Designing the electricity market of the future: Current applied research at the Midcontinent Independent System Operator
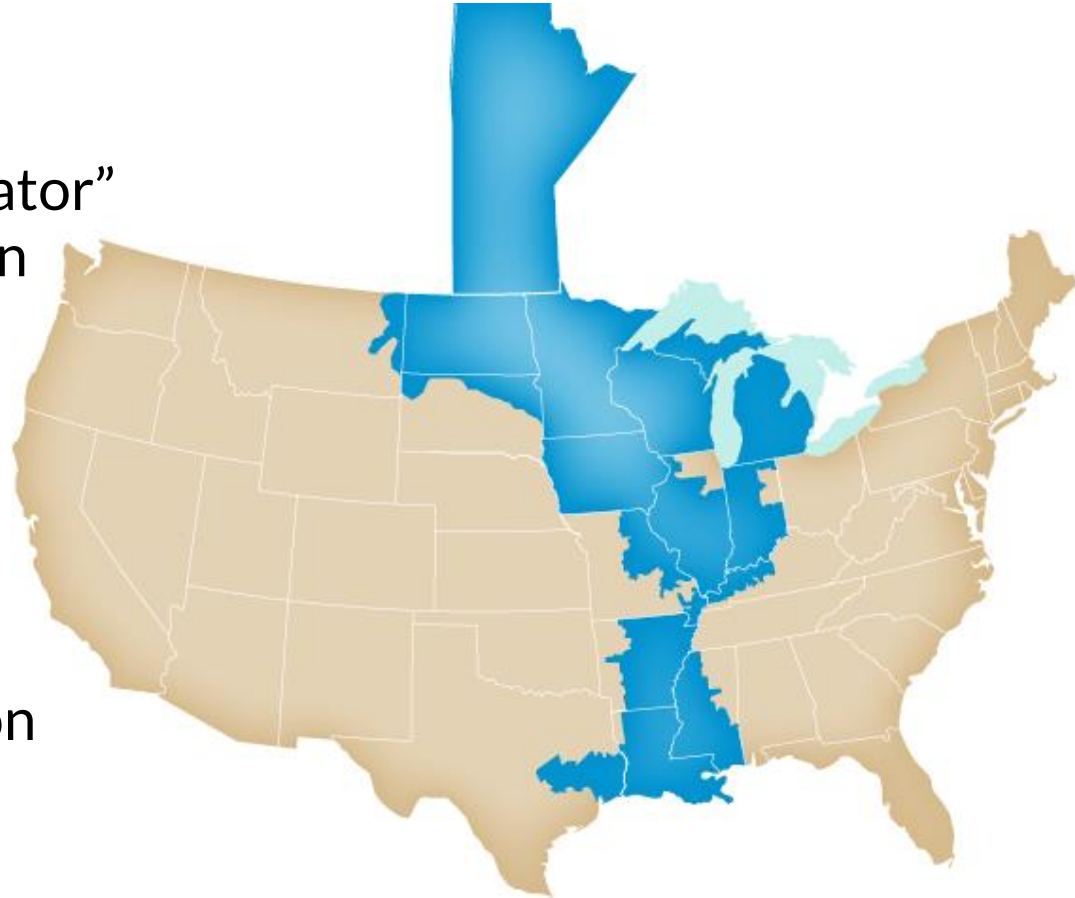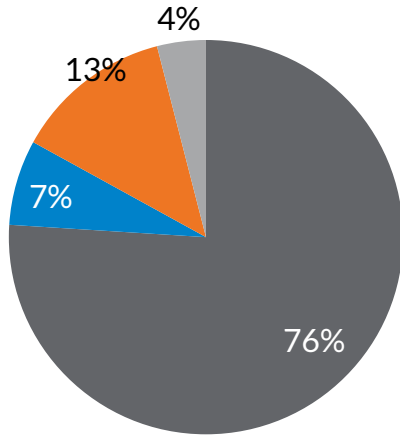
Stephen Rose

June 12, 2019

What is MISO?

An "Independent System Operator" (ISO) and Regional Transmission Organization" (RTO)
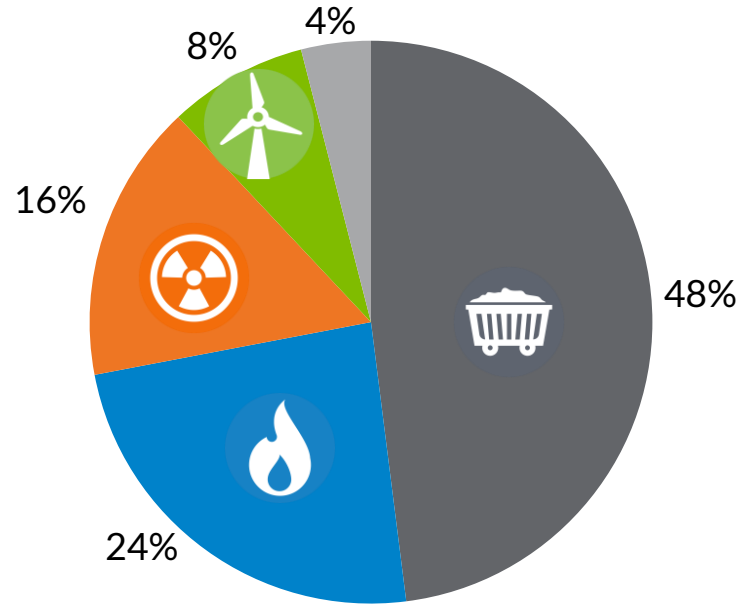
- 42 million customers
- 131 GW peak load
- 189 GW gen. capacity
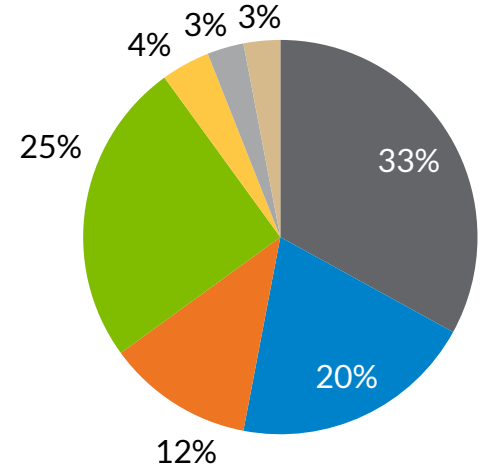- 68,000 miles of transmission lines
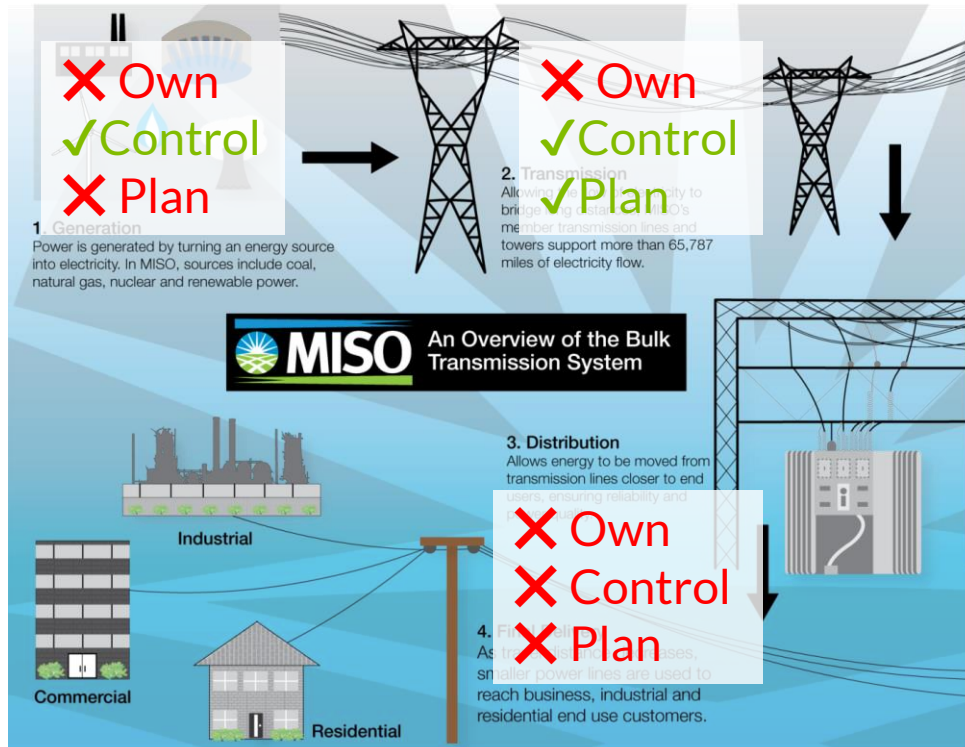
Where does the energy come from?

2005

2017

2032?

What does MISO do?

- Plan new transmission
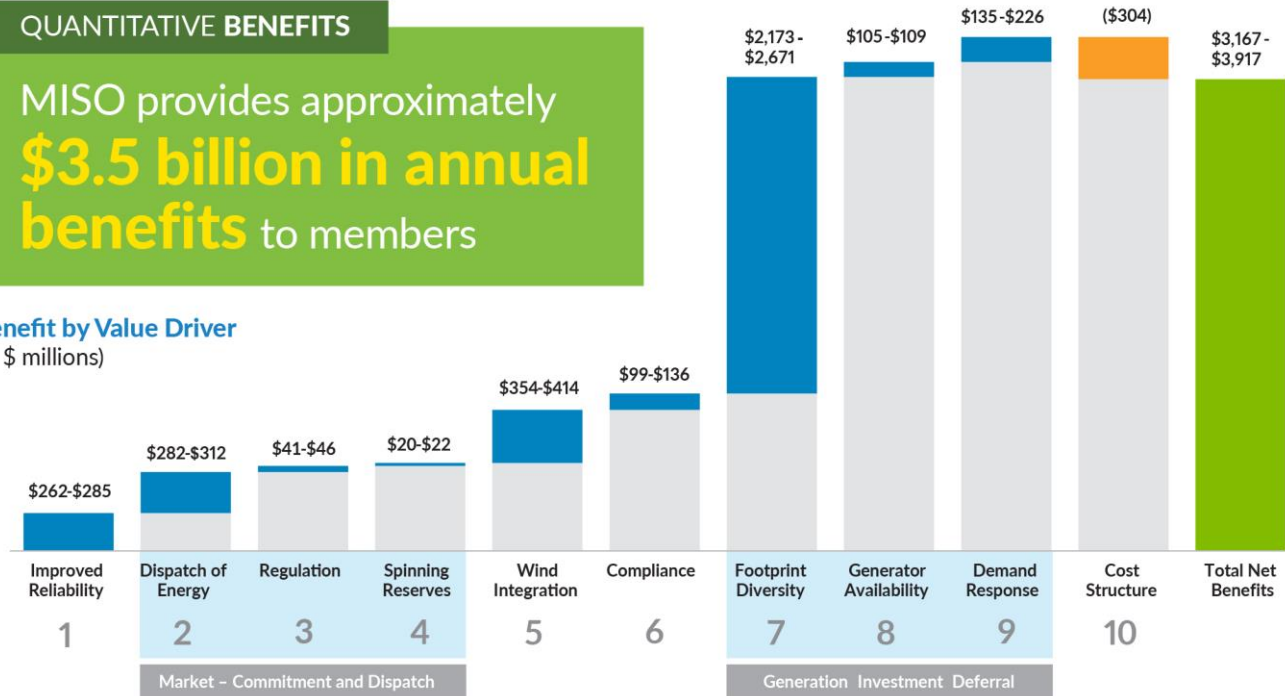- Operate market(s)
- Control generation

MISO's Vision: Most reliable, value-creating RTO

QUANTITATIVE BENEFITS

MISO provides approximately **$3.5 billion in annual benefits** to members

Benefit by Value Driver
(in $ millions)

Value Driver	Benefit
1. Improved Reliability	$262-$285
2. Dispatch of Energy	$282-$312
3. Regulation	$41-$46
4. Spinning Reserves	$20-$22
5. Wind Integration	$354-$414
6. Compliance	$99-$136
7. Footprint Diversity	$2,173-$2,671
8. Generator Availability	$105-$109
9. Demand Response	$135-$226
10. Cost Structure	($304)
Total Net Benefits	$3,167-$3,917

Market – Commitment and Dispatch (2, 3, 4)

Generation Investment Deferral (7, 8, 9)

MISO

MISO is trying to anticipate effects of 3 key trends:

- ## De-marginalization

  - How to run a market when marginal cost for main commodity is lower than average cost?

- ## Decentralization

  - How to operate the grid with many more resources, which we don't control (or even see)?

- ## Digitalization

  - How do we use the increasing amount of data available?

De-marginalization

- If energy is cheap, what other services should resources be paid for?
    - ("Essential Reliability Services")
- Incentives:
    - Short-term for performance, e.g. scarcity prices
    - Long-term for investment, e.g. capacity markets

MISO

Decentralization

- How to operate the grid if distributed resources don't participate in the market?

  - Those resources may be invisible

- How could distributed resources participate?

  - Aggregation and "Virtual Power Plants"

- Who has jurisdiction over distributed resources?

Digitalization

- We have more and better data

- Communications enables new resources, e.g. Nest thermostats as demand-response

- Inverter-based resources (solar PV) can provide new grid services

# MISO sees 3 key future needs:

- **Availability**: will we have enough resources when needed?
  - Quantifying uncertainty of generation & load
  - Estimating effect of changes in generator fleet
  - How to incentivize?
- **Flexibility**: can resources respond as needed?
  - How to define and measure?
  - How much do we need? How much is available?
  - How to incentivize?
- **Visibility**: can we forsee
  - Collaborations with neighbors
  - Forecasts and real-time information about Distributed Energy Resources

Other current research

- Improving speed of optimization algorithm

- Expanding scope of optimization algorithm

- Renewables integration

- Congestion forecasting

Optimization: Unit commitment is a hard problem

Is SCUC MIP Model Particularly Large?
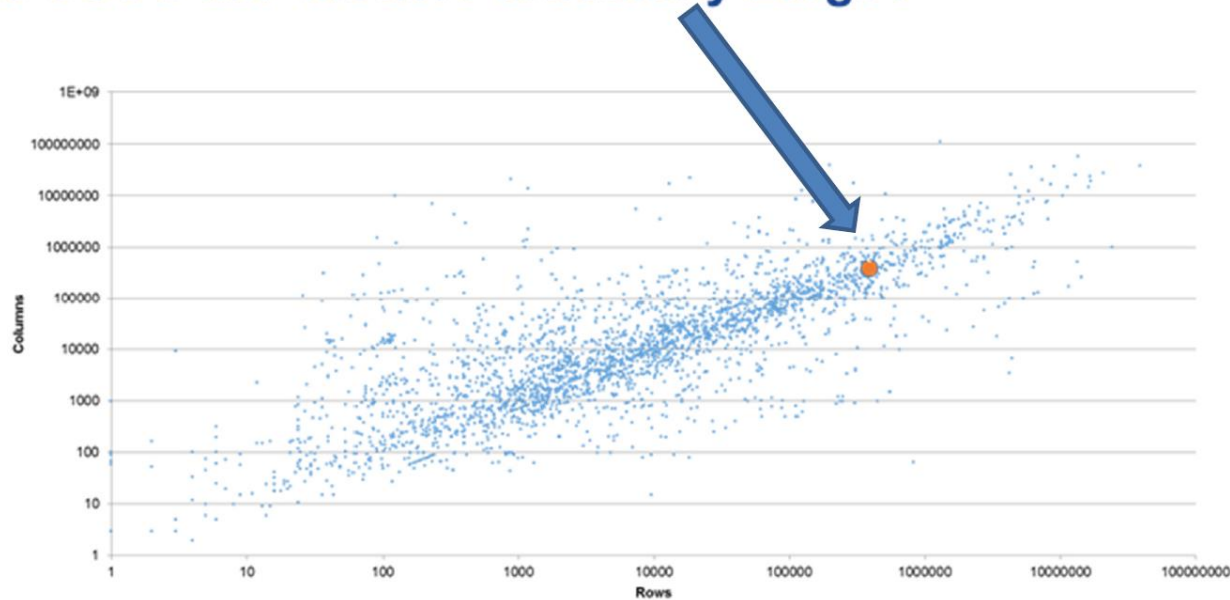
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Optimization: Improving speed

- Algorithms to take advantage of high-performance computers (esp. parallelization)

- Heuristics to simplify problem

  - e.g. pre-screen constraints

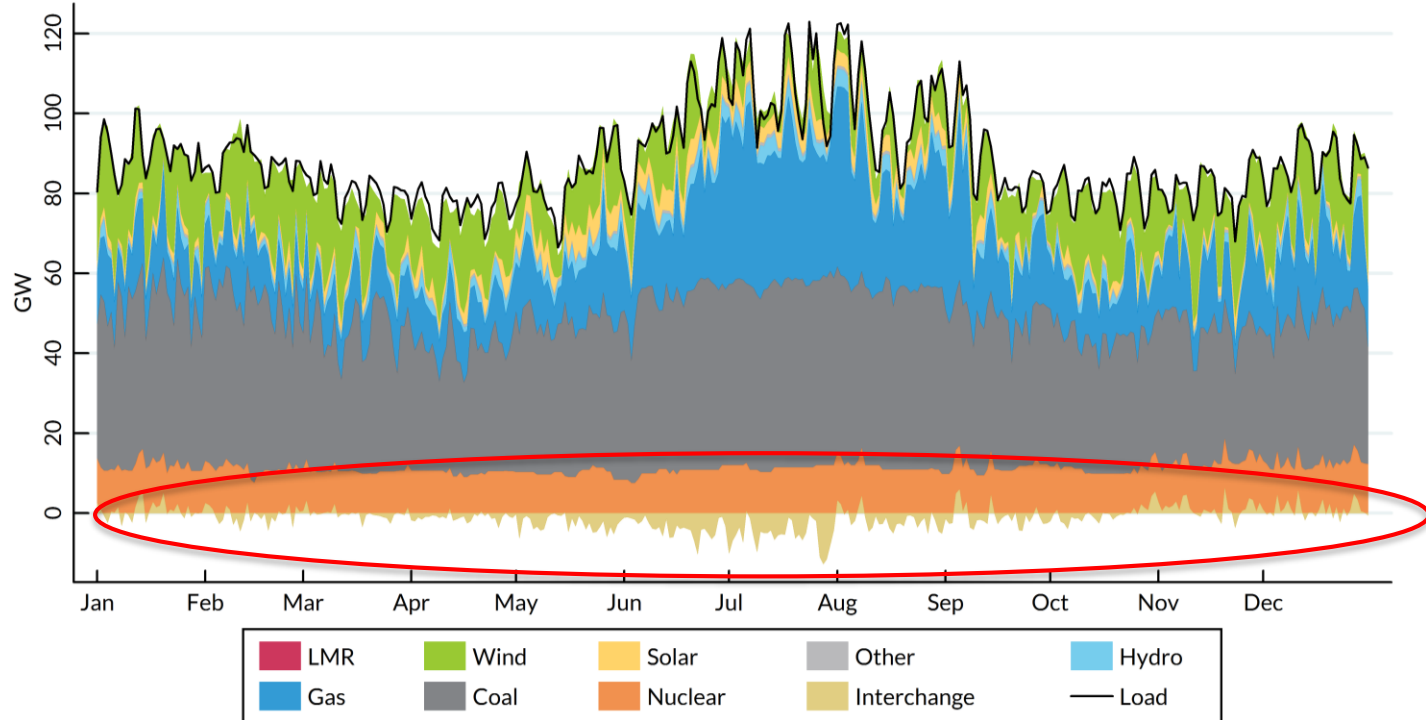- Evaluate alternative commercial solvers

Optimization: Expanding the scope

- Optimize configuration of individual combined-cycle plants

- Multi-day commitment?

- Stochastic or robust unit commitment?

Renewables will cause little change to peak load by 2023
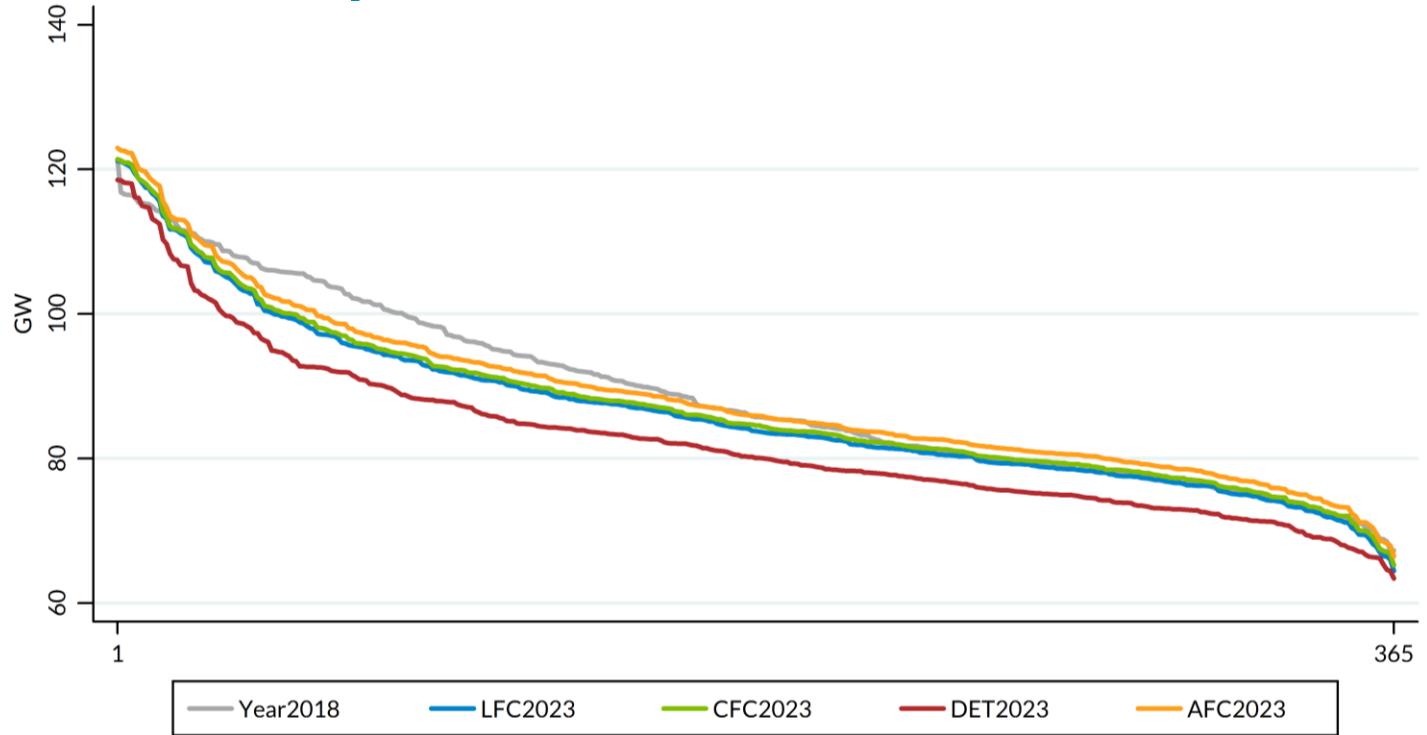
Renewables could make MISO a net exporter in 2023

MISO's University Partnerships

- Center for Ultra-Wide-Area Resilient Electric Energy Transmission Networks (CURENT)

- Power Systems Engineering Research Center (PSERC)

- Individual partnerships with several universities across the country, focusing on joint R&D efforts

Summary

- Electricity system is changing fast

- We have lots of questions

- We're interested in collaboration

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