EFFECTIVE CONGESTION MITIGATION WITH TRANSMISSION TOPOLOGY OPTIMIZATION AT ALLIANT ENERGY AND ITC

ESIG Webinar, January 30, 2025

Presented by:
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AGENDA

- Congestion Management and Topology Optimization
- Integration to RTO/TOP/RC* Processes: A Path for Incremental Implementation
- MISO Reconfiguration Request Process
- ITC Congestion Management Processes and Reconfiguration Experience
- Alliant Energy Topology Optimization Experience and Results
- Concluding Remarks and Recommendations

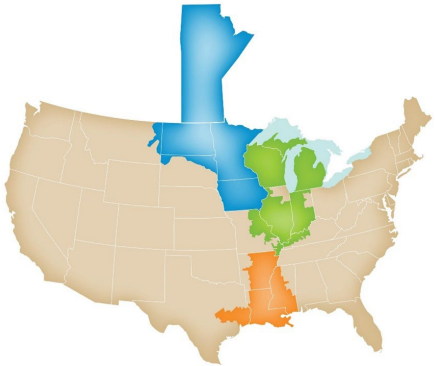
* RTO – Regional Transmission Organization, TOP – Transmission Operator, RC – Reliability Coordinator.

TRANSMISSION CONGESTION MANAGEMENT

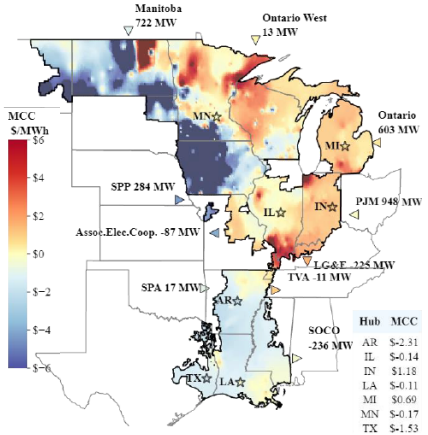
Traditional congestion management treats the transmission grid as fixed

- Congestion management approach is to redispatch, i.e., "*increase the tolls!*"
- Congestion costs spiked in 2022 (estimated costs in the U.S. were $20.7 billion[1])
- Frequent overloads (emergency rating exceedance), customer outages during extreme events [2]

Midcontinent ISO (MISO) 2024 Congestion Costs: $1.73 billion [3]



Source: FERC.



Source: Potomac Economics MISO IMM Quarterly Report Fall 2024.

1 Transmission Congestion Costs Rise Again in U.S. RTOs, Richard Doying, Michael Goggin and Abby Sherman, Grid Strategies Report, July 2023.

2 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.

3 Calculated from the four seasonal Potomac Economics MISO IMM Quarterly Reports 2024.

TOPOLOGY OPTIMIZATION ENABLES FLEXIBLE GRID OPERATION

Topology optimization software quickly *finds* and *evaluates* reliable reconfigurations to reroute flow around congestion ("*Google Maps 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.
- Technology supports transmission decision making processes.
  - Utilities already reconfigure the transmission system, based on staff experience, on ad hoc basis.
  - Fast search time: seconds to minutes
- Reconfigurations are **reliable** under all specified contingencies and do not radialize load beyond a user-specified value.

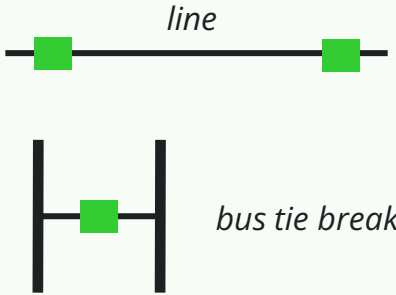
THERE ARE DIFFERENT RECONFIGURATION TYPES

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:

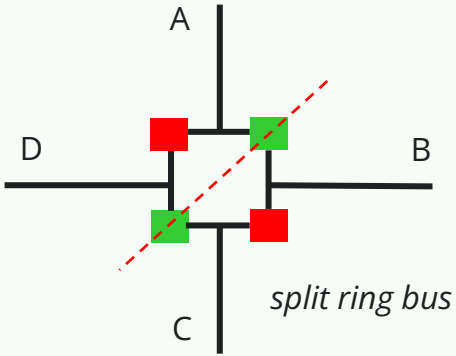
- Lines
- Transformers
- Bus tie breakers
- Reactor by-pass breakers



Bus split/merge

Some substation arrangements allow bus splits:

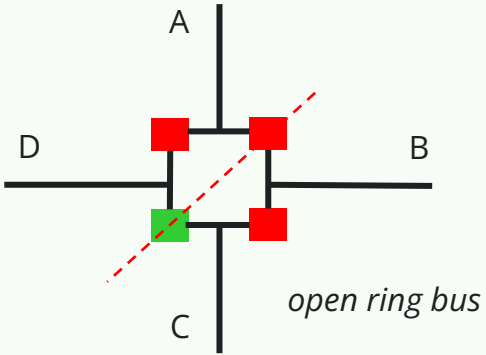
- Ring bus
- Double bus double breaker
- Breaker and a half



Contingency-change

Substation reconfigurations

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



Closed Circuit Breaker

Open Circuit Breaker

TOPOLOGY OPTIMIZATION APPLICATIONS

Topology optimization can support business processes across many scales.

Real-time

- **Adapt to emergency system conditions**, increasing grid resilience
- Relieve N-1 flow violations
- Minimize RUC and manual unit starts for constraint management

Intra-Day

- Unlock capacity from export-constrained areas
- **Minimize congestion costs** in the real-time market
- Reduce renewables curtailments

Day-ahead

- Pre-position the system topology to match expected conditions
- Minimize congestion costs in the day-ahead market
- Support **outage scheduling and coordination** (enable conflicting tickets)

Weeks Ahead

- Mitigate the expected congestion impacts of outages
- **Develop Operating Guides** for extreme events that minimize load shedding
- Adjust underlying system topology when new projects are energized

Long-Term

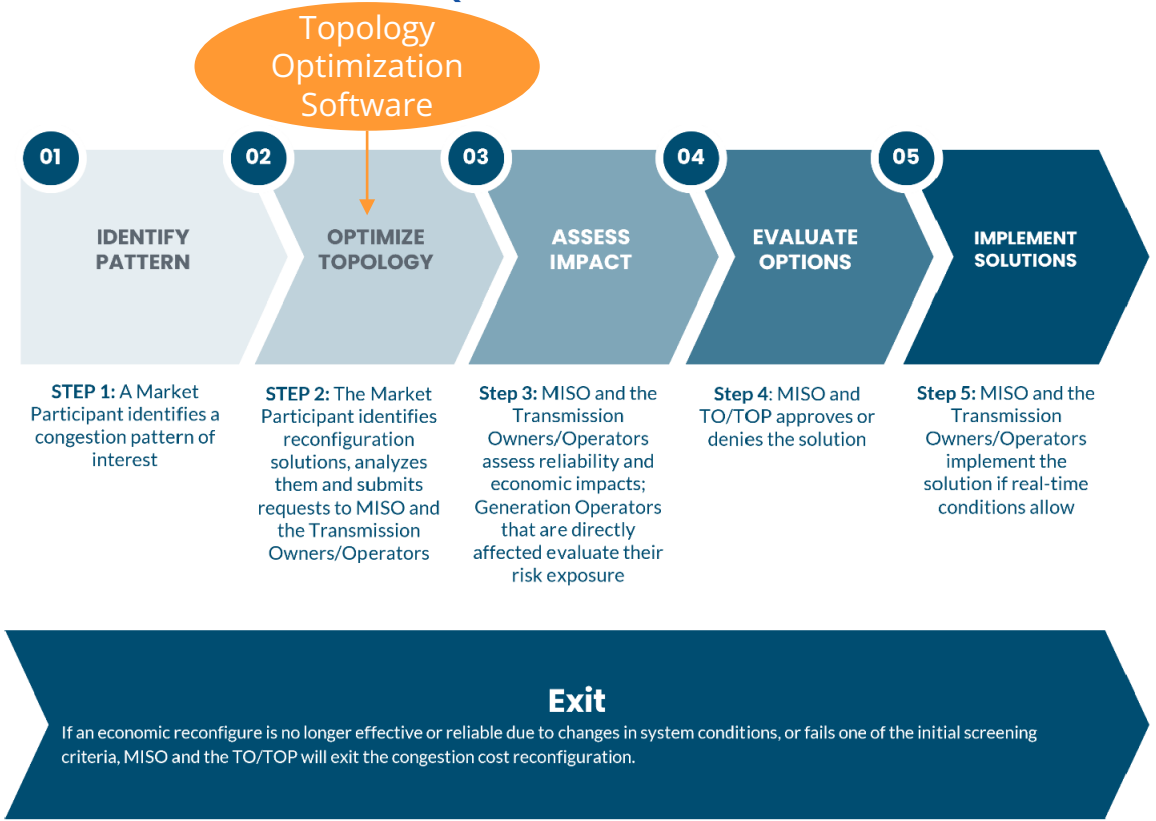
- Optimize transmission expansion portfolio
- Maximize the benefit-to-cost ratio of new projects

A PATH FOR INCREMENTAL TECHNOLOGY IMPLEMENTATION

Simplest → *Highest benefits*

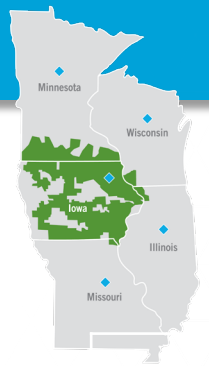
Process	Technology User	Application	System Integration	Timeframe
Stage 1 **Reconfiguration Request Process**	**Market Participants** (RTOs, RCs and TOPs have the software needed to evaluate requests)	mitigation of major expected constraints	none	days / weeks / months ahead
Stage 2 **Planning and Operations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

MISO RECONFIGURATION REQUEST PROCESS



Midcontinent ISO, MISO Congestion Cost Reconfiguration Process.

ABOUT ITC



	ITC Michigan	ITC Midwest	ITC Great Plains	Total
System Peak Load	~22 GW	~4GW	-	~26GW
Service Area	Lower Peninsula of MI	IA, MN, IL, WI & MO	KS & OK	8 States
Wind	3,551	5,449	1,329	10,329
Transmission Miles	~8,700	~6,600	~480	~15,780
RTO	MISO	MISO	SPP	

	ITC Michigan	ITC Midwest	ITC Great Plains	Total
GENERATION SOURCE MIX				
Natural Gas / Combined Cycle	11,330	1,793	-	13,041
Coal	9,135	1,711	-	10,846
Wind	3,551	5,449	1,329	10,329
Nuclear	1,982	-	-	1,982
Pumped Storage Hydroelectric	2,241	-	-	2,241
Solar	888	550	189	1,627
Total	**29,127**	**9,503**	**1,518**	**40,066**

ITC A FORTIS COMPANY | FOR THE GREATER GRID

CONGESTION MANAGEMENT OVERVIEW

Identify

- ITC MACE Program
- Customer Request

Assess

Model
- Load
- Generation
- Interchange
- Dispatch
- Topology

Scenarios
- System Normal
- Contingencies

Optimize

- Redispatch
- Outage Schedule
- Low Cost – High Impact Upgrades
- **Topology Optimization**
- Ambient Adjust Ratings

Evaluate

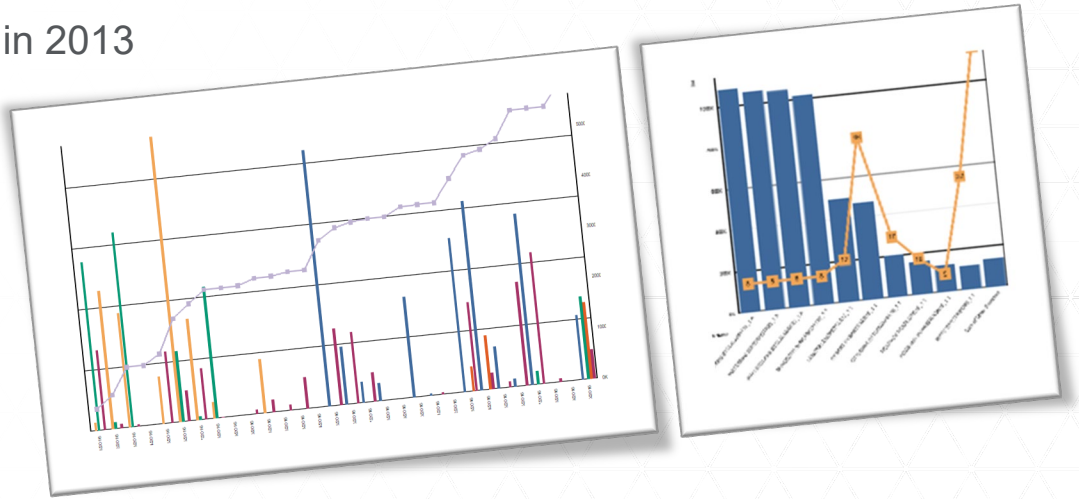
- Operational Impact
  - Risk to Load
  - Connectivity
  - Gen Capacity
- Coordination Requirement
- Time to Implement
- Flexibility
- Cost to Implement

Implement

- Standing Actions
- Forward Looking
- RealTime

CONGESTION MANAGEMENT PROGRAM AT ITC

- Market Analysis & Congestion Evaluation (MACE)
  - Program to help us monitor congestion in our footprints and act on that information when possible
  - Started work on the program early in 2013
  - Covered at daily Operations call
  - Daily, weekly, and monthly reports
  - Detailed monthly review



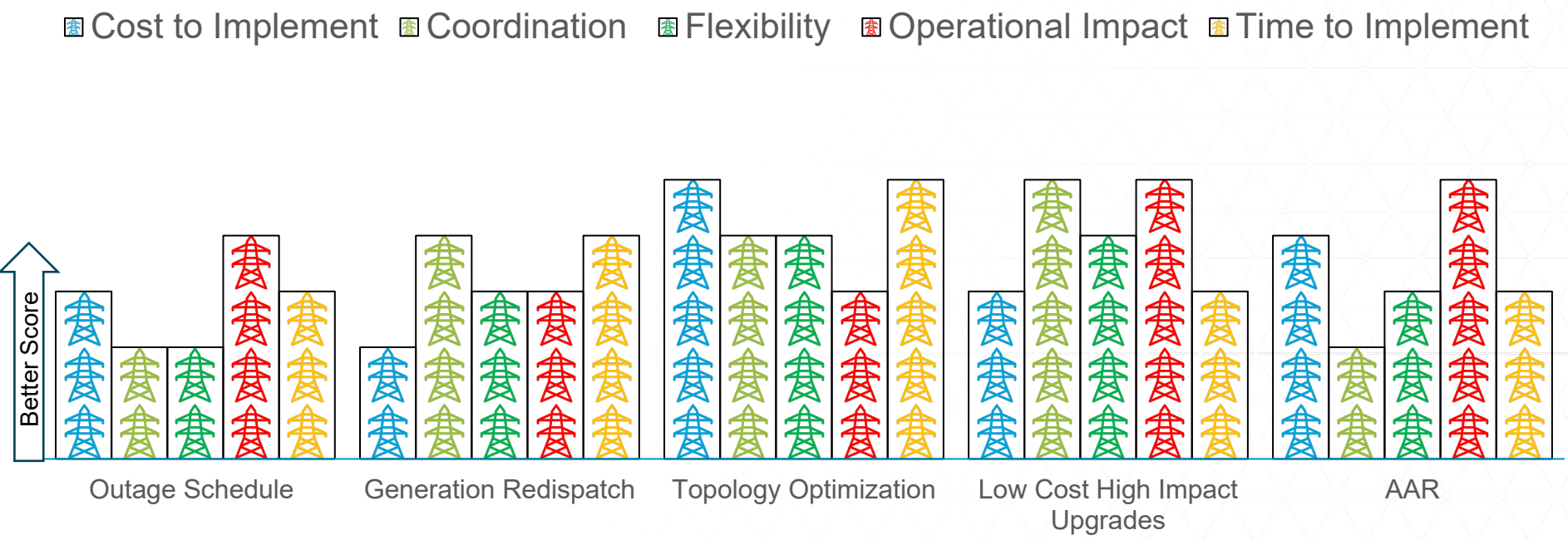
MACE MONITORING AND CALCULATION

- **How do we monitor congestion?**
  - ***Real Time:*** Operations Control Room (OCR) staff monitor via:
    - MISO verbal communication and MISO Binding Constraint information
  - ***After the Fact Review***: archive, issue, review, and discuss reports on a daily, weekly, monthly and yearly basis
  - Will discuss more and give examples in later section
- Congestion Calculation Methodology
  - Primary calculation method today is based on MISO binding constraint report

CALCULATION LIMITATIONS AND DISCLAIMER

- Calculated congestion costs are a *benchmark*
- *Not* true cost of congestion experienced by customers
- Customers hedge for congestion with a variety of tools:
  - Day Ahead Market versus Real-time Market
  - FTRs
  - Virtual Transactions
  - Other methods
- *Impossible* for ITC to calculate true cost of congestion in our footprints
- *However…* Congestion benchmark tells us the magnitude of "unhedged" congestion, and allows us to track trends

MITIGATION OPTIONS



RECONFIGURATION OPTIONS

Station Configuration

- Low impact to network connectivity
- Could be use in place of complicated remedial action schemes
- Could be restored at any time
- May impact load or generation connected at the station

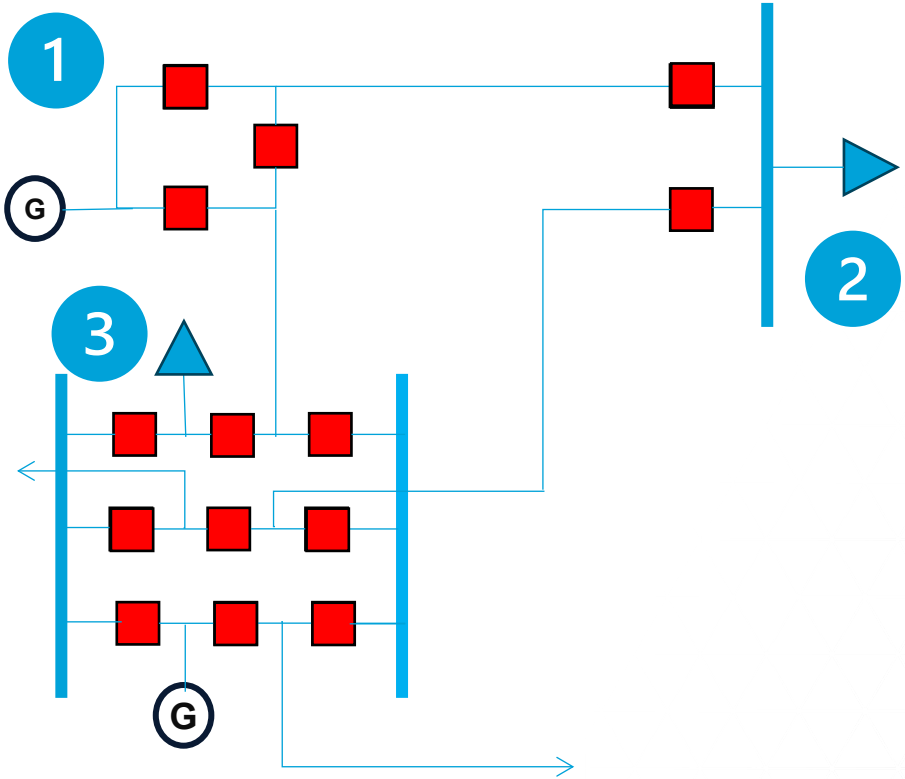
Facility Disconnection

- Disconnect lower rated facilities to reroute power to higher capacity ones
- May put load on radial condition
- Some impact to network strength
- Prefer to use SCADA controlled devices

Station Splits

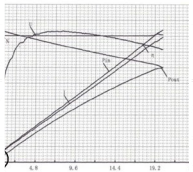
- Successful applications have shown to be very effective
- More complex, requires more careful review
- Typically requires relay coordination review
- May impact load or generation connected at the station

TOPOLOGY OPTIMIZATION CONSIDERATIONS



Generation Impact

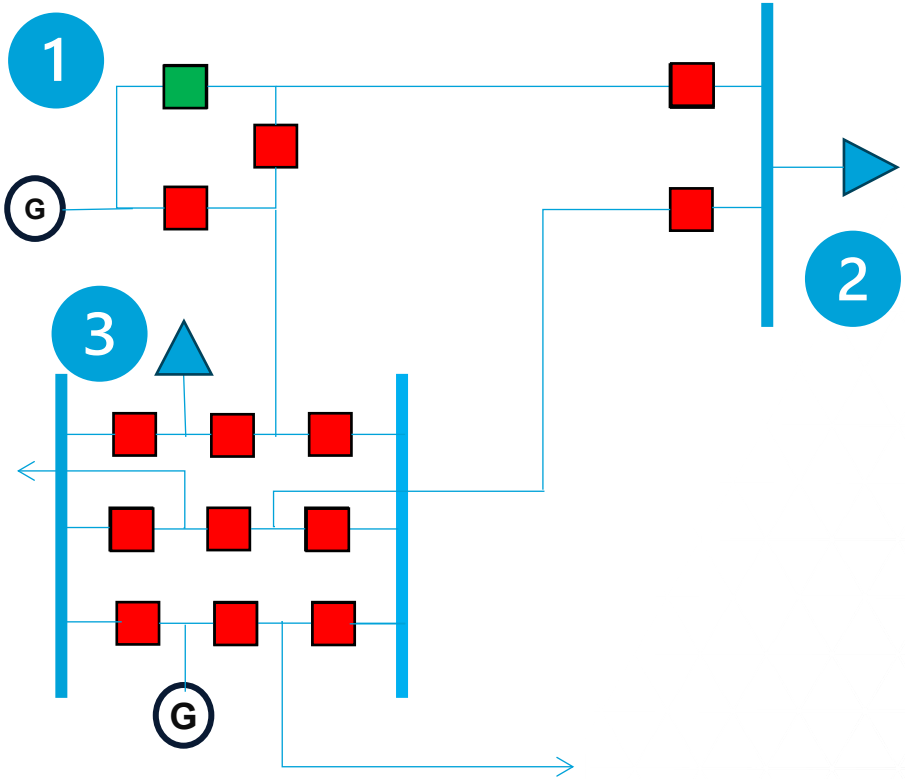
Load Impact



Relay Coordination

Problem Shifting

TOPOLOGY OPTIMIZATION CONSIDERATIONS



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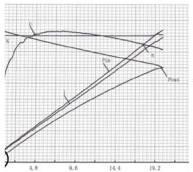

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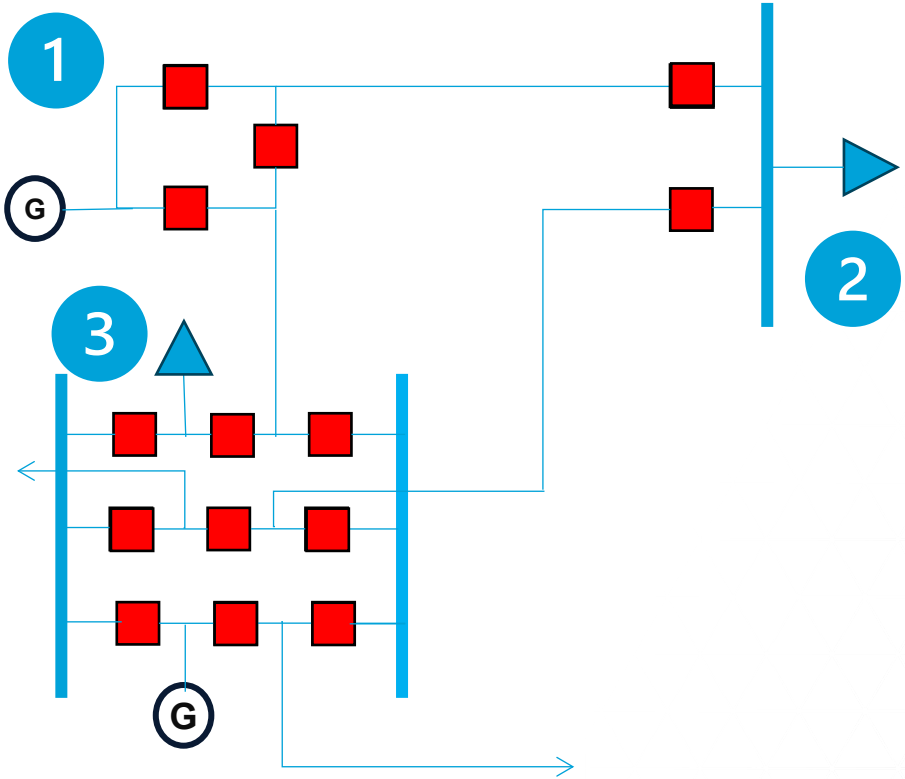

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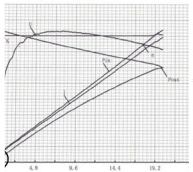

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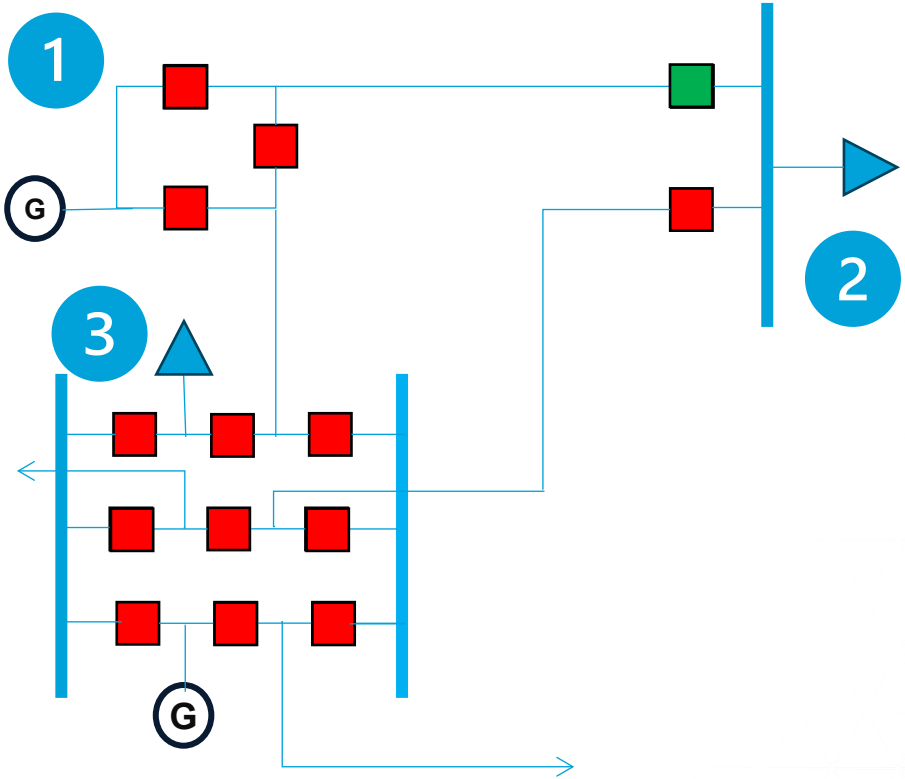

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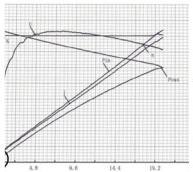

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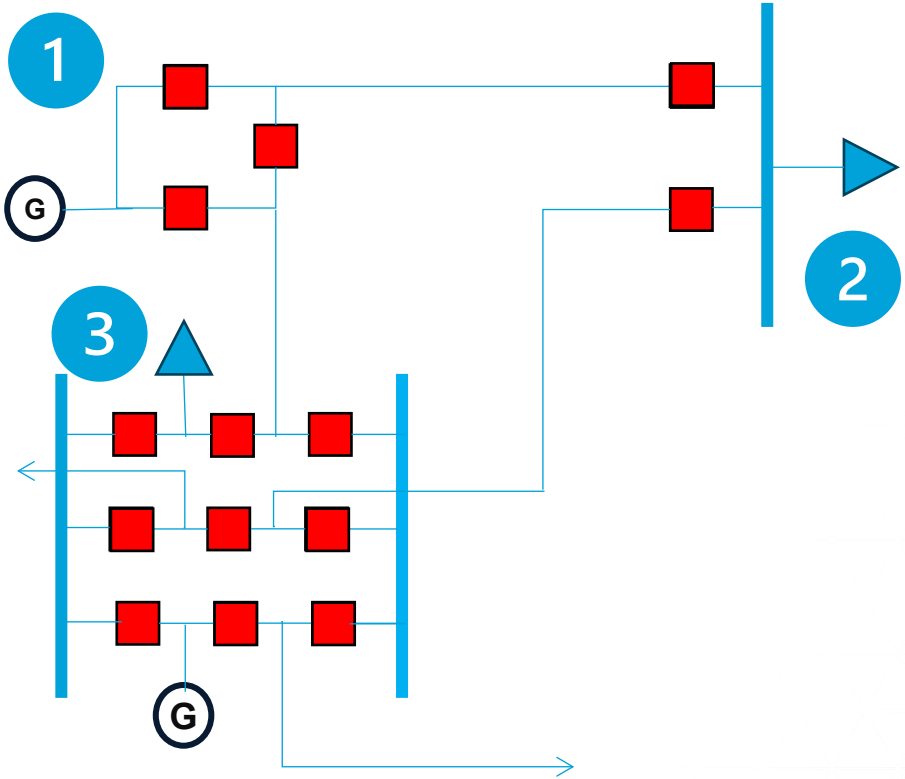

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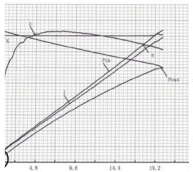

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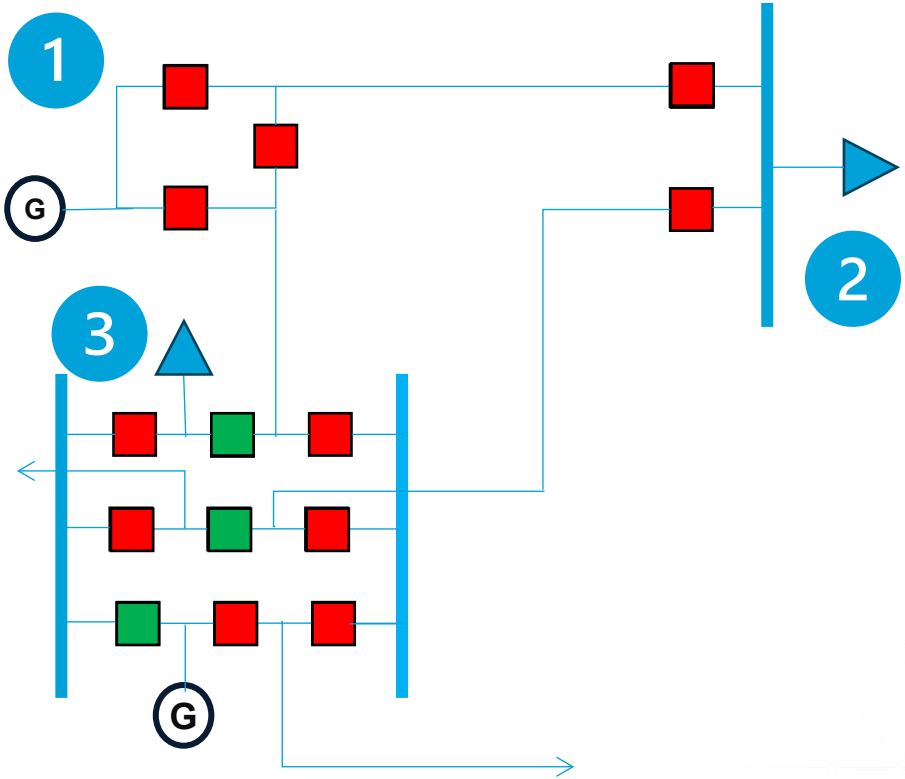

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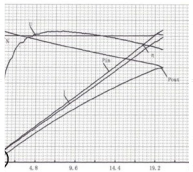


Relay Coordination

Problem Shifting

IMPLEMENTATION CONSIDERATIONS

All actions are at the discretion of System Operators

Standing Actions

- Persistent issues
- Customer impact mitigated
- Not ideal when competing constraints exists

Forward Looking

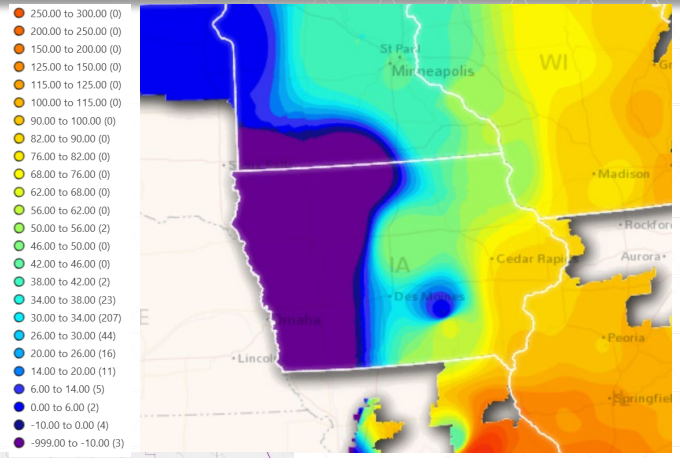
- Used for Planned outages
- Works best when conditions could be forecasted reliably
- Day Ahead benefits

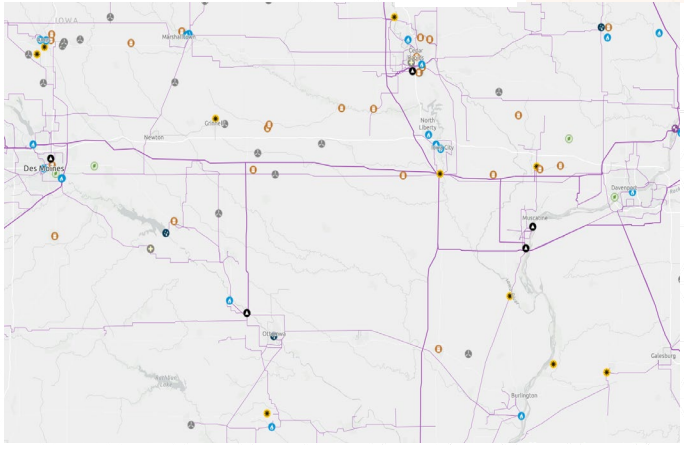
Real Time

- Used when conditions are less predictable
- Unplanned events
- Typical when competing constraints exists

TOPOLOGY OPTIMIZATION EXAMPLE – OTTUMWA

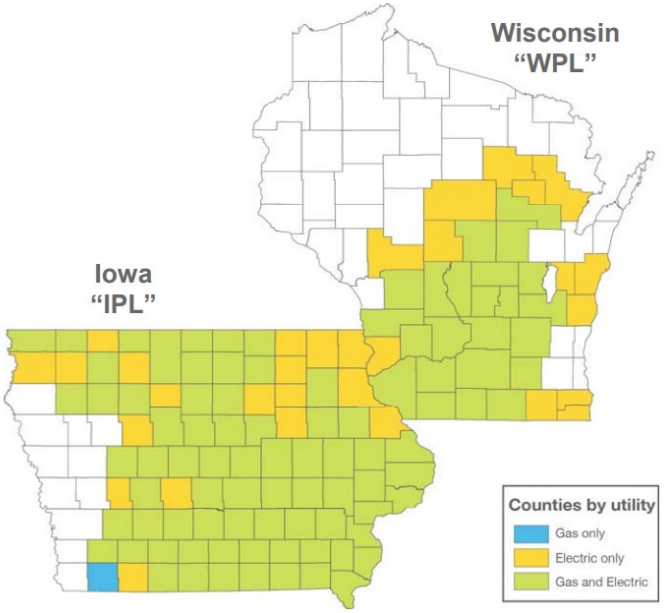
- Outage of Ottumwa Generating Unit
- Increased congestion on
  - Beacon-Irvine 161 kV (AAR) &
  - Poweshiek-Reasnor 161 kV (AAR)
- Multiple configurations implemented
- Mitigated System Operating Limits exceedances
- Savings of over $4.4M

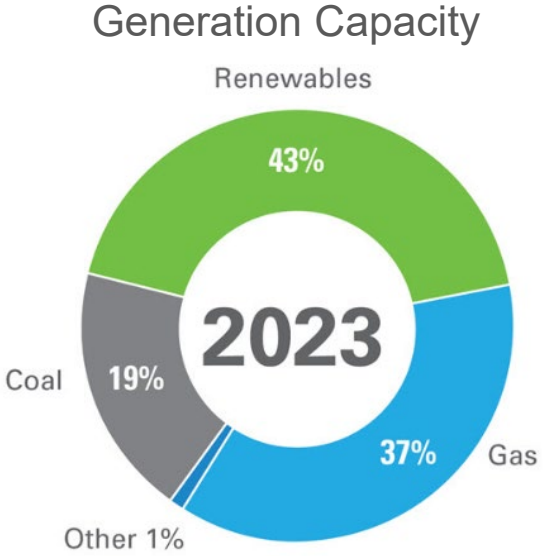




About Alliant Energy

- Alliant Energy provides regulated electric and natural gas service to approximately 1,000,000 electric and approximately 425,000 natural gas customers in the Midwest.





- Third largest regulated wind owner-operator in the U.S.
- Top five regulated solar owner-operator.
- No direct ownership and operation of transmission.

Alliant Energy Perspective

- Transmission optimization should be a priority and is needed to help meet increasing demands on the system as well as affordability and reliability objectives.

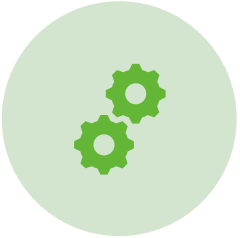
- Transmission reinforcements and expansion is a long-term solution; but there is also a need for near-term efforts to optimize the current transmission system and consider alternatives.

An "*all of the above" approach* is needed to address congestion which includes better utilization of the existing transmission system

Collaboration on Optimization

Analyze current congestion events affecting Alliant Energy generation assets and demand

Identify upcoming events with potentially high congestion impact



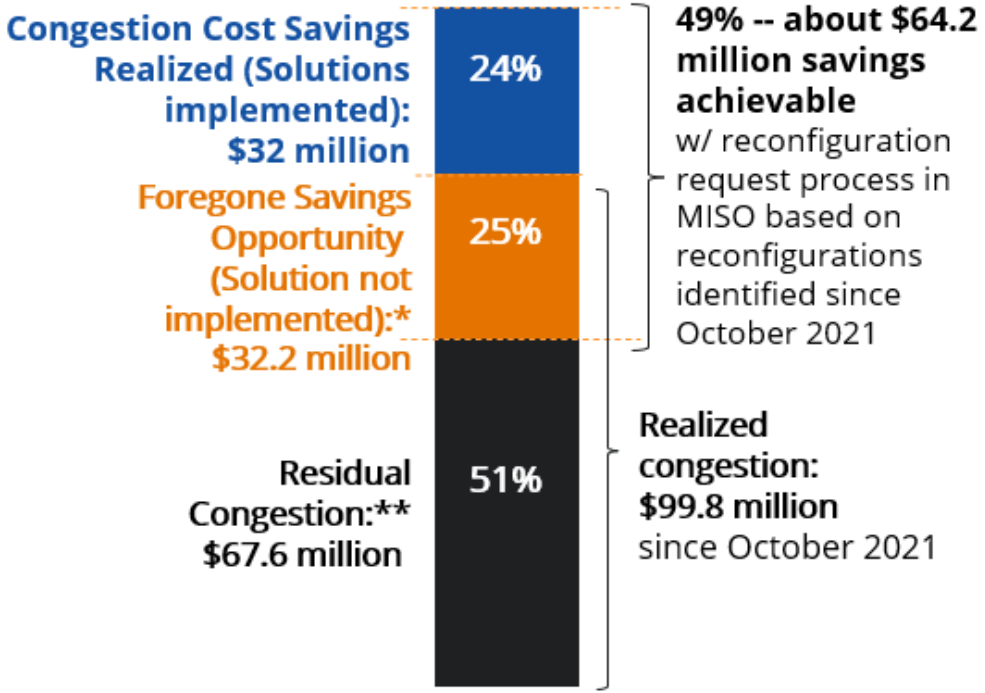
Develop reconfiguration solutions to mitigate the impacts of those events

Work with transmission owners and MISO to implement

Optimization effort has been a joint effort between Alliant Energy, NewGrid, ITC, MISO and other transmission and generation owners.

Alliant Energy

Results: Alliant Energy Congestion Savings



Other Benefits Provided:

- Increased Production Tax Credit (PTC) Revenues
- Increased MISO market revenue from reduced curtailments
- Ability to perform required testing for new resources to achieve commercial operation
- Increased reliability from reducing overload lines

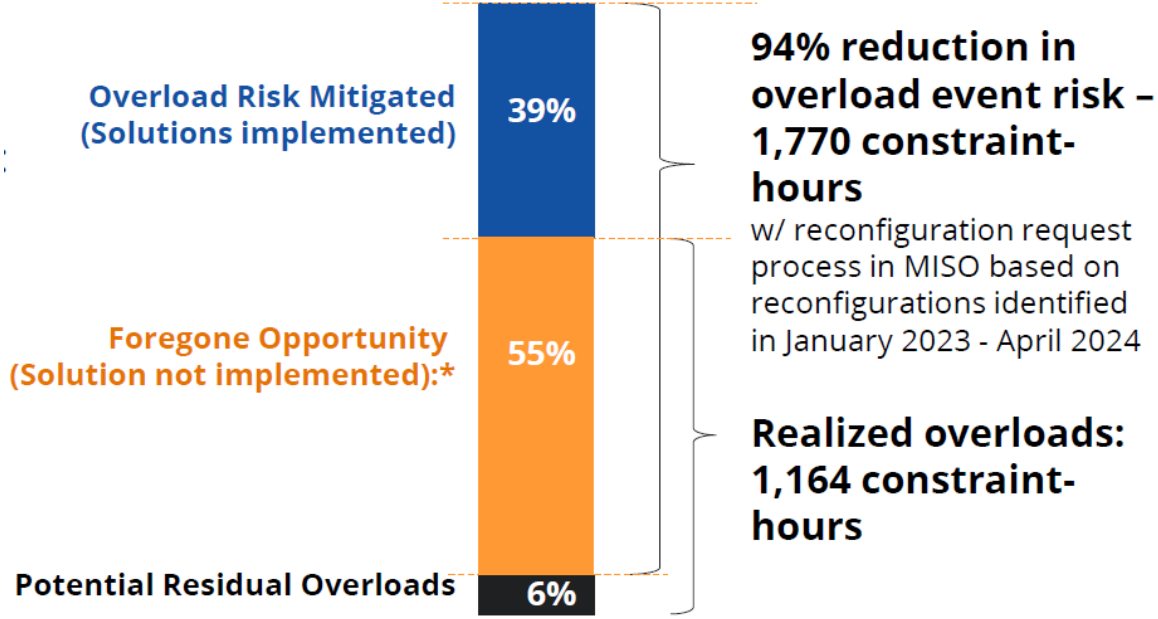
The impacts were calculated ex-post based on analyses of state estimator cases published by MISO and of historical market data. The total chart shows the cumulative costs for all months since the effort started in October 2021.

* 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.

** Residual congestion may be reduced further, as not all significant constraints affecting Alliant were analyzed during the pilot due to scope of work.

Alliant Energy

Results: Reliability Benefits



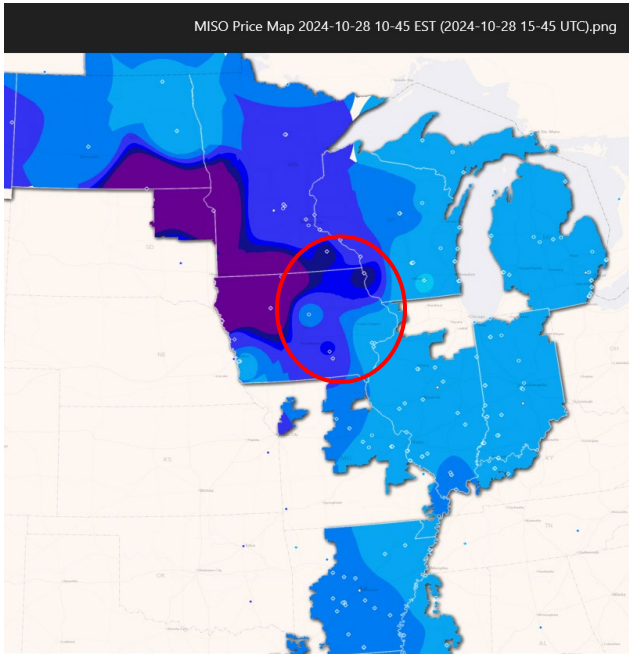
Note: Impacts calculated ex-post based on analyses of state estimator cases published by MISO and of historical market data.

* Impacts of solutions declined on a non-technical basis, and solutions not requested due to lack of a request process (prior to July 2023).

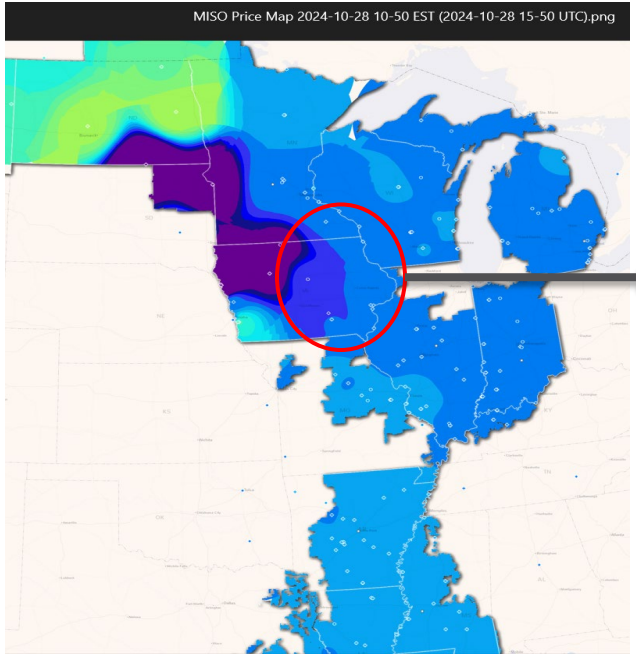
Alliant Energy

Regional Impacts

Before



After



MISO LMP maps show a large area in Minnesota, Wisconsin and Iowa becoming uncongested immediately after reconfiguration was picked up by MISO markets.

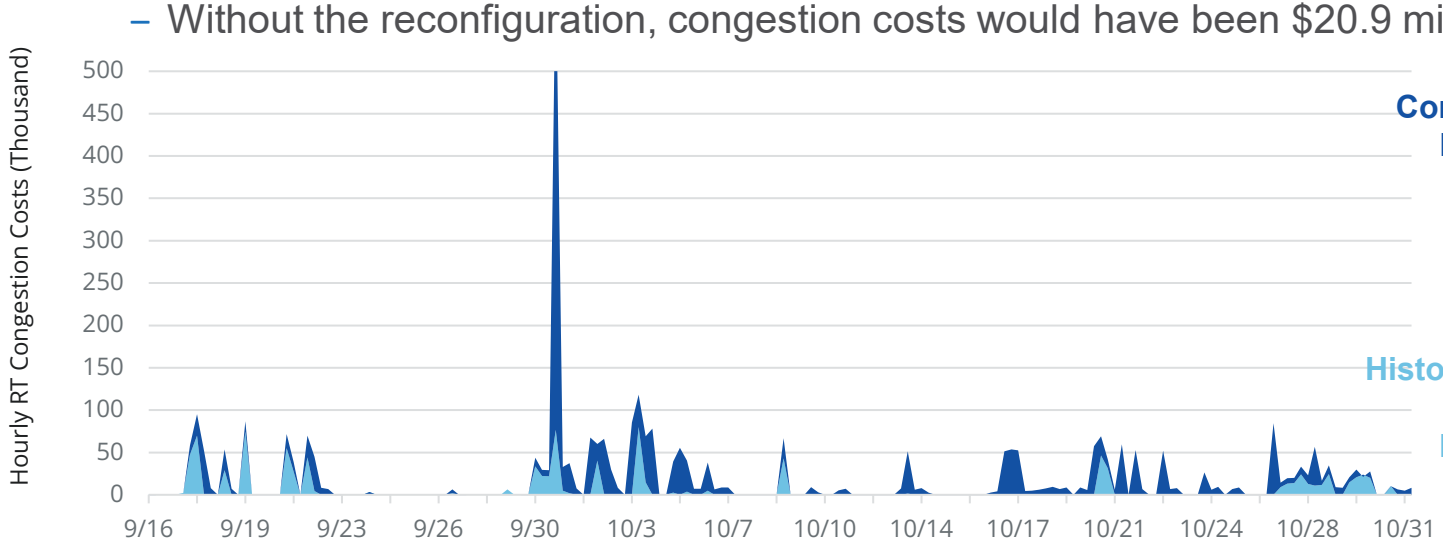
NewGrid-developed reconfiguration solution was estimated to provide between 15% and 28% of flow relief on the constraint of focus. The reconfiguration involved opening a 161 kV line in the area of the constraint and fully mitigated congestion on it.

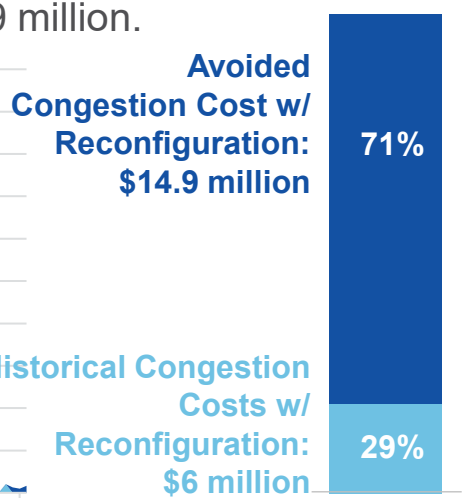
Alliant Energy

Iowa Example: Congestion Impact

Reconfiguration implemented for major planned outage on Hayward 161 kV substation. Solution involved two actions: open a line and split a bus.

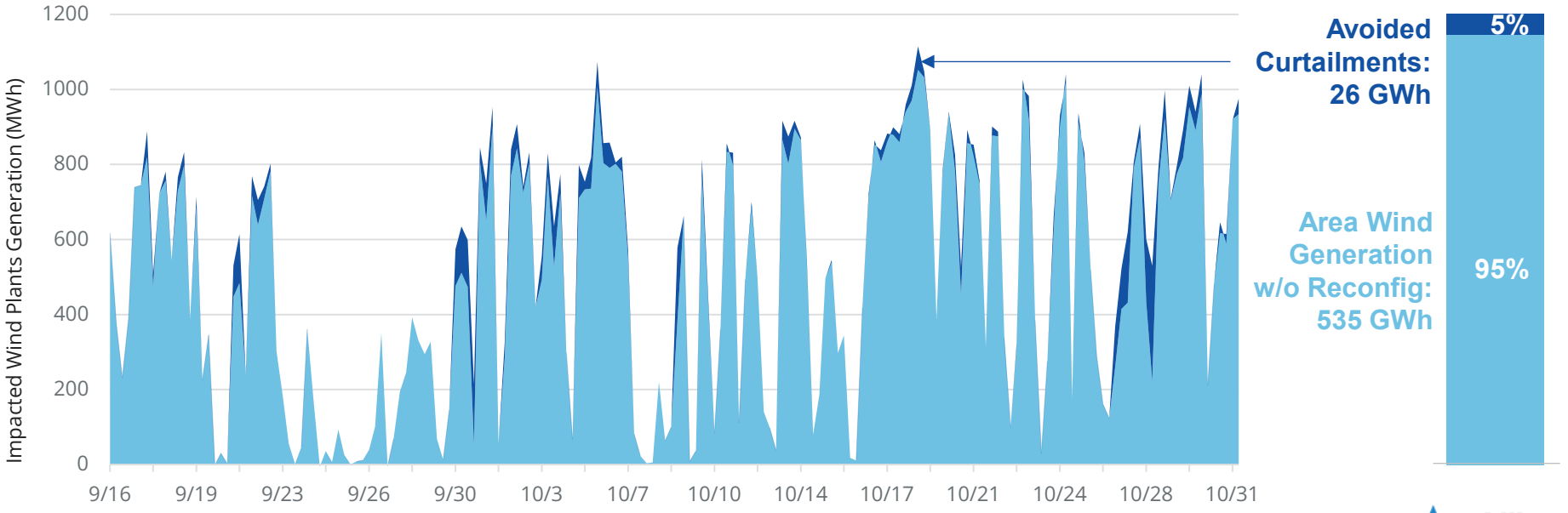
- **The reconfiguration saved $14.9 million** in regional congestion costs (71% reduction).
  - With the reconfiguration, costs were **$6 million**.
  - Without the reconfiguration, congestion costs would have been $20.9 million.





Iowa Example: Avoided Curtailments

- **The reconfiguration avoided 26 GWh of wind curtailments**.
  - The generation from area wind plants was **561 GWh**.



Final Thoughts & Recommendations

Topology Optimization

- Proven technology.
- Readily implementable.
- A win / win / win alternative for economic efficiency, reliability and resilience.
- Complementary to transmission investment and all other Grid-Enhancing Technologies.

Future Needs

- More time and effort on finding, evaluating and implementing reconfiguration solutions.
- Develop reconfiguration processes in other regions (SPP and ERCOT efforts ongoing).
- Topology optimization integration with RTO systems to timely support operations decisions.
- Additional state and federal policy support to help ensure items above move forward.

Alliant Energy