DER Research Insights

DERTF - March 8, 2021

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Purpose & Key Takeaways

Purpose:

Review insights gathered to date on integrating DERs into the markets

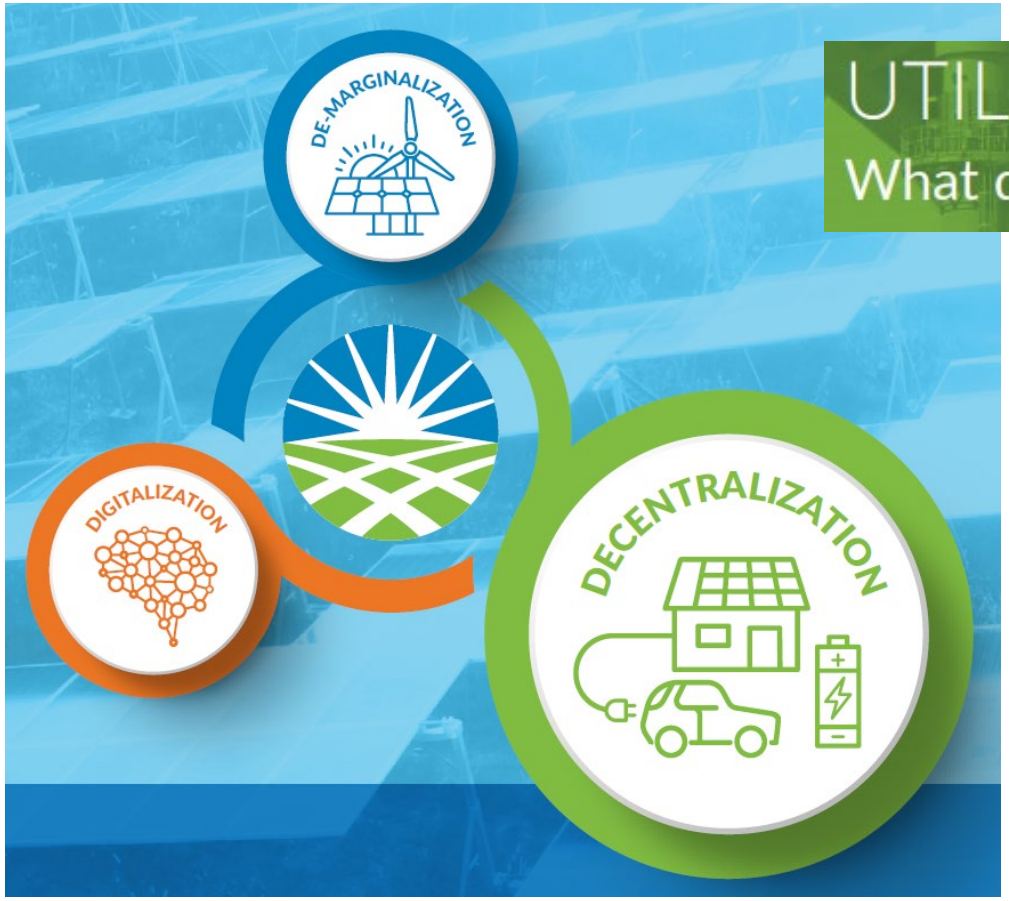
Key Takeaways:

Efficient DER integration into MISO markets

- Can pose challenges in visibility, grid management and market efficiency
- May require simplified approaches for aggregation and treatment of small resources can reduce challenges

MISO is exploring the concept of a pilot to explore approaches to DER integration

Megatrends and the MISO Forward reports



UTILITIES OF THE FUTURE:
What do they need from a grid operator?

- MISO Forward 2019: Delivering Reliability and Value in a 3D Future
- MISO and DER: Framing and Discussion Document
- MISO Forward 2020: Utilities of the Future
- MISO and DER: Ensuring Grid Reliability Through Visibility and Communication

These reports and other insights can also be found at: MISO Strategy and Value Proposition > MISO Strategy > Strategy Papers

DER integration requires work on multiple issues. Today, we will focus on insights about aggregation range and size

Multi-Node vs. Single Node DER Aggregations

- Without new tools, DER integration has the potential to create sizeable price and power flow oscillation on the T&D seams
- Inaccurate transmission locational impacts can challenge the ability to manage transmission constraints
- Large aggregations that cut across nodes create inconsistencies with a nodal pricing construct that needs to be resolved (Zonal pricing by nature is less efficient)
- Aggregating underneath a single pricing node can lesson these issues

Size of DER Aggregations

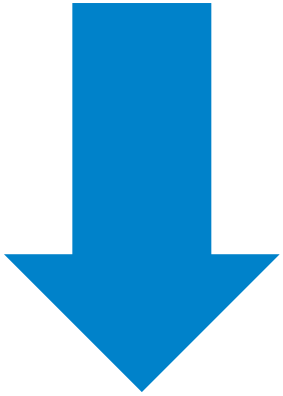
- Integrating small DERs or DER aggregations < 0.1 MW requires significant changes to the optimization approach (0.1 MW is smaller than the errors!)
- The larger the number of aggregations, the larger the computational needs

Market Efficiency

- DERs have the potential to provide services to wholesale markets in an economic fashion – enhanced flexibility
- Representing distribution limitations in wholesale markets would be very difficult
- Market efficiency can increase with increased frequency of DER offers

There are tradeoffs when determining DER aggregation locational range

Must balance the advantages of broad locational aggregation with challenges to control and accurate pricing.

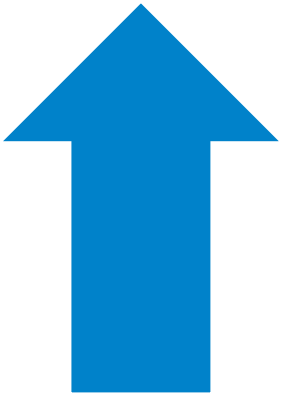


Limited Aggregation

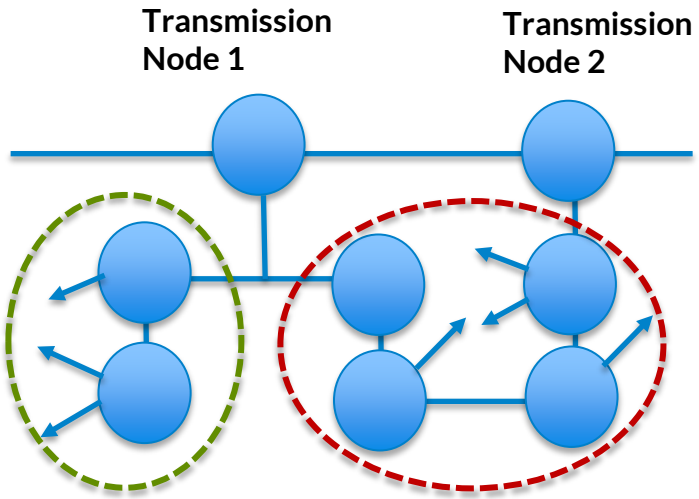
- Small participation size
- Large number of resources
- Computation burden
- Data/ communication cost

Broad Aggregation

- Transmission flow error
- Reliability risk
- Market inefficiency (Nodal vs zonal)
- Visibility/ forecast challenges
- State boundaries



Broad aggregation without accurate locational transmission impact will challenge constraint management



Distribution Factors refer to the fractional representation of a DER's impact on a transmission node

Aggregation for radial connections is manageable

For aggregation across multiple buses, where do MWs go?

Accurate Distribution Factors are needed, but are they achievable?

Are accurate distribution factors achievable?

Discussions with distribution operators and DER aggregators concluded accurate distribution factors are not currently achievable

- Distribution grid is very dynamic
  - Switching and maintenance
  - Storm or other damage
  - Tap settings and voltage management
- DER response within an aggregation is very dynamic
  - Aggregators will often call on more resources than requested based on historic performance
  - Aggregators will rotate response among resources within a call-on period
- Frameworks don't exist to track and report out dynamic distribution factors

A recent study illustrates challenges to transmission constraint management

Future Resource Study 2019 - 2021 (Stevens and Clarkson University)

- Utilizing multiple MISO day-ahead cases, attempted to cluster transmission nodes with similar sensitivities to the transmission constraints
  - Was able to cluster 15,000 transmission nodes down to 1,500
    - Still too small for aggregation zones
    - Clusters changed from one DA case to another DA case because of the change in transmission constraints in each case
    - Still saw up to 100 MW flow error on transmission constraints
  - Identifying multi-node aggregation zones not currently feasible in MISO

Price oscillation links to inaccurate distribution factors

Future Resource Study 2019 - 2021 (Stevens and Clarkson University)

- Observed price oscillation in simulated system with DERs responding to wholesale prices
  - With price oscillation prices and resource dispatch signals cycle up and down over sequential dispatch intervals
  - This is worsened with inaccurate distribution factors

Implication: Single transmission node aggregation makes sense initially

- Single node aggregations will provide more certainty and control of DER aggregations as MISO manages transmission grid

- Consistent with generator modeling today

Efficient commitment of many small DER aggregations can be challenging

- Most ISOs use a mixed integer algorithms in commitment processes
- MISO's algorithm iterates between combinations of commitments to achieve a solution within a small tolerance band of the theoretical optimum
- That tolerance band is much larger than the commitment cost of a small (0.1 MW) resource
  - If we lower the tolerance band then cases cannot solve within the Tariff's allotted time
  - If we perform post-solution analysis and clean up "out of money" commitments, then we will struggle to meet deadlines on time
    - If we miss some clean-up, then we will have settlement disputes

Commitment of DER aggregations at the bulk system level may have little practical value

- DER aggregations are on distribution for a reason
  - most likely DERs self-commit to meet host customer or retail needs
- Aggregation commitment cost is a nebulous concept and would be hard to quantify and justify
- Small aggregations can represent commitment cost within dispatch offer

Implication: Small DER aggregations should self commit

- DER aggregations that are large enough to qualify as traditional generator type resource can participate under the existing generator resource types and be economically committed
  - Start up related cost must be justifiable and may be reviewed by the Independent Market Monitor

- Small DER aggregations (< 1 MW) can self commit
  - Will not be eligible for make whole of start up cost

What are we still exploring?

- What aggregation options would work best considering the dynamic nature of MISO's transmission constraints?
- What techniques best address distribution factor uncertainty?
- What techniques best address the potential for price and flow oscillations in sequential economic dispatch intervals?
- How can price responsive demand in real time be managed and used to advantage?
  - At what level of participation will MISO need new approaches to price responsive demand?

Pilot programs at MISO

- MISO currently does not have a formal pilot program
- MISO is in the early stages of exploring governance for a pilot program
- MISO will consider DER pilot opportunities along with other priorities when a formal pilot program is launched

Reference

Kunyu Zuo, Yikui Liu, Jiarong Xia, Yafei Yang, Lei Wu, Yonghong Chen, "Impact of Distributed Energy Resource Integration on Real-time Energy Market Oscillation," accepted for IEEE PES General Meeting, 2021.

Appendix

Future resource Integration into Wholesale market - simulation 2019

Key takeaways:

- Substantial gap between retail and wholesale prices brings opportunities for efficiency improvement for DERA participation in wholesale
- Batteries have significant potential to provide benefit participating in energy markets
- DERA profits and market efficiency are increased with more frequent offer updates
- Significant potential for savings from DERs providing regulation services
- Two stage optimization may prove beneficial where MISO optimizes among DERAs and sends awards and aggregator optimizes within DERA

Future Resources Studies: Initial findings summary

Out-of-market and self-responding DER	• Potential pricing oscillation: status quo is not a good idea
Aggregate in large regions and update distribution factors	• Potential price oscillation even when updating distribution factors instantaneously • Current information may not be a good prediction of the future
Only aggregate resources with similar congestion impact	• A large number of small resources with less than 2% sensitivity approximation may result in over 100 MW flow differences • Requires a large number of zones

Only allow DERs to participate under EPNode (Similar to DRR-2 and generators)	• Most efficient market outcome right now
	• Size issue and computational challenges:
	  • May result in a large number of small resources under one EPNode and restrict effectiveness of aggregations by limiting diversity
	  • MIP solver may not make effective commitment decisions for small resources due to relative MIP gap size
	  • Even if model small resources as continuous variables, may still face computational challenges due to the large number of non-zeros

T&D coordination	• Similarity to SEAMS. We have experienced M2M flow oscillation due to limited information from the other side of SEAMS • Lack of information and visibility between T&D can also lead to oscillation

DER at MISO is more than FERC Order 2222

Although Order 2222 provides the most immediate area of focus, other work on DER is ongoing at MISO. Many of the same staff work on both O2222 and other initiatives

- Demand response and demand side management constitute much of MISO's existing DER; existing Load Modifying Resources have grown
- Updating MISO's planning processes to understand the impacts of DER not participating in the MISO market is critical to enabling visibility for MISO operations
- Interconnection of DER is under the purview of the states, and where those interconnections could impact MISO operations, there will need to be coordination to ensure MISO, as an affected system, remains secure and reliable
- Research and development continue to prepare MISO for future technology changes, including the growth of DER and its communication and control systems