Understanding the Reliability Value of DERs

Fall Technical Workshop

October 23rd, 2024

Providence, RI

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Outline

- Background on DER participation in wholesale markets
- Traditional wholesale resource adequacy
- How should we value DER participation in wholesale markets
  - Providing the right signals to DERs
- Bridging the gap between wholesale and distribution
  - For efficient operation of DERs, wholesale and distribution interaction is essential
  - High resolution metrics at the wholesale level can enable efficient interactions for overall reliability

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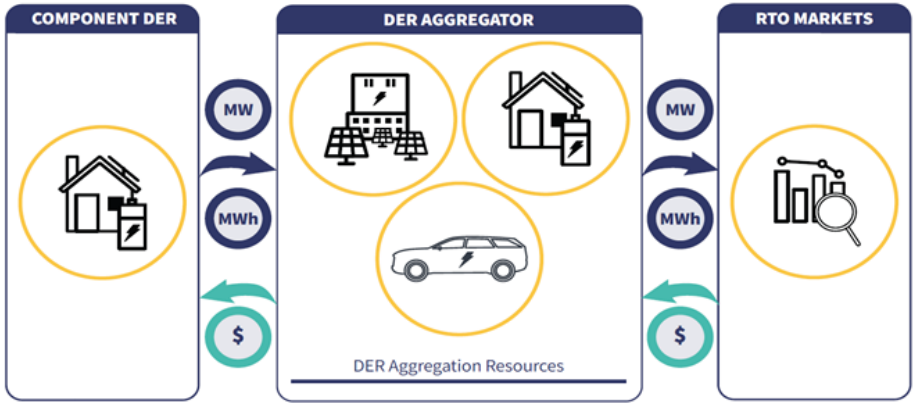
DERs as a Wholesale Resource - Overview

- FERC Order 2222, September 2020
- Paves the way to aggregate DERs
- *"remove barriers to the participation of DER aggregations in the RTO and ISO markets"*

- RTOs/ISOs are expected to fully implement FERC 2222 rules by mid-2025 to 2027
- Varying degrees of progress among ISOs, with CAISO leading the implementation efforts

- Efficient utilization of DERs for adequacy and reliability will depend on the right payment mechanisms that incentivize contribution as well as transmission and distribution coordination



Source: FERC

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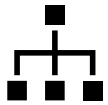
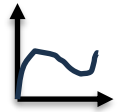
Traditional Wholesale Resource Adequacy

- Mostly copper plate or zonal, with increasing recognition of transmission
- Simplified or omitted operational details
- Mostly used as a planning tool with metrics that cannot be applied in the presence of limited transmission
- Allowing DERs to efficiently contribute to adequacy and reliability requires high-resolution analysis and metrics

Sending the Right Signals to DERs

Understanding where and when DERs are valuable to the bulk system requires *high-resolution* analysis:


Metrics should capture locational signals at each substation


Metrics should capture the intertemporal impact of DER consumption


Dynamic properties of DERs should be considered


Operational realities of the system should be considered

Using the right metrics for integration of DERs in bulk system resource adequacy and operational planning analysis is a critical piece of the puzzle

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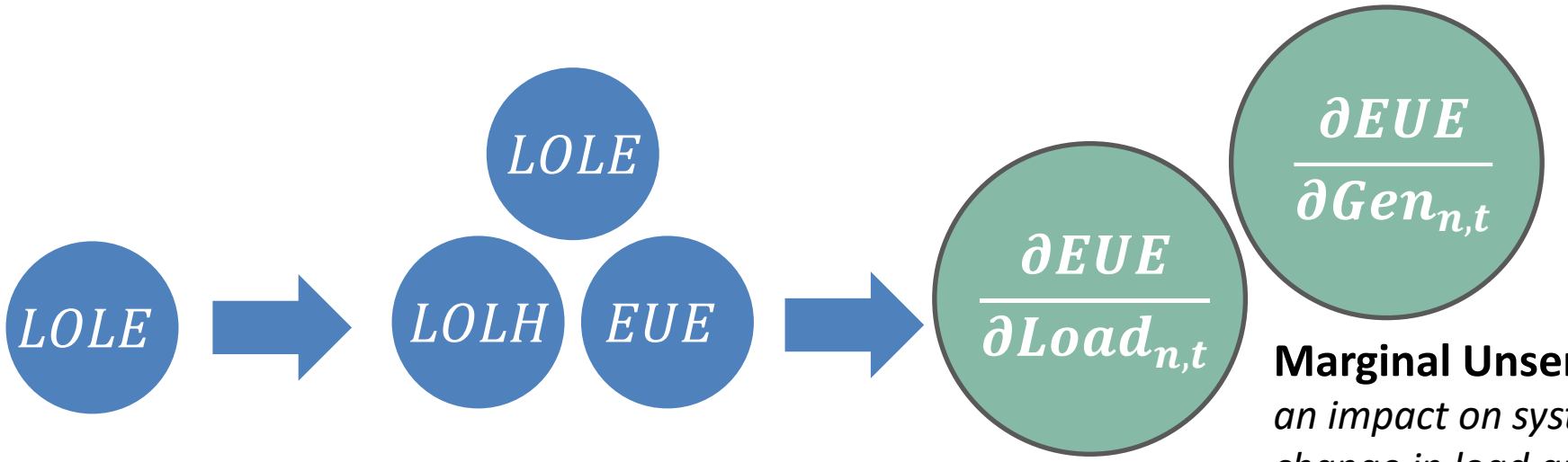
Marginal Reliability Metrics

- Analogous to Locational Marginal Prices (LMPs)
- Marginal reliability metrics send the right signal for WHEN and WHERE resources are needed
- In a transmission constrained and dynamic system, marginal metrics are needed to capture individual reliability contribution from system assets (generation, transmission, demand)
- Traditional metrics in use today (LOLH) are also marginal metrics in non-constrained systems



Marginal Unserved Energy – *an impact on system EUE given a change in load and resource capacity at each **location** and **hour***

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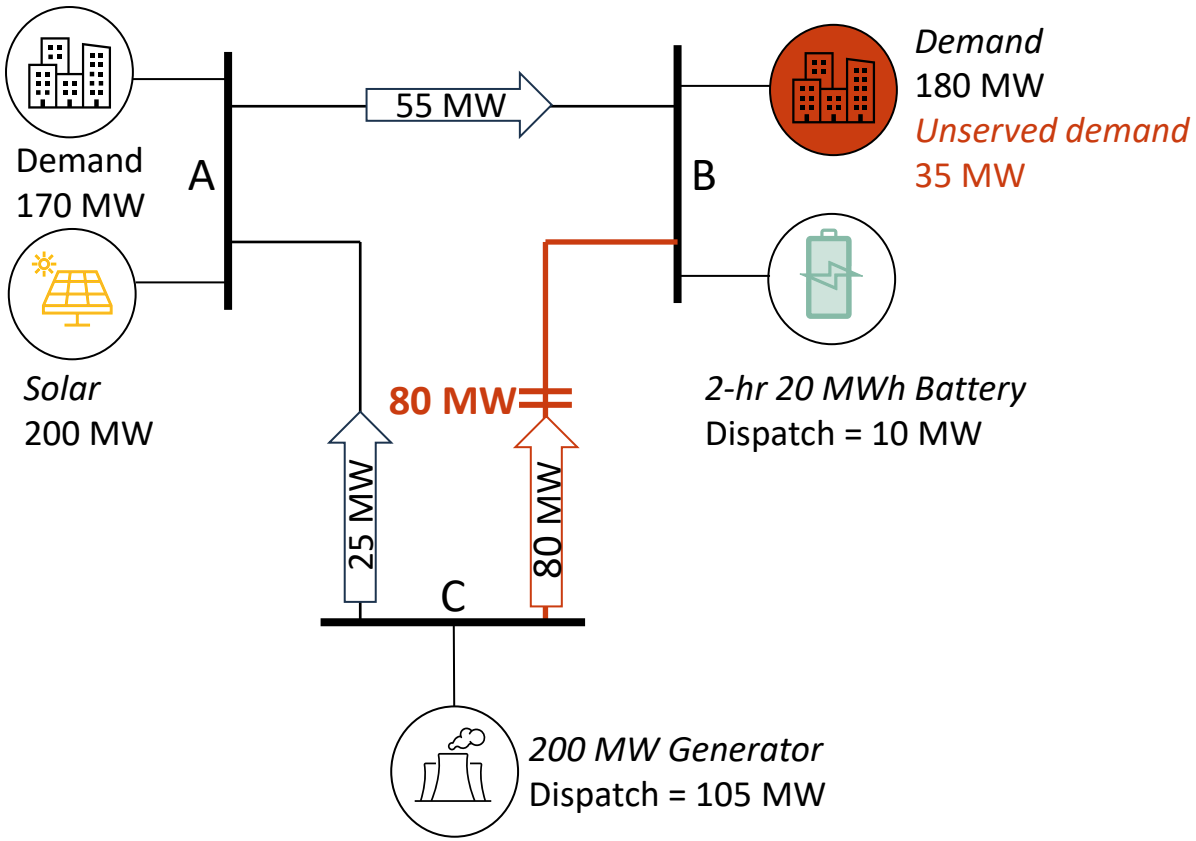
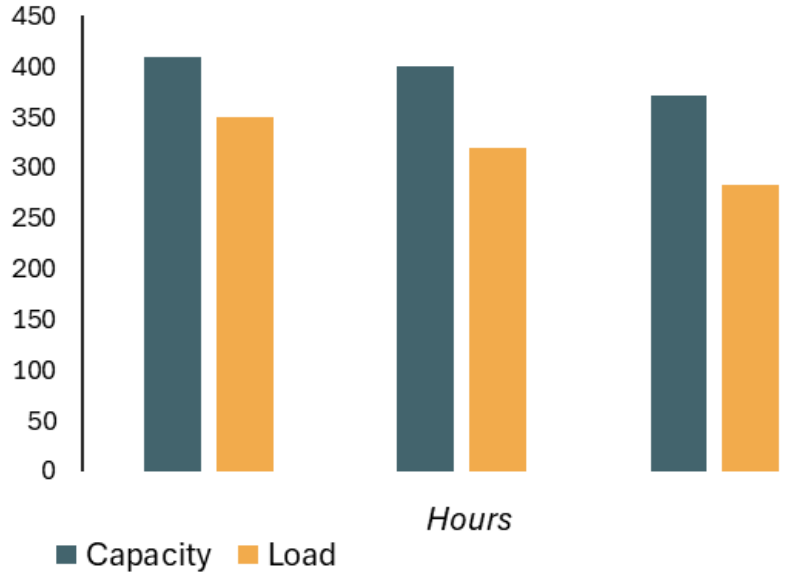
Recognition of Marginal Metrics by ISOs

- **ISO-NE:** "Marginal reliability impact" (MRI) to be adopted to measure a resource's reliability contributions
  - MRI: reduction of EUE given an incremental change of a resource's capacity
  - ISO-NE has already incorporated MRI in its capacity demand curves
- **PJM:** Replacement of average ELCC capacity accreditation method with marginal ELCC approved by FERC in early 2024
- **NYISO:** Marginal Accreditation methodology
- **MISO:** Sloped "reliability-based demand curves" (RBDCs) approved by FERC in June 2024

Illustration of Marginal Metrics





System has sufficient capacity in all hours, but due to limited transmission between zones B and C, load shedding is observed in zone B

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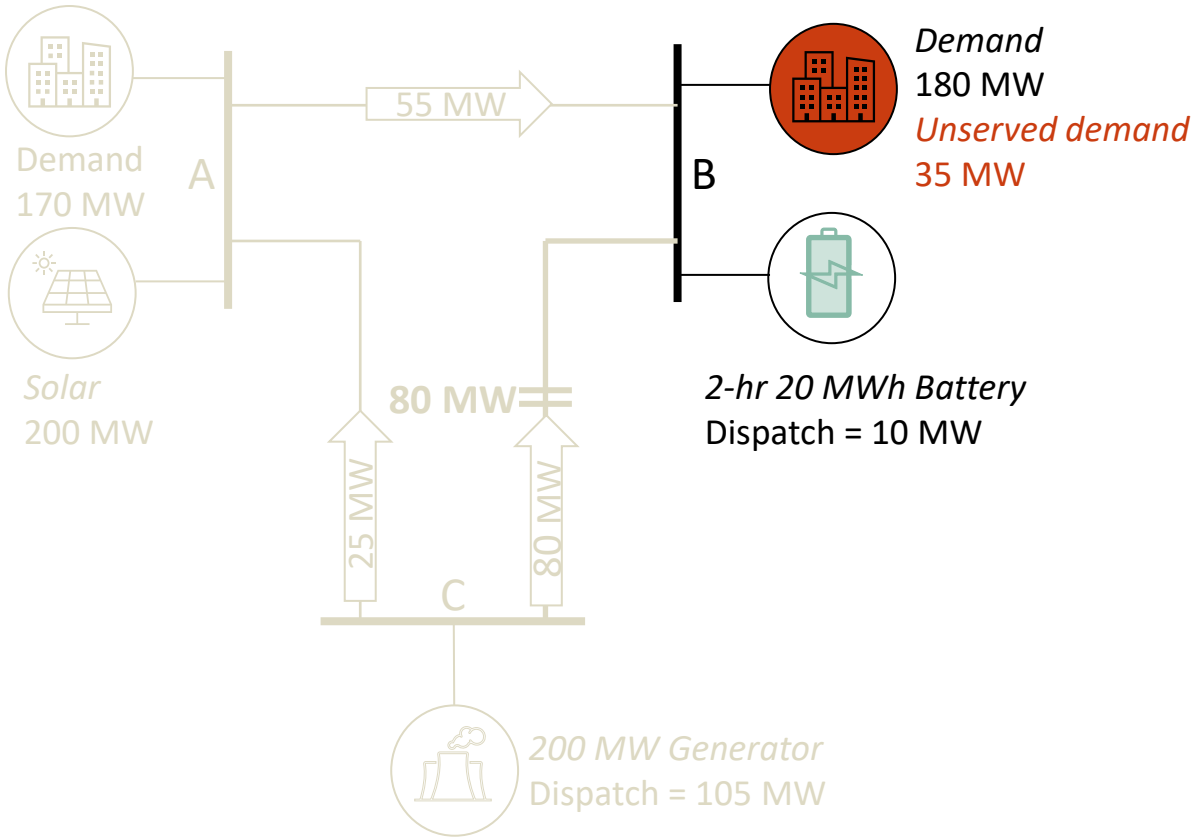
Where Is DER Most Valuable to the System?



1 MW of load reduction or DER dispatch at location **B**

Would reduce system unserved demand by **1 MW**

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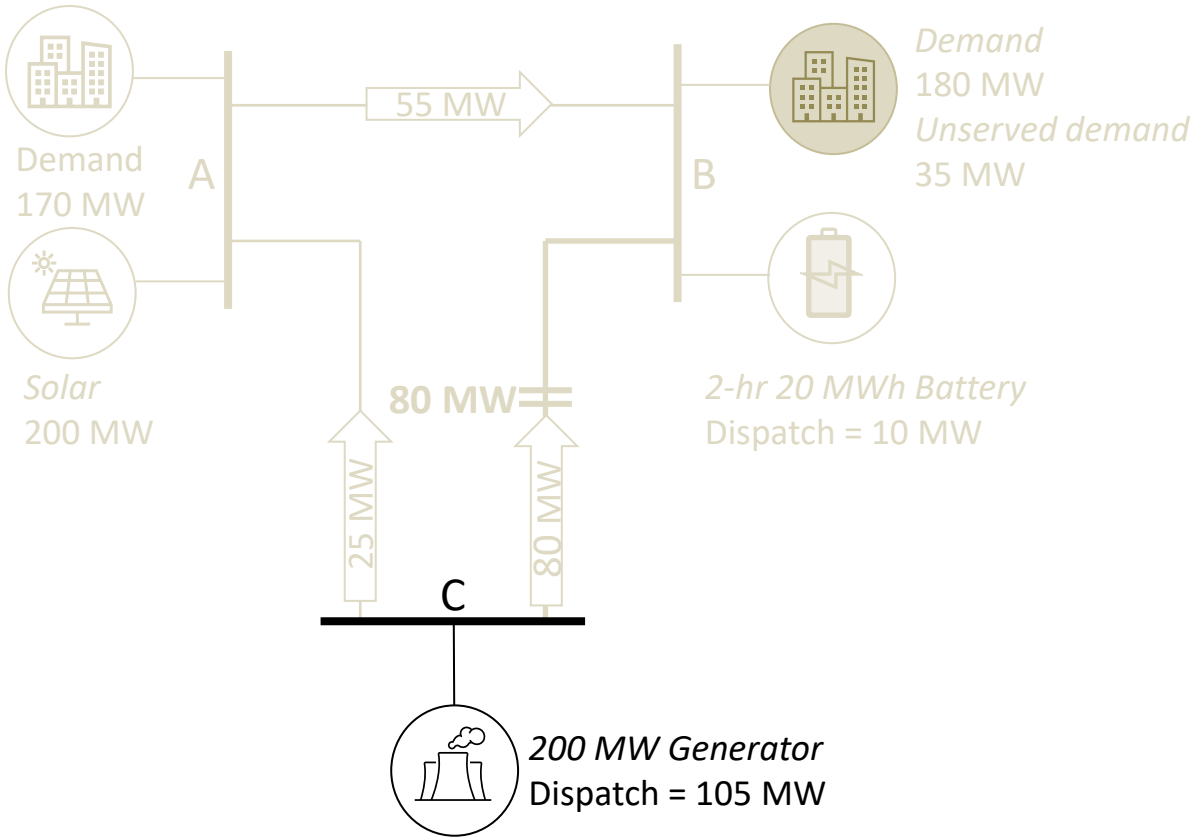

1 MW of load reduction or DER dispatch at location **C**

Would reduce system unserved demand by **0 MW**

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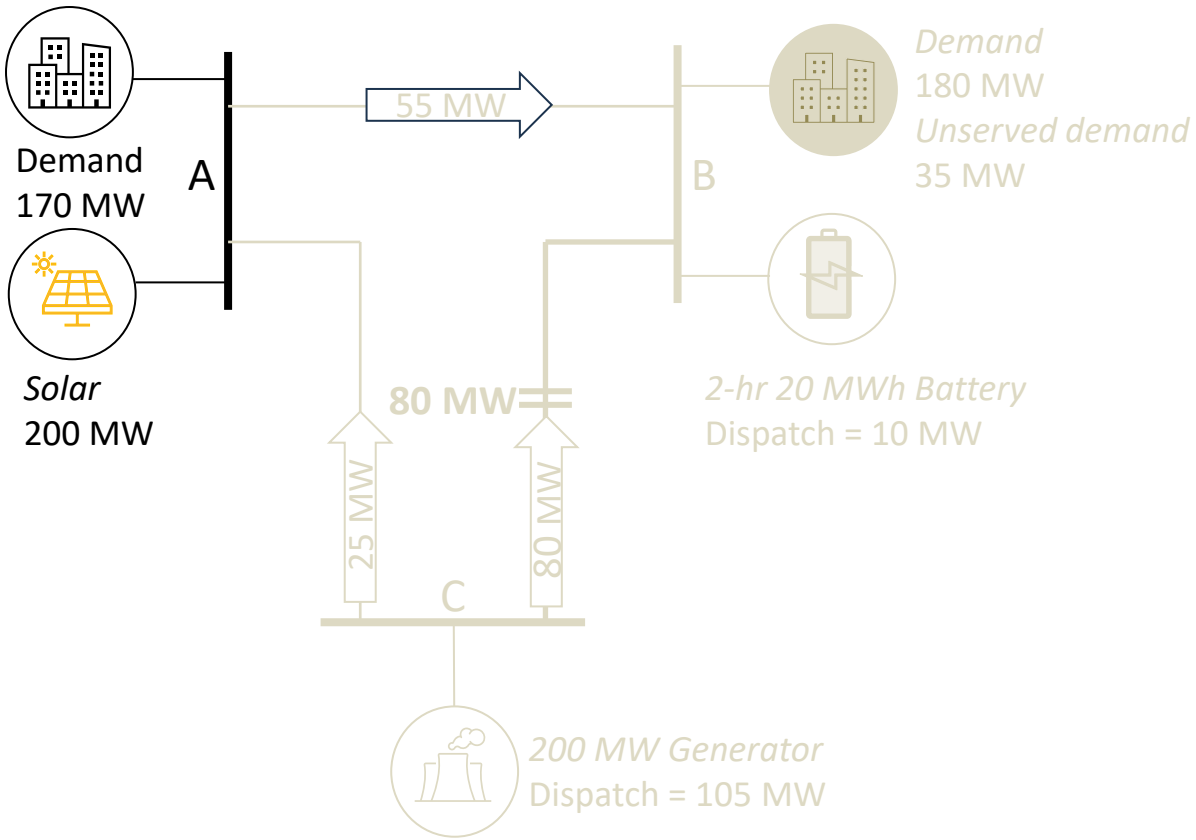
Where Is DER Most Valuable to the System?



1 MW of load reduction or DER dispatch at location **A**

Would reduce system unserved demand by **0.5 MW**

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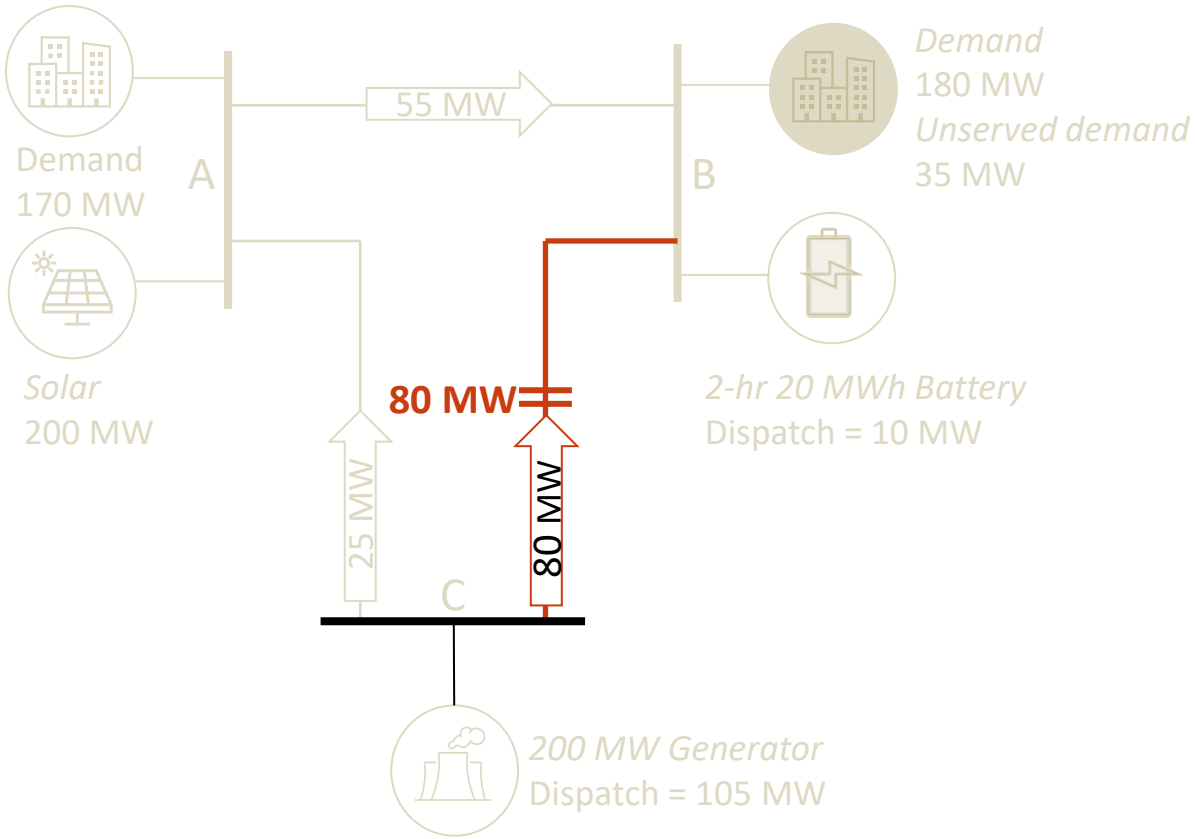
What is the Value of Transmission?



1 MW of additional operating limit of transmission line **B-C***

Would reduce system unserved demand by **1.5 MW**

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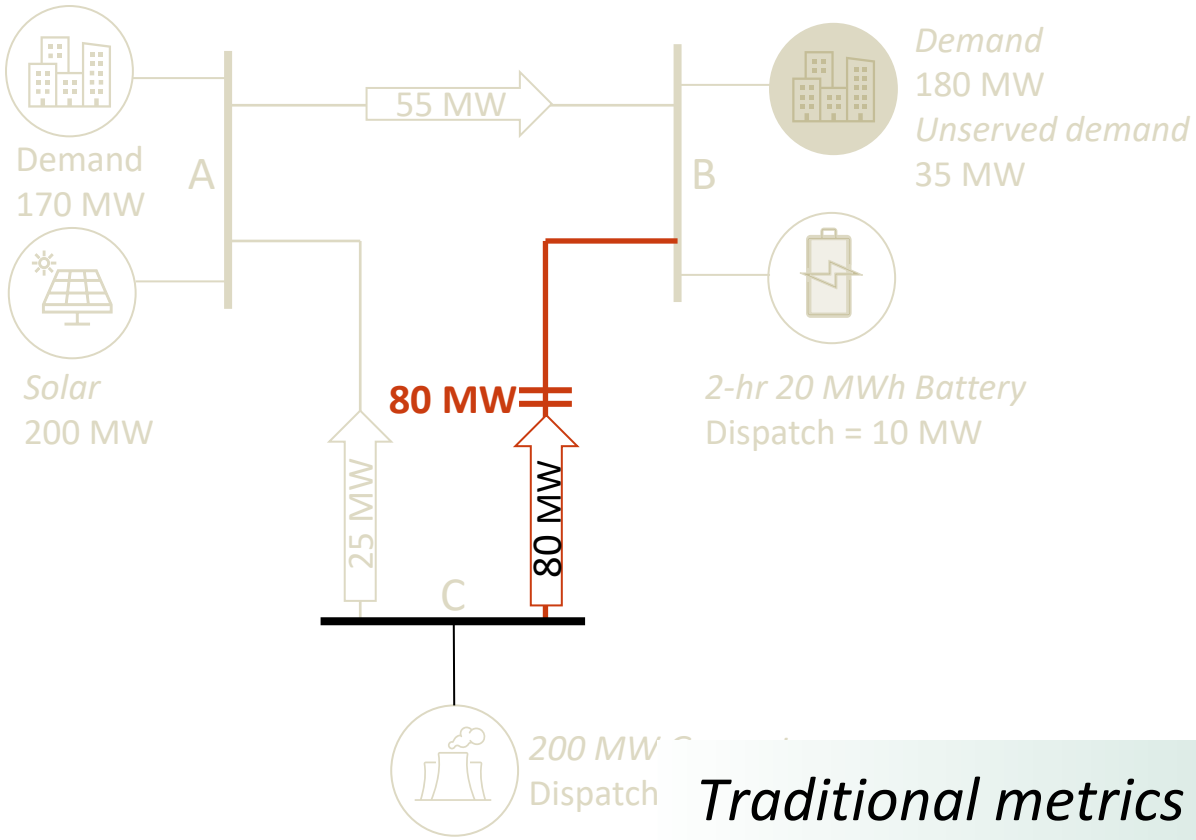
**Assuming the operating limit of the existing line is increased without impact on its impedance*

What is the Value of Transmission?



1 MW of additional operating limit of transmission line **B-C***

Would reduce system unserved demand by **1.5 MW**

Traditional metrics (EUE) do not capture the information we get from marginal metrics:

- *Locational risk*
- *Relative efficiency of injection/withdrawal in different locations*

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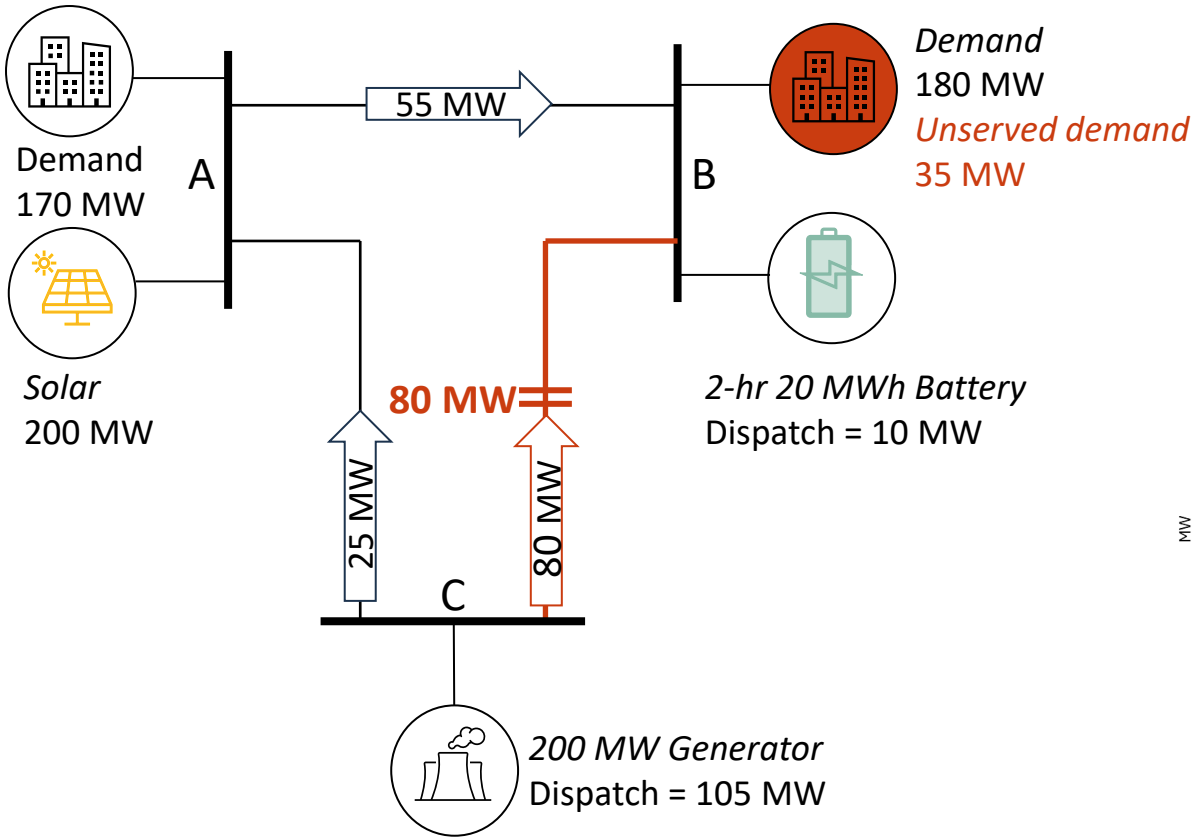
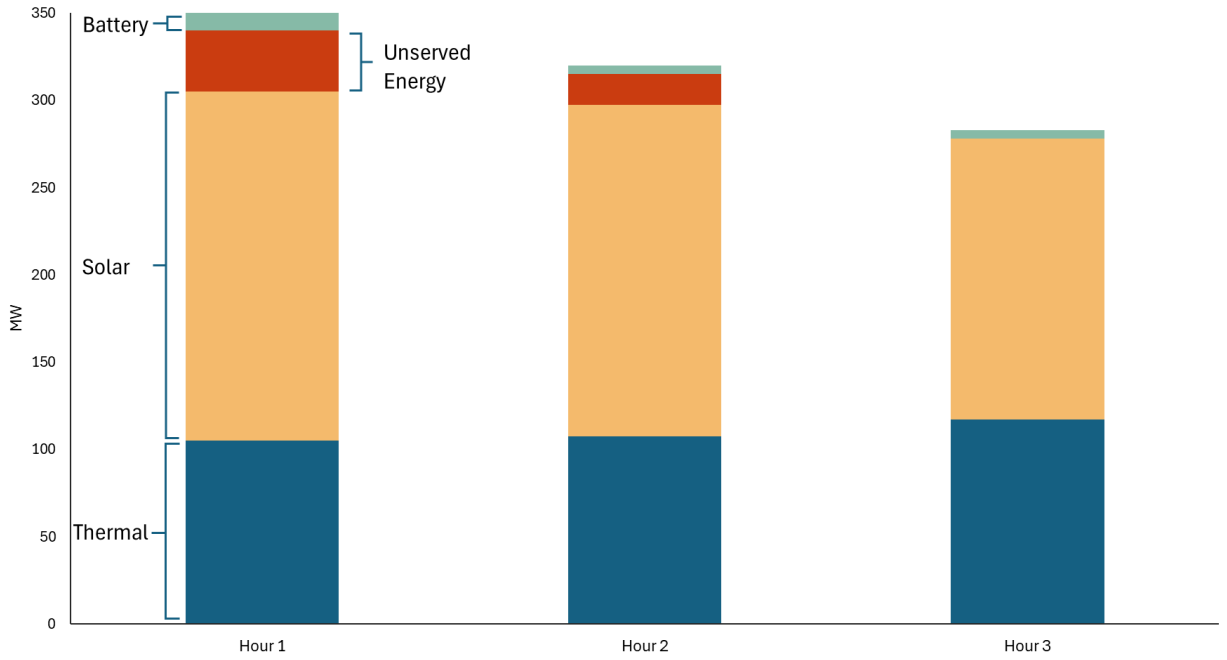
When Is DER Most Valuable to the System?





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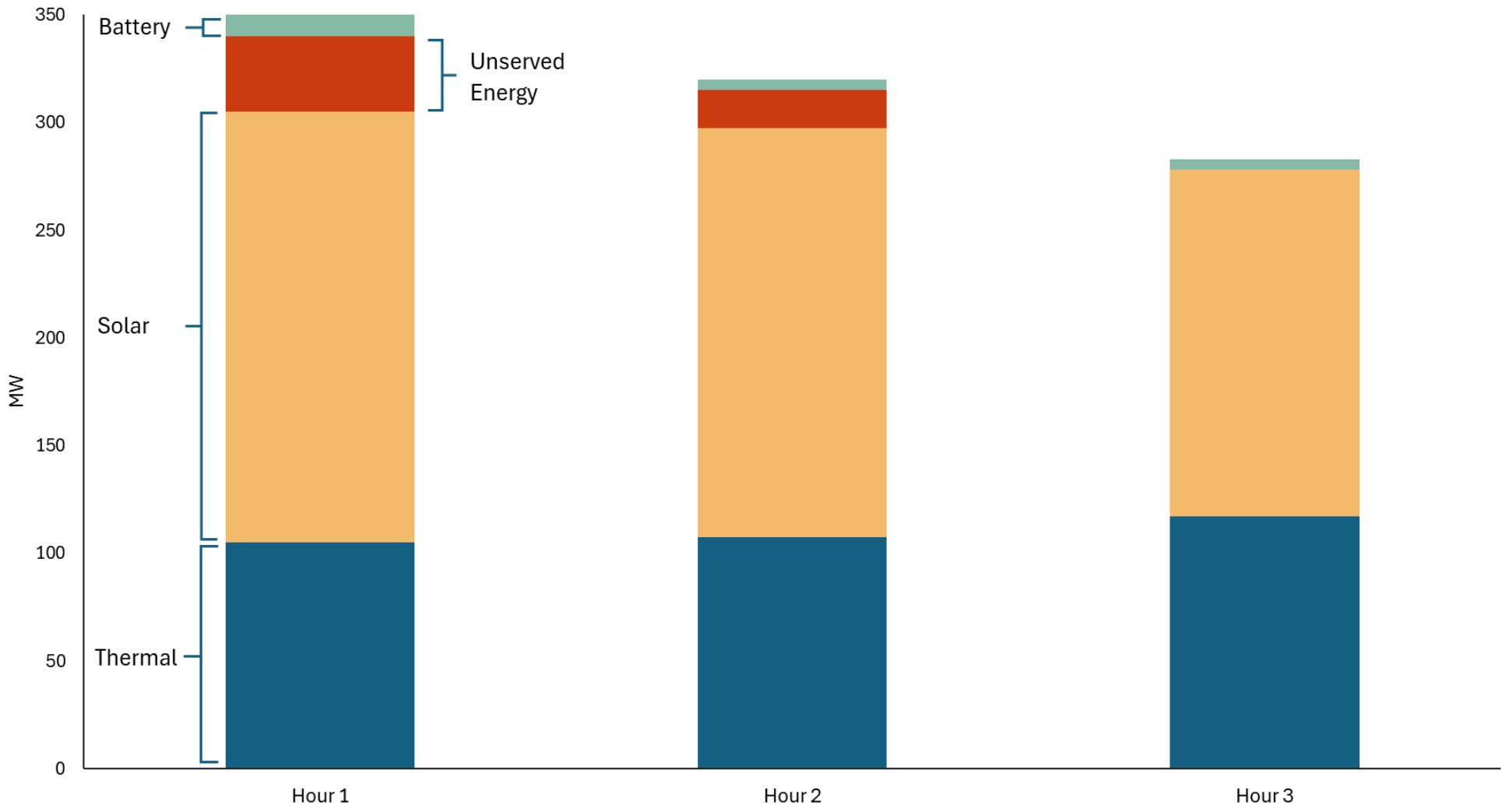
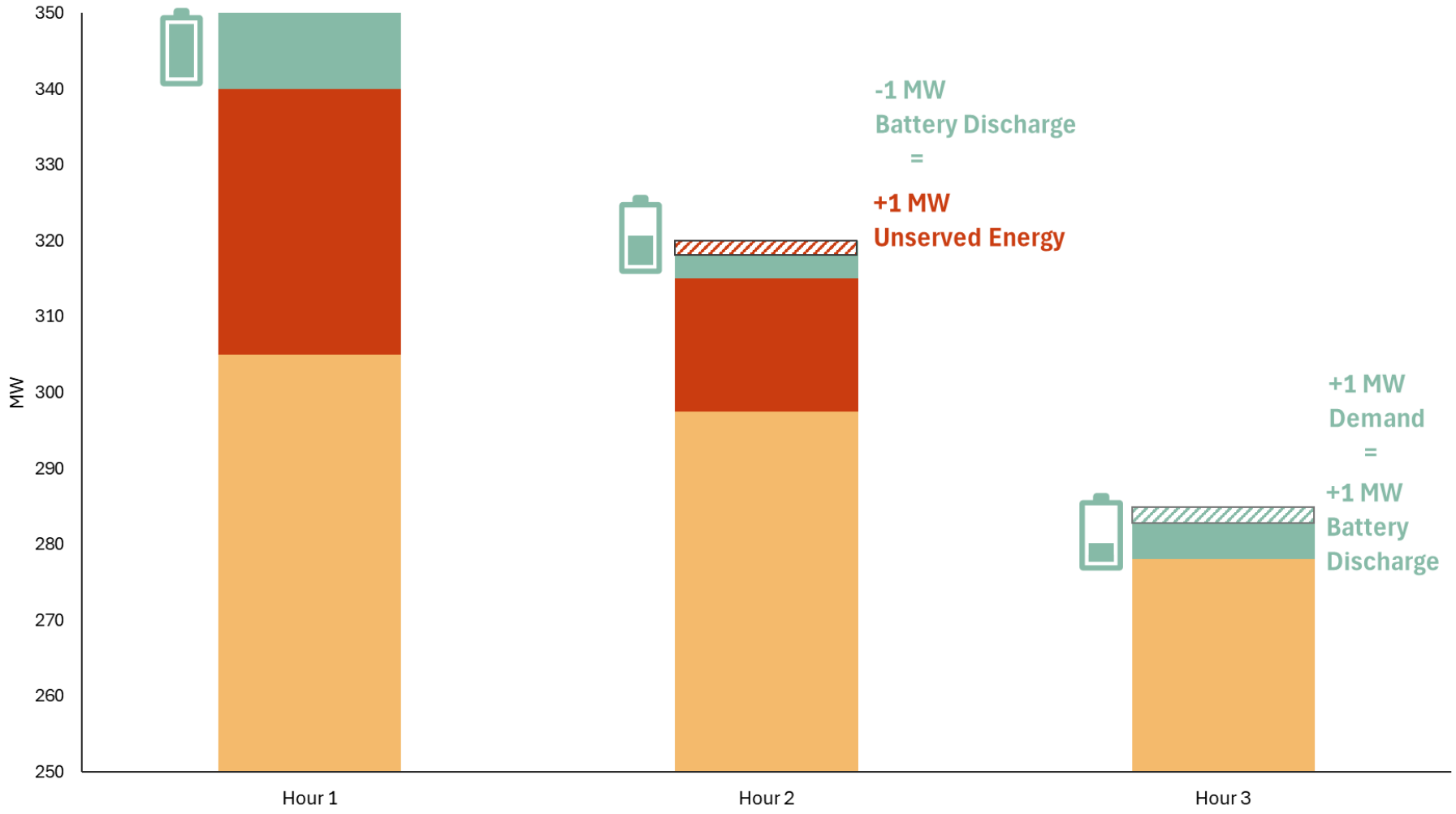
When Is DER Most Valuable to the System?



In Hour 3, even though there is no load shed event, marginal unserved energy is equal to **1** and this hour is a **shortage hour.** Marginal value reflects the increase in **shortage in other hours** if storage were to discharge more in this hour.

Event Hours Are Not the Only Critical Hours



Discharging +1MW in this hour would require discharging -1MW in other hours, increasing Unserved Energy

In Hour 3, even though there is no load shed event, marginal unserved energy is equal to **1** and this hour is a **shortage hour.** Marginal value reflects the increase in **shortage in other hours** if storage were to discharge more in this hour.

Example Applications to US Markets

MISO

- Day-Ahead operational planning with short-term weather scenarios applied to Winter Storm Uri, 2021
- Nodal with local and MISO North-South transmission constraints

ERCOT

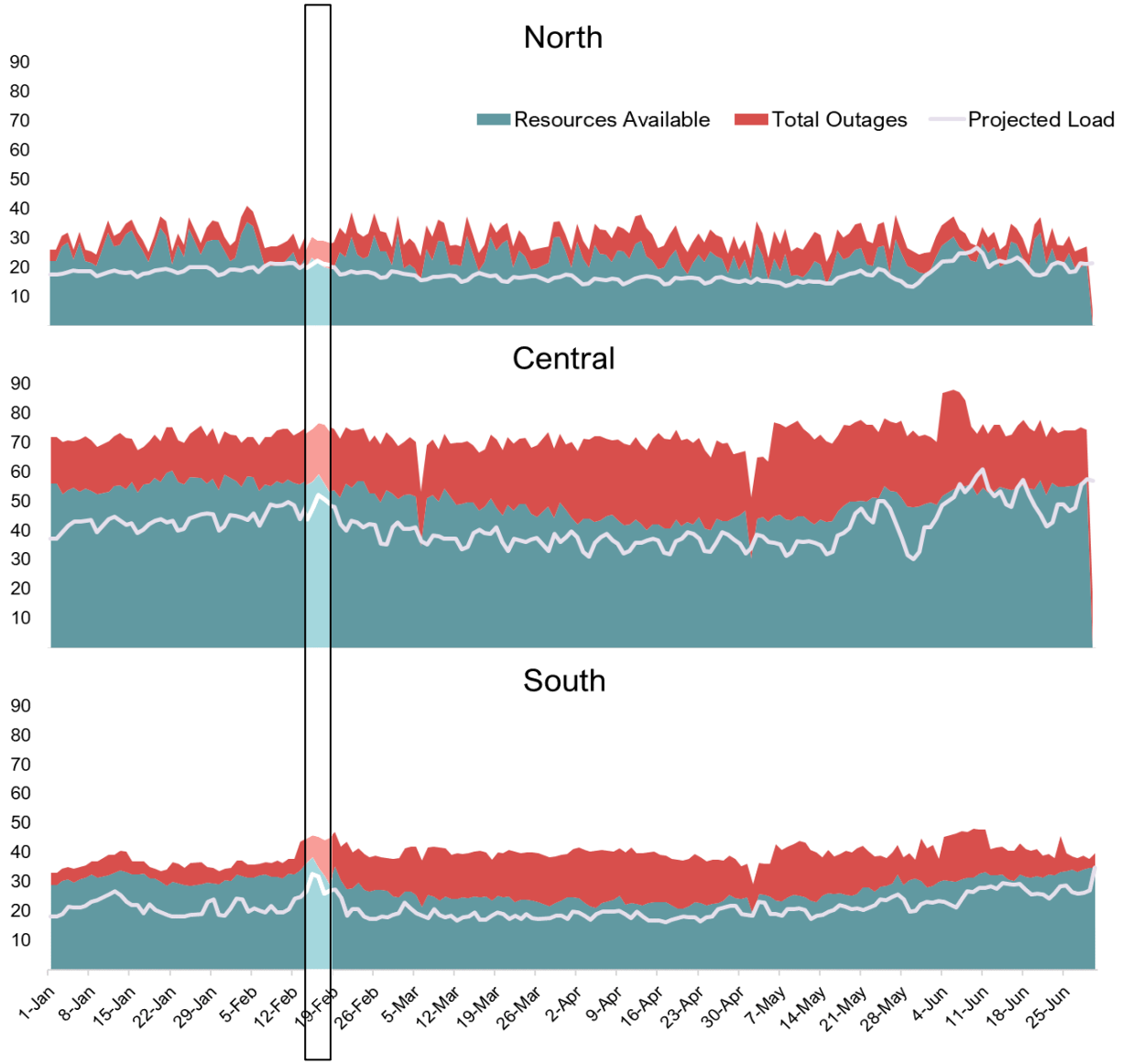
- Annual planning with operational details
- Nodal with 138 kV + Transmission constraints

- Using cloud computing and scenario reduction techniques, calculation of marginal metrics in high-fidelity models is feasible[1,2]

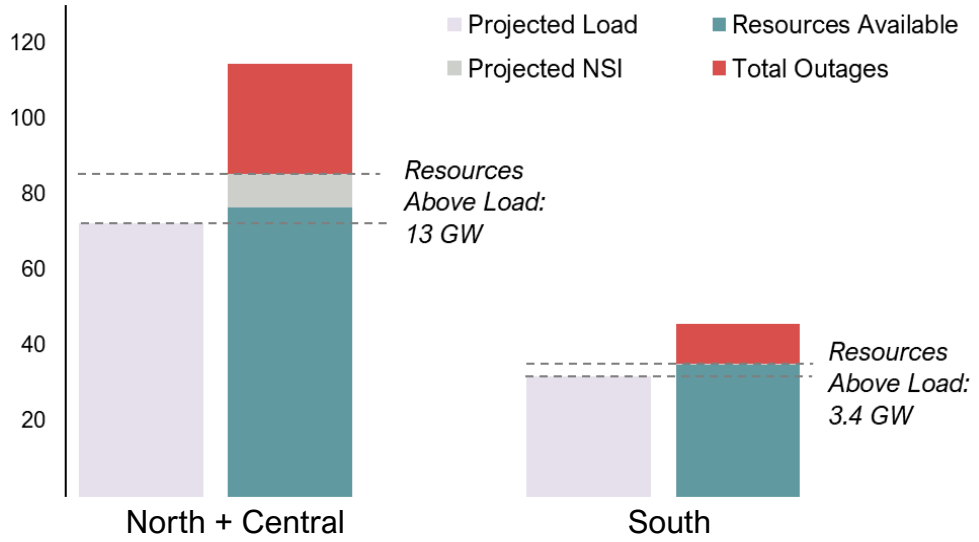
[1]F. S. Yanikara, A. Rudkevich, R. Philbrick, R. Tabors "Weather and Operational Uncertainty in Electricity Market Operations: Stochastic Nodal Adequacy Pricing Approach" (CIGRE 2024 Paris Session, Paris August 25-30 2024

[2]"Assessing Nodal Adequacy of Large VRE Power Systems with New Adequacy Metrics Reflecting RA Contributions of G, T, D", Selin Yanikara et al., ESIG Fall Technical Workshop, October 2023. https://www.esig.energy/download/assessing-nodal-adequacy-of-large-vre-power-systems-with-new-adequacy-metrics-reflecting-ra-contributions-of-g-t-d-selin-yanikara/

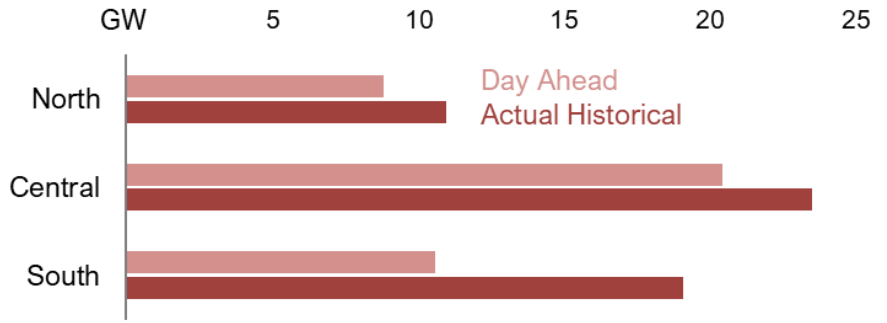
MISO: A Closer Look Into Day Ahead Conditions of Feb 16th, 2021



Conditions on Feb 16th with information from Feb 15th:

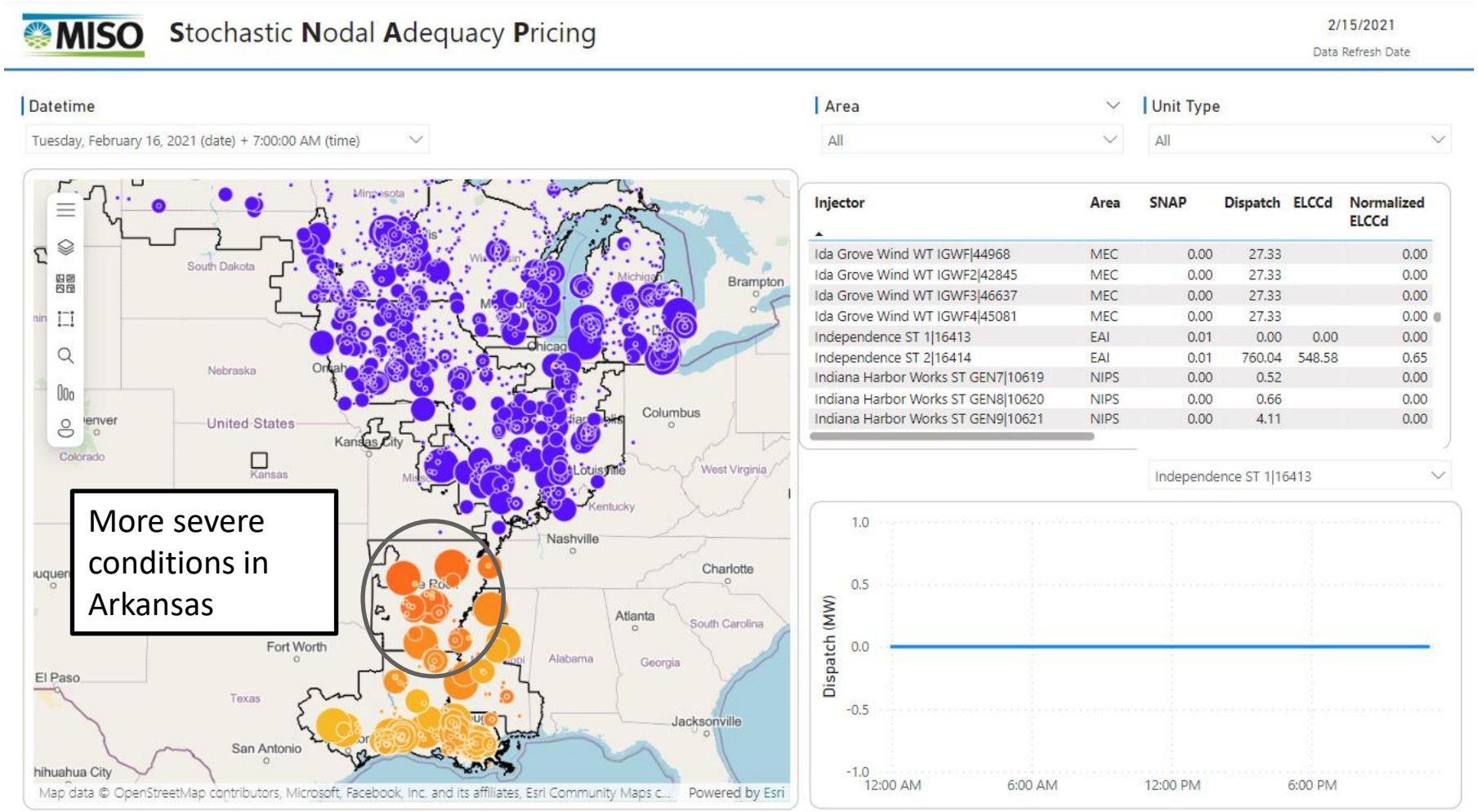


Projected outages on Feb 16th with information from Feb 15th versus actual outages reported:



Data shows snapshot from MISO MOM Report Feb 15, 2021

Local Conditions to Inform Actions



- Heatmap of marginal unserved energy
- Within an area, risk varies due to local congestion
- What if we provide this as signals to DER aggregators and flexible demand?

Size of the bubbles shows injector capacity in that location

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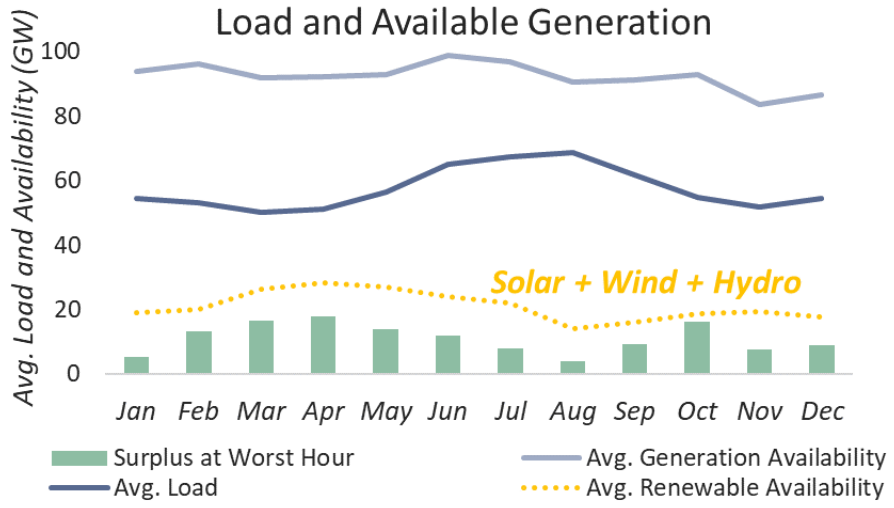
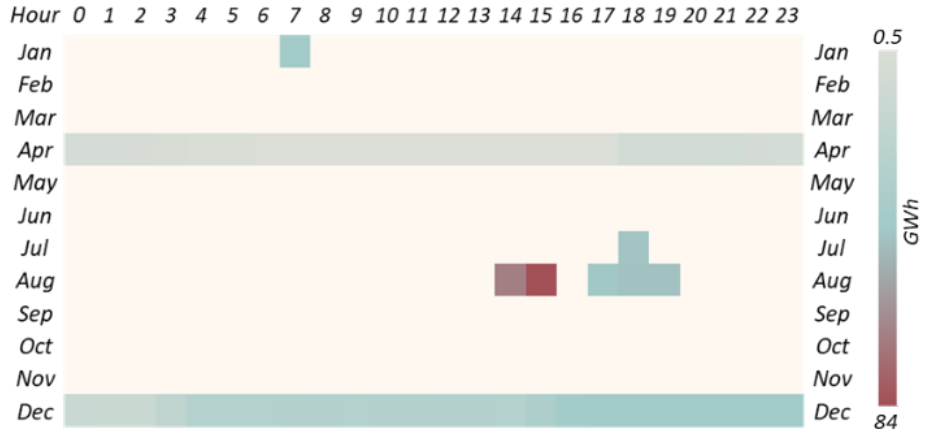
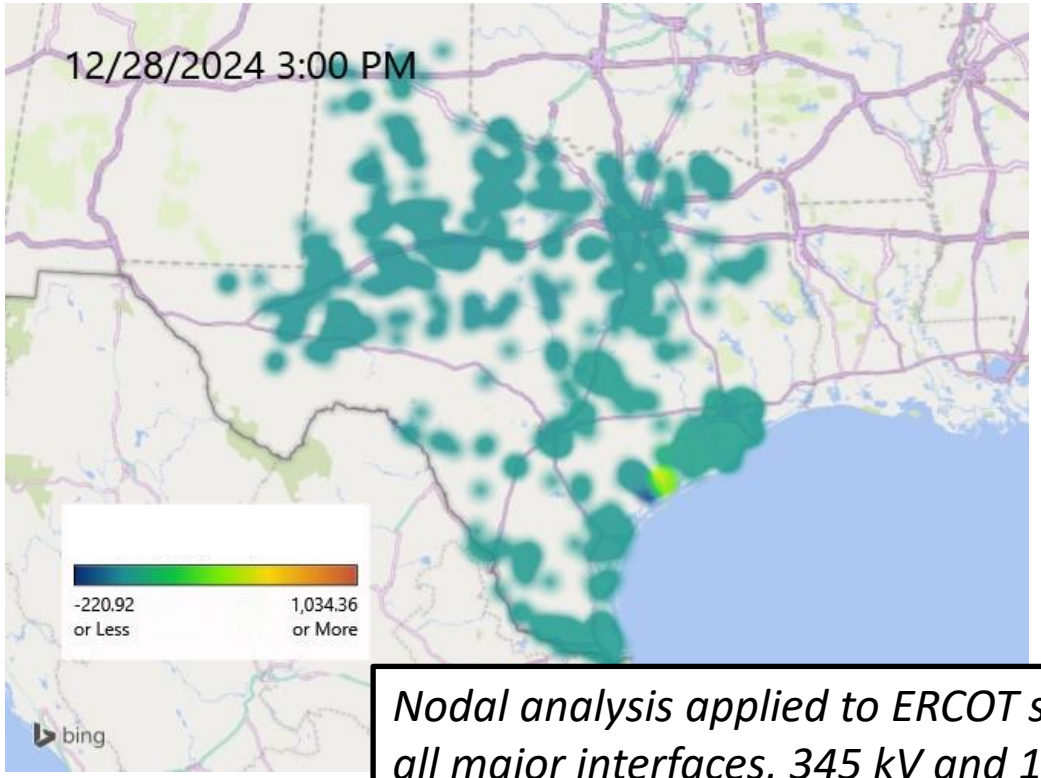
Results are obtained using public MISO data

ERCOT: High-Resolution Annual Planning







Nodal analysis applied to ERCOT system with all major interfaces, 345 kV and 138 kV constraints. Shortages can be observed in high margin hours due to local transmission

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Coordination Between Wholesale and Distribution System

- Use the nodal level resolution in wholesale as an opportunity to more precisely manage load shortage events and transmission congestion associated with these events
- Distribution system today has its distinct and separate criteria and processes to manage critical events
- Efficient consideration and management of DERs relies upon bridging the gap between wholesale and distribution
- Questions to address:
  - What are criteria and policies that distribution system use that wholesale system should factor in?
  - How can the distribution system benefit from high-resolution wholesale signals?
  - Is substation resolution sufficient for DER aggregators? Do we need more granular signals within the distribution system?

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Coordination Between Wholesale and Distribution System

Wholesale

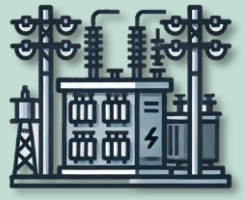
- Locational load shed decisions based on Distribution feedback
  - Impact of shedding load from one substation to another on the Tx system is different
  - Load shed can be more efficient if Tx considers the Distribution impact

High-resolution risk information

Feeder level characterizations:

- Criticality of loads
- DER presence
- Environmental Justice customers
- Critical transformer status on high-heat days

Distribution



- Putting mobile generators at the most effective locations
- DER management

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Contact

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