MARKET
Market and Retail-rate Knowhow for the Energy Transition

State regulatory opportunities to advance distributed energy resource aggregations in wholesale markets

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Sydney P Forrester (Berkeley Lab)
Ryan Hledik (Brattle)
Adam Bigelow (Brattle)
Natalie Mims Frick (Berkeley Lab)
Kala Viswanathan (Brattle)

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Argonne NATIONAL LABORATORY
BERKELEY LAB

State Regulatory Opportunities to Advance Distributed Energy Resource Aggregations in Wholesale Markets

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Authors
Sydney P. Forrester, Lawrence Berkeley National Lab
Ryan Hledik, Brattle
Adam Bigelow, Brattle
Natalie Mims Frick, Lawrence Berkeley National Lab
Kala Viswanathan, Brattle

Ernest Orlando Lawrence Berkeley National Laboratory
1 Cyclotron Road, MS 90R4000
Berkeley CA 94720-8136

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Acronyms and abbreviations

CAISO	California Independent System Operator
DER	distributed energy resources
DR	demand response
ERCOT	Electric Reliability Council of Texas
FERC	Federal Energy Regulatory Commission
GW	gigawatt
ISO	independent system operator
ISO-NE	Independent System Operator New England
MISO	Midcontinent Independent System Operator
MW	megawatt
NARUC	National Association of Regulatory Utility Commissioners
NEM	net energy metering
NYISO	New York Independent System Operator
RTO	regional transmission organization
SPP	Southwest Power Pool

Executive summary

Despite growth in distributed energy resource (DER) adoption, there are still significant barriers to broader participation by aggregations of DERs in wholesale electricity markets. This is partly due to complex wholesale market participation rules at the bulk system level and rules regulating the ability for a resource to participate dually across both retail and bulk system levels, which requires coordination among DERs, aggregators, utilities, regulators, wholesale market operators, and other stakeholders.

There are many benefits for states that promote DER aggregations in wholesale markets. Removing barriers to participation of DER aggregations across markets could promote market competition, advance the cost-effective deployment of DERs, and promote related state goals (e.g., affordability, clean or renewable technology adoption). When aggregated, DERs can be deployed more quickly than traditional utility-scale resources due to shorter siting, planning, and construction timelines, and even more so when leveraging existing DERs that may not currently be enrolled in programs to provide grid services (DOE 2024). Through coordination with regional transmission organizations (RTOs) and independent system operators (ISOs), state regulators can promote state goals and priorities while complementing wholesale market actions to successfully encourage aggregated DERs' provision of both retail and wholesale services and value.

The Federal Energy Regulatory Commission (FERC) regulates six wholesale electricity markets in the United States. The agency issued FERC Order 2222 in 2020 to allow DERs capable of providing applicable services (i.e., energy, capacity, and ancillary services) to compete against traditional utility-scale power resources, thereby increasing market competition and reducing overall system costs. Order 2222 requires jurisdictional RTOs and ISOs to establish market frameworks in which individual DERs can operate in wholesale markets through aggregations.[1]

While FERC Order 2222 refers to the "relevant electric retail regulatory authority," which is broader than just state regulators, this report focuses more specifically on the state regulator with jurisdiction over investor-owned utilities.[2] FERC has jurisdiction over wholesale markets, but not over retail regulators. Nevertheless, complementary actions by states can enable or promote aggregated DERs' wholesale market success.

To identify key issues for state regulators interested in advancing DER aggregations in wholesale markets, we reviewed Order 2222 compliance filings and related stakeholder comments to characterize emerging models for integrating DER aggregations into wholesale markets and the potential role of the state regulator in facilitating that integration. Of the 18 FERC-identified compliance categories, we identified four Compliance and Implementation Issues to explore in this report that have proven challenging for RTO/ISOs to satisfy and that provide an opportunity for retail regulators to play a

[1] Order 2222 builds on prior FERC orders — particularly Order 745, which focused on opening wholesale markets to demand response, and Order 841, which does so for electric storage.

[2] This report primarily references "state regulators," but for some FERC-specific comments or actions, the broader "retail regulators" may be used, which encompasses state regulators and other jurisdictional retail regulators.

meaningful role in Order 2222 implementation.[3] Figure ES-1 summarizes the history of progress toward RTO/ISO compliance for each of the 18 compliance categories in Order 2222, including the four Compliance and Implementation Issues that are the focus of our research for this report.[4] The Compliance and Implementation Issues are (1) Double Counting, (2) Role of the Distribution Company, (3) Ongoing Coordination, and (4) Metering and Telemetry.

	CAISO		NYISO		PJM		ISO-NE		MISO	SPP
	Filing 1 Jun-22	Filing 2 May-23	Filing 1 Jun-22	Filing 2 Apr-23	Filing 1 Mar-23	Filing 4 Jul-24	Filing 1 Mar-23	Filing 3 Nov-23	Filing 1 Oct-23	Filing 1 Mar-24
Small Utility Opt-In	○	○	○	○	○	○	○			○
Interconnection†			○	○			○		○	
Definitions of DER and DER Aggregator			○							
Participation Model*	●	●	●	○	○	○	●	●	○	●
Types of Technologies	○		○		○	○	○			○
Allow a DER to Serve as its Own Aggregator										
Double Counting of Services	●	●	○		●	○			○	●
Min and Max Size of Aggregation	○	○								
Min and Max Size for DER in an Aggregation	○									○
Distribution Factors and Bidding Parameters	○				○	○			○	○
Locational Requirements*			○		●	●			●	●
Information and Data Requirements†			○		○	○	○	○		
Metering and Telemetry System Requirements	●	●	●	●	●	○	●	●	○	●
Role of Distribution Company	●	●	●	●	○	○			●	●
Ongoing Operational Coordination	●	●	●	●	○	○	○	○	○	●
Role of Relevant Electric Retail Regulatory Authority†	○		○		○	○			○	○
Modifications to List of Resources in Aggregation			○		○	○	○			
Market Participation Agreements†			○	○						

○ = Minor discussion among stakeholders on this issue in this filing
● = Major discussion among stakeholders on this issue in this filing
= Issue resolved during current filing or already resolved
= Not yet in compliance

* Indicates an issue that has proven challenging for RTO/ISOs to resolve but does not have a material role for retail regulators

† Indicates an issue with a material role for retail regulators but which has not proven challenging for RTO/ISOs to resolve

Note: The four Compliance and Implementation Issues are highlighted in bold text and indicate that an issue was both (a) challenging for RTO/ISOs to resolve and (b) has a material role for retail regulators. Issues highlighted in blue in the most recent filing for each RTO/ISO are those still not in compliance, with dots indicating which issues resulted in material stakeholder discussion in each market. All dates represent FERC's response date to the compliance filing. NYISO has filed their third complaince filing as of May 2023, but FERC has yet to respond. For the purposes of this report, only filings to which FERC responded were reviewed.

Figure ES-1. Progress of RTO/ISOs with Order 2222 Compliance and Implementation Issues

Double Counting: Order 2222 allows RTO/ISOs to limit the participation of resources in wholesale markets if a DER aggregation is receiving compensation for the same services as part of another program. Addressing this issue will determine how aggregations can register DERs, bid into markets, and be compensated for both distribution and wholesale services. State regulators do not have jurisdiction over wholesale market participation, but they do determine DER eligibility in retail programs under their jurisdiction, conditional on wholesale market participation, as well as retain the ability to inform RTO/ISOs of potential double counting concerns. [5] (See Appendix A for references to all reviewed FERC compliance filings and orders.)

[3] Three additional issues that have been challenging for RTO/ISOs to comply with but are outside the purview of the state regulator are discussed in Appendix C.

[4] Implementation dates for the RTO/ISOs vary between early 2024 and 2030. Some RTO/ISOs have proposed revised dates, without resolution as of the writing of this report. For further discussion, see Collaborative Utility Solutions (2024).

[5] For example, NYISO 179 FERC ¶ 61,198 at paragraph 137

Role of the Distribution Company: In the context of Order 2222, the "role of the distribution company" focuses on the distribution utility review process that takes place during the registration for an aggregator of an aggregation. When a DER aggregation is registered to participate in the wholesale market, or when changes to existing DER aggregations are made, Order 2222 requires RTO/ISOs to develop a process for timely review by the applicable distribution utility. Additionally, RTO/ISOs must develop a review process for aggregations that determine (1) whether each proposed DER can participate in an aggregation and (2) whether the participation will pose significant risks to the distribution system. State regulators can provide guidance and transparency on what may preclude an individual DER's participation in wholesale market participation. Since dispute resolution pertaining to distribution utility decisions during the review process likely falls within retail regulator jurisdiction,[6] additional transparency could minimize those instances. To successfully co-develop a series of review criteria, regulators may need to engage with utilities and aggregators.

Ongoing Coordination: Order 2222 requires each RTO/ISO to: (1) establish a process for ongoing coordination related to data flows and communication among itself, the DER aggregator, and the distribution utility; (2) include protocols that allow distribution utilities to override RTO/ISO dispatch of an aggregation, if necessary, to maintain the reliable and safe operation of the distribution system; and (3) apply a performance penalty to a DER aggregator in the case of under- or non-performance due to a distribution utility override of the RTO/ISO dispatch. A retail regulator's primary role is to approve override processes of RTO/ISO market instructions to DER aggregations due to distribution system operational risk. Secondarily, they have a complementary role to review and approve distribution utility communications and tools for coordination with DER aggregators and RTO/ISOs. Finally, retail regulators would have jurisdiction over disputes between an aggregator and utility, so they would have the responsibility to adjudicate override disputes.

Metering and Telemetry: In the context of Order 2222, "metering" refers to the rules that determine how DER aggregations have their energy injection and withdrawal measured, and "telemetry" refers to how aggregations report real-time data (e.g., voltage and frequency) needed to provide fast-response services such as frequency regulation. Order 2222 did not set rigid requirements for metering and telemetry, and FERC has maintained a hands-off approach when approving each RTO/ISO's requirements, provided that the RTO/ISOs can justify their rationale for them.[7] RTO/ISOs require information from market participants, including aggregators, to ensure reliable operation within the wholesale market; and they may be inclined to specify metering and telemetry that is consistent with incumbent requirements (i.e., that required of large generators). This may indirectly impose metering and telemetry requirements onto individual DERs. FERC has stated an explicit preference to rely on meter data obtained through compliance with distribution utility or retail regulator requirements whenever possible. Individual DER interconnection agreements and metering and telemetry on the distribution system are in the purview of retail regulators, which provide an opportunity for state

[6] For example, NYISO 179 FERC ¶ 61,198 at paragraph 243
[7] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 242

influence in cases where RTO/ISOs allow flexibility. This may allow for DERs to participate in aggregations without the need to purchase expensive new equipment or develop new data protocols, while still providing sufficient information to verify performance and ensure proper compensation.

In addition to the four Compliance and Implementation Issues where state regulators have an opportunity to play a meaningful role in Order 2222 implementation, there are three cross-cutting opportunities that span the Compliance and Implementation Issues, along with general promotion of state goals and DER adoption at the local level:

Coordination: States can engage additional stakeholders in investigatory dockets or working groups on DER aggregations to consider multiple objectives and address relevant DER issues. Regional coordination between state regulators to standardize requirements or programs can alleviate barriers for third-party aggregators and other service providers to enter markets that often have differing rules from one to another, which was an issue that DER aggregators identified in our interviews. In addition, regulators can act as coordinators between retail and wholesale markets, where applicable.

Policy and Regulation: Individual DERs are both subject to, and influenced by, retail regulation. Relevant state regulation includes that which promotes both cost-effective DER adoption and integration, as well as that which values and provides grid benefits (e.g., tariff or incentive program design), and state policy has a large influence on which programs aggregators participate in and at which level (i.e., retail, wholesale, or both) (Downing et al. 2023). Relevant policy and regulation may include rate design, incentive and program design, establishing performance metrics and deployment targets, resource planning, and establishing rules around dual participation and coordination between retail and wholesale markets.

Data Collection, Evaluation, and Sharing: Data will be critical for DER aggregations to successfully participate in wholesale markets and has been identified as a major barrier to provision of grid services. This will be very influential in successfully addressing all four of the identified RTO/ISO Compliance and Implementation Issues. States can influence various aspects that include data sharing practices, interconnection and operations agreements, tariff requirements, measuring and verification for benchmarking, performance verification and settlement, and simplified enrollment requirements.

States can benefit from encouraging beneficial adoption and operation of DERs on their local grid. Encouraging dual participation could increase both the value that each DER can provide to the grid and the value streams that DER owners can receive. With increased coordination, this can be done while guarding local grid reliability. While Order 2222 primarily impacts RTO/ISO actions and states are not mandated actors within the FERC context, there are knock-on effects that will be felt at the local level. Engaging earlier to harmonize state and wholesale market activities can allow energy market changes to complement state goals.

1. Introduction

Adoption of distributed energy resources (DERs)[8] in the United States is rising as installed costs decline, financial incentives are put in place, and customers seek to achieve cost savings, improve their energy resilience, and lower emissions (FERC 2024a). Between 2024 and 2028, DER capacity is expected to grow by 217 gigawatts (GW) in the United States, as compared to bulk generation capacity additions of 310 GW during the same period (Wood Mackenzie 2024). Tapping into the flexibility of these DERs by allowing them to participate in grid services can leverage existing resources and promote a reliable and affordable power system. While this is done to some extent at the local level, participation in wholesale electricity markets is far more limited.

Despite growth in DER capacity, there are still significant barriers to broader participation in wholesale electricity markets. Currently, utility programs and retail rate designs (e.g., net energy metering [NEM] policies) often provide simpler and greater compensation opportunities than wholesale market participation for some DERs, especially for smaller resources. Indeed, residential DER aggregators interviewed for this study indicated that they find retail utility programs to be more attractive — in terms of simplicity and financial opportunity — than bidding directly into wholesale markets. To the extent that retail and wholesale compensation levels converge over time, further barriers to wholesale market participation may persist due to complex wholesale market participation rules at the bulk system level and rules regulating the ability for a resource to participate dually across both retail and bulk system levels, which would require additional coordination among DERs, aggregators, utilities, regulators, wholesale market operators, and other stakeholders (Power et al. 2023). Additional data collection and sharing may also be required, along with rules to facilitate and regulate those exchanges. Combined, these factors create an uncertain environment for investing in DERs or for aggregators interested in participating in certain regions.

The impact of these challenges is observed in the degree to which DERs currently participate in wholesale markets which, regardless of DER technology type, historically has occurred primarily under demand response (DR) participation rules. While there are over 33 GW of DR participating in wholesale markets from both mass-market customers and large commercial and industrial facilities, those participants are primarily providing services solely on the demand side, and often only during peak events (FERC 2024b). DERs that can provide injections of power to the grid — such as rooftop solar and batteries — have very different operational characteristics than typical DR and thus have historically participated in wholesale markets in a much more limited fashion. To address these challenges, FERC Order 2222 requires jurisdictional regional transmission organizations (RTOs) and independent system operators (ISOs) to establish market frameworks in which individual DERs can operate in wholesale

[8] For the purposes of this report, DERs are defined as resources that are located behind the meter and can generate electricity or shift load. Our definition of DERs encompasses a broad range of technology types including behind-the-meter solar and storage, on-site backup generation, electric vehicles, and DR through smart thermostats, grid-connected water heaters, and other controllable end uses.

markets through aggregation.[9] Creating this pathway would allow DERs capable of providing applicable services to compete against traditional utility-scale power resources, thereby increasing market competition and reducing overall system costs.

More specifically, Order 2222 requires that each RTO/ISO adhere to a set of directives that will enable DER aggregations to participate in wholesale markets fairly and safely. These directives include minimum size requirements, market participation structures that accommodate both heterogeneous (aggregations made up of multiple types of DER technologies) and homogeneous (aggregations made up of a single DER technology type) resource aggregations, and locational requirements that apply to the geographic breadth with which a portfolio of DERs can be aggregated. Additionally, Order 2222 requires that market rules define the responsibilities of each relevant party, including the RTO/ISO operating the wholesale market, the market participant (e.g., aggregator), distribution utilities, and any relevant electric retail regulatory authority. Finally, Order 2222 requires the development of processes for sharing data between relevant parties to ensure that performance expectations are met, issues such as double counting of DER compensation are addressed, and the system remains stable through appropriate operational awareness.

RTO/ISOs are continuing to make progress toward complying with the requirements of Order 2222, though the speed with which compliance is reached varies significantly from one market to the next.[10] As a general matter, RTO/ISOs have struggled to fully leverage DERs' unique operational characteristics. Order 2222 requires that RTO/ISOs coordinate with regulated distribution utilities to comply with existing local regulations and that all individual DERs comply with various rules and parameters of interconnection, tariffs, and any other rules that fall under state jurisdiction. Since all individual DERs must adhere to local rules as a prerequisite to participating in an aggregation, states have an important complementary role, even if indirect, with Order 2222 implementation. Regulators can choose to more closely coordinate with RTO/ISOs, utilities, third-party aggregators, and other stakeholders to promote successful and meaningful DER aggregation participation.

State regulators are not under FERC jurisdiction and play a voluntary role in Order 2222 implementation, but they do not need to wait for RTO/ISO compliance to unlock additional grid benefits by enabling DER aggregations. The increasing penetration of customer-sited DERs presents additional opportunities and challenges at the local level. Removing barriers to participation of DER aggregations across markets could promote market competition, advance the cost-effective deployment of DERs, and promote state goals (e.g., affordability, clean or renewable technology adoption). When aggregated, DERs can be deployed more quickly than traditional utility-scale resources due to shorter siting, planning, and construction timelines, even more so when leveraging existing DERs that may not currently be enrolled in programs to provide grid services (DOE 2024). Aggregations can alleviate resource adequacy constraints and promote grid affordability, reliability, and resilience, all while supporting related state goals.

[9] Order 2222 builds on prior FERC Orders, particularly Order 745, which focused on opening wholesale markets to demand response, and Order 841, which did so for electric storage.
[10] At the time of writing this report, only the California ISO and ISO New England had fully complied with Order 2222.

States have already begun to act. Several states in the Midcontinent Independent System Operator (MISO) and Southwest Power Pool (SPP) region such as Michigan, Missouri, and Wisconsin have voluntarily begun to reverse legislative and regulatory restrictions on third-party DR aggregators that were developed previously as a response to FERC Order 719 in order to gain experience ahead of Order 2222 implementation. Other states such as Maryland, New Jersey, and Pennsylvania have opened up proceedings and dialogues on Order 2222 implementation.[11] There have been parallel discussions and action surrounding grid modernization investments to further enable the capabilities and coordination of DERs to provide grid services (GridWise Alliance 2024). State regulators can create and evaluate DER programs and incentives in order to encourage optimal use of DERs and provide grid benefits (FERC 2024b). States may have an interest in facilitating the ability of DERs to participate in grid services dually across local and bulk system levels to fully capture these benefits, align with other state energy goals, and support all stakeholders' mutual goals of an affordable, efficient, and reliable grid.

The purpose of this report is to identify challenges in incorporating DER aggregations into wholesale electricity markets, characterize the various emerging approaches to address those challenges, and identify where state regulators may have a role in supporting Order 2222 implementation to scale DER aggregation participation in wholesale markets.

The remainder of the report is organized as follows. Section 2 discusses the research methodology used to develop the insights and recommendations in this report. Section 3 describes the current state of DER aggregation participation in wholesale markets. Section 4 identifies the most challenging aspects of Order 2222 compliance at the RTO/ISO level, discusses the range of approaches taken to address these challenges, and highlights the potential role of the state regulator in facilitating Order 2222 implementation. Section 5 discusses the role of the regulator to further advance the utilization of DERs for wholesale/bulk system value. Section 6 concludes the report.

[11] See FERC2222.org for a summary of these activities. They are also discussed in Section 4 of this report.

2. Methodology

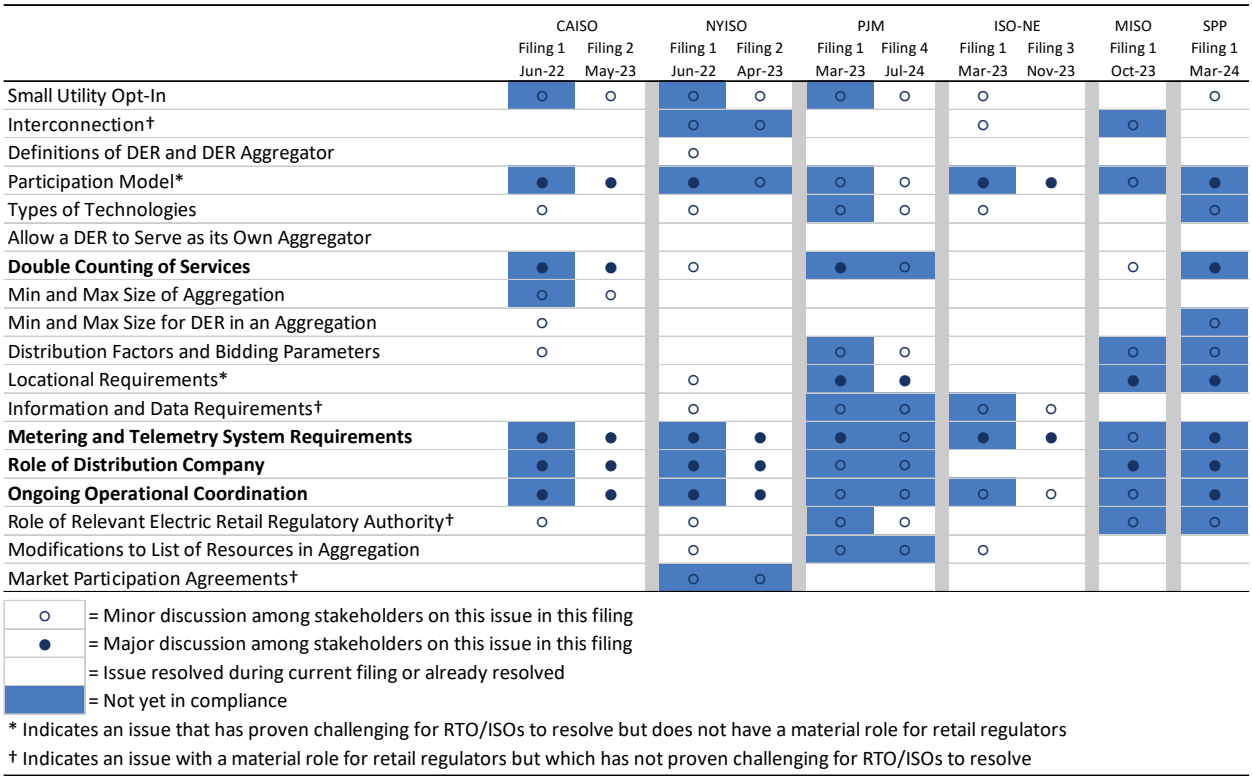
Our research for this report is based on a detailed review of the RTO/ISO Order 2222 compliance filings and stakeholder comments, a literature review, and interviews with 10 market participants and state regulators that are actively engaged in issues pertaining to DER aggregation participation in wholesale markets.

We reviewed Order 2222 compliance filings and related stakeholder comments to characterize emerging models for integrating DER aggregations into wholesale markets and the potential role of the state regulator in facilitating that integration. Our review identified 18 categories of requirements for RTO/ISO compliance with Order 2222.[12] We focused our subsequent research on the categories of compliance requirements at the intersection of those that have proven most challenging for RTO/ISOs to satisfy and those where state regulators have an opportunity to play a meaningful role in Order 2222 implementation. We identified four such areas, which we refer to in this report as "Compliance and Implementation Issues."

Figure 1 summarizes the history of progress toward compliance by RTO/ISO for each of the 18 compliance categories in Order 2222.[13] The four Compliance and Implementation Issues are highlighted in bold text. Issues highlighted in blue in the most recent filing for each RTO/ISO are those still not in compliance, with dots indicating which issues resulted in material stakeholder discussion in each market. The figure highlights that even the California ISO (CAISO) and ISO-New England (ISO-NE), the two RTO/ISOs that have reached full compliance with the requirements of Order 2222, required multiple rounds of discussion between the ISO, stakeholders, and FERC before aligning on an approved path forward.

We identified the four Compliance and Implementation Issues using the following criteria: (1) whether multiple RTO/ISOs required more than one filing in order to reach compliance, (2) whether stakeholders' comments identified material concerns with approaches proposed by the RTO/ISOs, (3) the revisions necessary to reach compliance were nontrivial, and (4) the issue is relevant to state regulator jurisdiction. Two additional implementation issues, wholesale participation models and locational requirements, were identified that meet the first three criteria for identifying Compliance and Implementation Issues, but they do not have a meaningful role for state regulators and are discussed in the Appendix C. Though each wholesale market is unique in their respective challenges and each state has its own regulatory structures, the criteria identified clear trends that highlight these four Compliance and Implementation Issues.

[12] See Appendix B for a description of each of the 18 categories of compliance requirements and relevant paragraphs from Order 2222. Appendix A contains references to all reviewed FERC compliance filings and orders.
[13] Implementation dates for the RTO/ISOs vary between early 2024 and 2030. Some RTO/ISOs have proposed revised dates, without resolution as of the writing of this report. For further discussion, see Collaborative Utility Solutions (2024).



Note: The four Compliance and Implementation Issues are highlighted in bold text and indicate that an issue was both (a) challenging for RTO/ISOs to resolve and (b) has a material role for retail regulators. Issues highlighted in blue in the most recent filing for each RTO/ISO are those still not in compliance, with dots indicating which issues resulted in material stakeholder discussion in each market. All dates represent FERC's response date to the compliance filing. NYISO has filed their third complaince filing as of May 2023, but FERC has yet to respond. For the purposes of this report, only filings to which FERC responded were reviewed.

Figure 1. Progress of RTO/ISOs with Order 2222 Compliance and Implementation Issues

As is reflected in subsequent sections of this report, our review and synthesis of Order 2222 compliance filings and associated stakeholder comments allowed us to define the various approaches that emerged for integrating DER aggregations into wholesale markets. To identify a broader range of potential approaches, we described the approved approaches and proposals by ISO/RTOs and stakeholders that were given consideration but not adopted. Where information was available, we also summarized opportunities identified by stakeholders and RTO/ISOs for state regulators to play a role in facilitating the wholesale market integration of DER aggregations. Given the volume of material that has been filed in the context of Order 2222, we focused our review primarily on FERC decision documents, which contained a summary of comments filed by all stakeholders and supplemented that with review of the original filed comments where additional detail was needed.

To understand the role of retail regulators, specifically the role of state regulators in advancing the integration of DER aggregations in wholesale markets, we conducted interviews with 10 organizations actively engaged in this area, including state regulatory staff and commissioners, aggregators, and other organizations with perspective on the role of the state regulator. The interviews were exploratory in nature but generally guided by three questions: (1) What can or should state regulators do to facilitate the integration of DER aggregations into wholesale markets, (2) What challenges are state regulators

encountering when attempting to facilitate the integration of DER aggregations into wholesale markets, and (3) What is needed to help state regulators address and overcome those challenges?

For the interviews, we selected geographically and organizationally diverse interviewees with expertise in DER aggregation and wholesale markets. The specific organizations included coalitions of regulators such as the New England Conference of Public Utilities and Organization of MISO States; state regulators such as the California Public Utilities Commission and Illinois Commerce Commission; aggregators such as Voltus, Sunrun, and Renew Home; and nongovernmental organizations such as RMI, the Environmental Law and Policy Center, and the National Association of Regulatory Utility Commissioners (NARUC).

3. Current DER aggregation participation in wholesale markets

FERC Order 2222 requires jurisdictional RTO/ISOs to establish market frameworks in which DER aggregations can operate in wholesale markets. Creating this pathway allows DERs capable of providing applicable services (i.e., energy, capacity, and ancillary services) to compete against traditional utility-scale power resources, thereby increasing market competition and reducing overall system costs. The goals of Order 2222 are to improve competition in wholesale markets and reduce market barriers to aggregated DERs providing grid services at the bulk system level (FERC 2024b). Order 2222 builds on prior FERC orders — particularly Orders 745 and 719, which focused on integrating DR, and Order 841, which did so for electric storage. Nevertheless, there is significant variability in participation and offerings across markets — MISO has more than 12 GW of DR resources (about 10% of peak demand), while SPP has less than 1 GW of DR resources (about 1% of peak demand)(FERC 2024b). Apart from DR, examples of DER aggregations participating in wholesale markets are limited. Moreover, resources such as distributed batteries that have the ability to provide multiple grid services often are currently limited to participating as DR due to market participation rules, which can limit a resource's offerings and consequent payment for services. While all markets allow DR aggregations, there are few examples of RTO/ISOs that allow aggregations to inject power, and the magnitude of this capacity remains small (see callout box for examples).[14]

Examples of DER Aggregations Currently Participating in Wholesale Markets

- PJM: 291 megawatts (MW) of backup generation approved to inject power to grid in the Capacity Market in 2023 (PJM 2024).
- ISO-NE: 20 MW of solar + storage in the Forward Capacity Market (from 5,000 distributed systems) (Sunrun 2019) delivered 1.8 gigawatt-hours during summer peak hours in 2022 (DOE 2024).
- Energy Reliability Council of Texas (ERCOT): Aggregated DERs, mostly made up of distributed batteries, provided 14.5 MW of energy services and 8.6 MW of ancillary services for non-spin and ERCOT Contingency Reserve Services as of September 2024 (Texas PUC 2024).

While RTO/ISOs ultimately determine how DER aggregations can participate in their respective markets, state regulations can enable or promote aggregated DERs' wholesale market success. States can coordinate between aggregators, utilities, and RTO/ISOs, require consideration of aggregated DERs in utility planning (Biewald et al. 2024) or allow aggregated DERs to offer services at both the retail and bulk system levels (i.e., "dual participation"). For example, New York allows retail DR programs such as the Commercial System Relief Program and Distribution Load Relief Program to participate in the New York ISO (NYISO) market (Downing et al. 2023).

[14] Additionally, MISO allows some DR to inject power and has proposed to use this capability to partially comply with Order 2222 before 2029.

State regulations can also hinder DER aggregations' wholesale market success. In the DR-specific context, aggregators interviewed for this report cited the "opt-out" provision of Order 719 as a critical barrier to wholesale market participation. Under the opt-out, a state can limit third-party aggregation participation in wholesale markets or completely ban it. Many states with vertically integrated utilities, especially those in MISO and SPP footprints, initially opted out, while those with retail choice did not (Forrester et al. 2023). Only in recent years have states begun to reverse these opt-outs, though most in a stepwise fashion. For example, Wisconsin's courts overturned the state's opt-out, leading the Commission to subsequently open a proceeding to determine next steps, while Michigan and Missouri now allow aggregation of large commercial and industrial DR for market participation. While this has been a significant barrier to third-party aggregation of DR, Order 2222-B notably does not allow an opt-out apart from resources that remain under the Order 719 ruling (i.e., DR).[15]

Complementary efforts at the state level could assist in the implementation and effectiveness of Order 2222 to allow aggregated DERs to further participate in wholesale markets. These are discussed in Sections 4 and 5. If successfully implemented in a coordinated fashion, DERs would be able to provide grid services both at the retail and bulk system level, improving grid efficiency and cost while also improving the economics of DERs.

[15] Federal Energy Regulatory Commission (FERC), Order Addressing Arguments Raised on Rehearing, Setting Aside Prior Order in Part, and Clarifying in Part Prior Order, Docket No. RM18-9-003; Order No. 2222-B, 175 FERC ¶ 61,227.

4. FERC Order 2222 Compliance and Implementation Issues

The RTO/ISOs have made progress on obtaining Order 2222 compliance. However, only CAISO has implemented its Order 2222 model, and ISO-NE is the only other RTO/ISO fully in compliance. DER aggregation participation in wholesale markets — once ISO/RTOs are in compliance with 2222 requirements — may depend on implementation barriers at the utility or regional level, which fall within state regulator's jurisdiction.

In this chapter, for each of the four Compliance and Implementation Issues identified (see Section 2, "Methodology"), we discuss the relevant compliance requirements, the different RTO/ISO implementation approaches to each requirement, and how state regulator decision-making may influence the implementation. The issues themselves are interrelated, and each wholesale market has a unique landscape that may influence how they address each compliance issue. While states have a voluntary role and are not under FERC jurisdiction, their role in local coordination; policy and regulation; and data collection, evaluation, and sharing (discussed further in Section 5, "Broader opportunities for state regulators") are cross-cutting and will influence how effective DERs may participate in aggregations at the wholesale level. The four Compliance and Implementation Issues are summarized below:

Double Counting: Order 2222 allows RTO/ISOs to limit the participation of resources in wholesale markets if a DER aggregation is receiving compensation for the same services as part of another program. Addressing this issue will determine how aggregations can register DERs, bid into markets, and be compensated for both distribution and wholesale services. Retail regulators do not have jurisdiction over wholesale market participation, but they do determine DER eligibility in retail programs conditional on wholesale market participation, as well as retain the ability to inform RTO/ISOs of potential double counting concerns. [16]

Role of the Distribution Company: In the context of Order 2222, the "role of the distribution company" focuses on the distribution utility review process that takes place during the registration for an aggregator of an aggregation. When a DER aggregation is registered to participate in the wholesale market, or when changes to existing DER aggregations are made, Order 2222 requires RTO/ISOs to develop a process for timely review by the applicable distribution utility. Additionally, RTO/ISOs must develop a review process for aggregations that determines (1) whether each proposed DER can participate in an aggregation and (2) whether the participation will pose significant risks to the distribution system. Retail regulators can provide guidance and transparency on what may preclude an individual DER's participation in wholesale market participation. Since dispute resolution pertaining to distribution utility decisions during the review process likely falls within retail regulator jurisdiction,[17] additional transparency could minimize those instances. To successfully co-develop a series of review criteria, regulators may need to engage with utilities and aggregators.

[16] For example, NYISO 179 FERC ¶ 61,198 at paragraph 137
[17] For example, NYISO 179 FERC ¶ 61,198 at paragraph 243

Ongoing Coordination: Order 2222 requires each RTO/ISO to: (1) establish a process for ongoing coordination related to data flows and communication among itself, the DER aggregator, and the distribution utility; (2) include protocols that allow distribution utilities to override RTO/ISO dispatch of an aggregation if necessary to maintain the reliable and safe operation of the distribution system; and (3) apply a performance penalty to a DER aggregator in the case of under- or non-performance due to a distribution utility override of the RTO/ISO dispatch. A retail regulator's primary role is to approve override processes of RTO/ISO market instructions to DER aggregations due to distribution system operational risk. Secondarily, they have a complementary role to review and approve distribution utility communications and tools for coordination with DER aggregators and RTO/ISOs. Finally, retail regulators would have jurisdiction over disputes between an aggregator and utility, so they would have the responsibility to adjudicate override disputes.

Metering and Telemetry: In the context of Order 2222, "metering" refers to the rules that determine how DER aggregations have their energy injection and withdrawal measured, and "telemetry" refers to how aggregations report real-time data (e.g., voltage and frequency) needed to provide fast-response services such as frequency regulation. Order 2222 did not set rigid requirements for metering and telemetry, and FERC has maintained a hands-off approach when approving each RTO/ISO's requirements, provided that the RTO/ISOs can justify their rationale for them.[18] RTO/ISOs require information from market participants, including aggregators, to ensure the reliable operation within the wholesale market, and they may be inclined to specify metering and telemetry that is consistent with incumbent requirements (i.e., that required of large generators). This may indirectly impose metering and telemetry requirements onto individual DERs. FERC has stated an explicit preference to rely on meter data obtained through compliance with distribution utility or retail regulator requirements whenever possible. Individual DER interconnection agreements and metering and telemetry on the distribution system are in the purview of retail regulators, which provide an opportunity for state influence in cases where RTO/ISOs allow flexibility. This may allow for DERs to participate in aggregations without the need to purchase expensive new equipment or develop new data protocols while still providing sufficient information to verify performance and ensure proper compensation.

4.1 Double counting

Order 2222 aims to improve market competition by enabling DERs to provide wholesale market services within aggregations, while still maintaining grid reliability. Since individual DERs are interconnected at the retail level and may be technically able to provide various services to both the retail and bulk system grid, allowing a DER to provide multiple services — even if across multiple programs — would maximize their value to the energy system. This includes allowing DER aggregations to participate dually across retail and wholesale programs (i.e., "dual participation"). Dual participation requires enhanced coordination across stakeholders such as wholesale market operators, distribution system operators and utilities, regulators, aggregators, and individual DERs. This includes establishing or enhancing communication protocols as needed, additional data collection and sharing, and rules in

[18] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 242

place to ensure both that (1) a resource responding to one market signal does not create reliability issues elsewhere on the grid, and (2) a resource is not compensated twice for the same overlapping service, also known as "double counting."

The issue of double counting is very complex. It requires coordination from RTO/ISOs, distribution utilities, regulators, and DER aggregators and depends highly on the intersection of wholesale market rules (set by RTO/ISOs and approved by FERC) with retail market rules (set by retail regulators). As such, the potential role of the state regulator is highly relevant.

RTO/ISO actions to mitigate double counting primarily take place during the registration process of DER aggregations and during operations (e.g., scheduling bids or during settlement). To avoid double counting at the point of registration, Order 2222 instructs RTO/ISOs to ensure that the aggregator attests that each individual DER in their aggregation complies with local rules and regulations, including those from the retail regulator. These include compliance with any retail programs that the individual DER may be enrolled in that would preclude participation in an aggregation or wholesale market service (registration and distribution company review are discussed more in Section 4.2, "Role of the distribution company"). To avoid instances of double counting during operation, Order 2222 instructs RTO/ISOs to ensure that an aggregator restricts an individual DER's services from being offered into the wholesale market via an aggregation if that same DER is providing conflicting retail services in parallel (this includes cases where participation in the retail program reduces a distribution utility's obligations to purchase those same services from the wholesale market).[19] This also would be subject to retail regulator rules and restrictions surrounding double counting. Failure to do so may impact settlement and compensation, which could subsequently lead to underperformance of the aggregation as a whole and exposure to fines.

Though individual state and RTO/ISO rules may vary, generally, a DER providing different services (e.g., energy and capacity) would not violate double counting. For example, for a wholesale market participant to bid into in a must-offer capacity market, they are obligated to provide energy services simultaneously if called upon. As such, bidding into a must-offer capacity market is functionally offering two different services at the same time but does not constitute double counting. Similarly, many ancillary services are co-optimized with energy services. Thus, many existing resources participating in wholesale markets already provide different service simultaneously without violating double counting. Similarly, a DER could hypothetically participate in an aggregation offering wholesale energy and ancillary services while still enrolled in a retail capacity product (e.g., providing interruptible load DR), subject to respective state and RTO/ISO rules.

A DER providing the same overlapping service dually would be in violation of double counting rules, though this again depends on how "same service" is defined by the retail regulator and RTO/ISO. For example, a DER providing capacity at the bulk system level at one point in time and at the retail level at a separate point in time may be allowed. Rules could also hypothetically allow for parallel participation

[19] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 161

as long as priorities and restrictions were set (e.g., if a DER is called to participate at both grid levels at the same time, rules may specify that one command takes higher priority and will supersede the other, perhaps with an additional override stopgap for the other operator in the case of potential reliability issues arising). This issue is particularly relevant for DERs that are compensated through NEM.

A net-metered DER is compensated by its distribution utility for providing energy services for each unit of energy exported to the grid. This would conflict with several wholesale market services (e.g., capacity and ancillary services) because energy services are often inextricably linked to these services at the wholesale level in the case of must-offer capacity markets or co-optimized energy and ancillary service markets. Retail regulators may specify whether NEM resources are precluded from participating in aggregations bidding into the wholesale market, and many have. Currently, there is an exception in Massachusetts where the state regulator allowed an aggregation of net-metered distributed solar-plus-storage to bid into the ISO-NE Forward Capacity Market, which has a must-offer requirement. The state considered solar-plus-storage as passive energy services at the retail level but dispatchable at the wholesale level — differentiating the services sufficiently such that it would not constitute double counting.

While state regulators do not have jurisdiction over wholesale market participation, they do determine DER eligibility in retail programs, conditional on wholesale market participation, and also inform RTO/ISOs of potential double counting concerns. [20,21] Based on current compliance filings, regulators have a strong role on this issue because RTO/ISOs have proposed more flexible definitions of retail program double counting, deferring to the distribution utility and regulator for more specific guidance.

States have a role in defining and evaluating instances of double counting (Figure 2). If retail regulators choose not to develop specific rules and guidelines, double counting would be subject to RTO/ISO rules, which often defer to utilities. This would allow utilities more discretion on what may disqualify an individual DER from providing wholesale market services at the time of registration for an aggregation. Some commenters worry that this may lead to an overly conservative definition of double counting that may not functionally enable dual participation and could discourage third-party aggregators from operating in certain regions.

[20] For example, NYISO 179 FERC ¶ 61,198 at paragraph 137
[21] For example, CAISO 179 FERC ¶ 61,197 at paragraphs 94 and 109; NYISO 179 FERC ¶ 61,198 at paragraph 298

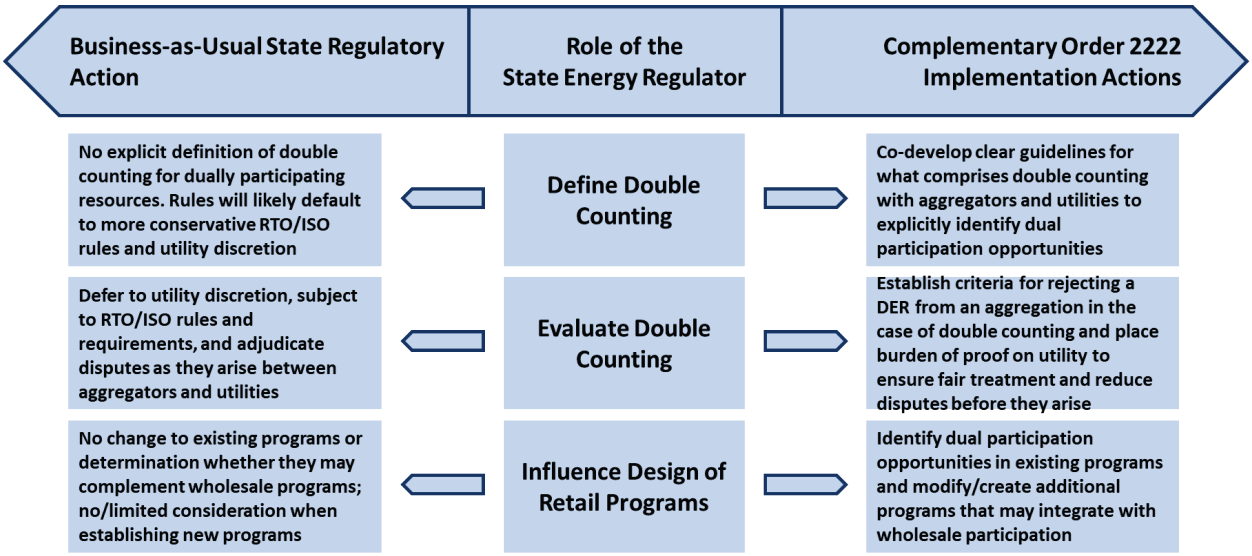


Figure 2. Opportunities for state regulators: Double counting of services

If states do choose to engage on the issue of double counting, there are a variety of approaches to select from (see Figure 2). First, state regulators can develop clear guidelines and definitions for double counting. This would provide aggregators with a clear understanding of how to encourage dual participation while avoiding double counting.

Second, state regulators can pair double counting definitions with a protocol to evaluate instances of double counting. RTO/ISOs may have their own protocol that utilities must use in the case of an operational override of individual DERs participating in an aggregation or if double counting is detected. However, state regulators could engage with RTO/ISOs, utilities, and aggregators to establish protocols as to what data is needed, from whom, and how it is shared, such that the burden of proof is allocated across utilities and aggregators to prove (or disprove) cases where an individual DER may have violated double counting rules. Advanced coordination across stakeholders could increase clarity and reduce instances of double counting and disputes. Additionally, disputes that arise between the aggregator and utility over an individual DER's eligibility likely fall under state jurisdiction. Establishing clear and comprehensive rules could minimize disputes and encourage more aggregation participation, which could support state priorities of affordable and efficient grid operation.

Finally, related to "defining double counting," states can consider these rules when surveying existing and new programs for complementarity with wholesale programs. The case likely relevant to most states is that of NEM resources, as in the Massachusetts case, where regulators can explicitly address NEM cases and what limitations those resources have in participating in wholesale markets along with exemptions, if allowed. Beyond NEM, regulators may also specify whether specific retail programs allow or disallow participation in various wholesale programs, subject to relevant RTO/ISO rules. Since there may be a limited number of retail programs under a state regulator's jurisdiction, and since a state geographically will fall within the footprint of a limited number of wholesale markets, regulators may be able to provide guidance for many, if not most, instances of dual participation opportunities. This would

likely require engaging with stakeholders such as utilities and aggregators (and potentially RTO/ISOs) to weigh trade-offs and ensure that competition is encouraged while still maintaining local grid reliability. Finally, regulators may be able to provide guidance on programs to identify services that may be temporally specific and thus allow a DER to provide the same type of service in the wholesale market at a separate time without risk of overlap. For example, a DER might receive retail compensation for a specific season (e.g., summer peak), but there might be other seasons where the potential for double counting does not exist and wholesale market opportunities are possible.[22] While the first step may be to provide clarity surrounding dual participation without risk of double counting for existing retail programs, regulators can further support dual participation and value-stacking by encouraging or requiring utilities to change or develop new retail programs that could more intentionally complement the provision of wholesale services. For example, New York has designed retail program tariffs with clear definitions of the conditions under which dispatch can occur, taking into account potential requirements of wholesale programs and explicitly enabling dual participation with NYISO programs.[23]

With regard to double counting, RTO/ISO compliance filings showed a high level of engagement surrounding (a) which (wholesale) services DER aggregations should be eligible to provide and (b) overruling default restrictions.

a. Services provided from DER aggregations

One challenge that RTO/ISOs have faced when imposing narrowly defined double counting restrictions is determining acceptable cases of dual participation (i.e., which services DERs are eligible to provide to the wholesale market while participating in retail programs). Broadly, a DER can provide the same service in the retail and wholesale market at different times, or a DER can provide different services across the retail and wholesale market. Based on review of FERC response to RTO/ISO compliance filings, FERC generally agreed with RTO/ISOs that DERs providing the same service at different times risked double counting. As such, approved proposals focused on providing different services into different markets (e.g., energy into a retail program and ancillary services into the wholesale market).[24]

The spectrum of RTO/ISO approaches ranges from preventing all wholesale participation for DERs participating in a retail program to allowing parallel participation conditional on no compensation for duplicated services (Figure 3). The advantages and disadvantages of these approaches are summarized in Table 1, but the spectrum essentially progresses from less-to-more flexible options. On one side, restrictions encourage fewer DERs participating in aggregations and wholesale market services (and little, if any, dual participation) but have very little risk of double counting. On the other side, options are flexible and encourage dual participation but require far more coordination and additional action to ensure no double counting. State regulators' role would be greater in cases that are more flexible and require more coordination between retail and wholesale levels.

[22] For example, SPP 186 FERC ¶ 61,162 at paragraph 173
[23] Ibid.
[24] Ibid.

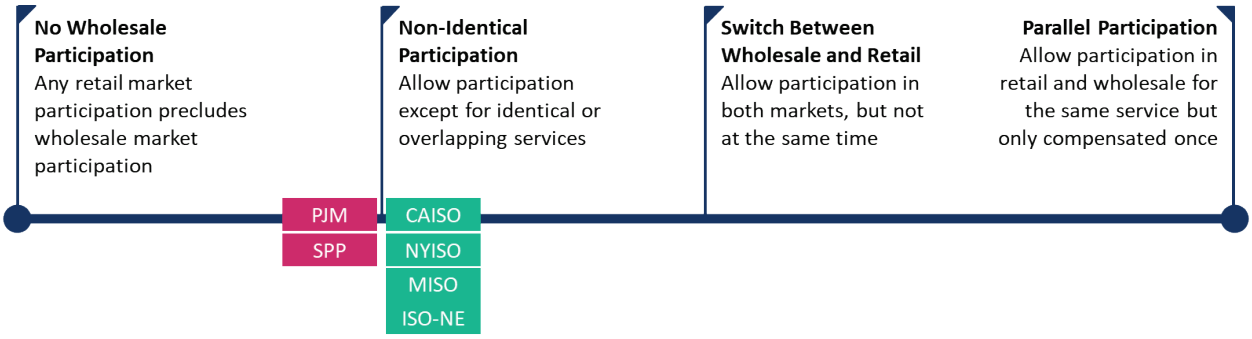


Figure 3. RTO/ISO approaches to compliance: Defining double counting of services. *Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance.*

On one end of the spectrum, RTO/ISOs can **prevent all wholesale market participation** for DERs participating in a retail program. CAISO initially proposed no wholesale participation for DER aggregations participating in retail programs unless explicitly approved by the distribution utility, but clean energy advocacy groups opposed the proposal as too broadly restrictive, and it was rejected by FERC.[25] In this more restrictive case, a state regulator's role would be limited.

On the other end of the spectrum, RTO/ISOs can allow **parallel participation** for the same services in retail and wholesale markets but only compensate the asset for services in one market to prevent double compensation. For example, a DER could participate in a retail NEM program as well as in an aggregation participating in a wholesale capacity market with a must-offer requirement that requires the resource to simultaneously provide wholesale energy services. If the DER was called upon by the wholesale market such that it provided parallel wholesale capacity and energy services, it would be compensated for the capacity services but not the energy services that it provides through wholesale market participation. This would enable DERs to participate in both the capacity market and retail programs without double compensation. This was proposed in PJM by DER advocacy groups.[26] In this case, state regulators could coordinate with RTO/ISOs, aggregators, and utilities in order to clearly define cases where parallel participation would be feasible, and dual participation could be encouraged while minimizing risk of double counting.

There are two additional alternatives that sit in between these bookend approaches. First, RTO/ISOs can **allow participation except for identical services or services where there is overlap**. RTO/ISOs could prohibit any DER aggregation participation in wholesale markets that could *potentially* obligate the DER to provide the same service it provides in a retail program. Specifically, for a DER participating in a retail program where energy is compensated, RTO/ISOs could allow the DER to participate in ancillary service markets but not in energy or capacity markets due to must-offer requirements. PJM specifically prevents capacity market participation for DERs participating in a retail program and SPP prevents

[25] CAISO 179 FERC ¶ 61,197 at paragraphs 108–111
[26] PJM 182 FERC ¶ 61,143 at paragraph 114

participation in operating reserve markets for DERs participating in retail programs.[27] Without state-level cooperation, it may be difficult to identify double counting violations in instances of overlap, which may lead to functionally only allowing participation across different services. State regulator rules surrounding the definition and evaluation of double counting could set more transparent rules that would allow the provision of similar services across markets while avoiding overlap. This would encourage more instances of dual participation and increase DER grid value.

Second, RTO/ISOs can **give DERs the flexibility to switch between retail and wholesale participation at different times**. For example, interruptible rate customers, who agree to reduce or pause their electricity usage during periods of high demand in exchange for lower electricity rates, are rarely curtailed and therefore could primarily participate in wholesale markets except when called upon to participate in the retail program.[28] Further, these retail programs usually have long dispatch notification lead times such that a DER aggregation could withdraw its wholesale energy market bid in time to avoid conflicting dispatch instructions when also participating in an interruptible rate load curtailment event. This approach was proposed by an aggregator stakeholder in SPP.[29] In this case, utilities would have to engage in order to attest to participation of specific resources at specific times. This would be an opportunity for state regulators to develop processes to evaluate double counting.

Despite a wide range of options presented, all RTO/ISOs have adopted or proposed very similar approaches in which DERs are able to provide different services separately to retail and wholesale markets. FERC found the approach where wholesale market participation was, by default, not allowed unless explicitly approved by distribution utilities to be too limiting and gave distribution utilities too much jurisdictional overstep. On the other hand, more flexible proposals by stakeholders discussed DERs participating in retail programs and wholesale markets for the same product but at different times or even at the same time but only being compensated once. FERC did not find these necessary for RTO/ISOs to become compliant.[30] To complement the RTO/ISO proposed actions, state regulators could incentivize retail program design that considers these wholesale market rules and provide clear guidelines on what would result in double counting.

[27] PJM Compliance Filing 1, pp. 41–42; SPP Compliance Filing 1, p. 10; SPP 186 FERC ¶ 61,162 at paragraph 144. Note: While PJM and SPP are not in compliance with this subtopic, it is due to implementation details. FERC generally approves of their high-level approach to defining double counting of services.
[28] For example, SPP 186 FERC ¶ 61,162 at paragraph 152
[29] Ibid.
[30] Id. at paragraph 174

Table 1. Advantages and disadvantages of RTO/ISO approaches: Defining double counting of services

Approach	Advantages	Disadvantages
No wholesale participation *Any retail market participation precludes wholesale market participation*	Prevents double counting because payments made under retail programs are derived exclusively from retail rates that already compensate DERs for energy, capacity, and ancillary service costs, and any additional payments are double counting. There is no risk that a DER will need to provide the same service to both a retail program and in the wholesale market at the same time due to overlapping service requirements (e.g., must-offer requirements for capacity market participation that could result in a DER needing to provide energy to both a retail program and in the wholesale market at the same time).	Very restrictive approach that prevents DERs from providing additional service they are not already being compensated for in retail markets. FERC deemed this approach to be out of compliance. Not "narrowly designed" as required by Order 2222.[31]
Non-identical participation *Allow participation except for identical or overlapping services*	Enables DERs to provide additional services while keeping the risk of double counting low. Specifically, some utility commenters argued that that there is no "capacity-only product" and that many NEM retail tariffs include a "fully loaded" rate that includes capacity in the services that are recredited to the customer, so additional participation beyond this threshold would increase double counting concerns.[32] Does not require the complex communication between RTO/ISOs and distribution utilities that parallel participation in the same services would require.	Some stakeholders, including tech companies and trade associations, still feel that this is too restrictive and will result in barriers to DER participation in retail programs.[33]
Switch between wholesale and retail *Allow participation in both markets, but not at the same time*	DERs are given wide flexibility to move between retail and wholesale markets. Long lead times and infrequent dispatch in retail programs allow for operational flexibility.	There would need to be a high degree of coordination between the RTO/ISO operating the wholesale market and distribution utilities managing retail programs for each DER, creating a large administrative burden. Utilities feel that this switching between two markets is itself double counting because a DER would be compensated for the service of standing by in two

[31] For example, CAISO 179 FERC ¶ 61,197 at paragraphs 81–83
[32] For example, PJM 182 FERC ¶ 61,143 at paragraph 124
[33] Id. at paragraph 113

		markets.[34]
Parallel participation *Allow participation in retail and wholesale markets for the same service, but only compensated once*	DERs are given wide flexibility to move between retail and wholesale markets. There must be a protocol in place that makes clear which dispatch signal has priority in cases where the same service is called upon across both markets. The DER will then follow one signal and be compensated in one program. This may lead to non-performance or under-performance in the other program, which could lead to exposure to any relevant performance penalties.	A resource participating in both retail and wholesale markets for the same service would be unable to follow simultaneous dispatch instructions, services could overlap, and double counting concerns arise.[35] There would need to be a high degree of coordination between the RTO/ISO operating the wholesale market and distribution utilities managing retail programs for each DER, creating a large administrative burden.

b. Overruling default restrictions

An additional design choice that RTO/ISOs face is whether to allow a distribution utility to override RTO/ISO default double counting restrictions in cases where a retail program will not result in double counting, as defined in any local rules or regulations. This would allow deference to any retail regulator rules that may be less restrictive than wholesale market rules and allow for greater influence from state regulators on dual participation. The spectrum of solutions ranges from never allowing exceptions to RTO/ISO double counting restrictions to allowing greater flexibility and accounting for the wide range of retail programs (Figure 4). On one end of the spectrum, retail regulators may have a very limited role, however, on the other end, there is an opportunity for states to identify cases in which dual participation may be encouraged beyond default RTO/ISO restrictions. Some commenters warn that, if not narrowly and clearly defined, allowable exceptions could also be used to discourage dual participation if utilities identify cases in which they claim that local restrictions may be more conservative than RTO/ISO rules. With a higher degree of regulator engagement, these exceptions could encourage dual participation, as opposed to discouraging it. The advantages and disadvantages of these solutions are summarized in Table 2.

Figure 4. RTO/ISO approaches to compliance: Overruling default double counting restrictions. *Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance.*

[34] For example, SPP 186 FERC ¶ 61,162 at paragraphs 158–159
[35] For example, SPP 186 FERC ¶ 61,162 at paragraphs 158–159

On one end of the spectrum, RTO/ISOs may **never allow exceptions** to double counting rules. This is the simplest approach to implement because default double counting regulations are always enforced. All RTO/ISOs except PJM proposed this type of approach.

Alternatively, RTO/ISOs can **allow exceptions** to double counting regulations**.** RTO/ISOs can create a "release valve" in wholesale markets that allow DER aggregations to participate and provide certain services, notably capacity if the distribution utility determines there is no risk of double counting. PJM has implemented this type of release valve mechanism.[36] PJM's release valve mechanism was primarily driven by its must-offer requirement in the capacity market. PJM determined the must-offer requirement would preclude DERs providing energy services in a retail program from also participating in the wholesale capacity market.[37] While some stakeholders felt that this was an "opt-in" similar to CAISO's initial proposal, in which DERs participating in retail programs were by default excluded from wholesale market participation, PJM's proposal was more narrowly defined and essentially provided an additional pathway for DER participation where DER would otherwise have been rejected outright.[38] The PJM release valve provides an additional path into the wholesale market for DER aggregations, provided that distribution utilities and retail regulators are willing to identify these opportunities.

Table 2. Advantages and disadvantages of RTO/ISO approaches: Overruling default double counting restrictions

Approach	Advantages	Disadvantages
Never allow exceptions *Always uphold RTO/ISO double counting requirements regardless of retail regulation*	Developing a single static criterion for double counting is very simple. There is no risk for distribution utilities to be provided with "opt-in" power that could prevent DER wholesale market participation.	Blanket restrictions applied to all DER aggregations in any retail program may lead to scenarios in which aggregations are not able to provide services they otherwise could have provided.
Allow for exceptions *Provide "release valve" if utility deems no double counting risk as per local rules and restrictions*	Narrowly defined, a "release valve" would enable participation where otherwise disallowed. This is particularly true given the wide variety of retail programs; there may be certain retail programs where there is no risk of double counting.	Industry advocacy groups note that this could create a scenario where distribution utilities can prevent wholesale market participation for certain DERs.[39]

[36] PJM Compliance Filing 1, pp. 41–42
[37] PJM 182 FERC ¶ 61,143 at paragraph 137
[38] CAISO 179 FERC ¶ 61,197 at paragraph 80
[39] For example, PJM 182 FERC ¶ 61,143 at paragraph 117

4.2 Role of the distribution company

In the context of Order 2222, the "role of the distribution company" focuses on the distribution utility review process that takes place during the registration for an aggregator of an aggregation. FERC has directed RTO/ISOs to develop a timely review process (no longer than 60 calendar days[40]) that allows a distribution company to determine whether a DER as part of an aggregation is able to participate in wholesale market services. [41] Grounds for disapproval include whether the DER is participating in another aggregation, whether the DER is participating in a program that may conflict with double counting restrictions (e.g., some DR programs, net metering, or another retail program), whether the DER does not comply with existing distribution utility or retail regulator requirements, or whether the DER would result in unsafe distribution system operation.[42] The review must be limited to only the incremental impacts of a DER's participation in an aggregation on the distribution grid's safe and reliable operation and is triggered once the aggregator has provided all other information required for the RTO/ISO registration. In cases where aggregators make modifications to an aggregation, FERC states that uncontested DERs can continue within the aggregation while a limited review takes place.

In terms of review criteria, FERC allowed for flexibility within this category, as did the RTO/ISOs in their subsequent compliance filings. While protesters did not always agree, FERC allowed RTO/ISOs to defer to respective retail regulators and distribution companies to best identify the specifics around what constitutes risks to safe and reliable operation, as well as the definition of double counting (see Section 4.1, "Double counting"). If the review results in anything but acceptance, the results of the study must be justified, and information must be shared with the aggregator and RTO/ISO. Stakeholder comments primarily reflected concerns that vague and flexible evaluation criteria may lead to anti-competitive behavior from utilities and lead to rejection of DER participation at a higher rate. On the other hand, FERC agreed with utility commenters that spoke of the need for flexibility. As there are many distribution companies within any RTO/ISO, each may have their own grid needs and concerns as well as their own set of analysis capabilities and criteria.

RTO/ISOs emphasized the jurisdiction of retail regulators in this space. This opens a clear role for state regulators (Figure 5). Previously discussed in Section 4.1, "Double counting," retail regulators have an opportunity to provide guidance and transparency on what may preclude an individual DER's participation in wholesale market participation. Doing so will likely require extra work and engagement with utilities and aggregators to co-develop a series of review criteria. This will likely weigh trade-offs between specifying precise requirements, which would increase transparency but may be overly prescriptive and too inflexible to account for reliability concerns or heterogeneity across utility territories, and general requirements, which may focus on certain categories or metrics that would allow utilities more flexibility but may not provide aggregators with as much transparency on whether a DER may or may not be eligible ahead of review. Successfully navigating these trade-offs would reduce

[40] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 295
[41] Id. at paragraph 242
[42] For example, CAISO Compliance Filing 1 pp. 23–24

aggregators' perceived or real market risk, which could encourage aggregation participation.

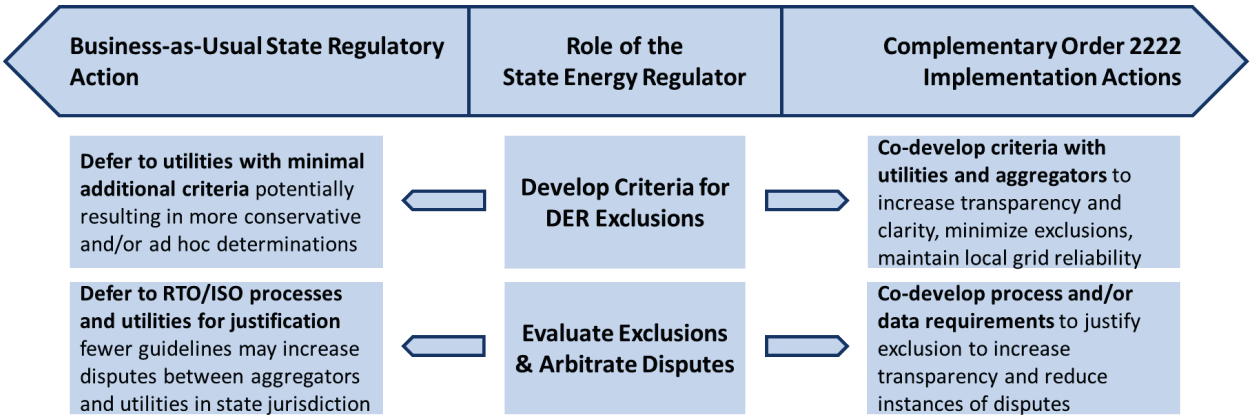


Figure 5. Opportunities for state regulators: Role of the distribution company

Secondarily, aggregations fall under RTO/ISO jurisdiction. RTO/ISOs have jurisdiction over dispute resolution pertaining to information sharing, timing of distribution utility review, the transparency of the review process, or incorporation of electric distribution company review results.[43] However, dispute resolution pertaining to distribution utility decisions during the review process, including the rejection of a DER into a DER aggregation, likely falls within retail regulator jurisdiction.[44] Establishing clear criteria for distribution company review may reduce the number of disputes and allow aggregators to better understand which DERs may be eligible before registering an aggregation, which would help reduce the timeline to actual operation of an aggregation and the provision of grid services.

a. Registration

FERC stated that the distribution utility review takes place as part of the registration process for an aggregation. The review period should not exceed 60 calendar days.[45] All RTO/ISOs have adopted the maximum 60 days of review apart from CAISO, which implemented a 30-day review period.[46] As previously stated, RTO/ISOs must each determine proper utility review criteria[47] to approve or reject DER participation in aggregations (Figure 6). The advantages and disadvantages of these solutions are summarized in Table 3.

[43] Order No. 2222-A 174 FERC ¶ 61,197 at paragraph 75; ISO-NE 182 FERC ¶ 61,137 at paragraph 220
[44] For example, NYISO 179 FERC ¶ 61,198 at paragraph 243
[45] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 295
[46] CAISO Compliance Filing 1 p. 23
[47] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 296. While we informally use the term "state regulator" in this report, Order 2222 uses the term "relevant electric retail regulatory authority," and state regulators are a subset of all retail regulators.

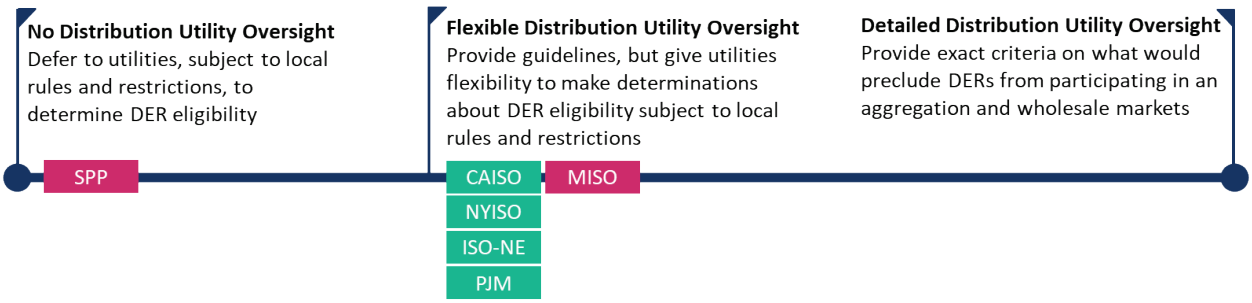


Figure 6. RTO/ISO approaches to compliance: DER aggregation registration. *Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance.*

On one end of the spectrum, RTO/ISOs can provide **no oversight** to distribution utilities; however, Order 2222 states that RTO/ISOs must provide criteria that distribution utilities will use to determine whether each DER can participate in an aggregation.[48] SPP's initial compliance filing had proposed something along these lines, strongly emphasizing that DER approval was under the jurisdiction of the retail regulator and the utility and providing no guidelines, but FERC deemed it to be too open-ended and rejected the proposal.[49] On the other end of the spectrum, RTO/ISOs can provide distribution utilities with a **detailed list of criteria** that would result in a DER being rejected for wholesale participation. No RTO/ISO has adopted this approach because this would impinge on retail regulator jurisdiction.

All compliant RTO/ISO proposals offered more **limited oversight** to distribution utilities. The oversight establishes high-level criteria that should be considered when assessing whether an individual DER can participate in an aggregation but ultimately defers to distribution utilities and retail regulators to determine specific criteria, recognizing their expertise and jurisdiction over the local system.[50] These high-level criteria will include evaluating issues such as double counting and will need to have a standard by which a distribution company would evaluate an individual DER. Additionally, RTO/ISOs must develop guardrails that limit the review of eligibility to only incremental system impacts that have not previously been considered.[51] MISO is proposing flexible distribution utility oversight, but FERC requires them to refine exact criteria and establish a more transparent scope for their distribution utility review to include only incremental impacts that have not previously been considered.[52]

Some stakeholders desire more specific guidance. For example, public interest organizations in New York did not think the ISO's proposal was detailed enough when defining roles and responsibilities during disputes and establishing criteria for DER exclusion, citing concerns about non-transparent review processes. NYISO's proposal has been accepted. Since no RTO/ISO proposal agreed to provide specific review criteria, state regulators have an opportunity to determine appropriate checks and

[48] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 297
[49] SPP 186 FERC ¶ 61,162 at paragraphs 341–342
[50] CAISO 179 FERC ¶ 61,197 at paragraphs 191–193; NYISO 179 FERC ¶ 61,198 at paragraph 267; ISO-NE 182 FERC ¶ 61,137 at paragraphs 211–217; PJM 182 FERC ¶ 61,143 at paragraph 313
[51] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 297
[52] MISO 185 FERC ¶ 61,011 at paragraph 296

arbitrate any disputes that arise during this process.[53] Actively engaging in this process to ensure thorough and unbiased distribution utility review will help to enable DERs to participate in wholesale markets.

Table 3. Advantages and disadvantages of RTO/ISO approaches: DER aggregation registration

Approach	Advantages	Disadvantages
No distribution utility oversight *Defer to utilities, subject to local rules and restrictions, to determine DER eligibility*	RTO/ISOs acknowledge that distribution utilities and retail regulators are best positioned to determine the exact criteria that would lead to a DER being approved or rejected for participation in an aggregation, since they are best positioned to understand the needs of their own system.[54]	FERC agreed with some commenters that this approach is too open-ended and does not allow for clear or transparent criteria for exclusion.
Flexible distribution utility oversight *Provide guidelines, but give utilities flexibility*	Compared to no oversight, environmental and DER advocates argue that providing guidelines increases review transparency and ensures that there is less room for anti-competitive discrimination.[55]	Without guidelines, public interest organizations argue that the review process will give distribution utilities review powers that are too broad and could result in arbitrary and anti-competitive denials for individual DERs.[56]
Detailed distribution utility oversight *Provide exact criteria on what would preclude a DER from participating in an aggregation and wholesale markets*	Creating strict guidelines that are both detailed and transparent would prevent utilities from rejecting DERs without clear reason. Ensures that distribution utilities are applying identical evaluation criteria to all DERs.	Stakeholders argue that this is an overstep of RTO/ISO jurisdiction because each distribution utility and retail regulator is best positioned to understand the needs of their own system and the concerns a DER might pose to that system. Environmental organizations were in favor of greater oversight to ensure that reviews were not discriminatory or redundant and did not result in an unnecessary delay during the review process.[57]

4.3 Ongoing coordination

Order 2222 requires each RTO/ISO to establish a process for ongoing coordination that addresses data flows and communication among the RTO/ISO, the aggregator, and the distribution company. In addition, the aggregator is required to report any changes to offered quantity and related distribution factors that result from distribution line faults or outages. Specifically, Order 2222 requires each RTO/ISO to include protocols that allow distribution utilities to override RTO/ISO dispatch of an

[53] For example, NYISO 179 FERC ¶ 61,198 at paragraphs 255–256
[54] Id. at paragraph 243
[55] Id. at paragraph 234
[56] Id. at paragraphs 255–256
[57] For example, ISO-NE 182 FERC ¶ 61,137 at paragraph 188

aggregation (or individual DER) if necessary in order to maintain the reliable and safe operation of the distribution system. Finally, each RTO/ISO must apply a performance penalty to an aggregator when the aggregation does not perform due to a distribution company override.

Ongoing coordination requires communication and coordination between the distribution company, aggregator, wholesale market operator, transmission owners, and other stakeholders on a day-ahead and/or real-time basis and include specifications of which data and information would be communicated. Aggregations require more communication and coordination than for other market participants due to potential issues that individual DERs may cause on the local system but also in cases where the distribution company and ISO/RTO may have conflicting operational directives.

Since there is a direct role for utilities, there is a consequent opportunity for state regulators. Retail regulators' primary role is to approve override processes of RTO/ISO market instructions to DER aggregations due to distribution system operational risk. Secondarily, they have a complementary role to review and approve distribution utility communications and tools for coordination with DER aggregators and RTO/ISOs. Finally, retail regulators would have jurisdiction over disputes between an aggregator and utility, so would have the responsibility to adjudicate override disputes (Figure 7).

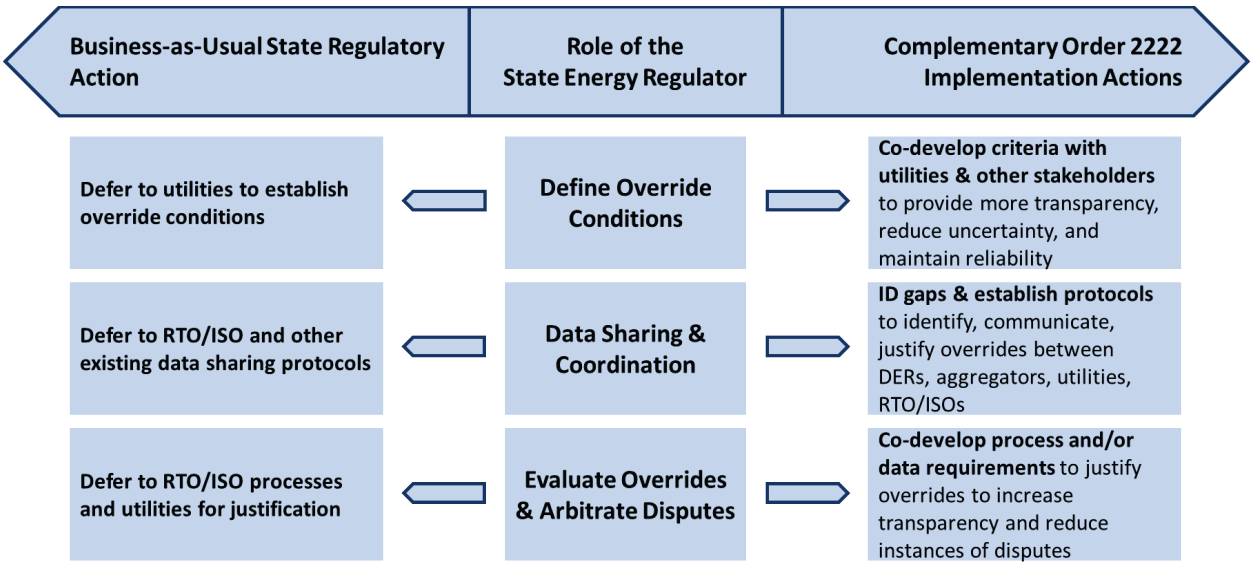


Figure 7. Opportunities for state regulators: Ongoing coordination

Regulators may choose to more precisely define override conditions in more detail than the RTO/ISO processes. This would include identifying categories of criteria that may justify an override and/or corresponding metrics closely with utilities, who know their respective systems better than any other, and other stakeholders that can ensure that the criteria are reasonable. Without regulator action, stakeholder comments (e.g., market monitors, consumer advocates, and those in the DER and/or aggregator space) illustrate concern that RTO/ISO proposals could give the utility too much authority if

appropriate override situations are not defined.[58] Some commenters feared that utilities may have conflicts of interest and, absent a transparent process to verify that the override is necessary to ensure grid safety and reliability, that there would be discriminatory and non-transparent overrides.[59] Since non-performance of an aggregation is penalized, this would have economic impacts and increase risk for the aggregator. FERC generally agrees that RTO/ISOs have the correct amount of deference to the distribution companies in determining overrides, but that these must only be in very limited cases with justification. This creates a clear role for state regulators to define what those "limited cases" may be and what evaluation and reporting may be necessary to provide "justification." Increasing transparency and placing burden of proof on the utility would limit illegitimate overrides and reduce the real or perceived risk that an aggregator that may be considering participating in one state market versus another. It may also provide aggregators with the information needed to assess the level of risk that an individual DER may be overridden and lead aggregators to target individual DERs that will provide greater net benefits to the grid without creating reliability issues.

In order to evaluate instances of double counting and coordinate in real time between the individual DER, aggregator, utility, and RTO/ISO, there must be established protocols to collect, evaluate, and share data among these various stakeholders. In many cases, utilities may be less willing to share data due to data privacy issues. Regulators could have a significant role in engaging with utilities to better understand the data that may be available, privacy and sharing concerns, and potential pathways forward to ensure that overrides are properly identified. Well-designed criteria would ensure grid reliability while being fair, justified, and as transparent as possible. See Section 5 for a broader discussion on state regulator roles in coordination and establishing data protocols.

Here, we discuss the RTO/ISOs' criteria through which a utility may override DER participation in wholesale market dispatch events.[60]

a. Override requirements

RTO/ISOs must define the criteria through which a utility may override RTO/ISO dispatch instructions for DERs. The spectrum of approaches ranges from establishing specific criteria that would result in a utility overriding RTO/ISO dispatch instructions to giving utilities and retail regulators broad control to override dispatch instructions (Figure 8). The advantages and disadvantages of these solutions are summarized in Table 4.

The spectrum generally moves from less specific RTO/ISO criteria and more deference to the utility to more specific criteria and less flexibility for the utility. Since overrides are so specific to wholesale market participation, regulators may not have existing rules and restrictions that may govern or influence the utility's determinations. As such, utilities may have even more discretion than in some of these other Compliance and Implementation Issues, absent regulator engagement.

[58] For example, PJM 182 FERC ¶ 61,143 at paragraph 346, 349, 355 and SPP 186 FERC ¶ 61,162 at paragraph 366
[59] For example, PJM 182 FERC ¶ 61,143 at paragraph 345
[60] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 312

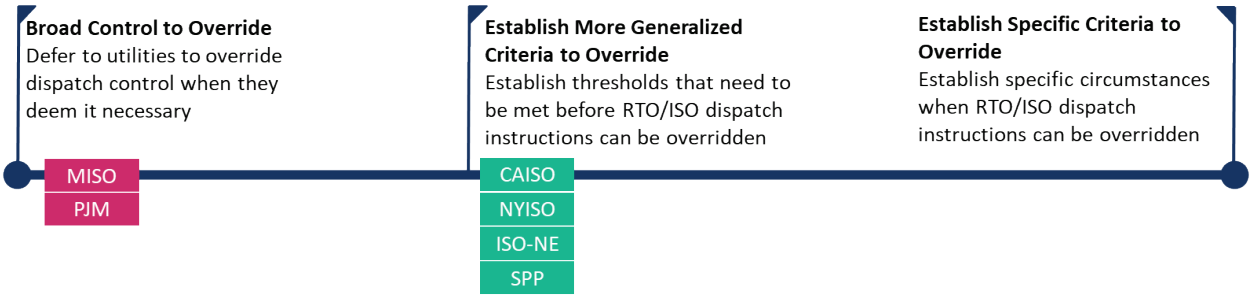


Figure 8. RTO/ISO approaches to compliance: Overriding dispatch instructions. *Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance.*

On one end of the spectrum, RTO/ISOs can provide distribution utilities **broad control** to override RTO/ISO dispatch instructions when they deem it necessary. This option provides the most control to retail regulators. Initial proposals from NYISO and PJM gave too much deference to distribution utilities, and FERC required them to add further details to ensure overrides are non-discriminatory and transparent.[61] On the other end of the spectrum, RTO/ISOs can **establish strict criteria** that define specific circumstances when RTO/ISO dispatch instructions can be overridden.

A moderated approach is to **establish more generalized criteria** that need to be met before a distribution utility overrides RTO/ISO DER aggregation dispatch instructions. All RTO/ISOs have proposed at least some protocols for utility override but do not prescribe exact requirements because distribution utilities are considered best positioned to understand the needs of the local system.[62]

Ultimately, each RTO/ISO opted to provide criteria that distribution utilities need to refer to when overriding RTO/ISO dispatch instructions to help ensure transparent and fair override events. These were broad categories that focused on issues within retail regulator jurisdiction, such as distribution system operations. RTO/ISOs declined to provide specific override criteria, which opens a role for state regulators to develop robust override criteria that are tailored to the local distribution system's specific needs without being overly burdensome for individual DERs trying to participate in wholesale markets.

The topic of overrides is important because it carries the potential to impact an aggregator's economics. RTO/ISOs must establish which non-performance penalties apply to aggregators in the case of distribution utility overrides. Despite FERC requiring that non-performance penalties apply across all RTO/ISO proposals,[63] several commenters protested that these penalties would create an undue burden on participation and that there should be a reduced risk of penalties for aggregations. RTO/ISOs and FERC disagreed and argued that this would constitute preferential treatment of aggregators above other market participants,[64] which are all subject to fines for non-performance, as in the parallel case

[61] NYISO 179 FERC ¶ 61,198 at paragraph 292; PJM 182 FERC ¶ 61,143 at paragraph 354
[62] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 310
[63] Id. at paragraph 312
[64] For example, NYISO 179 FERC ¶ 61,198 at paragraph 283 and SPP 186 FERC ¶ 61,162 at paragraph 367

where an incumbent generator's output is limited by a transmission operator to protect system reliability.[65]

FERC intended that the exposure to penalties due to non-performance could provide a price signal to aggregators to ensure that resources are properly scaled to the capability of the local distribution system, encourage the consideration of limiting bids during periods of high distribution system utilization, and encourage aggregation responsibility regarding distribution system upgrades to improve deliverability.[66] In sum, the intent is to encourage aggregators to enroll individual DERs that are less likely to create local reliability issues and that are more likely to be available and able to participate when called upon to provide wholesale services. RTO/ISOs also note that an aggregation is the only entity that could prevent issues by developing properly scaled resources, limiting bids when distribution utility systems are likely to be affected, and paying for distribution system upgrades.[67] Since non-performance penalties will be assessed in all RTO/ISOs, an important role for state regulators is to provide transparent oversight of criteria that are grounds for override, and to provide a forum for resolution of any disputes that may arise due to an override. States may also create measures such as standard over-enrollment buffer factors to minimize DER aggregation performance risk in the case of overrides (or individual DER event opt-outs).[68]

[65] SPP 186 FERC ¶ 61,162 at paragraph 357
[66] For example, NYISO 179 FERC ¶ 61,198 at paragraph 283
[67] Ibid.
[68] Ibid.

Table 4. Advantages and disadvantages of RTO/ISO approaches: Overriding dispatch instructions

Approach	Advantages	Disadvantages
Provide distribution utilities broad power to override *Defer to utilities to override when they deem necessary*	Gives utilities greater discretion to identify grid issues, since they are best positioned to understand the steps needed to safely operate the distribution system, and many aspects of the local distribution system are outside FERC and RTO/ISO jurisdiction.	Stakeholders such as the market monitor and consumer advocates in PJM argue that this approach grants too much authority to distribution utilities in the absence of rules created by retail regulators, which have a voluntary role and are not required to create rules.[69] Without criteria to identify appropriate situations for overrides, the utilities may be incentivized to be more conservative, which would increase aggregators' exposure to performance penalties.[70] Stakeholders such as the Illinois Commission in MISO noted that distribution utilities could prioritize their own aggregations over third-party aggregations.[71] While some utility stakeholders argued that this would not be the case, the perceived risk could limit aggregators' interest in specific states.
Establish more generalized criteria to override *Establish criteria that need to be met to override*	RTO/ISOs can establish narrowly defined, non-discriminatory override criteria so that overrides only occur when they are necessary to maintain the reliability and safety of the distribution system.[72] Provides aggregators with increased certainty and less financial risk.[73]	Gives distribution utilities less flexibility to tailor override criteria to their specific system needs.
Establish strict criteria for override *Establish specific circumstances when RTO/ISO dispatch instructions can be overridden*	Having clear criteria ensures that overrides would only occur for safety and reliability reasons, that override criteria are well understood by DER aggregators, and that overrides are non-discriminatory.[74]	Does not give distribution utilities any discretion to decide what overrides would ensure reliability for their system.

[69] For example, PJM 182 FERC ¶ 61,143 at paragraph 345
[70] Ibid.
[71] MISO 185 FERC ¶ 61,011 at paragraph 330
[72] For example, CAISO 179 FERC ¶ 61,197 at paragraph 219
[73] Id. at paragraph 223
[74] For example, SPP 186 FERC ¶ 61,162 at paragraph 352 and PJM 182 FERC ¶ 61,143 at paragraph 354

4.4 Metering and telemetry

In the context of Order 2222, "metering" refers to the rules that determine how DER aggregations have their energy injection and withdrawal measured and "telemetry" refers to how aggregations report real-time data (e.g., voltage and frequency) needed to provide fast-response services such as frequency regulation. Order 2222 did not set rigid requirements for metering and telemetry, and FERC has maintained a hands-off approach when approving each RTO/ISO's framework, provided that the RTO/ISOs can justify their rationale for the requirements.[75]

Each RTO/ISO must specify the metering and telemetry requirements at the point of an aggregation's interconnection to the bulk system; however, individual DERs are not subject to the requirements of an aggregation as a whole. Instead, they are subject to local interconnection rules for metering and telemetry. Even so, requirements at the aggregation level may indirectly necessitate a higher level of data collection and communication at the individual DER level in order for the aggregator to verify performance as well as for settlement and compensation. For example, an RTO/ISO that requires actual telemetry readings from all aggregations indirectly imposes telemetry requirements on all individual DERs since an aggregator cannot otherwise collect the telemetry data.[76] If an individual DER is unable to provide performance data at the interval required, it may functionally limit the suite of services that it is able to provide at the wholesale level. In particular, any service that may require bi-directional response and/or rapid, temporally specific response (e.g., frequency regulation).

RTO/ISOs require information from market participants, including aggregators, to ensure the reliable operation within the wholesale market, and they may be inclined to specify metering and telemetry that is consistent with incumbent requirements (i.e., that required of large generators). This may indirectly impose metering and telemetry requirements onto individual DERs. FERC has stated an explicit preference to rely on meter data obtained through compliance with distribution utility or retail regulator requirements whenever possible.[77] However, if pre-existing hardware does not meet requirements, additional metering infrastructure for individual DERs may be required. As such, some regions are discussing whether there are some services that may require less frequent data collection that may be possible with existing hardware and software at the individual DER's point of interconnection (e.g., services that may only require verification at one-minute intervals as opposed to sub-minute intervals). This may allow for DERs to participate in aggregations without the need to purchase expensive new equipment or develop new data protocols while still providing sufficient information to verify performance and ensure proper compensation. These cases will likely require state regulator engagement with aggregators and utilities to understand which data may be available or feasible to collect, and subsequently would likely require engagement with RTO/ISOs to better understand their requirements and what would be needed to prove sufficiency (Figure 9).

[75] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 242
[76] For example, CAISO 179 FERC ¶ 61,197 at paragraph 154
[77] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 269

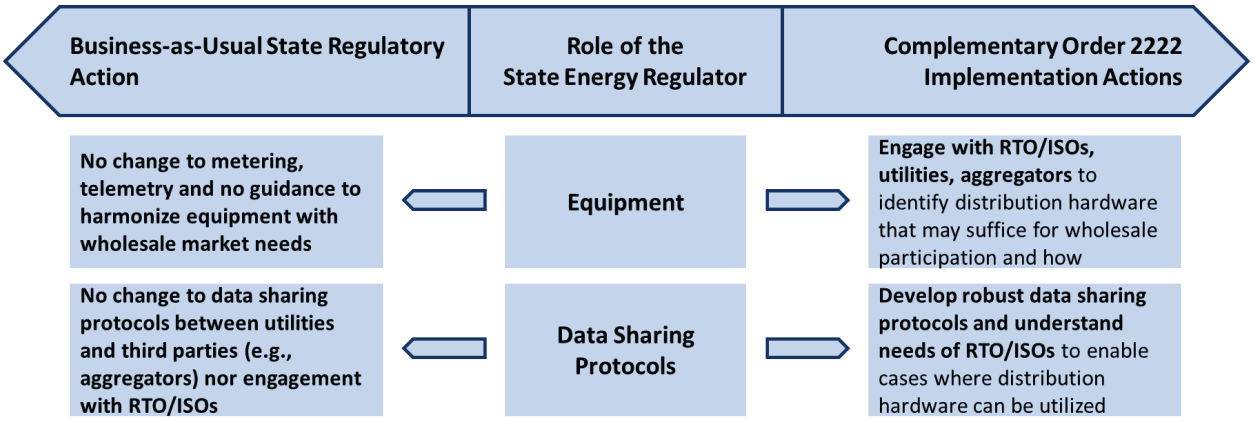


Figure 9. Opportunities for state regulators: Metering and telemetry

Retail regulators bear the responsibility of establishing protocols for data sharing and protection between retail customers, distribution utilities, and aggregators. This would impact the type of data collected, any rules and restrictions to protect customer and/or utility information, and other factors such as frequency of collection and reporting. State regulators' priorities align with effective and reasonable data protocols that allow for reliable local grid operation and proper retail program compensation while protecting privacy and cybersecurity.[78] While a state regulator cannot require additional hardware to be installed without justification at the local level, robust data sharing protocols can help ensure that, wherever possible, there is no duplication of metering hardware and that only the minimum amount of additional hardware is needed to meet wholesale market metering and telemetry data requirements (Figure 1).

More stringent metering and telemetry requirements could lead to more accurate coordination, operational control, and compensation. However, it may indirectly introduce an additional cost or practical participation barriers to individual DER participation. Metering and telemetry requirements and data sharing protocols already exist separately at respective RTO/ISO and local levels. To further increase the ability for DERs to provide wholesale services, engagement across stakeholders at the retail and bulk system level to harmonize these separate requirements could address the dual objective of minimizing the cost and need for additional equipment at the local level while ensuring that the wholesale market can dispatch, validate, and compensate performance at the aggregation level. Ultimately, this has led to a wide variety of approaches that consider trade-offs between enhanced visibility into asset performance and increased costs of reporting high-frequency interval data. This is reflected through RTO/ISO proposed requirements for (a) telemetry, (b) actual readings versus sampling, and (c) submetering. Since (b) and (c) have a smaller retail regulator role, those descriptions can be found in Appendix C.

[78] Note that this discussion pertains to data sharing protocols with respect to sharing metering and telemetry data, but other forms of data sharing, such as scheduling and dispatching, will also need to be developed between RTO/ISOs and distribution utilities.

a. Telemetry requirements

Telemetry requirements for DER aggregations are critical for ensuring grid reliability and maintaining real-time visibility for RTO/ISOs. The spectrum of approaches to telemetry requirements ranges from requiring telemetry for all aggregations across all services — consistent with incumbent requirements — to relaxing telemetry requirements where feasible based on aggregation size, services provided, or individual DER size (Figure 10). The advantages and disadvantages of these solutions are summarized in Table 5. The spectrum broadly progresses from favoring the same treatment for aggregations as for incumbent wholesale market participants to approaches that allow for flexibility depending on the size of the aggregation, the size of the individual DER, and/or the type of services that they are enrolled to provide at the wholesale level. Cases with increased flexibility allow state regulators to have a larger role in identifying opportunities where existing distribution equipment for a DER may suffice for participation in an aggregation. If such equipment is present, the state regulator can work to subsequently enable use of those data through changes to any necessary data collection and sharing protocols.

Figure 10. RTO/ISO approaches to compliance: Telemetry. *Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance.*

On one end of the spectrum, RTO/ISOs can **require telemetry consistent with other market participants for all aggregations** regardless of size or the services provided. RTO/ISOs argue that telemetry is essential for reliability and that if the costs of measurement and verification outweigh the benefits (as measured by market revenues), this reflects the cost-effectiveness of the resource rather than an undue market barrier.[79] This strict approach is proposed in SPP, ISO-NE, and MISO.[80]

On the other end of the spectrum, RTO/ISOs can **relax telemetry requirements based on aggregation size or services provided.** This more flexible approach is premised on the idea that smaller aggregations pose less risk to system reliability and can be monitored with less stringent requirements. Additionally, some services that require instantaneous response and/or alternating injection and absorption of power, such as frequency regulation, require precise and more frequent telemetry readings, but other

[79] For example, SPP 186 FERC ¶ 61,162 at paragraph 269 and CAISO Compliance Filing 2 pp. 6–7
[80] SPP 186 FERC ¶ 61,162 at paragraphs 291–292; ISO-NE 182 FERC ¶ 61,137 at paragraph 163; MISO 185 FERC ¶ 61,011 at paragraph 213

services such as energy and capacity could be provided with relaxed requirements. PJM allows one-minute scans, compared to sub-minute, for resources not providing regulation and exempts energy resources under 10 MW from telemetry entirely.[81] CAISO similarly exempts smaller DER aggregations, requiring direct telemetry only for those providing ancillary services or those above 10 MW.[82]

A similar alternative is that RTO/ISOs can **relax telemetry requirements based on individual DER size.** This strategy enables smaller resources to participate in aggregations without posing significant reliability risks and avoids the need for these resources to install prohibitively expensive hardware and software that may differ from that which is required for interconnection at the distribution level. NYISO, for instance, only requires five-minute readings for DERs under 100 kilowatts that are not providing regulation services, which can be fulfilled with most pre-existing DER hardware such as advanced meters.[83]

Nearly all parties agree that rigorous metering and telemetry should be required for at least some aggregations, such as those that provide regulation services, but divisions arise when deciding how widespread and how rigorous these requirements should be. Reduced telemetry reading approaches provide an opportunity for state regulators to share data with RTO/ISOs and reduce costs for DERs. To ensure that these opportunities are maximized, state regulators can engage with stakeholders to understand how existing hardware could be leveraged to provide the requisite data that may enable the provision of wholesale services. Once that opportunity is understood, state regulators could subsequently promote strong data sharing protocols that enable it. For example, NYISO's approach — smaller DERs do not have to provide stringent telemetry readings — is specifically designed so that existing metering infrastructure, such as advanced metering infrastructure, can be used and the cost burden can be minimized for individual DERs. To ensure that DER aggregators can use this data for wholesale validation and payment, data sharing protocols must be robust and maintain alignment with regulator goals of minimizing costs and ensuring data privacy and cybersecurity.

[81] PJM 182 FERC ¶ 61,143 at paragraph 234. Note that all assets under 10 MW in PJM are treated comparably.
[82] CAISO 179 FERC ¶ 61,197 at paragraph 152
[83] NYISO 179 FERC ¶ 61,198 at paragraph 194

Table 5. Advantages and disadvantages of RTO/ISO approaches: Telemetry

Approach	Advantages	Disadvantages
Make telemetry requirements consistent with other market participants *For all aggregations*	RTO/ISOs argue that telemetry is essential for reliability and necessary to avoid providing preferential treatment under market designs that comply with the Federal Power Act.[84]	Critics, including industry associations, contend that imposing telemetry on smaller DERs could be a costly barrier to entry.
Relax telemetry requirements based on aggregation size or services *For smaller aggregations or those not providing ancillary services*	Smaller aggregations pose less risk to system reliability and can be monitored with less stringent requirements. Aggregations that do not plan to provide ancillary services should not need to meet the requirements to provide these services.	Some DER advocates and aggregators feel these are still overly burdensome and would result in undue barriers.[85]
Relax telemetry requirements based on DER size *For smaller individual DERs*	Smaller DERs that pose less reliability risk can join aggregations without facing costly barriers to entry associated with expensive telemetry equipment.	Environmental stakeholder groups feel that this is not going far enough to reduce costs for small DERs.[86]

[84] For example, CAISO Compliance Filing 2 pp. 5–6
[85] For example, CAISO 179 FERC ¶ 61,197 at paragraphs 153–154
[86] For example, NYISO 179 FERC ¶ 61,198 at paragraph 188

5. Broader opportunities for state regulators

Beyond the specific opportunities for state regulators to address the Order 2222 Compliance and Implementation Issues discussed in Section 4 of this report, there is a broader range of cross-cutting actions available to state regulators to facilitate the integration of DER aggregations into wholesale markets. These opportunities generally fall into three categories: (1) coordination, (2) policy and regulation, and (3) data collection, evaluation, and sharing. The categories demonstrate state regulators' influence on the local scale and at the wholesale level through aggregations. For example, coordination activities typically revolve around engaging stakeholders to investigate and resolve key issues, which can be done within the state with those such as utilities and aggregators, or across states with those such as other state regulators, RTO/ISOs, or groups in other jurisdictions. Policy and regulation activities often involve incentivizing utilities or customers (and, by association, aggregators) to pursue DER aggregation opportunities or developing guidelines that jurisdictional groups (e.g., utilities) must abide by to facilitate these opportunities, provide transparency, and complement state-level goals. Data collection, evaluation, and sharing activities are vital to evaluate DER operation and identify opportunities for aggregations to provide grid services while maintaining grid reliability. Within the context of wholesale markets and voluntary action to complement Order 2222, each of these three categories are relevant to addressing all four of the Compliance and Implementation Issues (i.e., double counting, metering and telemetry, the role of the distribution utility, and ongoing coordination). This section discusses opportunities for state regulators via coordination, policy and regulation, and data collection, evaluation, and sharing.

5.1 Coordination

State regulators have established communication protocols with some parties such as utilities, however, recent activities related to DER aggregation focus on engaging additional stakeholders in investigatory dockets or working groups to consider multiple objectives and address relevant DER issues. Pennsylvania, New Jersey, Wisconsin, Michigan, and Indiana all have open regulatory proceedings that provide a forum for collecting stakeholder comments on key DER aggregation issues or otherwise discuss and share information to more broadly improve understanding of DER aggregation challenges and opportunities.

Regional coordination of individual states is an important consideration for state regulators. In jurisdictions with limited experience with DER aggregations, state regulators (or state energy offices) can identify barriers or information gaps that prevent the optimal deployment and use of DERs. For example, New England is experiencing winter reliability challenges, and the New England Conference of Public Utility Commissioners has created a regional working group focused on identifying and understanding available data on winter DR (NECPUC 2024).

Recent state regulatory activity in coordination: Wisconsin

In September 2024, the Wisconsin Public Service Commission initiated regulatory activity to review the possibility of allowing retail customers to be aggregated to provide demand response into wholesale markets. Among five questions being investigated was an issue related to Order 2222. Specifically: "What steps, if any, should the Commission take to ensure that any new Commission processes related to aggregations of retail customers for demand response align Wisconsin law and with Midcontinent Independent System Operator (MISO) processes, including MISO's compliance with FERC Order 2222 and existing MISO demand response resources and/or load-modifying resources?" (Wisconsin PSC 2024a) Stakeholder comments continue to be filed, though further commission action has not yet been taken as of the writing of this report (Wisconsin PSC 2024b).

Regional coordination between state regulators to standardize requirements or programs can alleviate barriers for third-party aggregators and other service providers to enter markets that often have differing rules from one to another, which was an issue that DER aggregators identified in our interviews. One solution is to create an industry-wide standard service agreement for aggregators that includes performance guarantees with a codified set of accepted measures to minimize aggregation performance risk for those such as utilities or wholesale market operators (Kahrl et al. 2022). Indeed, some solutions have emerged such as Collaborative Utility Solutions' DER registry, created to encourage partnerships and standardize data for easier exchange and coordination (also mentioned in "data collection, evaluation, and sharing") (Collaborative Utility Solutions 2023). Additionally, the North American Energy Standards Board announced in 2024 that it would develop a standardized contract covering transactions between utilities and DER aggregators to facilitate the provision of distribution grid services from DER aggregations to utilities in a way that both aligns with state policies and provides a level of flexibility for regulators. The contract will focus on consistency in terminology and definitions to reduce uncertainty, as well as encourage operational coordination across retail and wholesale markets (FERC 2024b). The contract includes an optional addendum to allow DER aggregators and utilities to specify regulatory, testing, certification, or other requirements and milestones that must be met in order for the aggregator to register with the utility (FERC 2024b).

In addition, or as an alternative to a docket or working group, state regulators could commission a study on DER opportunities, develop consistent terminology, or establish metrics to set a baseline and track progress toward DER goals. Across a wider group of states, the National Association of Regulatory Utility Commissioners and the National Association of State Energy Officials have developed a forum for providing state energy decision-makers with information, tools, and other resources to assist with Order 2222 implementation (NARUC n.d.-a). Referred to as the "Distributed Energy Resource Integration and Compensation Initiative," the group has hosted workshops on DER interconnection and integrated distribution system planning, and it has published reports on issues such as state actions that can facilitate the successful implementation of Order 2222 (NARUC and NASEO 2023).

Recent state regulatory activity in coordination: Michigan

The Michigan Public Service Commission has hosted stakeholder meetings on topics related to DR aggregation dating back to at least 2019 (Michigan PSC n.d.-a). In December 2023, the Commission issued a new order initiating the creation of a working group that would continue to address several specific DR aggregation issues, including "how Michigan's approach to DR aggregation comports with the frameworks being developed by PJM Interconnection, L.L.C., and MISO for compliance with Order 2222" (Michigan PSC 2023). Those workshops have explored a variety of related topics, such as the status of utility DER management system deployment, customer protections, and dual participation in retail/wholesale markets, among others (Michigan PSC n.d.-b).

Finally, regulators can act as coordinators between retail and wholesale markets, where applicable. For example, the California Public Utilities Commission led a collaborative initiative with CAISO and stakeholders to develop two new programs to allow aggregator participation in the CAISO market: the Proxy Demand Resource and the Reliability Demand Response Resource (CAISO n.d.). The Commission introduced the concept of developing the market products, then played an active role at stakeholder workshops in which market products were developed. This will ultimately increase visibility of individual DERs participating in both retail and wholesale programs and promote dual participation. Similarly, Minnesota and Massachusetts regulators have coordinated with their respective ISOs to adopt advanced inverter standards for DERs that promote grid stability, interoperability, and coordination between retail and wholesale system levels (Cordova and Boemer 2021). These forums can also be helpful to share information on other issues such as cybersecurity threats.

5.2 Policy and regulation

FERC and RTO/ISOs have jurisdiction over the DER aggregation at the point of interconnection to the bulk power system. However, each individual DER is both subject to, and influenced by, retail regulation that is outside of federal jurisdiction. Relevant state regulation includes that which both promotes cost-effective DER adoption and integration, as well as that which values and provides grid benefits (e.g., tariff or incentive program design), and state policy has a large influence on which programs aggregators participate in and at which level (i.e., retail, wholesale, or both) (Downing et al. 2023). Relevant policy and regulation may include rate design, incentive and program design, establishing performance metrics and deployment targets, resource planning, and establishing rules around dual participation and coordination between retail and wholesale markets. One example of state action to modify regulations in favor of DER deployment and market participation is the Maryland Public Service Commission's Public Conference 44 (PC44) initiative. Broadly, PC44 addresses a range of issues related to the affordability, reliability, and sustainability of the state's distribution system. One focus of this initiative has been to streamline the interconnection of distributed energy resources. The PC44 interconnection working group has addressed over 20 important issues, such as interconnection application process automation, flexible interconnection options, DER cybersecurity, and the role of meter collar adapters, among others (Maryland PSC n.d.). The initiative has resulted in several revisions to Maryland's code of regulations.

States can promote beneficial adoption of individual DERs by aligning incentives and rate design with system need through actions such advanced rate structures or performance-based ratemaking.[87] For example, recently the Colorado Public Utilities Commission required Xcel Energy, an investor-owned utility, to develop a new 50 MW virtual power plant program in Colorado. Subsequent supporting legislation was developed that requires Xcel to implement both a virtual power plant and a tariff for performance-based compensation for qualified virtual power plants (Walton 2024). States without robust DER programs may first need to identify where DER adoption may be most beneficial and how DERs may be leveraged. These states may consider conducting a DER potential study, which multiple regulatory interviewees noted as an important resource to collect evidence necessary for the design of new incentives or programs. Findings could also guide resource planning. States that have already begun to leverage DERs have often done so through robust stakeholder engagement. To encourage dual participation, states can further develop these incentives and rate structures in such a way that some may complement wholesale markets without risk of double counting while still providing local grid services. How this may be implemented in practice will depend on the relevant RTO/ISOs' rules (see Section 4.1, "Double counting").

Recent state regulatory activity in policy and regulation: Indiana

In December 2022, the Indiana Utility Regulatory Commission introduced an initiative to work with stakeholders to address Order 2222 implementation issues. Following an educational meeting, the Commission has hosted multiple stakeholder meetings, fielded several rounds of stakeholder comments, and conducted a series of focused roundtable discussion on issues such as interconnection rules, DER registration processes, the costs of DER aggregation, and other topics (Indiana Utility Regulatory Commission, n.d.)

Advanced rate structures include those such as California's CalFUSE pilot, which aims to develop a dynamic rate based on wholesale energy costs, capacity charges based on real-time grid utilization, and other features (California PUC 2022). Established and implemented statewide, New York's Value Stack is technology-agnostic and aligns compensation from the utility to the DER owner with a series of grid values. The tariff stemmed from a regulatory order in 2017 that established the principles and methodology of the Value of DER investigation and included multiple iterations with input from various stakeholders and cooperation from retail utilities (NYSERDA n.d.-a). An additional issue for consideration in the broader context of ratemaking is the design and application of NEM policy and the extent to which that may be introducing a financial disincentive for customers with DERs to participate in wholesale markets through aggregations.

Some states have also introduced performance metrics to incentivize utilities to develop DER programs, which could include increased earnings if specific targets are met, or the ability to earn a rate of return

[87] For example, a recent Berkeley Lab paper discussed practices for accounting for price-based DR in resource planning. See Carvallo and Schwartz (2023).

on certain operational expenses rather than just capital expenditures. For example, the Hawaii Public Utilities Commission approved an extensive portfolio of performance incentives to support the state's clean energy goals (Hawaii PUC 2021). These include "DER asset effectiveness metrics" that measure the enrollment, capabilities, and utilization of DERs to provide grid services, including load curtailment. Further, "customer engagement metrics" track enrollment in customer programs, including DER programs, as well as the number and percent of customers using and sharing hourly consumption data (i.e., Green Button Connect) that enables DER aggregators to target flexible energy technologies.

Beyond the creation of incentives and programs, state regulators directly influence rules and restrictions around state incentives and retail programs. This includes which technologies may be eligible, impacting the composition of an aggregation in that region and its consequent capabilities. These rules may complement incentives with broader state goals.

Recent state regulatory activity in policy and regulation: Pennsylvania

In February 2024, the Pennsylvania public utilities commission initiated a regulatory proceeding to determine whether any updates are needed to existing commission regulations or policy statements to better facilitate implementation of Order 2222 (Pennsylvania PUC n.d.). Prior to the order, the Commission facilitated three stakeholder meetings to identify relevant topics for the proceeding. Topics identified for public comment included, at a minimum, "changes to interconnection rules, changes to metering requirements, cost allocation issues, adjudication of DER registration disputes, [electric distribution company] overrides of DER dispatch, consumer protection for DER owners, preventing double compensation and double counting of services and electronic data exchange" (Pennsylvania PUC 2024). Comments were filed on these issues by nearly 30 stakeholders. As of the writing of this report, the Commission has not yet taken further action.

With increased adoption levels and higher concentration of DERs, aggregations can generate grid benefits and be considered within utility system planning, such as through integrated resource planning or distribution system planning (Downing et al. 2023). This may necessitate new modeling methods and decision tools to direct investments (Downing et al. 2023). For example, California has created a framework to identify, review, and select opportunities for DERs to alleviate future grid issues and defer new investments, and New York has created non-wires alternatives requirements for utilities to solicit bids from eligible DER solutions for all load-growth-driven grid upgrades (Downing et al. 2023).

State actions have a direct ability to further leverage DERs to provide not only retail services but wholesale services. Within the context of wholesale markets, state regulators may further investigate or codify rules or offer guidance that could encourage dual participation, avoid double counting, specify criteria for distribution utility review and operational overrides, and allow for data collection and sharing that leverages existing metering and telemetry (see Section 4). Standardizing data collection, data sharing, cybersecurity, and distribution system operation would enable more consistency for aggregators that wish to participate across multiple utility territories within the same state (Downing et al. 2023; DOE 2024).

5.3 Data collection, evaluation, and sharing

Data will be critical for DER aggregations to successfully participate in wholesale markets and has been identified as a major barrier to provision of grid services. This will be very influential in successfully addressing all four of the identified RTO/ISO Compliance and Implementation Issues (i.e., double counting, metering and telemetry, role of the distribution company, and ongoing coordination). Standardized practices across regions will further reduce barriers for aggregators participating across jurisdictions and with regional grid operators or RTO/ISOs. States can influence various aspects that include data sharing practices, interconnection and operations agreements, tariff requirements, measuring and verification for benchmarking, performance verification and settlement, and simplified enrollment requirements.

Several DER aggregators identified lack of access to uniform, high quality data as a major barrier to scaling programs including customer data (e.g., meter data), grid data (e.g., hosting capacity data), and information about the ownership and location of DERs. Utilities often collect and control grid, customer, and sometimes DER data that is needed to fully understand dynamic system operation and needs (Loiter et al. 2023). DER aggregators and some state regulators shared the perception that utilities do not have a strong incentive to share data, and do not dedicate sufficient resources to doing so. State regulators are increasingly being asked to coordinate between utilities and aggregators. Utilities are primarily concerned with data privacy while aggregators must request data for siting and program decisions, enrollment, and registration for retail and/or wholesale programs; determine availability when constructing bids or contracts; and validate performance for settlement purposes (Loiter et al. 2023). Moreover, disputes in this area likely fall under state jurisdiction. As such, state regulators may be motivated to engage in this topic to encourage aggregators to participate or to provide guidance as participation increases naturally or as Order 2222 implementation is further underway.

Recent state regulatory activity in data collection, evaluation and sharing: New Jersey

In April 2024, the New Jersey Board of Public Utilities issued a request for information regarding issues related to the participation of DER aggregations in wholesale markets. The request identified 20 questions related to the implementation of Order 2222 in New Jersey, on issues such as the impact of DER aggregations on grid reliability, the cost of facilitating the DER aggregation process, cybersecurity, and metering and telemetry, among many others (New Jersey BPU 2024). Comments were subsequently filed by a variety of stakeholders. On January 7, 2025, the BPU issued a notice of a technical conference to further discuss these issues (New Jersey BPU n.d.).

Currently, data sharing practices vary widely by state and utility and few states have taken a comprehensive approach (FERC 2024b). One example is New York, which provides a comprehensive approach and has completed the first phase of its Integrated Energy Data Resource platform to centralize and expand access to utility data. The first phase includes utility hosting capacity maps, locational installed DER capacity, and tools for rate and tariff information. The second phase will include energy consumption and emissions data (NYSERDA n.d.-b). In the majority of states, however, there are inconsistencies regarding whether utilities are required to share data with regulators or stakeholders and to what extent, and only 14 states have considered whether and how utilities should be making hosting capacity data available to DER aggregators and public (Constantini et al. 2023). Industry initiatives are addressing this challenge as well. For example, Collaborative Utility Solutions has created a non-profit DER registry as a centralized resource for DER data (Collaborative Utility Solutions 2023).

At a higher level, there are recent efforts to provide more consistent guidance, which overlaps with "coordination" discussed at the top of this section. For example, NARUC began a data sharing collaboration in 2022 with various stakeholders and published a framework (NARUC n.d.-b) and playbook (Constantini et al. 2023) for grid data sharing for states to use and tailor to their own respective needs. The framework includes a series of questions under seven categories: use case; state priorities; current practices, requests for additional data, and options for enabling use cases; data details; potential impacts; and data sharing tactics. For specifics, NARUC summarizes state proceedings and various available utility grid data (Loiter et al. 2023).

Data sharing practices are often embedded within interconnection and operations agreements or tariffs (Loiter et al. 2023). As such, states could address data sharing within these agreements as well. For example, several states have integrated advanced inverter standards into interconnection agreements (Loiter et al. 2023). These standards often specify communications requirements in order to promote interoperability and coordination across distribution operators and other stakeholders such as DER aggregators and/or wholesale markets.

Standard methodologies for collecting, measuring, and evaluating DER performance data will be necessary for individual DERs to participate in aggregations and be compensated for their performance — especially if participating dually across retail and wholesale markets. Interviewees indicated that data

measurement and verification to measure DER performance is of particular importance, as they determine compensation levels and are not consistent across jurisdictions. Regulators could develop evaluation requirements that are robust and could even coordinate across other jurisdictions to create uniform standards and leverage best practices (Spurlock et al. 2016). Uniform and clear evaluation standards would also allow aggregators to improve performance and reduce risk of penalties. In fact, several interviewees identified system operators' distrust in DER aggregation performance when compared to traditional utility-scale assets as another key barrier to aggregators' provision of grid services. Data sharing and coordination, in tandem with clear rules on dual participation, will ensure no double counting and allow for DERs to provide optimal grid value and gain fair compensation.

Though few states have addressed data sharing issues, and even fewer have done so in a comprehensive manner, some states are not only striving to standardize data sharing within their states but also with neighboring states. Utilities across Connecticut, Massachusetts, Maine, and New Hampshire are creating a regional energy data platform aimed at improving access to detailed energy usage, building on a New Hampshire initiative to provide standardized access for customers and third parties (FERC 2024b). One DER aggregator interviewee suggested the concept of a data access platform independent of utilities and accessible to all registered service providers.

One DER aggregator explained that over half of residential customers who begin the enrollment process do not complete it. As such, simplified enrollment could increase the number of individual DERs enrolled in aggregations (Hledik et al. 2024). Regulators could streamline enrollment by offering multiple options for user authentication, pre-populating enrollment forms with customer data, and minimizing the number of clicks and number of forms to be filled out. Additionally, some successful DER programs offer default pre-enrollment of devices sold on utility marketplaces and point-of-sale enrollment at third-party retailers. This could be achieved, for example, through a checkbox to indicate enrollment in the relevant VPP program when adding a device to the cart on a marketplace or retailer website.

6 Conclusion

While wholesale markets are regulated by FERC and state regulators are outside of FERC jurisdiction, complementary actions by states can enable or promote aggregated DERs' wholesale market success. Actions states can take are summarized across each of the four Compliance and Implementation Issues explored in this paper below and the cross-cutting issues discussed in Section 5.

Double Counting: Order 2222 allows RTO/ISOs to limit the participation of resources in wholesale markets if a DER aggregation is receiving compensation for the same services as part of another program. Addressing this issue will determine how aggregations can register DERs, bid into markets, and be compensated for both distribution and wholesale services. State regulators do not have jurisdiction over wholesale market participation, but they do determine DER eligibility in retail programs, conditional on wholesale market participation, and they retain the ability to inform RTO/ISOs of potential double counting concerns.[88] Examples of actions that state regulators can take are provided below.

- Develop clear guidelines and definitions for double counting with feedback from relevant stakeholders. This would provide aggregators and utilities with a clear understanding of how to enroll dually participating resources while avoiding double counting.
    - If applicable (i.e., RTO/ISOs allow parallel participation), coordinate with RTO/ISOs, aggregators, and utilities to clearly define cases where parallel participation would be feasible, and dual participation could be encouraged while minimizing the risk of double counting.
    - If applicable (i.e., RTO/ISO allows participation except for identical services or services where there is overlap), establish transparent definition and evaluation rules for double counting to allow the provision of similar services across markets while avoiding overlap.
    - If the RTO/ISO allows for a release valve that allows local double counting rules to supersede RTO/ISO restrictions, identify additional opportunities for DER wholesale market participation that will not result in double counting.
    - Establish clear and comprehensive rules to minimize disputes and encourage more aggregation participation, which could support state priorities of affordable and efficient grid operation.
- Develop a process to evaluate and verify instances where a utility identifies a case of double counting.
    - Establish protocols for what data is needed, from whom, and how it is shared such that the burden of proof for double counting is allocated properly across utilities and aggregators to prove (or disprove) cases where an individual DER may have violated double counting rules. Advanced coordination across stakeholders could increase clarity and reduce instances of double counting and disputes.
- Specify whether specific retail programs allow or disallow participation in various wholesale programs, subject to relevant RTO/ISO rules, or create new programs that complement RTO/ISO programs. This would likely require engaging with stakeholders such as utilities and aggregators

[88] For example, NYISO 179 FERC ¶ 61,198 at paragraph 137

(and potentially RTO/ISOs) to weigh trade-offs and ensure that competition is encouraged while still maintaining local grid reliability.
    - Provide guidance on existing or new retail programs to identify services that may be temporally specific and allow a DER to provide the same type of service in the wholesale market at a separate time without risk of overlap (e.g., seasonal programs).

Role of the Distribution Company: In the context of Order 2222, the "role of the distribution company" focuses on the distribution utility review process that takes place during the registration for an aggregator of an aggregation. When a DER aggregation is registered to participate in the wholesale market, or when changes to existing DER aggregations are made, Order 2222 requires RTO/ISOs to develop a process for timely review by the applicable distribution utility. Additionally, RTO/ISOs must develop a review process for aggregations that determine (1) whether each proposed DER can participate in an aggregation and (2) whether the participation will pose significant risks to the distribution system. Examples of actions that state regulators can take are provided below.

- Provide guidance and transparency on what may preclude an individual DER's participation in wholesale market participation.
    - Engage with utilities to ensure that grid reliability is maintained but also engage with aggregators and other stakeholders to ensure that criteria are fair and not overly restrictive. This can be done via workshops or working groups to co-develop a series of review criteria to provide more transparency for aggregators, maintain reliability for utilities, and reduce uncertainty for both.
    - Identify which data are necessary to establish whether a DER may be eligible to participate in an aggregation and establish data sharing protocols between aggregators and utilities that allow for this determination and justification in the case of rejection.
- Evaluate overrides and adjudicate over disputes pertaining to distribution utility decisions during the review process, including the rejection of a DER into a DER aggregation.
    - Co-develop process and/or data requirements to justify an exclusion of a DER to an aggregation in order to increase transparency.
    - Ensure clear utility and aggregator understanding of rules in order to reduce the number of disputes and increase transparency of which DERs may be eligible before registering an aggregation. This knowledge could help reduce the timeline to actual operation of an aggregation and the provision of grid services.

Ongoing Coordination: Order 2222 requires each RTO/ISO to: (1) establish a process for ongoing coordination related to data flows and communication among itself, the DER aggregator, and the distribution utility; (2) include protocols that allow distribution utilities to override RTO/ISO dispatch of an aggregation if necessary to maintain the reliable and safe operation of the distribution system; and (3) apply a performance penalty to a DER aggregator in the case of under- or non-performance due to a distribution utility override of the RTO/ISO dispatch. Examples of actions that state regulators can take are provided below.

- With utilities, define operational risk and more specific categories of criteria and metrics to assess it that consider the local distribution system's specific needs without being overly burdensome for individual DERs trying to participate in wholesale markets or for aggregators.
- Co-develop, review, and approve distribution utility communications and tools for coordination with DER aggregators and RTO/ISOs.
    - Identify gaps and help establish protocols to identify, communicate, and justify overrides between DERs, aggregators, utilities, and RTO/ISOs.
- With utilities and aggregators, establish a process and specific guidelines for utilities to present proof to justify cases of operational overrides and adjudicate override disputes.
    - Provide transparent oversight of criteria that are grounds for override to decrease uncertainty and subsequently reduce number of disputes and overrides.

Metering and Telemetry: In the context of Order 2222, "metering" refers to the rules that determine how DER aggregations have their energy injection and withdrawal measured, and "telemetry" refers to how aggregations report real-time data (e.g., voltage and frequency) needed to provide fast-response services such as frequency regulation. Order 2222 did not set rigid requirements for metering and telemetry, and FERC has maintained a hands-off approach when approving each RTO/ISO's requirements, provided that the RTO/ISOs can justify their rationale for them.[89] RTO/ISOs require information from market participants, including aggregators, to ensure the reliable operation within the wholesale market, and they may be inclined to specify metering and telemetry that is consistent with incumbent requirements (i.e., that required of large generators). This may indirectly impose metering and telemetry requirements onto individual DERs. FERC has stated an explicit preference to rely on meter data obtained through compliance with distribution utility or state regulator requirements whenever possible. Individual DER interconnection agreements and metering and telemetry on the distribution system are in the purview of state regulators, which provide an opportunity for state influence in cases where RTO/ISOs allow flexibility. This may allow for DERs to participate in aggregations without the need to purchase expensive new equipment or develop new data protocols while still providing sufficient information to verify performance and ensure proper compensation. Examples of actions that state regulators can take are provided below.

- If applicable, determine which data may be available or feasible to collect with existing metering and telemetry at the point of interconnection of the individual DER to the distribution system and whether those data may be useful in the aggregation context for wholesale market participation. This would likely require engagement with RTO/ISOs to better understand their requirements and what would be needed to prove sufficiency and would only apply in cases where RTO/ISOs allow for flexibility in their metering and telemetry requirements.

In addition to the four Compliance and Implementation Issues where there is an opportunity for state regulators to play a meaningful role in Order 2222 implementation, there are three cross-cutting opportunities that span the Compliance and Implementation Issues, along with general promotion of state goals and DER adoption at the local level.

[89] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 242

Coordination:

- Engage additional stakeholders in investigatory dockets or working groups on DER aggregations to consider multiple objectives and address relevant DER issues.
- Establish avenues of regional coordination between state regulators, especially those that may fall within similar RTO/ISO footprints, to standardize requirements or program offerings.
- Identify areas where states can coordinate between retail and wholesale markets, where applicable, to focus on specific barriers or opportunities.

Policy and Regulation:

- As explained in the double counting entry above, states could develop or adapt relevant policy and regulation to promote dual participation and develop rules to avoid instances of double counting.
- Consider complementary design in interconnection rules and requirements, rate structures, incentives and programs, performance metrics and deployment targets, and resource planning.
- Set requirements from utilities that may help increase the utilization of DERs and promote grid affordability, efficiency, and reliability to help implement Order 2222.

Data Collection, Evaluation, and Sharing:

- Develop or amend data sharing practices within the context of wholesale market complementarity. These could fall under:
    - Interconnection and operations agreements
    - Tariff requirements
    - Measuring and verification for baselining DER performance
    - Performance verification and settlement
    - Simplified enrollment requirements.

States can benefit from encouraging beneficial adoption and operation of DERs on their local grid. With increased utilization, grid services could be deployed much quicker than traditional utility infrastructure and at a lower overall cost to ratepayers. Encouraging dual participation could also increase both the value that each DER can provide to the grid as well as the value streams that DER owners can receive. With increased coordination, this can be done while guarding local grid reliability. While Order 2222 primarily impacts RTO/ISO actions and states are not mandated actors within the FERC context, there are knock-on effects that will be felt at the local level. Engaging earlier to harmonize state and wholesale market activities can allow energy market changes to complement state goals.

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Appendix A. Reviewed FERC compliance filings and orders

Federal Energy Regulatory Commission (FERC), Participation of Distributed Energy Resource Aggregations in Markets Operated by Regional Transmission Organizations and Independent System Operators, Docket No. RM18-9-000; Order No. 2222, 172 FERC ¶ 61,247

Federal Energy Regulatory Commission (FERC), Order Addressing Arguments Raised on Rehearing, Setting Aside Prior Order in Part, and Clarifying Prior Order in Part, Docket No. RM18-9-002; Order No. 2222-A, 174 FERC ¶ 61,197

Federal Energy Regulatory Commission (FERC), Order Addressing Arguments Raised on Rehearing, Setting Aside Prior Order in Part, and Clarifying in Part Prior Order, Docket No. RM18-9-003; Order No. 2222-B, 175 FERC ¶ 61,227

CAISO

California Independent System Operator (CAISO), Tariff Amendment to Comply with Order No. 2222, Docket No. ER21-2455-000, July 19, 2021. ("CAISO Compliance Filing 1")

California Independent System Operator (CAISO), Motion to Amend Effective Date, Docket No. ER21-2455-000, August 15, 2022. ("CAISO Compliance Filing 2")

Federal Energy Regulatory Commission (FERC), Order on Compliance Filing, Docket Nos. ER21-2455-000, ER21-2455-001, 179 FERC ¶ 61,197

Federal Energy Regulatory Commission (FERC), Order on Compliance Filing, Docket Nos. ER21-2455-003, ER21-2455-004, 183 FERC ¶ 61,119

ISO-NE

ISO New England (ISO-NE), Revisions to ISO New England Inc. Transmission, Markets and Services Tariff to Allow for the Participation of Distributed Energy Resource Aggregations in New England, Docket No. ER22-983-000, February 2, 2022. ("ISO-NE Compliance Filing 1")

ISO New England (ISO-NE), Revisions to ISO New England Inc. Transmission, Markets and Services Tariff In Further Compliance with Order No. 2222 and Request for Extension of Compliance Deadline, Docket No. ER22-983-000, May 9, 2023. ("ISO-NE Compliance Filing 3")

Federal Energy Regulatory Commission (FERC), Order on Compliance Filing, Docket Nos. ER22-983-000, ER22-983-001, 182 FERC ¶ 61,137

Federal Energy Regulatory Commission (FERC), Order on Compliance Filing, Docket Nos. ER22-983-004, 185 FERC ¶ 61,095

MISO

Midcontinent Independent System Operator (MISO), Order No. 2222 Compliance Filing, Docket No. ER22-1640-000, April 14, 2022. ("MISO Compliance Filing 1")

Federal Energy Regulatory Commission (FERC), Order on Compliance Filing, Docket Nos. ER22-1649-000, ER22-1640-001, 185 FERC ¶ 61,011

NYISO

New York Independent System Operator (NYISO), Compliance Filing and Request for Flexible Effective Date, Docket Nos. RM18-9-000, ER21-2460-000, July 19, 2021. ("NYISO Compliance Filing 1")

New York Independent System Operator (NYISO), Compliance Filing, Docket No. ER21-2460-000, November 14, 2022. ("NYISO Compliance Filing 2")

New York Independent System Operator (NYISO), Compliance Filing, Docket No. ER21-2460-000, May 22, 2023.

Federal Energy Regulatory Commission (FERC), Order on Compliance Filing, Docket Nos. ER21-2460-000, ER21-2460-001, 179 FERC ¶ 61,198

Federal Energy Regulatory Commission (FERC), Order on Compliance Filing, Docket No. ER21-2460-003, 183 FERC ¶ 61,035

PJM

PJM Interconnection (PJM), Motion for Extended Comment Period, Docket No. ER22-962-000, February 1, 2022. ("PJM Compliance Filing 1")

PJM Interconnection (PJM), Order No. 2222 Compliance Filing of PJM Interconnection, Docket No. ER22-962-000, September 1, 2023. ("PJM Compliance Filing 4")

Federal Energy Regulatory Commission (FERC), Order on Compliance Filing, Docket Nos. ER22-962-000, ER22-962-001, 182 FERC ¶ 61,143

Federal Energy Regulatory Commission (FERC), Order on Compliance Filing, Docket No. ER22-962-005, 188 FERC ¶ 61,076

SPP

Southwest Power Pool (SPP), Compliance Filing of Southwest Power Pool, Docket No. ER22-1697-000, April 28, 2022. ("SPP Compliance Filing 1")

Federal Energy Regulatory Commission (FERC), Order on Compliance Filing, Docket Nos. ER22-1697-000, ER22-1697-001, 186 FERC ¶ 61,162

Appendix B. FERC Order 2222 compliance requirements

The following are descriptions of each category of requirements in Order 2222, four of which are identified as Compliance and Implementation Issues that are described in further detail in the body of this report.

1. **Small Utility Opt-In:** Order 2222 directs each RTO/ISO to (1) accept bids from an aggregator if its aggregations include DERs that are customers of utilities that distributed over 4 million megawatt-hours in the prior year and (2) not accept bids from aggregators who are customers of smaller utilities unless the electric retail regulatory authority allows this to occur.[90]
2. **Interconnection:** Order 2222 declines to exercise jurisdiction over interconnections of DER to distribution facilities for the purpose of participating in aggregations and therefore will not require standard interconnection procedures. However, any resources that have already interconnected prior to Order 2222 will not have to convert to new state or local connection agreements.[91]
3. **Definition of DER and DER Aggregator:** Order 2222 defines a DER as "any resource located on the distribution system, any system thereof, or behind a customer meter" with specific emphasis on the technology-neutral aspect of the definition. An aggregator is defined as “the entity that aggregates one or more distributed energy resources for purposes of participation in the capacity, energy and/or ancillary service markets of the regional transmission organizations and/or independent system operators.” RTO/ISOs must align their own definitions of DER and DER aggregators with the definitions proposed in Order 2222.[92]
4. **Participation Model:** Order 2222 requires each RTO/ISO to have tariff provisions that allow DER aggregations to participate directly in RTO/ISO markets. This may include one or more participation models that accommodate the physical and operational characteristics of various DER aggregations.[93]
5. **Types of Technologies:** Order 2222 requires that each RTO/ISO's rules do not prohibit any particular type of DER technology from participating in DER aggregations and clarifies that RTO/ISOs must enable DR resources to participate as well. These DR resources are subject to net benefits tests to ensure that curtailed demand is cost-effective relative to supply.[94]
6. **Allow a Single Qualifying DER to Serve as Its Own Aggregator:** Order 2222 requires each RTO/ISO to revise its tariff to allow a single qualifying DER to serve as its own aggregation.[95]
7. **Double Counting of Services (Compliance & Implementation Issue, Section 4.1):** Order 2222 allows RTO/ISOs to limit the participation of resources in RTO/ISO markets through an aggregation that are receiving compensation for the same services as part of another program. There are three specific changes that must be made to the RTO/ISO tariff that (1) allow DERs that participate in retail programs to participate in wholesale markets, (2) allow DERs to provide multiple wholesale services, and (3) include any appropriate restrictions on DER participation, if narrowly designed, to avoid double counting.[96]

[90] Order No. 2222, 172 FERC ¶ 61,247 at paragraphs 45–67
[91] Id. at paragraphs 68–104
[92] Id. at paragraphs 105–118
[93] Id. at paragraphs 119–132
[94] Id.at paragraphs 133–146
[95] Id. at paragraphs 182–185
[96] Id. at paragraphs 147–164

8. **Min and Max Size of Aggregation:** Order 2222 requires each RTO/ISO to implement a minimum size requirement not to exceed 100 kilowatts for all aggregations.[97]
9. **Min and Max Size for DER Participating in an Aggregation:** Order 2222 does not impose a specific minimum or maximum size requirement but rather directs each RTO/ISO to propose capacity size requirements for individual DERs or to explain why such a requirement is unnecessary.[98]
10. **Distribution Factors and Bidding Parameters:** Order 2222 requires each RTO/ISO to establish market rules that address distribution factors and bidding parameters. Specifically, each RTO/ISO that allows multi-nodal aggregations must (1) require that aggregations give the RTO/ISO the total response they would provide from each pricing node when they initially register their aggregation and update distribution factors if they change and (2) incorporate appropriate bidding parameters into participation models as necessary to account for the operational characteristics of aggregations.[99]
11. **Locational Requirements:** Order 2222 requires each RTO/ISO to revise its tariff to establish locational requirements for DERs to participate in aggregations that are as geographically broad as technically feasible. Each RTO/ISO must provide an explanation for the geographical scope of its proposed locational requirements.[100]
12. **Information and Data Requirements:** Order 2222 requires that each RTO/ISO revise its tariff to (1) establish what information an aggregator must provide about its aggregation's operational characteristics, (2) require the aggregator provide a list of individual resources in its aggregation, and (3) establish any necessary information that must be submitted for each individual DER. Additionally, Order 2222 requires each RTO/ISO to describe what information they will share with the distribution utility and requires aggregators to provide aggregated settlement data for the aggregation and to retain performance data for individual DERs for auditing purposes. Finally, Order 2222 requires that the aggregation update its list of DERs and any associated information as it changes.[101]
13. **Metering and Telemetry (Compliance & Implementation Issue, Section 4.4):** Order 2222 does not establish specific metering and telemetry requirements for aggregations and instead provides RTO/ISOs with the flexibility to establish necessary metering and telemetry requirements for aggregations. Each RTO/ISO is required to explain why such requirements are just and reasonable and do not pose an unnecessary and undue barrier to individual DERs joining aggregations.[102]
14. **Role of Distribution Company (Compliance & Implementation Issue, Section 4.2):** Order 2222 requires that RTO/ISOs incorporate a process for timely review by the distribution utility of the individual DERs that comprise an aggregation, triggered by initial registration or incremental changes to an aggregation already participating in markets. Additionally, RTO/ISOs must develop a review process for aggregations that determine (1) whether each proposed DER can participate in an aggregation and (2) whether the participation will pose significant risks to the distribution system. RTO/ISOs must incorporate the results of the distribution utility's review process into their registration process. However, if a distribution utility recommends the removal of a DER for reliability reasons, the RTO/ISO should only remove it if it

[97] Id. at paragraphs 165–174
[98] Id. at paragraphs 175–181
[99] Id. at paragraphs 208–229
[100] Id. at paragraphs 187–207
[101] Id. at paragraphs 230–240
[102] Id. at paragraphs 241–271

would present significant risks to the reliable and safe operation of the distribution system.[103]

15. **Ongoing Operation Coordination (Compliance & Implementation Issue, Section 4.3):** Order 2222 requires each RTO/ISO to (1) establish a process for ongoing coordination, including operational coordination, that addresses data flows and communication among itself, the aggregator, and the distribution utility and (2) require the aggregator to report any changes to an aggregation's offered quantity and related distribution factors that result from distribution line faults or outages. Specifically, the Order requires each ISO to include protocols that allow distribution utilities to override RTO/ISO dispatch of an aggregation if necessary to maintain the reliable and safe operation of the distribution system. Additionally, each RTO/ISO must apply a performance penalty to an aggregator when the aggregation does not perform because a distribution utility overrides the RTO/ISO dispatch.[104]
16. **Role of Relevant Electric Retail Regulatory Authority:** Order 2222 requires each RTO/ISO specify how each RTO/ISO will incorporate voluntary relevant electric retail regulatory authority involvement in coordinating the participation of aggregations in RTO/ISO markets.[105]
17. **Modifications to List of Resources in Aggregation:** Order 2222 requires each RTO/ISO to specify that aggregators must update their list of DERs in each aggregation and any associated information and data. However, the aggregator will not be required to re-register or re-qualify the entire aggregation, as modifications will often be minimal. Any impacts to operational characteristics or performance must also be reported.[106]
18. **Market Participation Agreements:** Order 2222 requires that each RTO/ISO include a standard market participation agreement that defines the aggregator's role and responsibilities and its relationship with the RTO/ISO. Additionally, Order 2222 requires that the aggregator's participation agreement include an attestation that the aggregation complies with the tariffs and operation procedures of the distribution utility and any relevant electric retail regulatory authority.[107]

[103] Id. at paragraphs 281–299
[104] Id. at paragraphs 300–313
[105] Id. at paragraphs 314–324
[106] Id.at paragraphs 332–338
[107] Id. at paragraphs 339–356

Appendix C. Additional Order 2222 Compliance and Implementation Issues

This appendix discusses two additional Compliance and Implementation Issues: Participation Models and Locational Requirements. In addition, while Metering and Telemetry is included in the body of the document (Section 4.4), two subtopics are discussed here instead of the main text due to limited state regulator influence: actual readings versus sampling, and submetering.

As discussed in Section 2 of this report, these issues satisfy the criteria that (1) multiple RTO/ISOs required more than one filing in order to reach compliance, (2) stakeholder comments identified material concerns with approaches proposed by the RTO/ISOs, and (3) the revisions necessary to reach compliance were nontrivial. However, these issues are not relevant to state regulator jurisdiction. They are discussed below to provide additional information on ISO/RTO approaches to compliance.

C-1. (Additional) metering and telemetry

a. Telemetry

The discussion around telemetry requirements did satisfy the criteria of state regulators having influence over it. Thus, it is discussed in the main body of the document in Section 4.4.a.

b. Actual Readings vs Sampling

There is flexibility regarding whether telemetry readings for aggregations must be comprised of actual readings from individual DERs or if calculated readings from individual DERs can suffice (Figure C-1). The advantages and disadvantages of these solutions are summarized in Table C-1.

Figure C-1. RTO/ISO approaches to compliance: Telemetry readings. *Note: Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance.*

On one end of the spectrum, RTO/ISOs can require that aggregation telemetry readings be composed of **actual readings** for all individual DERs. This is the most accurate approach for compensation and system reliability but results in more stringent requirements that may not be necessary, especially for smaller individual DERs. ISO-NE strongly emphasized data accuracy in its filing and requires actual telemetry readings for all assets.[108]

[108] ISO-NE 182 FERC ¶ 61,137 at paragraphs 117 and 149

Alternatively, RTO/ISOs can allow **third-party scheduling coordinators that are authorized to represent the supply resource,** separate from the utility or grid operator, **to handle the measurement and validation of performance data**. This could reduce the cost burden of measurement equipment but could result in less accurate data readings. CAISO, NYISO, MISO, and SPP allow third-party scheduling coordinators to supply meter readings.[109]

Another alternative that RTO/ISOs can pursue to reduce the cost burden of data collection is to allow telemetry readings, specifically for smaller DERs, to be **calculated based on sampling** rather than requiring direct telemetry for each DER. One aggregator commenter noted that the cost of telemetry on resources smaller than 1 MW for the purposes of gathering actual readings makes wholesale market participation infeasible, and removing these requirements could help small DERs to participate.[110] CAISO, NYISO, PJM, and SPP allow for calculated telemetry readings.[111]

As stated above, ISO-NE was unique in that it prioritized data integrity over reduced metering and telemetry requirements that may reduce the cost burden for individual DERs. For example, ISO-NE rejected requests to use the "best available data" over five-minute interval metering because ISO-NE has a five-minute requirement for all existing resources, and it did not want to provide preferential treatment to aggregations over market participants.[112] Similarly, ISO-NE rejected the use of third-party scheduling coordinators to provide metering data because it had observed data quality issues associated with third-party metering within the DR context.[113]

Table C-1. Advantages and disadvantages of RTO/ISO approaches: Telemetry readings

Approach	Advantages	Disadvantages
Require actual telemetry readings	The most accurate approach for compensation and system reliability. Aligns with existing approaches to measuring telemetry for traditional assets.	Results in more stringent requirements that could impose additional costs on individual DERs and may not be necessary for system reliability.
Third-party measurement	An aggregator and consumer advocate commenter argued that it would reduce costs associated with data measurement and would reduce the cost burden of measurement equipment from getting passed onto ratepayers by utilities.[114]	RTO/ISOs and utilities counter that there have been concerns around validation challenges and data quality issues with third-party metering. This was discussed by stakeholders in ISO-NE.[115]

[109] CAISO 179 FERC ¶ 61,197 at paragraph 163; NYISO 179 FERC ¶ 61,198 at paragraph 187; MISO 185 FERC ¶ 61,011 at paragraph 192; SPP 186 FERC ¶ 61,162 at paragraph 275. PJM does not mention third-party meter readings.
[110] CAISO 179 FERC ¶ 61,197 at paragraph 155
[111] CAISO 179 FERC ¶ 61,197 at paragraph 165; NYISO 179 FERC ¶ 61,198 at paragraph 186; PJM 182 FERC ¶ 61,143 at paragraph 234; SPP 186 FERC ¶ 61,162 at paragraph 275. MISO does not explicitly address calculated vs estimated meter reads.
[112] ISO-NE 182 FERC ¶ 61,137 at paragraphs 149
[113] ISO-NE 182 FERC ¶ 61,137 at paragraphs 152
[114] For example, ISO-NE 182 FERC ¶ 61,137 at paragraphs 150–152 and MISO 185 FERC ¶ 61,011 at paragraph 188
[115] ISO-NE 182 FERC ¶ 61,137 at paragraph 150

Calculate telemetry readings	Accommodates an increased volume of small DERs by eliminating the need to install costly telemetry equipment.	Requires sacrificing some system visibility.

c. Submetering

Submetering in energy markets involves the use of device-level meters to record a portion of a facility's energy usage behind the main connection point to the grid, known as a retail delivery point "master meter." Most customer-sited DERs would measure their wholesale market participation through a submeter, but submeter data from a DER and actual load impacts to the system can differ and lead to double counting. For example, a metered solar array generating energy during the day may show gross generation at the submetered device level. However, grid exports are not equivalent to gross generation and instead must account for concurrent load as net generation. Some commenters worry that if submetering were used to determine the operation and performance of that DER, it would be misleading and double count the generation that went directly toward load reduction.[116] On the other hand, protesters argue that the majority of small DERs are submetered and that the outright prohibition of these resources from participating in aggregations would be an undue burden. RTO/ISOs must decide if submetered data are allowed in order to determine the operation and performance of a DER within an aggregation (Figure C-2). The advantages and disadvantages of these solutions are summarized in Table C-2.

Figure C-2. RTO/ISO approaches to compliance: Submetering. *Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance.*

All RTO/ISOs are currently in compliance but have taken opposite approaches to the topic of submetering. On one end of the spectrum, RTO/ISOs can **prohibit submetered DERs from participating in aggregations** unless certain conditions are met that ensure no double counting. These conditions include the DER acting only as DR, the entire customer (i.e., home or business) participating as a single asset, or the installation of costly parallel metering to participate at a separate connection point to the grid. These approaches, or having a DER's data read at the interconnection point to the distribution system, ensures the meter and telemetry readings represents the actual impact to the system. This approach is taken in ISO-NE and PJM.[117]

[116] ISO-NE 182 FERC ¶ 61,137 at paragraph 120
[117] PJM 182 FERC ¶ 61,143 at paragraph 247; ISO-NE 185 FERC ¶ 61,095 at paragraphs 75–78

Alternatively, RTO/ISOs can **allow use of submetered data**. To verify that submetered data is equivalent to the impact on system load, the aggregator must make individual DER metering data available for auditing alongside system impact data to ensure that a submetered DER accurately reports its impact on the system to avoid double counting.[118] This is the case even if metering data is usually reported with DER aggregation-level granularity, compared to the individual DER granularity, which means there is a much larger burden placed on validating or reconciling meter level data.[119] This method is adopted by CAISO, NYISO, MISO, and SPP.[120]

The biggest discussion around submetering occurred within the ISO-NE compliance filing. ISO-NE argued that submetering could result in data quality issues, while multiple stakeholders countered that not allowing submetering would severely limit wholesale market participation of behind-the-meter DERs. This was such a contentious issue that FERC initially rejected ISO-NE's proposal to restrict submetering, requiring that ISO-NE further explain why its proposal was just and reasonable or propose alternative tariff revisions. In a subsequent compliance filing, ISO-NE reinforced its arguments, stating why its proposal was necessary and not an undue barrier, and it discussed the steps contemplated to avoid imposing burdensome costs on DER.[121] Specifically, ISO-NE noted that its proposal used existing metering infrastructure, including retail delivery point meters that may already monitor interval data to reduce costs associated with metering. Additionally, ISO-NE noted that alternatives such as parallel metering are deemed necessary, and the inability of resources to participate because of necessary hardware reflects cost-effectiveness rather than an undue barrier.[122] FERC ultimately approved ISO-NE's proposal.

Other RTO/ISOs seemed more willing to accept the potential for data quality risks, and submetering did not come up in filing documents. One of the important arguments that ISO-NE used to justify its restriction of submetering was that retail delivery point meters already exist and can be used to collect necessary data and eliminate the need to install additional hardware. These retail delivery point meters are owned by distribution utilities and are under the jurisdiction of the retail regulators. For cost savings to be fully realized, retail regulators must ensure that robust data sharing exists so that this metering infrastructure can also be used to send data to RTO/ISOs for wholesale market operations.[123]

[118] For example, SPP 186 FERC ¶ 61,162 at paragraph 277
[119] Reconciling meter data involves validating, comparing, and aligning energy consumption or production data from different sources, such as utility meters, third-party meters, or system forecasts, to ensure accuracy, resolve discrepancies, and create a consistent record for billing, settlement, or regulatory compliance in energy markets.
[120] CAISO 179 FERC ¶ 61,197 at paragraph 54; NYISO 179 FERC ¶ 61,198 at paragraph 58; MISO 185 FERC ¶ 61,011 at paragraph 201; SPP 186 FERC ¶ 61,162 at paragraph 277
[121] ISO-NE 185 FERC ¶ 61,095 at paragraph 43
[122] ISO-NE 185 FERC ¶ 61,095 at paragraph 48
[123] For example, ISO-NE 185 FERC ¶ 61,095 at paragraph 45

Table C-2. Advantages and disadvantages of RTO/ISO approaches: Submetering

Approach	Advantages	Disadvantages
Prevent submetering	More accurately measures the DER's impact on the grid, ensures no double counting, and places a lower administrative burden on utilities to audit and reconcile master metered data.[124]	DER advocates argue that it severely limits the participation of behind-the-meter DERs in the market.[125]
Allow submetering	Since nearly all behind-the-meter DER record operations are using a submeter, using this as a source of wholesale marked data would eliminate the need to install costly hardware alternatives. DER advocates argue that demand reduction is the same regardless of increases or decreases with load, as long as loads act independently, and therefore there is no issue with submetering.[126]	RTO/ISOs state that even after auditing, it can be difficult to ensure that energy measurements at the submeter level correspond to energy measurements at the point of grid interconnection, and inaccuracies can result in double counting, inaccurate dispatch measurements, and the potential to game the system.[127]

C-2. Participation model

Order 2222 requires each RTO/ISO to have tariff provisions that allow DER aggregations to participate directly in RTO/ISO markets. This may include one or more participation models that accommodate the physical and operational characteristics of DER aggregations. In the context of Order 2222, "participation model" refers to the rules that define how DER aggregations are allowed to bid into wholesale markets. FERC's primary requirement for RTO/ISOs when establishing participation models is that DER aggregations should be able to offer into the wholesale market all services that they are technically capable of providing.[128] Ultimately, RTO/ISOs faced three major design choices when developing participation models for aggregations: (a) market participation rules, (b) services provided from DER aggregations, and (c) market monitoring rules.

a. Market participation rules

Approaches to establishing market participation rules for DER aggregations vary according to the extent to which they rely on existing or new models. The spectrum of solutions for market participation rules ranges from using existing models to using a newly designed model, specific for DER aggregations in tandem with existing models (Figure C-3). The advantages and disadvantages of these solutions are summarized in Table C-3.

[124] For example, ISO-NE Compliance Filing 1 pp. 33–35
[125] For example, ISO-NE 182 FERC ¶ 61,137 at paragraph 125
[126] For example, ISO-NE 182 FERC ¶ 61,137 at paragraphs 146–149
[127] For example, ISO-NE 182 FERC ¶ 61,137 at paragraphs 146–149
[128] Order No. 2222, 172 FERC ¶ 61,247 at paragraph 130

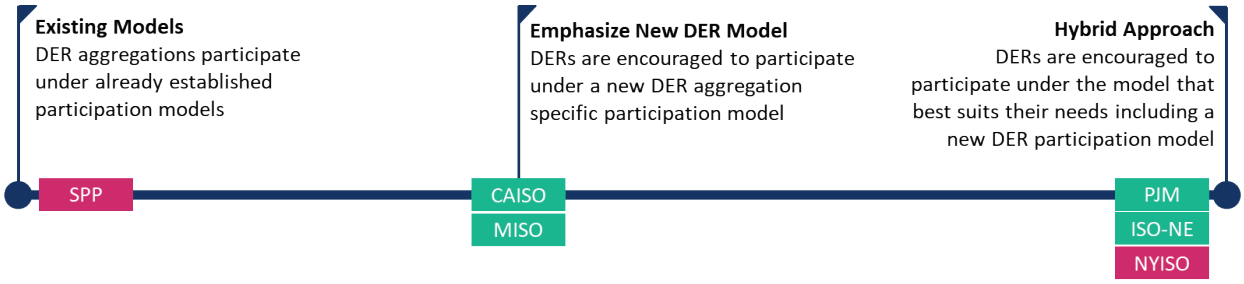

Figure C-3. Spectrum of market participation rules. *Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance. As of January 2025, NYISO has filed an additional compliance filing addressing small issues within its prior filings, but FERC has not yet responded.*

On one end of the spectrum, RTO/ISOs can use an **existing model**, designed for traditional resource types, to allow DER aggregations to participate. In their filings, RTO/ISOs note that nearly all DER aggregation market participation can already be accommodated through existing participation models.[129] For example, ISO-NE noted that any DER aggregations that need to inject and withdraw energy, regardless of whether they actually contain an individual storage DER, could be integrated into the market through its existing storage participation models.[130] SPP initially proposed relying exclusively on existing participation models, though FERC found that the approach would not provide enough flexibility for heterogeneous aggregations because it could not accommodate aggregations that both inject energy and provide DR.[131]

On the other end of spectrum, RTO/ISOs can **develop a DER aggregation-specific participation model in addition to encouraging the continued use of existing participation models**. This would ensure at least one participation model can accommodate all DER aggregations (e.g., heterogeneous aggregations with solar, storage, and DR), but also allow for aggregations to participate in other pre-existing participation models if additional requirements are met (e.g., solar-only aggregations can participate as an intermittent resource). Allowing for the choice of different participation models enables market participants to select the models that best suit individual DERs in an aggregation and the operational characteristics of the aggregation as a whole. For example, an aggregator could aggregate only solar resources to have intermittent resource rules applied to its resource, rather than have generic DER aggregation rules applied.[132] Some RTO/ISOs, such as NYISO, require that any homogeneous DER aggregation must participate under the existing rules for that resource type if eligible, as opposed to the more generic DER aggregation participation model, because these rules are more aligned with operational characteristics.[133] NYISO, ISO-NE, and PJM have adopted this flexible approach.[134]

[129] While nearly all DER aggregations can participate in wholesale markets using existing participation models, there are still complex heterogeneous DERs that would be unable to provide all services that they are technically capable of providing within existing participation models.
[130] ISO-NE 182 FERC ¶ 61,137 at paragraph 44
[131] SPP 186 FERC ¶ 61,162 at paragraph 104
[132] For example, NYISO Compliance Filing 1, p. 21
[133] NYISO 179 FERC ¶ 61,198 at paragraphs 68 and 78
[134] NYISO Compliance Filing 1, pp. 15-21; ISO-NE Compliance Filing 1, pp. 10–24; PJM Compliance Filing 1, p. 24

As a third approach, an RTO/ISO can **develop a DER aggregation-specific participation model and discourage continued use of existing participation models**. While an RTO/ISO would not preclude a DER aggregation from participating under existing participation models if it is technically eligible to participate, the new model developed with Order 2222 requirements in mind would better enable DERs to provide all services they are technically capable of providing. For example, MISO's proposal does not prevent DERs from participating in existing participation models primarily designed for DR resources, but it emphasizes that these participation models are distinct from the newly proposed DER aggregation model and that existing DR models have more restricted wholesale participation opportunities.[135] CAISO has adopted this approach, and it has been proposed by MISO.[136]

Despite some RTO/ISOs' attempts to solely use existing participation models for compliance, FERC has generally not agreed that they satisfy Order 2222's requirement that DERs can provide all services they are technically capable of providing through aggregation. This has pushed all RTO/ISOs to introduce a new market participation model specific to DER aggregations in order to come into compliance. RTO/ISOs are divided on whether all DER aggregations need to operate exclusively within a new model or whether other pre-existing market participation models are also available to DER aggregations. In some cases, such as MISO, there are existing participation models that allow DER aggregations to participate in wholesale markets in a limited fashion (e.g., as DR), but the intent is for all new DER aggregations to participate through a new model that more fully accounts for the capabilities of DER aggregations.[137] In other markets such as NYISO, additional participation models can enhance DER aggregation options, and there is a greater emphasis on ensuring that each DER aggregation is subject to the most appropriate market rules.

Table C-3. Advantages and disadvantages of market participation rules

Approach	Advantages	Disadvantages
Existing models	Existing models maintain market status quo and do not create new participation models that could be costly, disruptive, and/or slow to implement.	Existing models may not be sufficient to allow all types of heterogeneous DER aggregation to provide all services they are technically capable of providing.
Emphasize new DER model	Does not rely on existing participation models and therefore is not bound to any participation limitations within the existing models. All DER aggregations are subject to the same set of rules. Individual DERs can be added and removed without concern of losing eligibility to participate under the current participation model.	DER aggregations are subject to a single set of participation rules that may not be best suited for all compositions of DER aggregations (e.g., solar only vs. solar plus storage).

[135] MISO 185 FERC ¶ 61,001 at paragraph 113 and 193. Restrictions include bulk commitment and only able to act as price takers in the market.
[136] CAISO 179 FERC ¶ 61,197 at paragraph 49; MISO Compliance Filing 1, p. 5.
[137] MISO 185 FERC ¶ 61,011 at paragraphs 113 and 193

Hybrid Approach	DER aggregators have the flexibility to use the market rules most appropriate for their DER aggregation.[138] Ensures that homogeneous aggregations are not treated differently than stand-alone assets of the same type (e.g., solar farm vs. an aggregation of only rooftop solar).[139]	DER aggregators could decline to include certain individual DERs to maintain eligibility under specific market participation models (e.g., reject a storage DER to still participate as an intermittent resource).[140] Adding individual DERs could require a re-registration of an existing DER aggregation under a more generic participation model if it no longer qualifies for its current participation model.[141]

b. Services provided from DER aggregations

RTO/ISOs must establish which services each DER aggregation can provide. The spectrum of solutions ranges from using the least capable individual DER to using a weighted average of individual DER capabilities to determine the services an aggregation can provide (Figure C-4). The advantages and disadvantages of these solutions are summarized in Table C-4.

Figure C-4. Spectrum of services provided from DER aggregations. *Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance.*

On one end of the spectrum, RTO/ISOs can use the **least capable individual DER,** meaning that a DER aggregation's services are restricted to the services that can be provided by the least capable resource. For example, an aggregation could only provide regulation services if every individual DER could provide regulation services.[142] NYISO initially proposed this approach, but FERC found that this was too restrictive.[143]

On the other end of the spectrum, RTO/ISOs could use the **weighted average of individual DER capabilities.** With this approach, RTO/ISOs consider the underlying makeup of individual DERs and their capabilities when determining the services an aggregation is allowed to provide. The amount of each service an aggregation can provide is a weighted average of all individual DER capabilities. For example,

[138] For example, NYISO 179 FERC ¶ 61,198 at paragraph 84
[139] For example, NYISO Compliance Filing 1, p. 21
[140] For example, NYISO 179 FERC ¶ 61,198 at paragraphs 74–75
[141] Ibid.
[142] For example, NYISO Compliance Filing 1, p. 16
[143] NYISO 179 FERC ¶ 61,198 at paragraphs 92-93

an aggregation comprising one 5-MW solar array with a capacity accreditation of 50% and a 1-MW storage asset with a capacity accreditation of 80% would be able to provide 1.8 MW of capacity into the wholesale capacity market. All RTO/ISOs are proposing this approach.[144] This is the only approach that complies with FERC's requirement that each DER is able to provide all services that they are technically capable of providing through aggregation.[145]

Table C-4. Advantages and disadvantages of services provided from DER aggregations

Approach	Advantages	Disadvantages
Least capable resource	Ensures that regardless of which individual DER is called upon, it can meet the required operational constraints and prevent any reliability concerns.[146]	Advocacy groups and FERC determined that this would prevent aggregations from providing all services they are technically able to provide.[147]
Weighted average	Most inclusive approach toward eligibility to provide services.	There is no guarantee that the aggregation can provide highly regulated services, like regulation ancillary service products, at the aggregation level if certain individual DERs are unable to provide that service.[148]

c. Market monitoring rules

RTO/ISOs must determine the level of market monitoring necessary to ensure DER aggregations are not able to manipulate the market and wholesale prices.[149] The spectrum of solutions ranges from requiring market monitoring for all aggregators to allowing reduced oversight for smaller aggregators (Figure C-5). The advantages and disadvantages of these solutions are summarized in Table C-5.

[144] ISO-NE 182 FERC ¶ 61,137 at paragraph 63; CAISO 179 FERC ¶ 61,197 at paragraph 49; PJM 182 FERC ¶ 61,143 at paragraph 53; MISO 185 FERC ¶ 61,011 at paragraph 33; SPP 186 FERC ¶ 61,162 at paragraph 102

[145] NYISO 179 FERC ¶ 61,198 at paragraph 93

[146] For example, NYISO 179 FERC ¶ 61,198 at paragraph 80

[147] For example, NYISO 179 FERC ¶ 61,198 at paragraph 76

[148] FERC believes that NYISO can address its reliability concerns by means other than requiring that all individual DERs within an Aggregation satisfy relevant reliability requirements. See FERC ¶ 61,198 at paragraphs 92–93.

[149] Market monitoring provisions in wholesale energy markets are mechanisms designed to ensure transparency, competitiveness, and compliance with market rules by detecting and mitigating anti-competitive behavior, such as market manipulation or abuse of market power. These provisions are typically implemented by independent market monitors or regulatory bodies, which analyze market operations, investigate anomalies, and recommend corrective actions to maintain fair and efficient market functioning.

Figure C-5. Spectrum of approaches to market monitoring. *Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance.*

On one end of the spectrum, RTO/ISOs can require **market monitoring for all aggregations** by treating all DER aggregations in the same manner, regardless of size or makeup, and requiring them to adhere to the same market monitoring provisions. This approach was approved for CAISO, NYISO, and ISO-NE.[150] On the other end of the spectrum, RTO/ISOs can **reduce market oversight** of smaller aggregations that are below a certain size threshold, exempt certain DER aggregations (like those that are co-located with retail load), or provide simplified default mitigation measures that can be applied across the board for all small aggregations.

PJM, SPP, and MISO initially proposed reduced oversight for smaller DERs and DER aggregations, citing an opportunity to reduce administrative costs for smaller DER aggregations.[151] However, FERC rejected these proposals, stating that changes to market monitoring provisions were outside the scope of Order 2222 and that DER aggregations must be able to meet the current qualifications and performance requirements to provide the services that they are offering into wholesale markets. FERC stated that it was in favor of a consistent market oversight approach for all aggregations regardless of size or makeup.

[150] CAISO 179 FERC ¶ 61,197 at paragraph 40; NYISO does not mention specific market monitoring requirements for aggregations; ISO-NE Compliance Filing 1 p. 42

[151] PJM 182 FERC ¶ 61,143 at paragraph 87; SPP 186 FERC ¶ 61,162 at paragraph 106–109; MISO 185 FERC ¶ 61,011 at paragraph 34; MISO exempts all resources less than 10 MW from market monitoring provisions.

Table C-5. Advantages and disadvantages of market monitoring approaches

Approach	Advantages	Disadvantages
Market monitoring for all	Lowest risk for market manipulation because all market participants, regardless of size, can manipulate prices and cause market outcomes that are non-competitive.	RTO/ISOs note that this approach could stifle the development of cost-effective DERs and increase administrative burden, particularly for small DER aggregations.[152]
Reduced oversight	Reducing oversight can reduce costs. This may be an acceptable risk since smaller resources are less likely to have market power.[153]	Utilities, industry advocates, and independent market monitors themselves note that even small market participants can influence prices. Since aggregators have control over the size of aggregations, a malicious actor could design a set of small aggregations to avoid market power review.[154]

C-3. Locational Requirements

In the context of Order 2222, "locational requirements" refer to rules that determine the footprint across which DERs can participate in a single aggregation. Historically, each generating asset participating in the wholesale market has been located at a single interconnection point, which makes it simple for the RTO/ISO to provide dispatch instructions and compensate assets based on their location on the grid.

Forcing all DERs in an aggregation to be located at a single pricing node would fit most cleanly into this existing construct and would be easiest for RTO/ISOs to implement, but this approach is restrictive and could prohibit DER participation at market pricing locations where there are not many DERs present.

Alternatively, allowing DERs to aggregate across entire markets would make it challenging to accurately compensate aggregations for wholesale services, could distort market pricing signals, and could create operational challenges. For example, an aggregation that has DERs located on opposite sides of a system constraint might receive a dispatch instruction in order to alleviate system congestion. A DER on the "wrong" side of the constraint potentially could exacerbate the congestion rather than alleviating it.[155]

No stakeholder has argued for geographically unlimited aggregation. At the same time, FERC has rejected all single-node aggregation proposals due to their restrictive nature. As such, all approaches to locational requirements fall between the two extremes, with some price node grouping and flexibility, while also imposing guardrails to maintain system stability.

[152] For example, PJM 182 FERC ¶ 61,143 at paragraph 74
[153] For example, PJM 182 FERC ¶ 61,143 at paragraph 73
[154] For example, MISO 185 FERC ¶ 61,011 at paragraph 39
[155] For example, SPP 186 FERC ¶ 61,162 at paragraph 195

a. Individual DER locational requirements

The spectrum of approaches to locational requirements ranges from those that work within existing market structures and prevent or limit aggregations from spanning more than one node, to allowing DERs to aggregate across multiple nodes with similar pricing (Figure C-6). The advantages and disadvantages of these solutions are summarized in Table C-6.

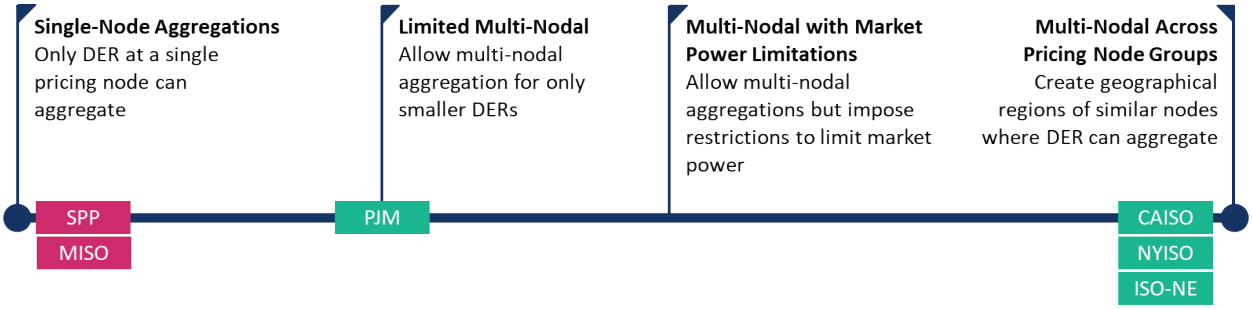

Figure C-6. Spectrum of DER locational requirements. *Red indicates that an RTO/ISO is not in compliance. Green indicates that an RTO/ISO is in compliance.*

On one end of the spectrum, RTO/ISOs can permit only **single-node aggregations**. This approach preserves much of the status quo and preserves how assets currently operate in the wholesale market. FERC has acknowledged RTO/ISO concerns that multi-nodal aggregation may make it more difficult to reliably manage congestion but has rejected this single-node approach as too inflexible in all markets where it was initially proposed, including PJM, SPP, and MISO.[156]

On the other end of the spectrum, RTO/ISOs can allow **multi-nodal aggregation across pre-defined pricing node groups**. The ultimate goal of this approach is to create broad geographical regions of similar pricing nodes and make these as large as possible to maximize DER aggregation opportunities without increasing system operating risk beyond an acceptable threshold. This was the broadest geographical approach considered by RTO/ISOs, FERC, and stakeholders, given that complete geographic flexibility would lead to more DER aggregation opportunities but would significantly increase operating risk. Pricing node groups would minimize inter-zonal congestion between pricing nodes in the groups, reduce operational risk, and improve pricing signals while still allowing multi-nodal aggregations. Specifically, pricing node groups could be defined by transmission and distribution load pockets, boundaries between transmission districts or utilities, and the design of distribution system substations.[157] Changes to pricing node groups as the system topography changes would be reported with sufficient time for DER aggregators to respond and update individual DER in each aggregation.[158] CAISO, NYISO, and ISO-NE use this approach.[159]

[156] PJM 182 FERC ¶ 61,143 at paragraph 185; SPP 186 FERC ¶ 61,162 at paragraph 221; MISO 185 FERC ¶ 61,011 at paragraph 133
[157] For example, NYISO Compliance Filing 2 p. 11
[158] For example, NYISO 179 FERC ¶ 61,198 at paragraph 149
[159] CAISO Compliance Filing 1 p. 17; NYISO Compliance Filing 1 pp. 25–27; ISO-NE Compliance Filing 1 pp. 25–27

There are two additional strategies for defining locational requirements. First, RTO/ISOs can **allow multi-nodal aggregations only for smaller DERs**, such as those smaller than 100 kilowatts. Larger DERs would only be allowed to participate in a multi-nodal aggregation if small DERs on their own are unable to meet minimize sizing requirements. Additionally, the RTO/ISO can impose additional restrictions that will ensure system reliability and limit market power such as a requirement to self-schedule and a cap on total multi-nodal participation at some limited amount of total system load. This was a compromise proposal by PJM and approved by FERC after their initial single-node aggregation proposal was rejected.[160]

Second, RTO/ISOs can **allow multi-nodal aggregation but impose market participation restrictions** to ensure aggregations have limited market power. These restrictions could include (1) no commitment requirements (i.e., assets do not always have to be available for dispatch), thereby reducing a DER aggregation's ability to manipulate prices by withholding supply or strategically bidding to inflate prices, (2) setting a price offer cap (i.e., $1,000 per megawatt-hour), which prevents aggregations from inflating prices, (3) dispatch and settlement based on zonal price rather than more granular nodal prices, diluting the impact of individual aggregations on price, and (4) uplift payments that would cover operating costs and reduce incentives to inflate prices or exploit market power to secure higher payments. These limitations are all based on existing DR aggregation models. This was proposed by a DER advocate in the PJM filing as a standalone alternative, but an RTO/ISO could utilize these strategies to limit market power in tandem with a different approach.[161]

The RTO/ISOs have taken a wide range of approaches to locational requirements, with three (CAISO, NYISO, and ISO-NE) adopting pricing node groups and the other three (PJM, SPP, and MISO[162]) proposing a more restrictive single-node aggregation approach. PJM is a notable standout because, despite stakeholder pressure, it has received FERC approval without aligning with the other three RTO/ISOs currently in compliance. PJM's approved approach may serve as a model for the remaining RTO/ISOs seeking approval without developing pricing node groups.

PJM's subsequent compliance filing softened its language on locational requirements to allow some flexibility for smaller DERs to aggregate across multiple pricing nodes, but it re-emphasized that a single-node aggregation framework was still the only technically feasible option for DER aggregations containing large individual DERs, and the only option at scale.[163] PJM argued that constraint control would be compromised otherwise, and multi-nodal aggregations would make it more challenging to maintain accurate nodal LMPs. To support this view, PJM opted to provide a detailed technical analysis of its system topography exploring congestion within its system.[164] Some stakeholders critiqued the analysis as cherry-picking results, since it focused on maximum observed congestion instead of average, but PJM was able to receive FERC approval without aligning with all other RTO/ISO proposals.[165]

[160] PJM 188 FERC ¶ 61,076 at paragraph 170
[161] PJM 182 FERC ¶ 61,143 at paragraph 179
[162] For example, MISO 185 FERC ¶ 61,011 at paragraph 119
[163] PJM Compliance Filing 4 p. 20
[164] PJM Compliance Filing 4 pp. 22–28
[165] PJM 188 FERC ¶ 61,076 at paragraph 56–60 and 70–78

Table C-6. Advantages and disadvantages of DER locational requirements

Approach	Advantages	Disadvantages
Single-node aggregations	• Favored by some RTO/ISOs because it fits cleanly into existing market optimization engines, increases accuracy of pricing, and allows for greater visibility and operational awareness into market conditions.[166] • RTO/ISOs argue that no two pricing nodes are exactly the same, and therefore, allowing aggregation at more than one node creates potential for inaccurate market dispatch instructions and incorrect pricing.[167] • Particularly as DER aggregations increase in number, single-node aggregations do not increase market complexity in the same way that multi-nodal aggregations could.[168] • Utilities and market monitors are in favor of this simpler approach, especially in early states of DER implementation when their role and safety record in wholesale markets is still uncertain.[169]	Early stages of DER adoption may lead to insufficient levels of capacity within single nodes, effectively prohibiting participation. Clean energy advocates argue that this approach is overly restrictive and that some trade-offs of operational awareness are needed to enable DER participation.[170]
Allow multi-nodal aggregations only for only smaller DERs	Very similar advantages to a single-node aggregation approach but with increased DER flexibility for small DERs and for DERs at individual nodes where there is insufficient DER capacity to reach aggregation size requirements for participation.	Generally, stakeholders did not favor this compromise approach, as utilities and the market monitor felt that it was too expansive and clean energy advocate groups felt that it was still too limiting.[171]
Allow multi-nodal aggregation but impose restrictions	Enables multi-nodal aggregation while ensuring that some operational risks associated with multi-nodal aggregations are addressed.	Multi-nodal aggregations would have operational restrictions, operating more like DR with limited opportunities in wholesale markets.
Allow multi-nodal aggregation across pre-defined pricing node groups	• Mitigates inter-zonal congestion between individual DERs, reduces operational risk, and improves pricing signals while still allowing multi-nodal aggregations. • Mitigates risk associated with individual DERs responding to dispatch instructions and contributing to congestion as a result.	Pricing node groups need to be updated occasionally to account for changing system conditions that may require an aggregation to re-register. If a DER is no longer in the same pricing node group, it will not be able to participate in the same aggregation.[172]

[166] For example, MISO 185 FERC ¶ 61,011 at paragraph 111
[167] For example, PJM Compliance Filing 4 pp. 22–31
[168] For example, PJM Compliance Filing 4 pp. 20–21
[169] For example, PJM 182 FERC ¶ 61,143 at paragraphs 176–177 and PJM 188 FERC ¶ 61,076 at paragraph 61
[170] For example, PJM 188 FERC ¶ 61,076 at paragraph 56
[171] Id. at paragraphs 61–66, 73
[172] For example, NYISO 179 FERC ¶ 61,198 at paragraph 142

Appendix D: RTO/ISO approaches to Compliance and Implementation Issues

Table D-1 summarizes the range of approaches being used by RTO/ISOs to address the six Compliance and Implementation Issues in Order 2222, as discussed above. The approaches generally can be organized on a spectrum, with options to minimize constraints on DER development on one end, and options to maximize control for the RTO/ISO on the other end. We indicate which approaches have been approved by FERC for each market.

Table D-1. Approaches to address Compliance and Implementation Issues in Order 2222

	Key challenge	Why it matters	Encourage aggregation participation	Encourage status quo	Additional options
Double counting (Section 4.1)	Services provided from DER aggregations	Allowing aggregations to participate in both retail programs and the wholesale market facilitates "value stacking" but requires eligibility limits to avoid double compensation for the same service.	Allow dual participation except for identical services or services where there is overlap. (All markets)	Prevent all wholesale market participation for DERs participating in a retail program.	Allow DER aggregations to switch between retail and wholesale programs, or allow participation in both markets but only compensate for services in one market.
	Overruling default restrictions	Allowing the distribution utility to override RTO/ISO restrictions on dual participation in accordance to relevant retail regulation allows for more nuanced consideration of individual DER benefits but also could lead to unintentional double counting.	Allow for exceptions to RTO/ISO general rules prohibiting dual participation (PJM)	Do not allow for exceptions to RTO/ISO rules prohibiting dual participation (CAISO, MISO, NYISO, ISO-NE, SPP)	N/A
Role of the distribution company (Section 4.2)	Distribution review process	Creating strict guidelines for approving/rejecting DER participation that are both detailed and transparent would ensure that distribution utilities are applying identical and appropriate evaluation criteria to all DER; however, flexibility for distribution utilities allows for determinations that accommodate unique needs of their local system.	RTO/ISO provides detailed oversight to distribution utilities when determining whether an individual DER is eligible to participate in an aggregation.	RTO/ISO gives utilities complete flexibility to make determinations about DER eligibility. (SPP)	RTO/ISO provides limited/high-level guidance to distribution utilities, with utilities and retail regulators making the final approval/rejection decision. (CAISO, NYISO, PJM, ISO-NE, MISO)
Ongoing coordination (Section 4.3)	Override requirements	Expectations for ongoing coordination include defining the criteria through which a utility may override DER participation in an aggregation participating in wholesale services.	RTO/ISOs establish specific circumstances when RTO/ISO dispatch instructions can be overridden by a distribution utility.	Give utilities and retail regulators broad control over criteria that would result in override. (PJM, MISO)	RTO/ISO establishes thresholds that need to be met before dispatch instructions can be overridden. (CAISO, NYISO, ISO-NE, SPP)

	Key challenge	Why it matters	Encourage aggregation participation	Encourage status quo	Additional options
Metering & telemetry (Section 4.4)	Telemetry requirements	Requiring more advanced telemetry at the aggregation level (i.e., measuring real-time performance) allows system operators to monitor and manage the grid but can be burdensome for individual, small DERs.	Only require telemetry for DER aggregations above a certain size or for DERs providing ancillary services (CAISO, PJM).	Require telemetry for each aggregation, which may indirectly require telemetry for each individual DER (MISO, SPP, ISO-NE).	Only require telemetry for larger component DERs (NYISO).
Additional metering & telemetry (Appendix C-1)	Actual readings vs. sampling	Requiring reporting of actual telemetry readings provides the highest degree of accuracy in DER performance data, but sample-based calculations or reporting at the aggregation level reduce the administrative burden and may expand the pool of eligible DERs.	Telemetry readings can be calculated based on a sample of DERs (CAISO, NYISO, PJM, SPP, MISO).	Telemetry reading must be empirical for all assets (ISO-NE).	Allow third-party scheduling coordinators to measure telemetry data (CAISO, NYISO, MISO, SPP).
	Submetering	While many DERs have built-in mechanisms to measure and report gross electricity consumption and output, these measurements may not reflect the impact of the DER's net output or actual impact on the power grid.	Allow submetering as the basis for measuring DER output and compensating for market services (SPP, CAISO, NYISO, MISO).	Do not allow submetering unless the DER acts only as demand response, the entire customer participates as a single asset, or parallel metering is used to validate the submetering data (ISO-NE, PJM).	N/A
Participation model (Appendix C-2)	Market participation rules	Market participation rules that are designed to accommodate each unique aggregation of DERs can make market participation more dynamic but can be more complex for aggregators to navigate compared to a single new market participation model.	Create a new DER aggregation model while still making existing models available. Encourage DER aggregators to use the participation model that best aligns with an aggregation's operational characteristics (NYISO, ISO-NE, PJM).	Require DER aggregations to participate using only existing market rules (SPP proposed, but FERC rejected).	Encourage DER aggregators to use a new set of market participation rules specifically for DER aggregations, as opposed to existing models (CAISO, MISO).

	Key challenge	Why it matters	Encourage aggregation participation	Encourage status quo	Additional options
	Services provided from DER aggregations	Limiting the services that a DER aggregation is allowed to provide reduces the monetizable value of the DER aggregation.	Allow DER aggregation to provide any service that can be provided from a given DER within the aggregation (all markets).	DER aggregation is only eligible to provide the services that the least flexible DER in the aggregation is capable of providing.	N/A
	Market monitoring	Strict market monitoring requirements reduce the risk that DER aggregations exercise market power, but can be administratively burdensome and less relevant to small resources.	Reduce market oversight for smaller aggregations.	Subject DERs to the same requirements as any other asset participating in the market (CAISO, NYISO, ISO-NE, PJM).	N/A
Locational requirements (Appendix C-3)	Locational requirements	Aggregating DERs across multiple pricing nodes makes it easier for aggregators to scale their portfolios, but simultaneous dispatch of DERs in separate locations may exacerbate rather than relieve local congestion on the grid.	Allow aggregation of DERs across multiple pricing nodes (CAISO, NYISO, ISO-NE).	Allow only single-node aggregations.	Allow multi-nodal aggregation for small DERs with a cap (PJM) or allow multi-nodal aggregation with guardrails.