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Distributed Wind and Impacts of FERC Order No. 2222 Implementation

July 2024

Rebecca M Tapio
Danielle C Preziuso

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Summary

In September of 2020, the Federal Energy Regulatory Commission (FERC) issued Order No. 2222. This order directs Regional Transmission Organizations and Independent System Operators to adjust their long-standing tariffs and participation models to enable the operation of distributed energy resource (DER) aggregators in wholesale energy markets. The rule aims to bring wholesale markets under its jurisdiction in line with the expansion of DERs across the United States and to capture the potential benefits that these technologies can provide.

Order No. 2222 defines DERs as “any resource located on the distribution system, any subsystem thereof or behind a customer meter,” including but not limited to “electric storage resources, distributed generation, demand response, energy efficiency, thermal storage, and electric vehicles and their supply equipment (FERC 2020).” To best anticipate new types of distributed energy technologies that may emerge in the future, the rule was written as technology agnostic. Given the broad definition of DERs under Order No. 2222, the realm of benefits that can be created and compensated could vary based on individual technology characteristics.

This report describes the current implementation of FERC Order No. 2222 and the compliance plans that have been submitted so far. We attempt to understand the potential impact the rule may have on distributed wind and provide opportunities for future work to analyze and encourage deployment under these policy conditions.

While Order No. 2222 is agnostic on the technologies that make up an aggregation, there is an information gap for the type of market interactions distributed wind may have or how it could be best deployed in DER aggregations under future market conditions. There is significant potential for profitable deployment of distributed wind in states that are served by ISOs and covered under Order No. 2222.

Distributed wind and other distributed generation technologies provide local energy and avoid losses typically associated with long-distance energy transmission. Deployment of distributed wind can benefit communities by providing local, clean, and affordable energy. Aggregating DERs that include distributed wind could additionally provide these benefits across multiple far-ranging communities if they have access to participate in wholesale markets.

A new baseline valuation of distributed wind in areas covered by Order No. 2222 is required to accurately gauge where it is profitable and how it can compete or complement existing or future DER deployment, including as part of an aggregate.

Acknowledgments

The authors would like to thank the U.S. Department of Energy's Wind Energy Technologies Office (WETO) for their support of this work and Brittany Tarufelli, Brent Eldridge, Lindsay Sheridan, Jay Barlow, Daniel Boff, Juliet Homer, and Jessica Shipley for their support in developing this report.

Acronyms and Abbreviations

BTM	behind the meter
CAISO	California Independent System Operator
DER	distributed energy resource
ERCOT	Electric Reliability Council of Texas
FERC	Federal Energy Regulatory Commission
FTM	front of the meter
ISO	Independent System Operator
ISO-NE	Independent System Operator New England
MISO	Midcontinent Independent System Operator
NYISO	New York Independent System Operator
PJM	PJM Interconnection
RTO	Regional Transmission Organization
SPP	Southwest Power Pool

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1.0 Introduction

Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs), collectively referred to as ISOs in this report, are responsible for maintaining competitive neutrality in wholesale electricity markets and regional transmission system reliability. Competitive neutrality describes the prevention of price manipulation by the owners of transmission assets, who have a monopoly over their use (IEA 2001). ISOs operate and maintain competitive neutrality in a number of different markets within their regions, depending on whether the state is partly or fully deregulated (Cleary and Palmer 2020; FERC 1996). ISOs are also responsible for managing the reliability of the transmission system in their region and providing equal access to the electrical grid (NGA 2023). ISOs in North America (Figure 1.1) are, with one exception,[1] subject to regulation by the Federal Energy Regulatory Commission (FERC), which has in recent years engaged in a number of rulemakings to support market conditions for clean energy technology.

In September of 2020, FERC issued Order No. 2222, directing ISOs to adjust their long-standing tariffs and participation models to enable the operation of distributed energy resource (DER) aggregators in wholesale energy markets (FERC 2020).The rule aims to bring wholesale markets under its jurisdiction in line with the expansion of DERs across the United States and to capture the potential benefits that these technologies can provide.

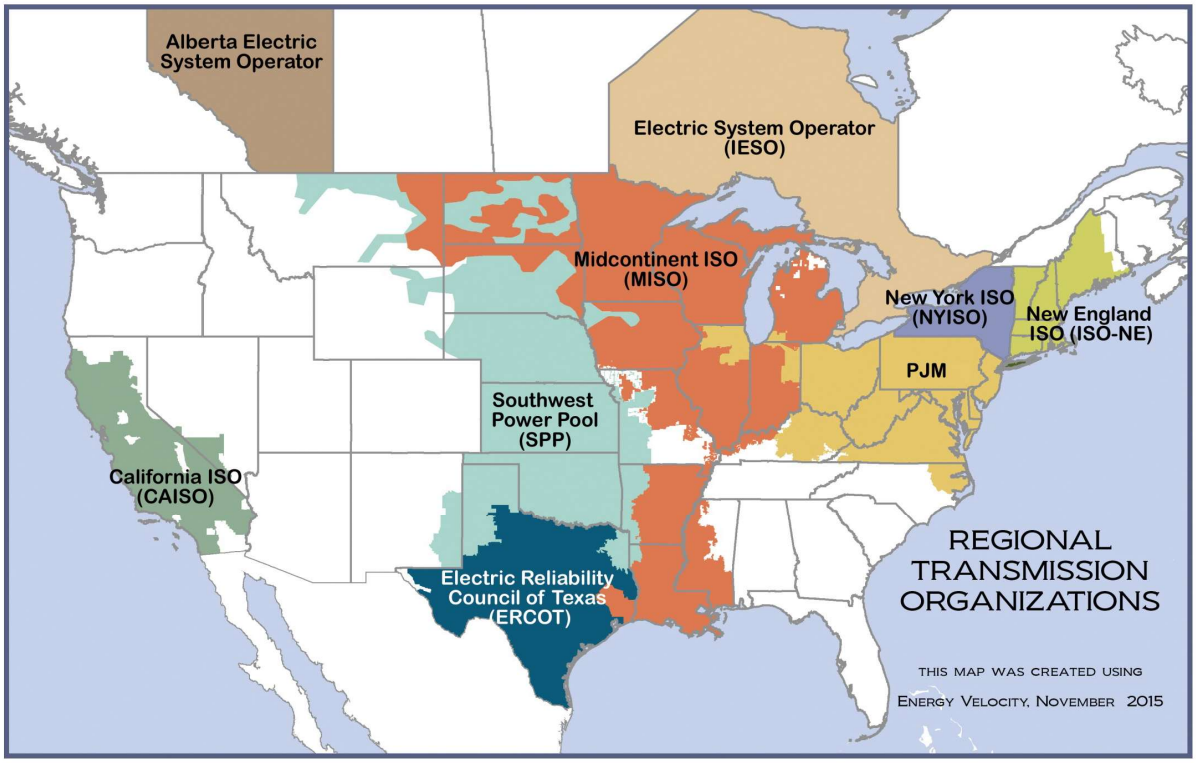

Figure 1.1 Map of Regional Transmission Organizations/Independent System Operators (FERC 2015)

[1] The Federal Power Act grants FERC the authority to regulate energy sales in interstate commerce and limits that authority when sales remain within a single state. The Electric Reliability Council of Texas (ERCOT) operates entirely within the Texas Interconnection and thus remains outside FERC's jurisdiction (U.S.C. 1920; Rod Walton 2022).

Order No. 2222 defines DERs as “any resource located on the distribution system, any subsystem thereof or behind a customer meter,” including but not limited to “electric storage resources, distributed generation, demand response, energy efficiency, thermal storage, and electric vehicles and their supply equipment (FERC 2020).” To best anticipate new types of distributed energy technologies that may emerge in the future, the rule was written as technology agnostic. Given the broad definition of DERs under Order No. 2222, the realm of benefits that can be created and compensated could vary based on individual technology characteristics.

While solar photovoltaics, demand response, electric vehicles, and battery storage have all been acknowledged as important DERs under Order No. 2222 (Zhou, Hurlbut, and Kaifeng 2021), there is an information gap for distributed wind energy technologies. Distributed wind turbines are DERs connected at the distribution system serving specific or local loads, thus meeting FERC’s definition of a DER under Order No. 2222 (Orrell et al. 2023). The vast majority of distributed wind capacity currently deployed in the United States is located in areas served by ISOs and therefore covered under Order No. 2222. There is also significant potential for profitable distributed wind deployment across many states served by ISOs, creating a need to understand the type of market interactions distributed wind may have or how it could be best deployed in DER aggregations under future market conditions.

In this report, we describe the implementation of FERC Order No. 2222 and the compliance plans that have been submitted so far, attempt to understand the potential impact the rule may have on distributed wind, and provide opportunities for future work to analyze and encourage deployment under these policy conditions. This report provides an update to *FERC Order No. 2222 and Considerations for Distributed Wind* (Tapio and Orrell 2023).

2.0 Independent System Operators and Order No. 2222

ISOs serve two-thirds of the electricity load in the United States (FERC 2023). The service territories of ISOs in North America are not divided along state lines (Figure 1.1). The New York Independent System Operator (NYISO) and the Electric Reliabity Council of Texas (ERCOT) stay within the bounds of individual states, but others – New England ISO (ISO-NE), Midcontinent ISO (MISO), Southwest Power Pool (SPP), and the Pennsylvania-New Jersey-Maryland Interconnection (PJM) – cross state lines and, in many cases, operate in the same state as other ISOs (FERC 2015). Even the California ISO (CAISO) extends into Nevada. ERCOT is not subject to the regulatory authority of FERC because it operates entirely within the Texas Interconnection and does not engage in interstate energy transmission. As a result, ERCOT is not required to comply with Order No. 2222 (U.S.C. 1920; Rod Walton 2022).

The order was intended to allow heterogeneous, aggregated groups of DERs – which would individually be too small to meet minimum capacity requirements – to participate in wholesale markets operated by ISOs, including capacity, energy, and ancillary service markets. When grouped into an aggregation, these DERs could provide benefits such as load shifting, increased flexibility and power system capacity, non-wired alternatives, and voltage support to the grid, where previously they would have benefitted individual users (McDonnell et al. 2022). DERs can provide benefits across the electricity system, including reduced transmission congestion and lowered transmission infrastructure costs, lower emissions, and lower wholesale costs for several markets. Capturing these benefits via wholesale market participation rather than through retail markets, which currently have more enticing compensation, is a challenge (McDonnell et al. 2022).

To date, only one of the six ISOs under FERC jurisdiction – the California Independent System Operator (CAISO) – has had their compliance plan fully approved. The rest of the ISOs are at various stages of the compliance process. Though all have submitted an initial plan, they have been submitting responses and adjustments ever since. This delay has created significant uncertainty around the timing, technology, and processes that will be used by each ISO in coming years.

To enable DER participation in wholesale markets, ISOs are required to address a number of considerations for DER aggregations:

- Locational requirements
- Distributional factors and bidding parameters
- Information and data requirements
- Metering and telemetry requirements
- Coordination between the ISO, the aggregator, the distribution utility, and relevant electric retail authorities
- Modifications to the list of resources in a DER aggregation
- Market participation agreements for DER aggregators

Following the finalization of Order No. 2222, ISOs were required to submit initial compliance filings to FERC by July 19, 2021. To date, all ISOs have submitted their compliance plans and completed at least one round of additional edits in accordance with feedback from FERC.

The compliance process has been extensive and included a number of revisions between FERC and each ISO. For each compliance plan that ISOs filed with FERC, energy industry entities could submit comments or motions to request changes to the plan, the process or timing of judgement. The FERC commissioners responded to those entities and to compliance plans, often accepting some pieces of the plan and rejecting others. The commissioners would then require additional filings to address the pieces that were out of compliance. However, FERC's response time for ruling on compliance plans has varied greatly, and in some cases created confusion due to taking six months or more after the filing was submitted to be returned to the ISO (SPP 2024).

An informational filing from SPP on April 29, 2024, noted that the time between their previous filing and FERC's response on March 1st was 14 months (SPP 2024). The FERC ruling approved their original suggested compliance date, but in the most recent letter SPP stated that it would be impossible to comply with the original timing because in the interim they could not justify implementing a methodology without approval from FERC. Based on decisions in FERC's next response, they indicated they could comply within two to three years (SPP 2024).

There has been significant uncertainty throughout the Order No. 2222 implementation process due to the variable time it takes FERC to respond to filings. This level of uncertainty is a challenge not only for ISOs but also for DER deployment. Even CAISO, who had previous FERC-approved DER aggregation programs in place, has required changes to bring their tariffs and market regulations in line with Order No. 2222.

All ISOs have filed, but only CAISO has acquired approval of their compliance plans (Table 1). For previous actions between FERC and the ISOs, please see (Tapio and Orrell 2023) and (NARUC and NASEO 2023).

Table 1 Current status of ISO implementation of FERC Order No. 2222 as of July 2, 2024*

ISO	Current Status	Last Action Date	Docket Number	Detailed Notes
SPP	Informational filing submitted	6/28/24	ER22-1697	Submitted an informational filing stating that the 3rd quarter 2025 target effective date is no longer feasible. FERC responded to the April 2022 filing and October 2022 additional information request on March 1, 2024. They accepted the 2022 filing and that it partially complies with Order No. 2222. Due to changes and having not implemented any without an approved plan, they estimate that a single-nodal approach could be implemented 3 years from the date of a final order. In the event of a multi-nodal construct, extended timeline of another 2 years due to increased complexity. They moved to extend their compliance filing deadline until December 26, 2024.
CAISO	Second Compliance filing accepted	5/18/23	ER21-2455	FERC accepted CAISO's second compliance filing, which proposed revisions to its Open Access Transmission Tariff. Effective date no later than November 1, 2024
NYISO	Compliance filing conditionally accepted,	4/22/24	ER21-2460	Finalizing market design and tariff revisions to allow aggregations to provide Operating Reserves/ancillary services, built off rules developed for hybrid storage resources. Also developing software requirements to support

	second informational filing submitted			the market design and business process infrastructure. Compliance by end of 2026. Informational filings every six months are required t detail the stakeholder process and compliance with the directive from the First Compliance Order.
PJM	FERC accepted this compliance filing	3/4/24	ER22-962	FERC accepted their filing that reorganizes and redates eTariff records with an effective date of July 1, 2024. This clarifies tariffs and term definitions that are needed for DER capacity aggregation resources' participation in time for pre-auction activities that meet their overall compliance date. FERC rejected PJM's previous request of an indefinite date for this tariff action.
MISO	Compliance filing submitted	5/10/24	ER22-1640	Filing submitted 5/10/24 with desired effective dates of September 1, 2026, and June 1, 2029, for tariff revisions to require the DERA to retain performance data of individual DERs for auditing purposes.
ISO-NE	Awaiting next compliance filing	4/11/24	ER22-983	FERC accepted their last compliance filing and asked for a further one with revisions that include the meter data submission deadline in its Tariff. Due by mid-June - 60 days from 4/11.

*Compliance plan statuses were determined by accessing the Federal Energy Regulatory Commission's eLibrary at https://elibrary.ferc.gov/eLibrary/search. Last accessed July 2, 2024.

FERC has directed ISOs to allow for aggregations to the greatest geographic extent that is technically feasible, with the ideal being across multiple transmission nodes within their service territory. However, in filings, ISOs such as MISO and PJM have asserted that a single-node market participation framework is the most technically feasible method that their current systems can sustain (PJM 2023). These locational requirements, which have been highly contested during compliance plan development, could greatly limit the physical distance that an aggregator can group DERs because they need to ultimately connect to the transmission system at the same node.

PJM specifically cites constraint control as a "foundational component of PJM operations," which provides integrity to their locational marginal pricing model. Constraint control is used to dispatch the least cost set of resources at a particular marginal cost of energy and to avoid local transmission shortages (Marcino and Canchi 2018). PJM concedes that smaller DER aggregations may be able to aggregate on their system across multiple nodes if they meet certain criteria, including greatly limiting their size and that the DERs must not be dispatchable (PJM 2023). Further study is necessary to understand how these locational requirements may impact distributed wind deployment, which can provide flexibility when in multi-nodal heterogeneous aggregations. There may be different implications for larger front of the meter projects and smaller behind the meter projects, which are too small to serve as their own aggregation and are thus dependent on the location of other complementary DERs nearby to participate in one.

Challenges remain for Order No. 2222 to have a significant impact on DER deployment. The small utility and state demand response opt-out provisions that were included in the two 2021 updates to the rule could severely curtail its effectiveness. Thirteen states, mostly located within MISO, SPP, and PJM, restrict or prohibit direct customers and/or third-party aggregators from participating in wholesale markets (Robert Walton 2024; Guidehouse 2021).

3.0 Distributed Wind and Order No. 2222

The wide geographic range of distributed wind energy deployment makes the interaction between Order No. 2222 and distributed wind energy technologies highly likely across the country. All fifty states and the District of Columbia have some installed distributed wind capacity – even if the total is very small. The states with the most installed distributed wind energy capacity, through 2023, are Iowa, Minnesota, California, Massachusetts, Texas, and Ohio (Orrell et al. 2023). These states are located within the service territories of SPP, MISO, CAISO, ISO-NE, ERCOT, and PJM, with Iowa having coverage from both MISO and SPP in parts of the state. Of these six states, five are fully or partially served by ISOs (Figure 3.1). in the United States is located, at least partially, within the service territory of an ISO. The total capacity of distributed wind in states served by ISOs is 882 MW.

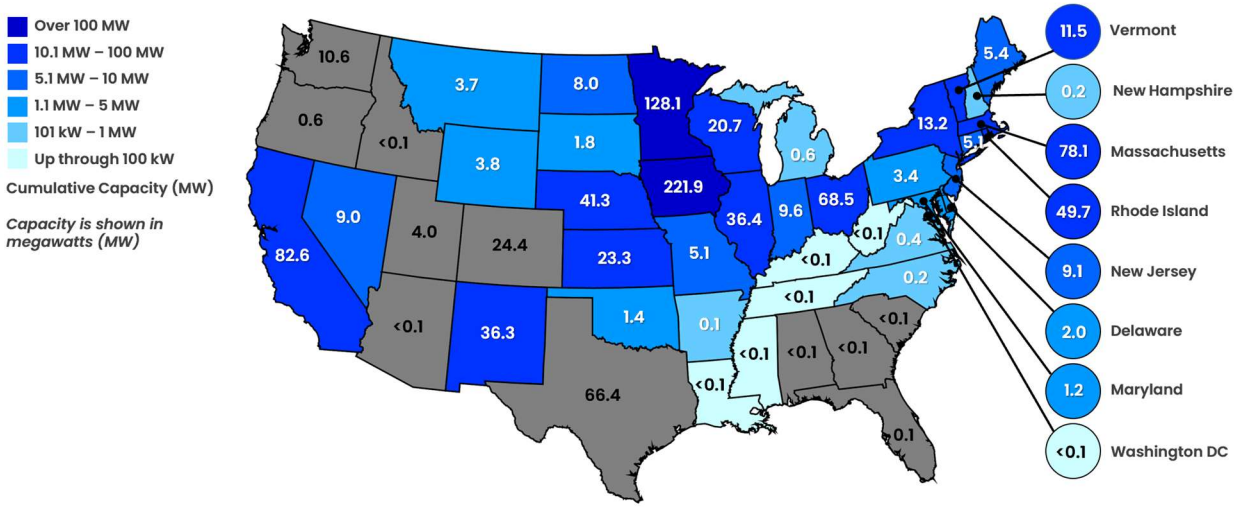

Figure 3.1 U.S. Cumulative (2003-2023) capacity for distributed wind, color-coded with a blue gradient for states with at least partial ISO coverage and a grey background for states with none. (Sheridan et al. 2024)

The vast majority of distributed wind projects are located behind the meter (BTM), providing electricity for on-site use, but those projects only account for 22% of distributed wind capacity across the nation. In comparison, front of the meter (FTM) projects represent 78% of installed distributed wind capacity and are connected to the distribution grid for local use, primarily by utilities (Orrell et al. 2023). BTM and FTM distributed wind projects both qualify as distributed energy resources that can be included in aggregations under Order No. 2222; however, they may be subject to different restrictions or provided disparate opportunities.

FTM projects are typically larger than BTM projects, and often meet the size requirement under the order to be considered a standalone aggregation. The order allows ISOs to set a minimum size requirement for aggregations. That minimum size requirement can be no larger than 100kW and does allow a single DER to act as an aggregation (Zhou, Hurlbut, and Kaifeng 2021). BTM projects, on the other hand, are typically much smaller in their rated capacity but account for the majority of existing distributed wind projects. The bulk of BTM projects would need to be part of an aggregation in order to participate in wholesale markets and would be greatly impacted by locational requirements if there is not enough capacity in a particular geographic area.

To date, studies of the profitability of present and future distributed wind have not included the potential implications of Order No. 2222 (McCabe et al. 2022). There is considerable uncertainty around most of the ISOs' compliance dates and implementation because only CAISO has received final approval from FERC that their plan meets the requirements. Many ISOs have anticipated compliance dates between 2026 and 2029, lessening the incentive for short-term deployment in accordance with legislation including the Bipartisan Infrastructure Law and the Inflation Reduction Act, which both require that their funding allotments be distributed in the next few years.

The potential of future distributed wind deployment relies heavily on policies enacted at the state and federal level due to the close competition between existing DER technologies that may have lower project costs (McCabe et al. 2022). Past federal policies have been associated with increased distributed wind deployment (Figure 3.2). In their 2022 analysis, the Distributed Wind Energy Futures Study incorporated the Bipartisan Infrastructure Law, but the report came just behind the passage of the Inflation Reduction Act (McCabe et al. 2022). As federal laws increase support for clean energy, distributed wind deployment could increase as it has in previous trends. However, it's still unclear how this support will extend to projects in locations served by ISOs, where DER aggregations may create new participation opportunities for this technology.

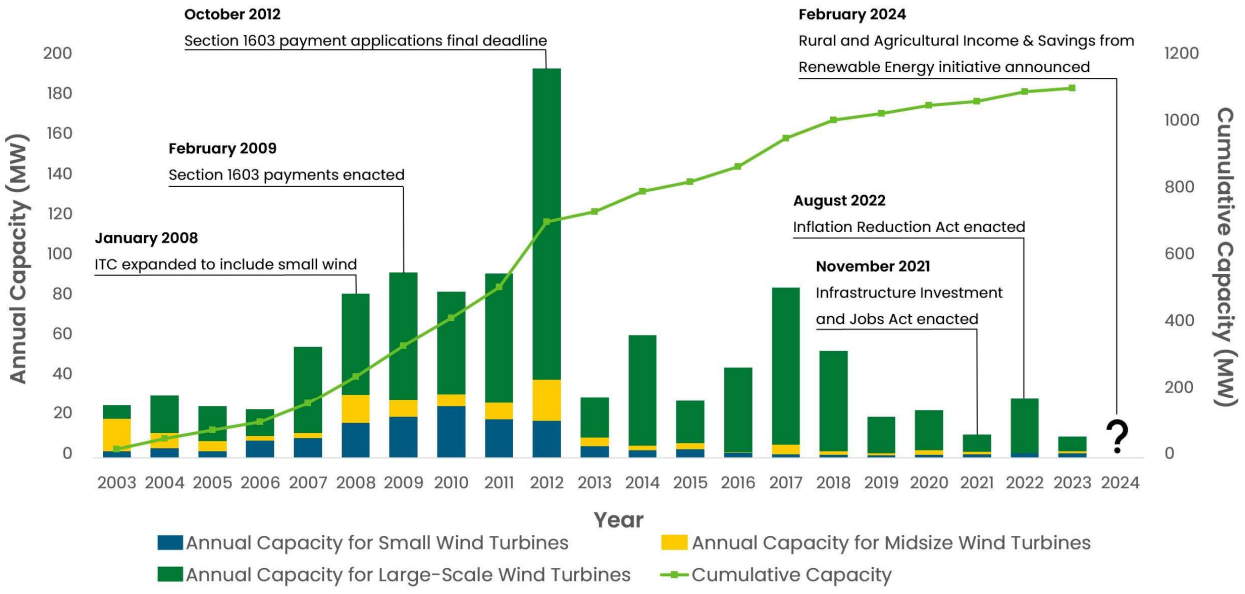

Figure 3.2 U.S. Distributed Wind Capacity and Federal Policies, 2003-2024 (Sheridan et al. 2024)

At the time of publishing the Futures Study, FERC Order No. 2222 had been issued but compliance plans were yet to be finalized. Order No. 2222 may have significant impact and support for distributed wind deployment, both in front of and behind the meter, due to the extent of existing and projected future capacity installed within the service territories of ISOs. Future analyses can use the compliance plans of ISOs as they become finalized to capture the true value of distributed wind (Laurie 2024). The order's impact could change or increase the ways that distributed wind can participate in different markets and be compensated for the benefits the industry can deliver to communities and the grid, potentially shifting project economics throughout the country.

As compliance plans emerge, distributed wind developers in states that are partially covered by one or more ISOs may need to select sites carefully to both balance the regulatory requirements of the state and/or ISO(s) as well as determine the profitability of participating in retail or wholesale markets, and under which programs. In their efforts to avoid double counting between retail and wholesale programs, a number of the ISOs have restrictive dual participation regulations that may result in DERs avoiding participation in wholesale markets altogether because their compensation would not be cost effective. If this is the case, valuable benefits like capacity and ancillary services will be left on the table and not delivered to the grid.

Double counting between retail and wholesale programs describes the same DER receiving compensation for participating in multiple markets without providing additional energy or other benefits. Existing distributed wind deployment indicates that MISO and SPP currently have the most installed capacity, including both BTM and FTM projects (Figure 3.3). To determine BTM and FTM capacity in each ISO, the cumulative capacity of each state in an ISO's service territory (partially or completely) was included towards an ISOs total installed capacity (i.e., distributed wind capacity is double-counted for states that are served by more than one ISO). The geographic granularity of data for distributed wind deployment is limited.

Most of the capacity from existing DW deployments is in FTM applications, which is connected to the distribution line and can likely provide more grid services as part of an aggregation because individual FTM installations are often large enough to act as a standalone participant (IEA 2022). BTM deployments of distributed wind typically provide benefits by reducing or shifting energy purchase consumption away from the energy provider through on-site generation. BTM deployments are less likely to provide grid services because their smaller capacity limits their ability to meaningfully participate in markets – these installations would need to be part of an aggregation to participate in wholesale markets (IEA 2022). The disparity in capacity between front of the meter projects, which are larger, and smaller behind the meter projects, which occur with much greater frequency, could have significant influence who get to benefit from Order No. 2222.

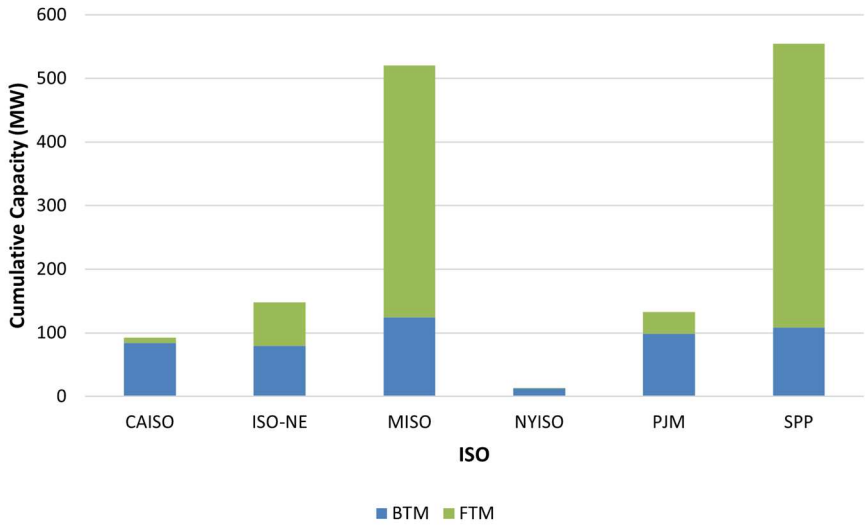

Figure 3.3 Cumulative distributed wind capacity by ISO as of 2023 (data from Sheridan et al. 2024).

As of 2022, distributed wind project development lasts on average around 2 years, from first customer contact to the commissioning of the project (Orrell et al. 2023). In the Midwest that time is greatly decreased, to roughly 9 months, which may be due to the extensive wind resources available in that region. Distributed wind deployment at this scale is proceeding at a much faster pace than the time it takes to achieve compliance with Order No. 2222. Due to the speed of federal policy investments, the window during which new distributed wind installations will be built as part of planned DER aggregations may be closing, and wholesale markets could miss out on the benefits they could provide to the grid.

4.0 Conclusion

There are a number of challenges still in place for the implementation of Order No. 2222, and DER deployment continues apace with the help of federal funding from legislation like the Bipartisan Infrastructure Law and the Inflation Reduction Act. Understanding how all of these policy conditions, including Order No. 2222, interact can create a clear and full picture of distributed wind's value and help support additional deployment. In the meantime, ISOs will continue to finalize and implement their compliance plans between now and 2029.

To understand the full interactions between FERC Order No. 2222 and distributed wind deployment, the following are recommended:

- A new baseline valuation of distributed wind at the greatest possible spatial granularity to show where it could be most profitable and useful for community needs when paired with other DERs and as part of an aggregation.
- Participation models for distributed wind in wholesale markets and how they compare to compensation currently delivered in retail markets.
- The impact of dual participation regulations on distributed wind and DERs generally.
- Analysis of the locations of existing distributed wind capacity, whether individual states forbid DER aggregation or not, and how planned deployment in areas within the service territories of ISOs can be supported despite these conditions.

Order No. 2222 could have an impact on distributed wind economics and the distribution of areas across the United States where installations are cost competitive, including what configurations would provide the greatest benefit and lowest cost. The rule may make other DERs more profitable as well, which would shift the target of cost competitiveness for future distributed wind deployments, a vital factor for developers. As ISOs continue to finalize their compliance plans for FERC Order No. 2222, there will be ample opportunity for further study and policy analysis for the impact that implementation will have on the competitiveness and deployment of distributed wind. Impacts and outcomes may vary at the granularity of county levels due to the unique territories of ISOs across the United States. Planning for future deployment must be supported by accurate and up-to-date data, including project sizes, locations, and the programs they may participate in.

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6.0 Appendix

Table 2 Markets operated by independent system operators (Adapted from (Tapio and Orrell 2023))

Market Type	Description	CAISO	ERCOT	ISO-NE	MISO	NYISO	PJM	SPP
Day-ahead	Forecasted load for the next day – about 95% of market transactions, sales, and purchases of electricity	X	X	X	X	X	X	X
Real-time	Transactions that follow daily demand changes – the difference between day-ahead and variations in supply and demand	X	X	X	X	X	X	X
Capacity	Ensure that NERC reliability standards are met to serve future peak electricity demand			X	X	X	X	
Ancillary services	Maintain transmission system frequency and operation – supporting reliability through frequency control, spinning reserves, standby/reactive power, voltage control/support	X	X	X	X	X	X	X
Congestion revenue rights	Financial instruments that enable the rights holders to manage congestion cost changes based on the marginal pricing of their location	X	X					
Operating reserve	Participants can buy and sell reserve electricity to meet emergency needs and regulate load changes							X

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