



# CONGESTION MITIGATION WITH TRANSMISSION RECONFIGURATIONS

Background, Experience To Date and Opportunity for Technology Deployment at MISO  
OMS MWG and TWG Meeting, March 11, 2024



Presented by: Pablo A. Ruiz, *NewGrid*  
Mitch Myhre, *Alliant Energy*



# AGENDA

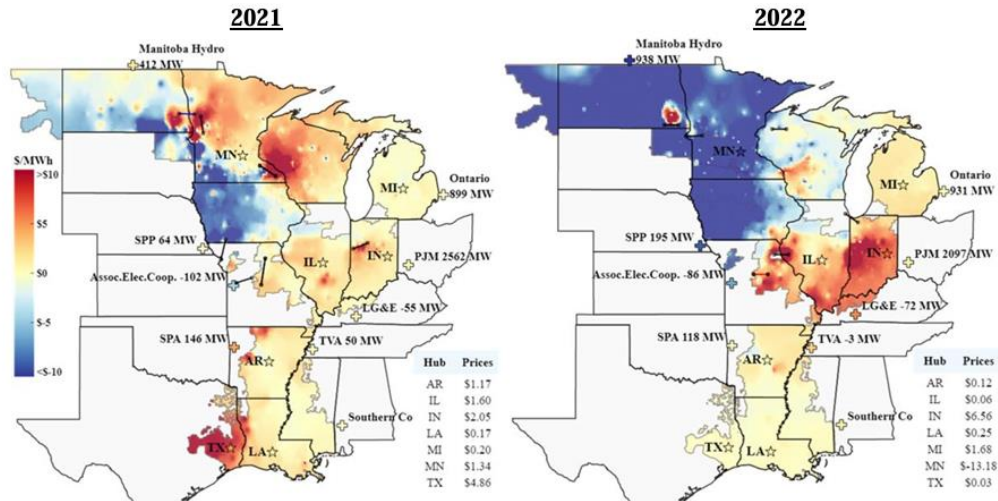
- **Congestion Management and Topology Optimization Background**
- **Applications**
- **Technology Integration to ISO/TSO Processes: A Path for Incremental Implementation**
- **MISO Reconfiguration Request Process**
  - Reconfiguration Example: Congestion Mitigation During 3-Week Outage in Iowa/Minnesota
  - Alliant Energy Pilot Results
- **DOE GRIP Funding Opportunity to Implement Technology in MISO**
- **Appendix**

# TRANSMISSION CONGESTION MANAGEMENT

Traditional congestion management treats the transmission grid as a fixed asset

- Congestion management approach is to redispatch, i.e., ***"increase the tolls!"***
- MISO real-time congestion costs in 2022: \$3.7 billion <sup>1</sup>
- Frequent overloads, customer outages during extreme events <sup>2</sup>

## Congestion Costs in MISO increased 30% from 2021 to 2022 <sup>1</sup>



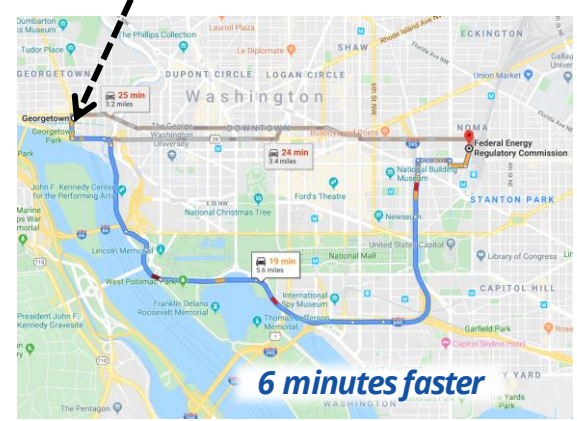
<sup>1</sup> Potomac Economics, [MISO IMM 2022 MISO State of the Market Report](#), June 15, 2023.

<sup>2</sup> For example, transmission congestion led to customer outages in SPP during the Arctic Blast, see [Bitter cold overwhelms grid, leaves millions in dark](#), Edward Klump, Peter Behr and Mike Lee, Energywire, February 16, 2021.

# TOPOLOGY OPTIMIZATION: FLEXIBLE GRID OPERATION

Topology optimization software quickly *finds* and *evaluates* reliable reconfigurations to reroute flow around congestion ("***Waze for the transmission grid***").


- Reconfigurations implemented by opening or closing circuit breakers.
  - Analogous to temporarily diverting traffic away from congested roads to make traffic flow smoother.
- Reconfigurations are **reliable** under all specified contingencies and do not radialize load beyond a user-specified value.
- **Not a new concept:**
  - Reconfigurations happen every day across MISO,
  - Identified based on staff experience, employed mostly on ad hoc basis.



# A PATH FOR INCREMENTAL TECHNOLOGY IMPLEMENTATION

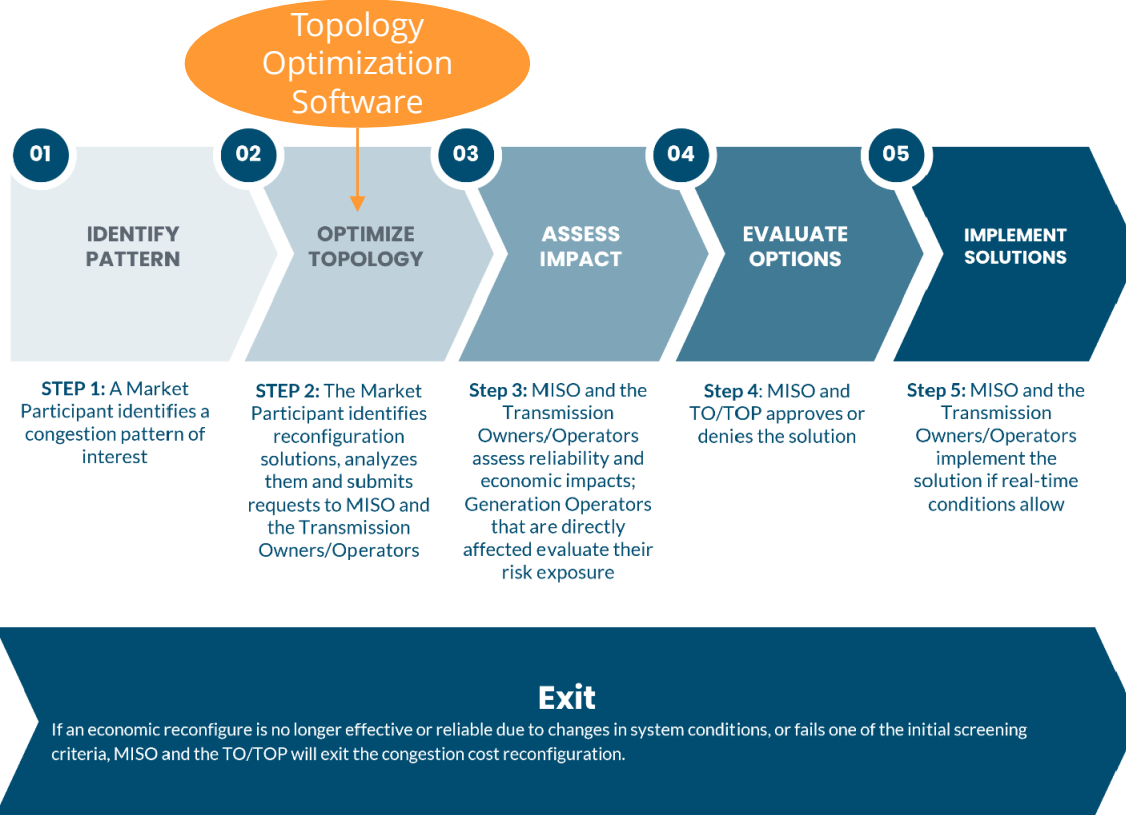
	Process	Technology User	Application	System Integration	Timeframe
<p>Simplest</p> <p>Highest benefits</p>	<b>Step 1</b> <b>Reconfiguration Request Process</b>	<b>Market Participants</b> (RTOs, RCs and TOs have the software needed to evaluate requests)	mitigation of major expected constraints	none	days / weeks / months ahead
	<b>Step 2</b> <b>Planning and Operations Planning Support</b>	<b>RTO, RC, TOP</b>	operating/mitigation plan development, outage scheduling support, optimize transmission expansion	none to minimal (offline advisory tool)	days / weeks / months ahead
	<b>Step 3</b> <b>Real-Time Operations Support</b>	<b>RTO, RC, TOP</b>	reconfiguration options tailored to real-time conditions	EMS	days ahead to real time
	<b>Step 4</b> <b>Market Clearing</b>	<b>RTO</b>	continuous optimization of topology as conditions evolve	EMS and MMS	days ahead to real time

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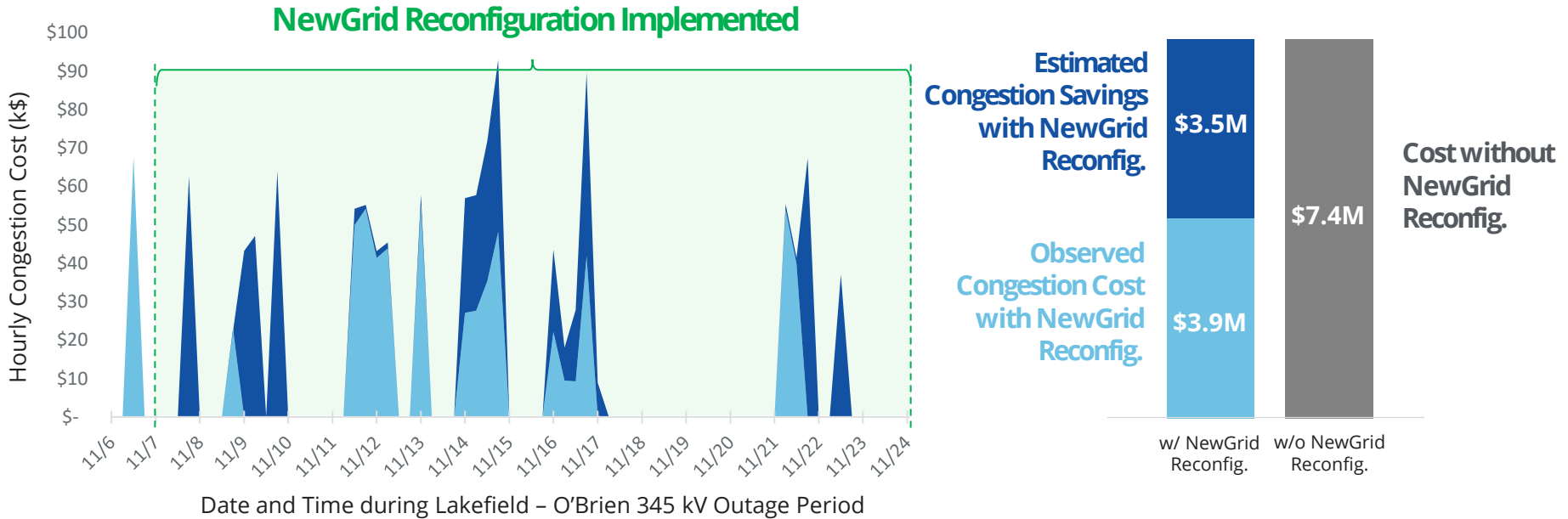
# RECONFIGURATION REQUEST PROCESS



Midcontinent ISO, [MISO Congestion Cost Reconfiguration Process](#).

# CONGESTION COST SAVINGS FROM ONE RECONFIGURATION

- A reconfiguration developed by NewGrid reduced regional congestion costs by **\$3.5 million**.
  - Mitigated the impacts of a 3-week outage of a 345 kV line across Iowa/Minnesota border.

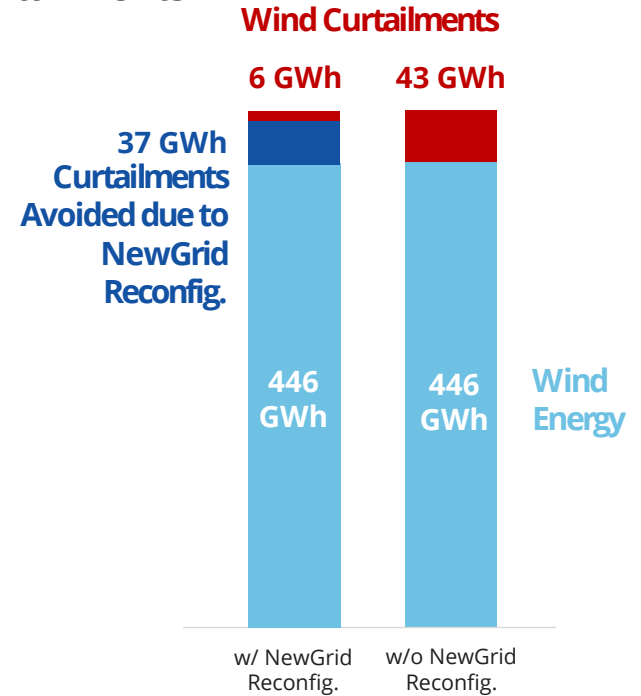
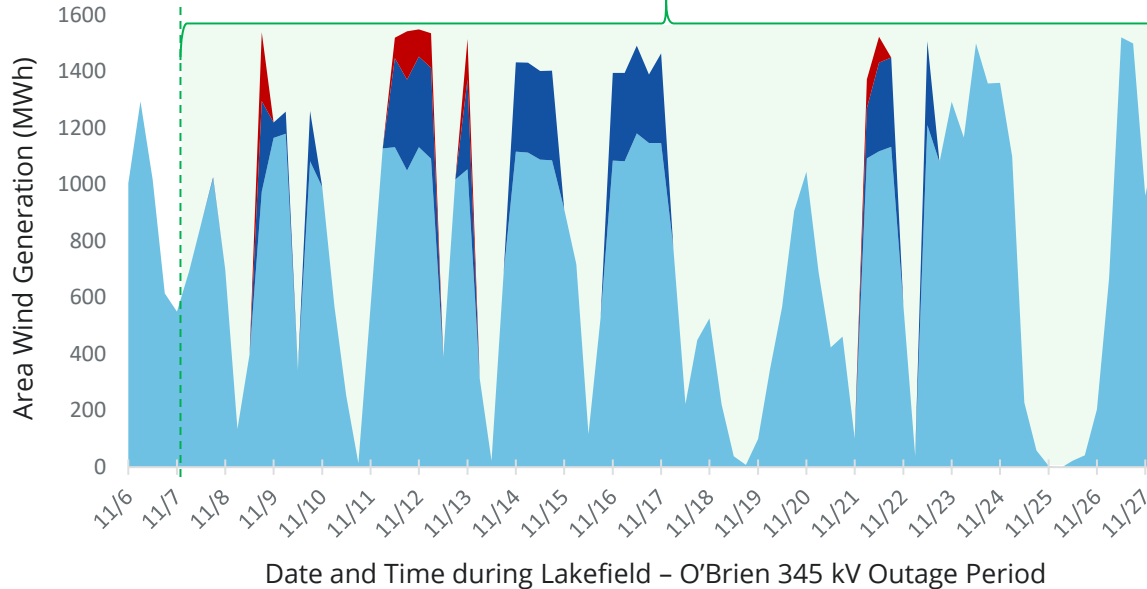




# AVOIDED WIND CURTAILMENTS FROM ONE RECONFIGURATION

- During the outage, the total generation by the area wind plants was **483 GWh**. The reconfiguration avoided **37 GWh** of wind curtailments (86% reduction).

**NewGrid Reconfiguration Implemented**



# OVER 80% ACHIEVABLE CONGESTION COST SAVINGS



- Alliant Energy and NewGrid pilot:
  - Identify and analyze regionally beneficial reconfigurations
  - Request their implementation
  - Evaluate congestion cost mitigation for Alliant's customers.
- Looking for low-hanging fruit
  - Simple & robust solutions

**IPL Congestion Savings Realized  
(Solutions implemented):  
\$24.2 million**

**IPL Foregone Opportunity  
(Solution not implemented):\*  
\$15.6 million**

**IPL Residual Congestion:  
\$10 million**



**81% -- about \$39.8 million savings achievable**  
based on reconfigurations identified October 2021 – December 2023

## *How to replicate across MISO, increase the potential savings and deliver them?*

Impacts calculated ex-post based on analyses of state estimator cases published by MISO and of historical market data.

\* Solution not implemented includes the impacts of all solutions found, requested and that were not declined on a technical basis, as well as solutions not requested due to the lack of an established request process (prior to July 2023).

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# OPPORTUNITY TO DEPLOY TECHNOLOGY WITH DOE FUNDING

- [Grid Resilience and Innovation Partnership grant](#) concept paper submitted to DOE GDO
  - Scope: Deploy topology optimization software technology in MISO to support congestion mitigation reliably and consistently across MISO.
  - Grant Funding: \$10 million (\$20 million total project cost).
  - Consistent with IMM recommendation.
  - Project Benefits: Potential savings exceed \$1.5 billion annually.<sup>1</sup>
- Concept paper submission in partnership with OMS and others.
- DOE encouraged full application for this concept paper.
- Full application due on May 22.
- Full application will need support from OMS and MISO.



<sup>1</sup> Based on \$3.7 billion real-time congestion costs in 2022 and over 50% savings achievable as found in the Alliant Energy pilot.

# CONTACT

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CEO and CTO

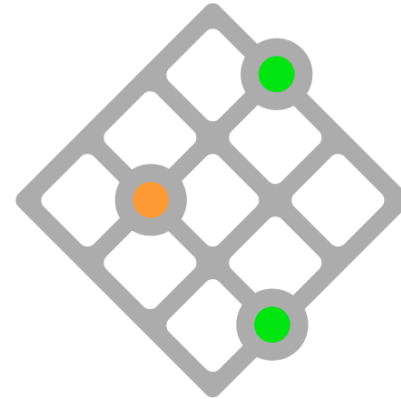
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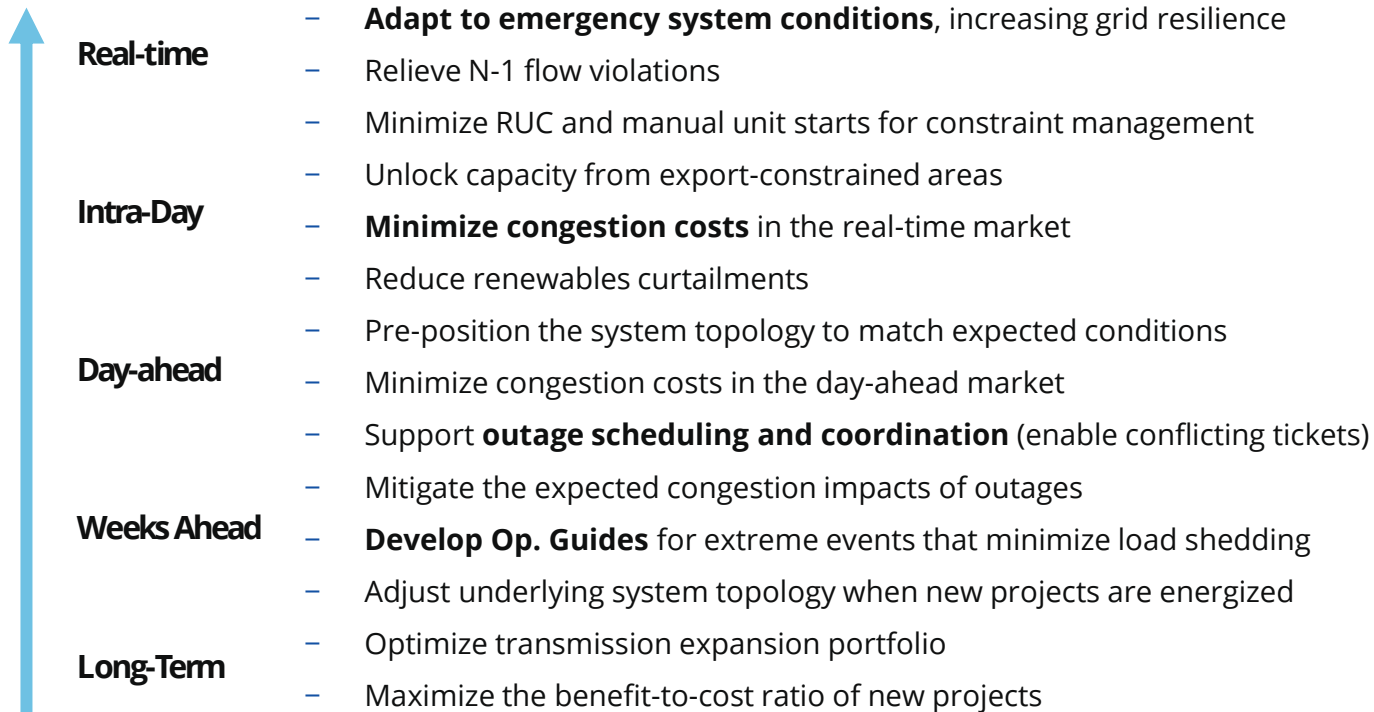
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# APPENDIX

- **Topology Optimization Applications**
- **Reconfiguration Types**
- **Case Study 2: Overload Event Risk Reduction with Reconfigurations**
- **Case Study 3: Generation Released During Winter Storm Elliott with Reconfigurations**

# APPLICATIONS

Topology optimization can support business processes across many scales.



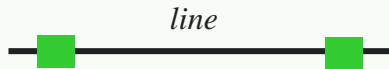
# THERE IS A VARIETY OF RECONFIGURATION TYPES

Optimization routines search reconfigurations to relieve **one or more simultaneous constraints**, and identify **preventive or corrective solutions**. Reconfiguration types vary depending on system topology, system conditions and congestion problem characteristics.

## Open/close branch

Branch types:

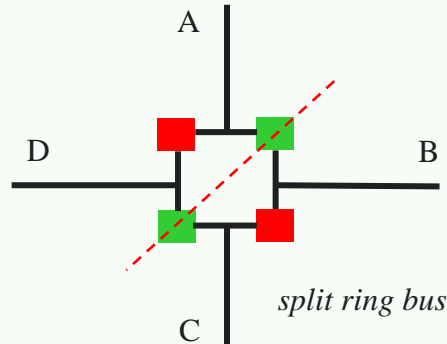
- Lines
- Transformers
- Bus tie breakers
- Reactor by-pass breakers



## Bus split/merge

Some substation arrangements allow bus splits:

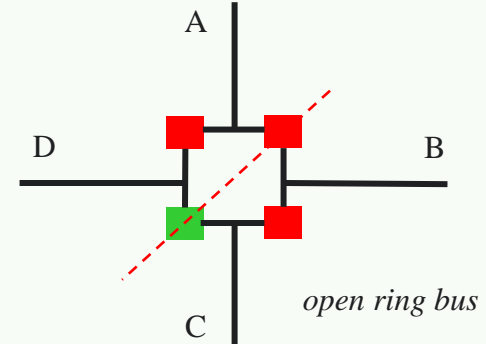
- Ring bus
- Double bus double breaker
- Breaker and a half



## Contingency-change

Substation reconfigurations

- Bus normally connected
- Split bus or disconnected element under specific contingency conditions



■ Closed Circuit Breaker

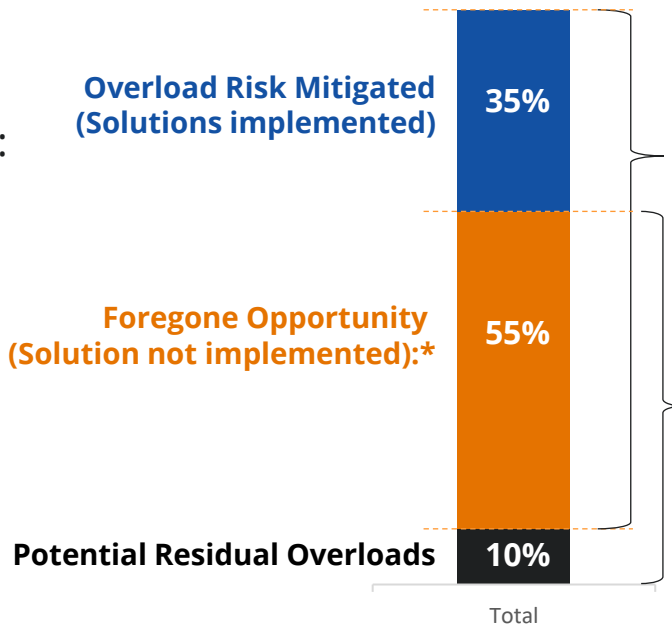
■ Open Circuit Breaker



# OVERLOAD EVENT RISK CAN BE REDUCED BY 90%



- Alliant Energy and NewGrid pilot:
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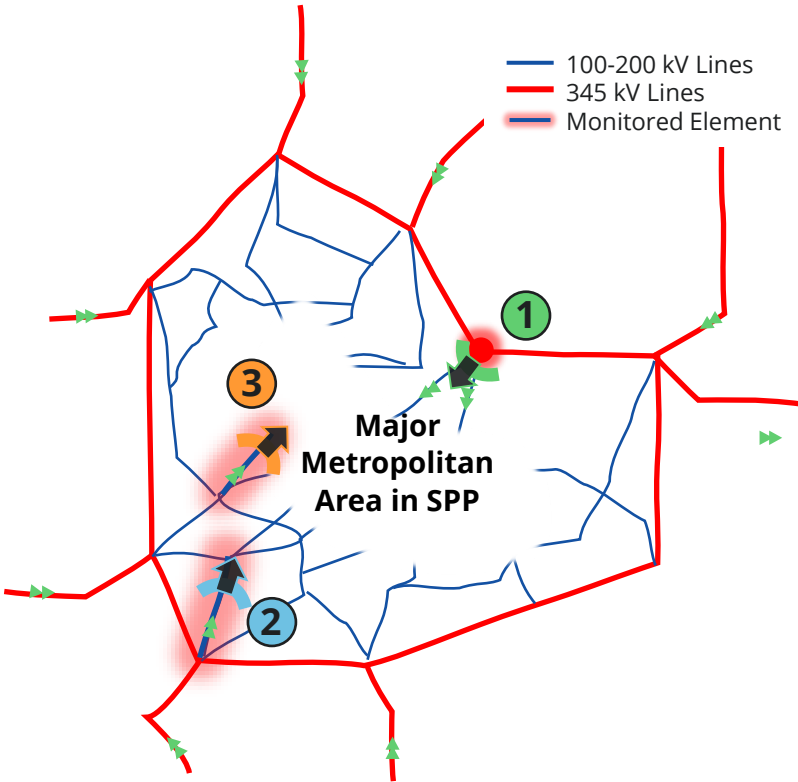
**90% reduction in overload event risk – 614 constraint-hours** w/ reconfiguration request process in MISO based on reconfigurations identified in January - August 2023

**Realized overloads: 444 constraint-hours**

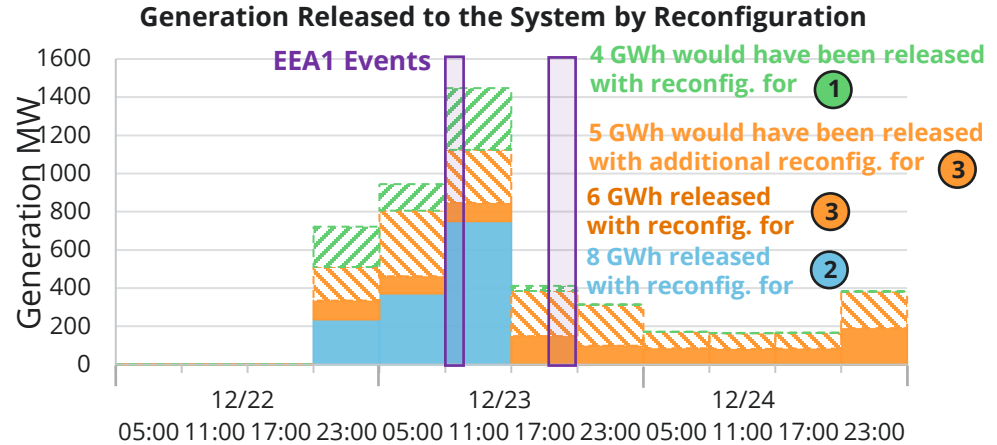
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# UP TO 1445 MW GENERATION RELEASED DURING EMERGENCY



System Diagram Source: NewGrid.



- Two implemented reconfigurations allowed higher transfers, releasing up to **845 MW** from available plants upstream of the constraint.
- Two other reconfigurations would have released up to **600 MW of additional generation** to the system.
- The capacity released varies by SE case, depending on system conditions.