1	6	1,500 hrs; $115,500	9,000 hrs; $693,000	$115,500

Title: FERC-516H, Electric Rate Schedules and Tariff Filings (in Final Rule in Docket

[431] The estimated hourly cost (salary plus benefits) provided in this section is based on the salary figures for May 2016 posted by the Bureau of Labor Statistics (BLS) for the Utilities sector (at http://www.bls.gov/oes/current/naics2_22.htm) and benefits information for September 2017 (issued 12/15/2017, at https://www.bls.gov/news.release/ecec.nr0.htm). The hourly estimates for salary plus benefits are: (a) Legal (code 23-0000), $143.68; (b) Computer and mathematical (code 15-0000), $60.70; (c) Computer and information systems manager (code 11-3021), $100.68; (d) Information security analyst (code 15-1122), $66.34; (e) Auditing and accounting (code 13-2011), $53.00; (f) Information and record clerk (code 43-4199), $39.14; (g) Electrical Engineer (code 17-2071), $68.12; (h) Economist (code 19-3011), $77.96; and (i) Management (code 11-0000), $81.52. The average hourly cost (salary plus benefits), weighting all of these skill sets evenly, is $76.79. The Commission rounds it to $77 per hour.

[432] The one-time tariff filing is due within 270 days of the publication date of the Final Rule in the Federal Register.

[433] Respondent entities are either RTOs or ISOs.

Nos. RM16-23-000 and AD16-20-000).

Action: Proposed information collection.

OMB Control No.: To be determined.

Respondents for this Rulemaking: RTOs and ISOs.

Frequency of Information: One-time.

Necessity of Information: The Commission implements this Final Rule to eliminate barriers to electric storage resource participation in the RTO/ISO markets.

Internal Review: The Commission has reviewed the changes and has determined that such changes are necessary. These requirements conform to the Commission's need for efficient information collection, communication, and management within the energy industry. The Commission has specific, objective support for the burden estimates associated with the information collection requirements.

347. Interested persons may obtain information on the reporting requirements by contacting the following: Federal Energy Regulatory Commission, 888 First Street, NE, Washington, DC 20426 [Attention: Ellen Brown, Office of the Executive Director] E-mail: DataClearance@ferc.gov; Phone: (202) 502-8663; fax: (202) 273-0873.

348. Comments concerning the collection of information and the associated burden estimate(s) may also be sent to: Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th Street, NW, Washington, DC 20503 [Attention: Desk Officer for the Federal Energy Regulatory Commission].

349. Due to security concerns, comments should be sent electronically to the following e-mail address: oira_submission@omb.eop.gov. Comments submitted to OMB should refer to FERC-516H and OMB Control No. To be determined.

VII. Environmental Analysis

350. The Commission is required to prepare an Environmental Assessment or an Environmental Impact Statement for any action that may have a significant adverse effect on the human environment.[434] We conclude that neither an Environmental Assessment nor an Environmental Impact Statement is required for this Final Rule under section 380.4(a)(15) of the Commission's regulations, which provides a categorical exemption for approval of actions under sections 205 and 206 of the FPA relating to the filing of schedules containing all rates and charges for the transmission or sale of electric energy subject to the Commission's jurisdiction, plus the classification, practices, contracts and regulations that affect rates, charges, classifications, and services.[435]

VIII. Regulatory Flexibility Act Certification

351. The Regulatory Flexibility Act of 1980 (RFA)[436] generally requires a description and analysis of rules that will have a significant economic impact on a substantial

[434] *Regulations Implementing the National Environmental Policy Act of 1969*, Order No. 486, 52 Fed. Reg. 47,897 (Dec. 17, 1987), FERC Stats. & Regs., ¶ 30,783 (1987).

[435] 18 CFR § 380.4(a)(15).

[436] 5 U.S.C. §§ 601-12.

number of small entities. The RFA mandates consideration of regulatory alternatives that accomplish the stated objectives of a rule and that minimize any significant economic impact on a substantial number of small entities. The Small Business Administration's (SBA) Office of Size Standards develops the numerical definition of a small business.[437] The small business size standards are provided in 13 CFR 121.201.

352. Under the SBA classification, the six RTOs/ISOs would be considered electric bulk power transmission and control, for which the small business size threshold is 500 or fewer employees.[438] Because each RTO/ISO has more than 500 employees, none are considered small entities.

353. Furthermore, because of their pivotal roles in wholesale electric power markets in their regions, none of the RTOs/ISOs meet the last criterion of the two-part RFA definition of a small entity: "not dominant in its field of operation."[439]

354. The estimated cost related to this Final Rule includes: (a) preparing and making a one-time tariff filing ($115,500 per entity, as detailed in the Information Collection

[437] 13 CFR §121.101.

[438] 13 CFR § 121.201 (Sector 22, Utilities).

[439] The RFA definition of "small entity" refers to the definition provided in the Small Business Act, which defines a "small business concern" as a business that is independently owned and operated and that is not dominant in its field of operation. The Small Business Administration's regulations at 13 CFR § 121.201 define the threshold for a small Electric Bulk Power Transmission and Control entity (NAICS code 221121) to be 500 employees. *See* 5 U.S.C. § 601(3) (citing to section 3 of the Small Business Act, 15 U.S.C. § 632).

section above), and (b) updating the economic dispatch software. Revisions to the economic dispatch software are due to be implemented within 365 days after the due date of the tariff filing. We estimate the one-time software work will take 1,500 hours with an approximate cost of $114,000 per entity.[440] Therefore the total estimated one-time cost for the tariff filing and software work is $229,500 per entity (or $115,500 + $114,000); the total estimated one-time industry cost is $1,377,000.

355. As a result, we certify that the reforms required by this Final Rule would not have a significant economic impact on a substantial number of small entities, and therefore no regulatory flexibility analysis is required.

IX. Document Availability

356. In addition to publishing the full text of this document in the Federal Register, the Commission provides all interested persons an opportunity to view and/or print the contents of this document via the Internet through the Commission's Home Page (http://www.ferc.gov) and in the Commission's Public Reference Room during normal

[440] Based on the BLS data, the hourly estimates (for wages plus benefits) related to updating the software are: (a) Computer and mathematical (code 15-0000), $60.70; (b) Computer and information systems manager (code 11-3021), $100.68; (c)Information security analyst (code 15-1122), $66.34; (d) Electrical Engineer (code 17-2071), $68.12; (e) Economist (code 19-3011), $77.96; and (f) Management (code 11-0000), $81.52. We estimate these skill sets are equally involved in updating the software. The hourly average is $75.89, so we will round to $76 per hour.

We estimate a total of 1,500 hours per entity to develop and implement the software changes, so the related cost is estimated to be $114,000 per entity ($76/hour X 1,500 hours). The one-time industry-wide cost is $684,000.

business hours (8:30 a.m. to 5:00 p.m. Eastern time) at 888 First Street, NE, Room 2A, Washington, DC 20426.

357. From the Commission's Home Page on the Internet, this information is available on eLibrary. The full text of this document is available on eLibrary in PDF and Microsoft Word format for viewing, printing, and/or downloading. To access this document in eLibrary, type the docket number of this document, excluding the last three digits, in the docket number field.

358. User assistance is available for eLibrary and the Commission's website during normal business hours from the Commission's Online Support at (202) 502-6652 (toll free at 1-866-208-3676) or email at ferconlinesupport@ferc.gov, or the Public Reference Room at (202) 502-8371, TTY (202) 502-8659. E-mail the Public Reference Room at public.referenceroom@ferc.gov.

X. Effective Date and Congressional Notification

359. This Final Rule will become effective on **[INSERT DATE 90 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. The Commission has determined, with the concurrence of the Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, that this rule is not a "major rule" as defined in section 351 of the Small Business Regulatory Enforcement Fairness

Act of 1996. This Final Rule is being submitted to the Senate, House, and Government Accountability Office.

List of subjects in 18 CFR Part 35:
Electric power rates
Electric utilities

By the Commission.

(S E A L)

Nathaniel J. Davis, Sr.,
Deputy Secretary.

XI. Regulatory Text

In consideration of the foregoing, the Commission amends Part 35 Chapter 1, Title 18 of the *Code of Federal Regulations* as follows:

PART 35 – FILING OF RATE SCHEDULES AND TARIFFS

1. The authority citation for Part 35 continues to read as follows:

AUTHORITY: 16 U.S.C. 791a-825r, 2601-2645; 31 U.S.C. 9701; 42 U.S.C. 7101-7352.

2. Amend § 35.28(b) as follows, by adding new paragraph (9).

§ 35.28 (b) Definitions

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(9) *Electric storage resource* as used in this section means a resource capable of receiving electric energy from the grid and storing it for later injection of electric energy back to the grid.

Amend § 35.28(g) as follows, by adding new paragraph (9)(i)(a-d), (ii).

§ 35.28

(g) Tariffs and operations of the Commission-approved independent system operators and regional transmission organizations.

*****

(9) Electric Storage Resources.

(i) Each Commission-approved independent system operator and regional transmission organization must have tariff provisions providing a participation model for electric storage resources that

a. Ensures that a resource using the participation model for electric storage resources in an independent system operator or regional transmission organization market is eligible to provide all capacity, energy, and ancillary services that it is technically capable of providing;
b. Ensures that a resource using the participation model for electric storage resources can be dispatched 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;

c. Accounts for the physical and operational characteristics of electric storage resources through bidding parameters or other means; and
d. Establishes a minimum size requirement for resources using the participation model for electric storage resources that does not exceed 100 kW.

(ii) The sale of electric energy from an independent system operator or regional transmission organization market to an electric storage resource that the resource then resells back to that market must be at the wholesale locational marginal price.

NOTE: The following appendix will not be published in the Code of Federal Regulations.

XII. Appendix A: Abbreviated Names of Commenters

The following table contains the abbreviated names of the commenters that are used in this Final Rule.

Abbreviation	Commenter (Full Name)
Advanced Energy Economy	Advanced Energy Economy
Advanced Energy Management	Advanced Energy Management Alliance
Advanced Microgrid Solutions	Advanced Microgrid Solutions, Inc.
Advanced Rail Energy Storage	Advanced Rail Energy Storage, LLC
AES Companies	AES Companies
Alevo	Alevo USA Inc.
Altametric	Altametric LLC
Amanda Drabek	Amanda Drabek, Pantsuit Nation of East Texas
American Petroleum Institute	American Petroleum Institute
APPA/NRECA	American Public Power Association and National Rural Electric Cooperative Association
Avangrid	AVANGRID, Inc.
AWEA	American Wind Energy Association
Beacon Power	Beacon Power, LLC
Benjamin Kingston	Benjamin D. Kingston
Bonneville	Bonneville Power Administration
Brookfield Renewable	Brookfield Renewable
CAISO	California Independent System Operator Corporation
California Commission	Public Utilities Commission of the State of California
California Energy Storage Alliance	California Energy Storage Alliance
California Municipals	California Municipal Utilities Association (incorporated by reference APPA/NRECA's comments)
Center for Biological Diversity	Center for Biological Diversity
City of New York	City of New York
Connecticut State Entities	Bureau of Energy and Technology Policy of the Connecticut Department of Energy and Environmental Protection and the Connecticut Public Utilities Regulatory

Abbreviation	Commenter (Full Name)
	Authority (incorporate by reference NESCOE comments)
Delaware Commission	Delaware Public Service Commission
DER/Storage Developers	DER and Storage Developers
Dominion	Dominion Resources Services, Inc. (supports EEI's comments)
DTE Electric/Consumers Energy	DTE Electric Company and Consumers Energy Company
Duke Energy	Duke Energy Corporation (supports EEI's comments)
E4TheFuture	E4TheFuture
Eagle Crest	Eagle Crest Energy Company
EEI	Edison Electric Institute
Efficient Holdings	Efficient Holdings, LLC
ELCON	Electricity Consumers Resource Council
Electric Vehicle R&D Group	EV R&D Group, University of Delaware
Energy Storage Association	Energy Storage Association
EPRI	Electric Power Research Institute
EPSA/PJM Power Providers	Electric Power Supply Association and PJM Power Providers Group
Exelon	Exelon Corporation
FirstLight	FirstLight Power Resources, Inc.
Fluidic	Fluidic Energy
Fresh Energy/Sierra Club/Union of Concerned Scientists	Fresh Energy, the Sierra Club, and the Union of Concerned Scientists
Genbright	Genbright LLC
GridWise	GridWise Alliance (supports some of Advanced Energy Economy's and EEI's comments)
Guannan He	Guannan He
Harvard Environmental Policy Institute	Harvard Environmental Policy Institute
Imperial Irrigation District	Imperial Irrigation District
Independent Energy Producers Association	Independent Energy Producers Association
Institute for Policy Integrity	Institute for Policy Integrity
IPKeys/Motorola	IPKeys Technologies and Motorola Solutions
IRC	ISO-RTO Council
ISO-NE	ISO New England Inc.
Kathy Seal	Kathy Seal

Abbreviation	Commenter (Full Name)
Liza White	Liza C White
Lyla Fadali	Lyla Fadali
Magnum	Magnum CAES, LLC (supports some of APPA/NRECA's and National Hydropower Association's comments)
Maryland and New Jersey Commissions	Maryland Public Service Commission and New Jersey Board of Public Utilities
Massachusetts State Entities	Massachusetts Department of Public Utilities and Massachusetts Department of Energy Resources
Massachusetts Municipal Electric	Massachusetts Municipal Wholesale Electric Company
Matthew d'Alessio	Matthew d'Alessio
Mensah	AF Mensah Inc.
Microgrid Resources Coalition	Microgrid Resources Coalition
Minnesota Energy Storage Alliance	Minnesota Energy Storage Alliance
MISO	Midcontinent Independent System Operator, Inc.
MISO Transmission Owners	MISO Transmission Owners
Mosaic Power	Mosaic Power, LLC
NARUC	National Association of Regulatory Utility Commissioners
National Hydropower Association	National Hydropower Association
NEPOOL	New England Power Pool
NERC	North American Electric Reliability Corporation
NESCOE	New England States Committee on Electricity
New York State Entities	New York Public Service Commission and New York State Energy Research and Development Authority
New York Utility Intervention Unit	Utility Intervention Unit of the New York State Department of State
NextEra	NextEra Energy Resources, LLC
NRG	NRG Energy, Inc.
NYISO	New York Independent System Operator, Inc.
NYISO Indicated Transmission Owners	Central Hudson Gas & Electric Corporation, Consolidated Edison Company of New York, Inc., National Grid, New York Power Authority, Orange

Abbreviation	Commenter (Full Name)
	and Rockland Utilities, Inc., and Power Supply Long Island
NYPA	New York Power Authority
Ohio Commission	Public Utilities Commission of Ohio
Open Access Technology	Open Access Technology International, Inc.
OpenADR	OpenADR Alliance
Organization of MISO States	Organization of MISO States
Pacific Gas & Electric	Pacific Gas and Electric Company
PJM	PJM Interconnection, L.L.C.
PJM Market Monitor	Monitoring Analytics, LLC
Power Applications	Power Applications and Research Systems, Inc.
Protect Sudbury	Protect Sudbury
Public Interest Organizations	Public Interest Organizations
R Street Institute	R Street Institute
Research Scientists	Drs. Audun Botterud, Apurba Sakti, and Francis O'Sullivan
Robert Borlick	Robert L. Borlick
San Diego Water	San Diego County Water Authority
Schulte Associates	Schulte Associates LLC
SEIA	Solar Energy Industries Association
Silicon Valley Leadership Group	Silicon Valley Leadership Group
Six Cities	Cities of Anaheim, Azusa, Banning, Colton, Pasadena, and Riverside, California
SoCal Edison	Southern California Edison Company
SPP	Southwest Power Pool, Inc.
Starwood Energy	Starwood Energy Group Global, L.L.C.
Stem	Stem, Inc.
Sunrun	Sunrun Inc.
TAPS	Transmission Access Policy Study Group
TechNet	TechNet
TeMix	TeMix Inc.
Tesla/SolarCity	Tesla, Inc. and SolarCity Corporation
Trans Bay	Trans Bay Cable LLC
Union of Concerned Scientists	Union of Concerned Scientists
US Senators	Senator Cory A. Booker, Senator Edward J. Markey, Senator Bernard Sanders, Senator Elizabeth Warren, Senator Sheldon Whitehouse, and Senator Ron

Abbreviation	Commenter (Full Name)
	Wyden
Xcel Energy Services	Xcel Energy Services Inc.