Renewable Integration MISO

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About MISO

- **MISO is a FERC approved Regional Transmission Organization (RTO) and Independent System Operator (ISO)**
- **MISO operates Day-ahead, Real-time and Ancillary Services markets**
- **Operate in 12 states and one Canadian province**
- **Peak market load in 2011 – approximately 104,000 MW**
- **Approximately 9,000 MW of wind on system**
  - Adding 1,000 MW of wind per year
  - Over 50,000 in GI queue
- **MISO does not own generation or transmission**
- **MISO plans for the transmission system**

Integration of Renewables Drivers

- **Renewable energy planning initiatives**
  - Primarily policy driven
- **Transmission needed to implement energy initiatives**
  - Meet policy needs, reduce curtailments
- **Cost allocation needed to implement transmission initiatives**
- **Diversity of resources needed to provide capacity benefits and operational flexibility**
- **Quality wind forecasts to provide additional operational flexibility through Market initiatives**
  - Dispatchable Intermittent Resources

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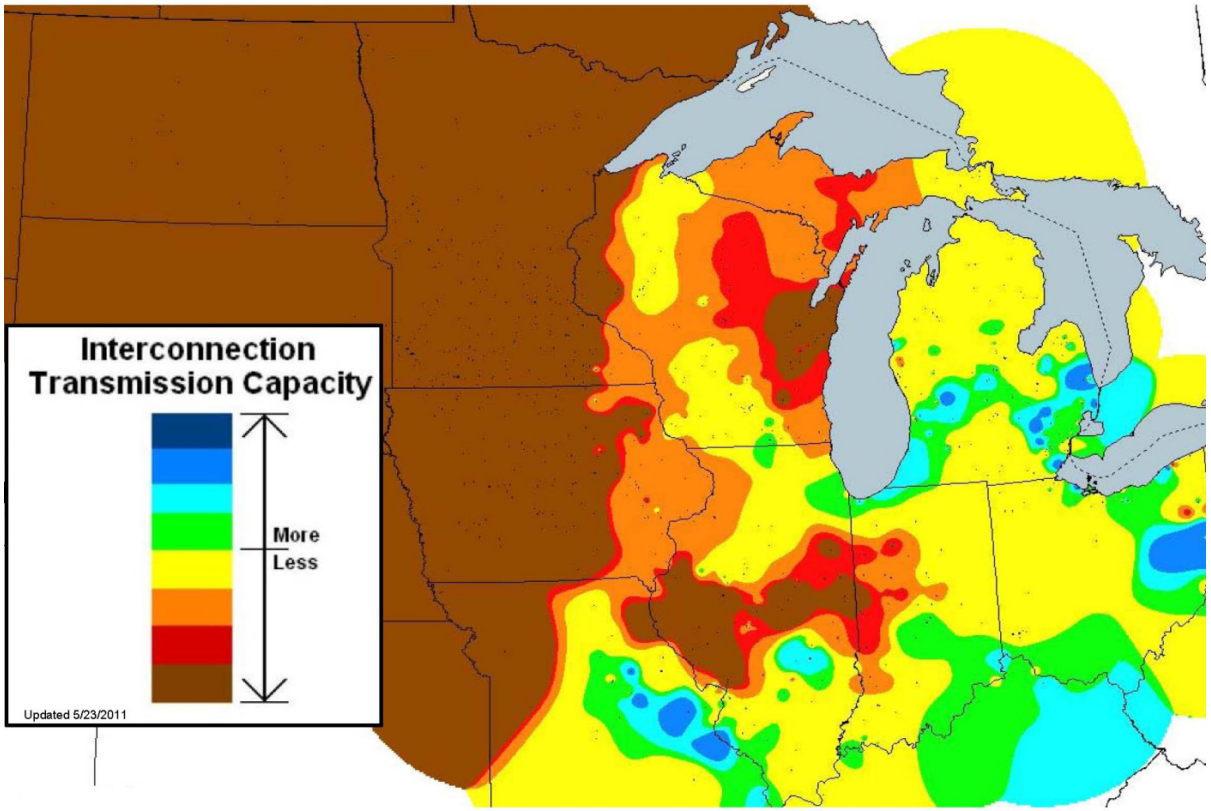
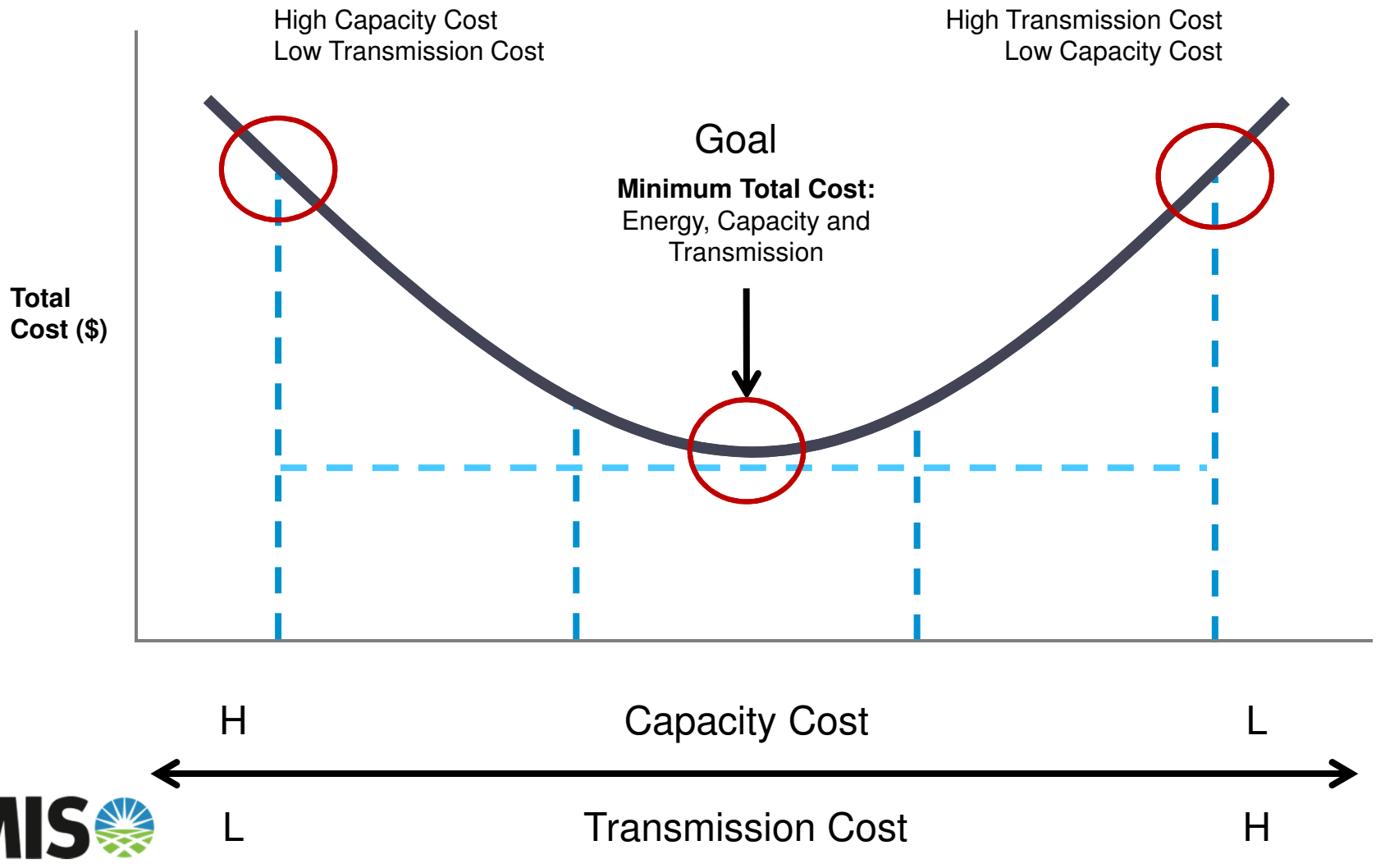
Public Policy and Regional Transmission Intersect

- The development of a MISO energy and operating reserve market allowed for regional transmission to provide regional benefits in increasing market efficiency and enabling low cost generation to be delivered to load
- Simultaneously, an increase in public policy energy mandates drove the need for a robust regional transmission network that can respond to legislated changes in generation requirements.

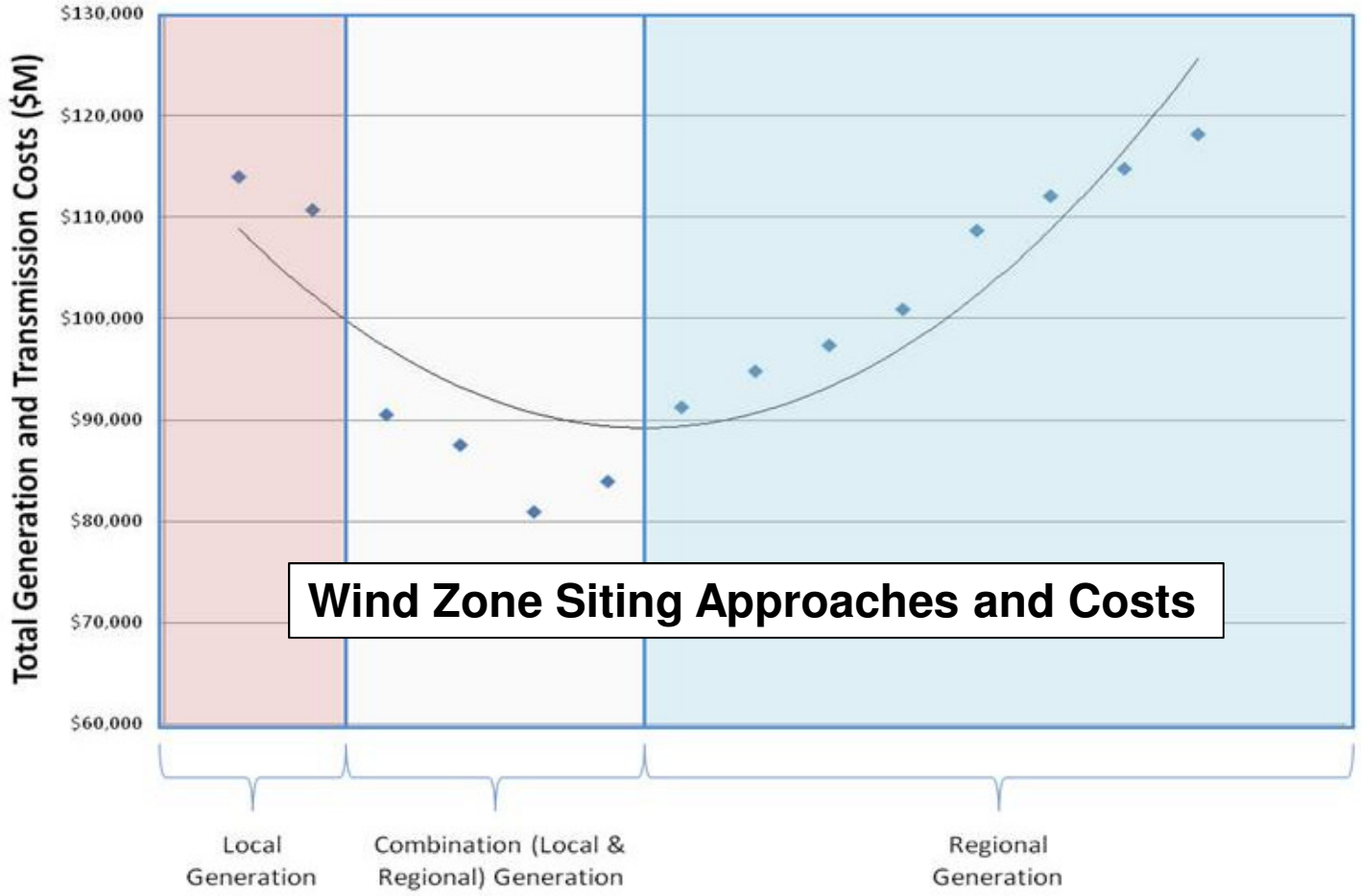
Generation Interconnection Available Capacity



MISO's transmission planning process is focused on minimizing the total cost of delivered power to consumers: energy, capacity and transmission

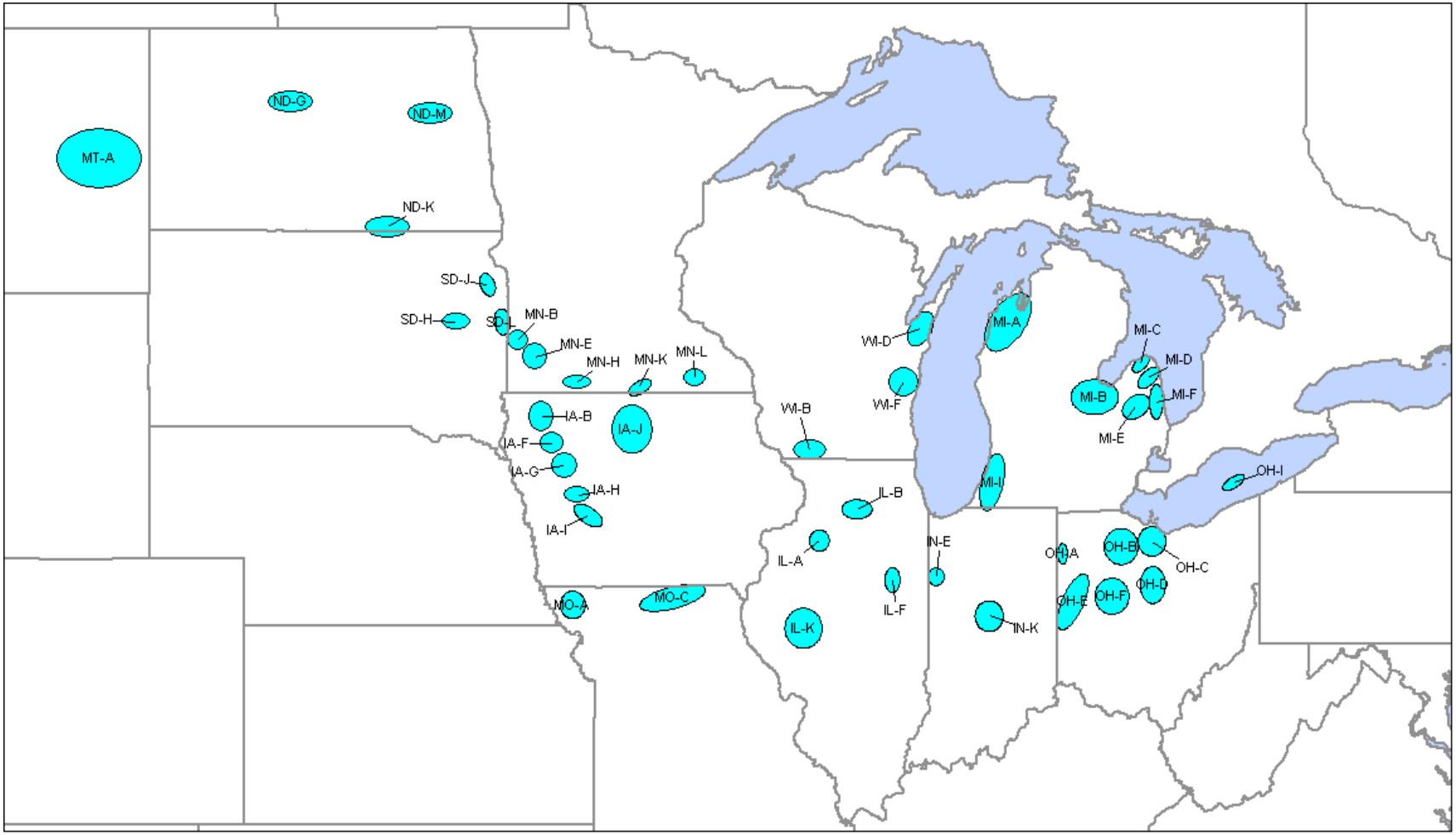


As an increasing number of renewable energy mandates were passed by MISO states, analyses were performed to determine the least cost wind generation siting methodology

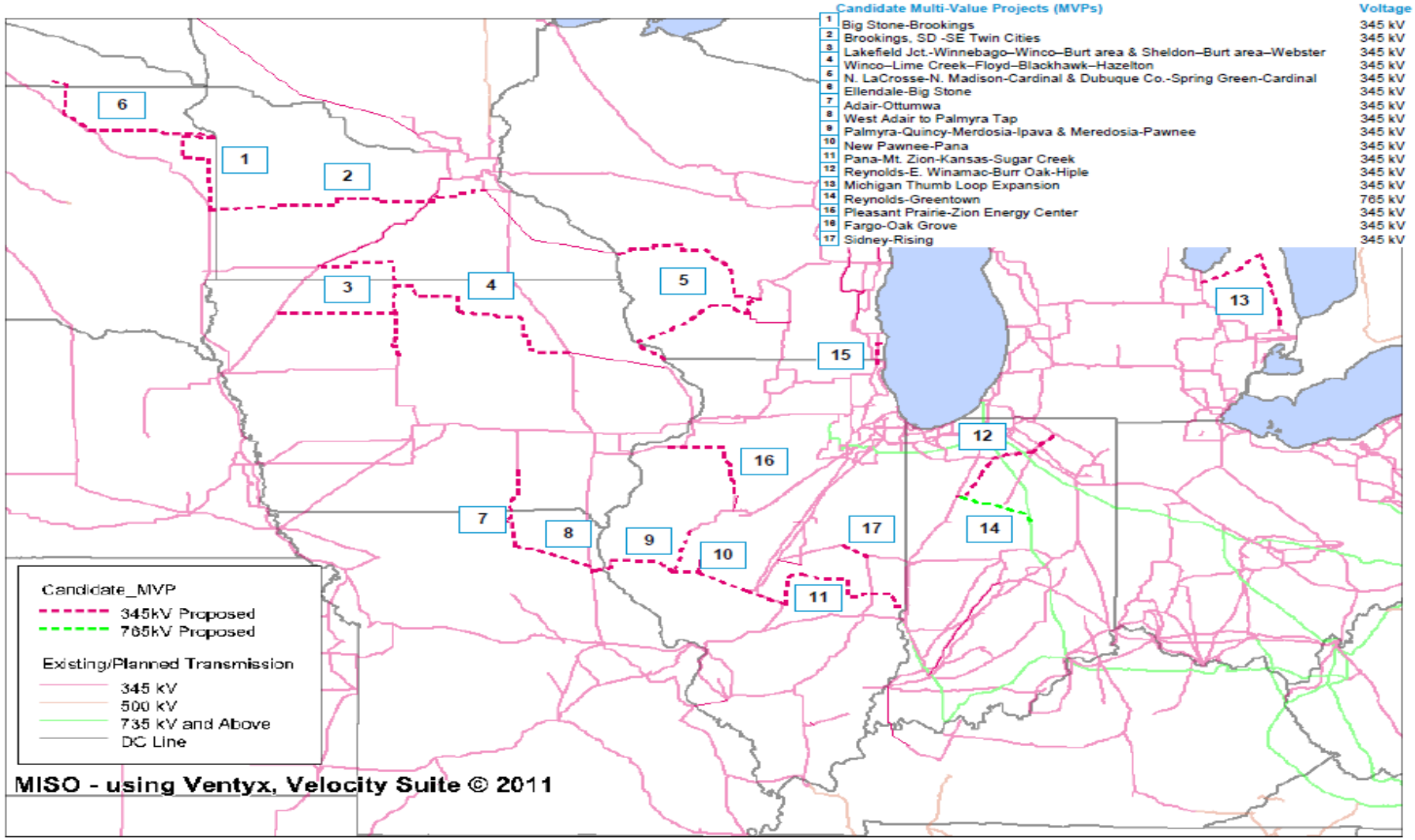


The least-cost approach to wind generation siting, when both generation and transmission capital costs are considered, is a combination of local and regional generation locations.

Regional Generation Outlet Study
Renewable Energy Zones

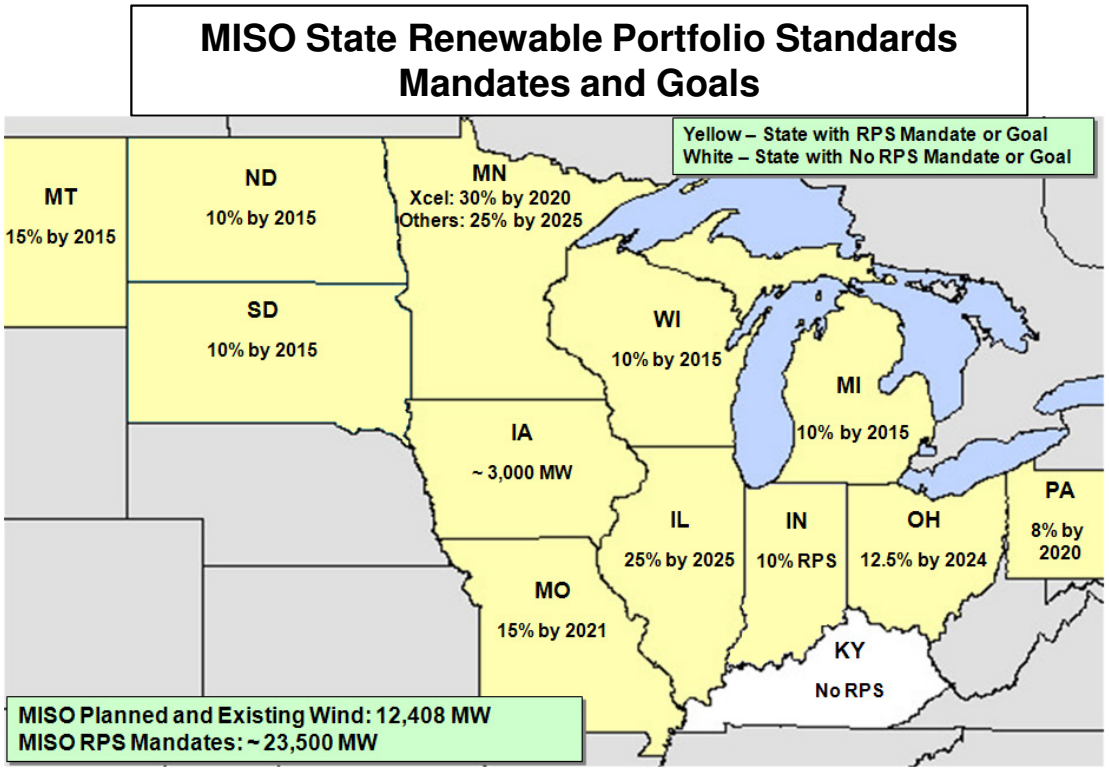


Proposed Candidate MVP Configuration



MVPs reliably and economically enable established energy policy choices

- The 2011 MVP Portfolio
  - Provides benefits in excess of its costs under all scenarios studied, with its Benefit–to–Cost ratio ranging from 1.7 to 5.4
  - Maintains system reliability by resolving reliability violations on about 700 elements for more than 5,000 system conditions that would require operator action
  - Mitigates at least 10 system stability conditions that could otherwise cause cascading outages
  - Enables approximately 10 GW of nameplate renewable capacity to meet renewable energy mandates and goals.



Planned and Existing Wind as of 3/28/3011

INTERIM RESULTS

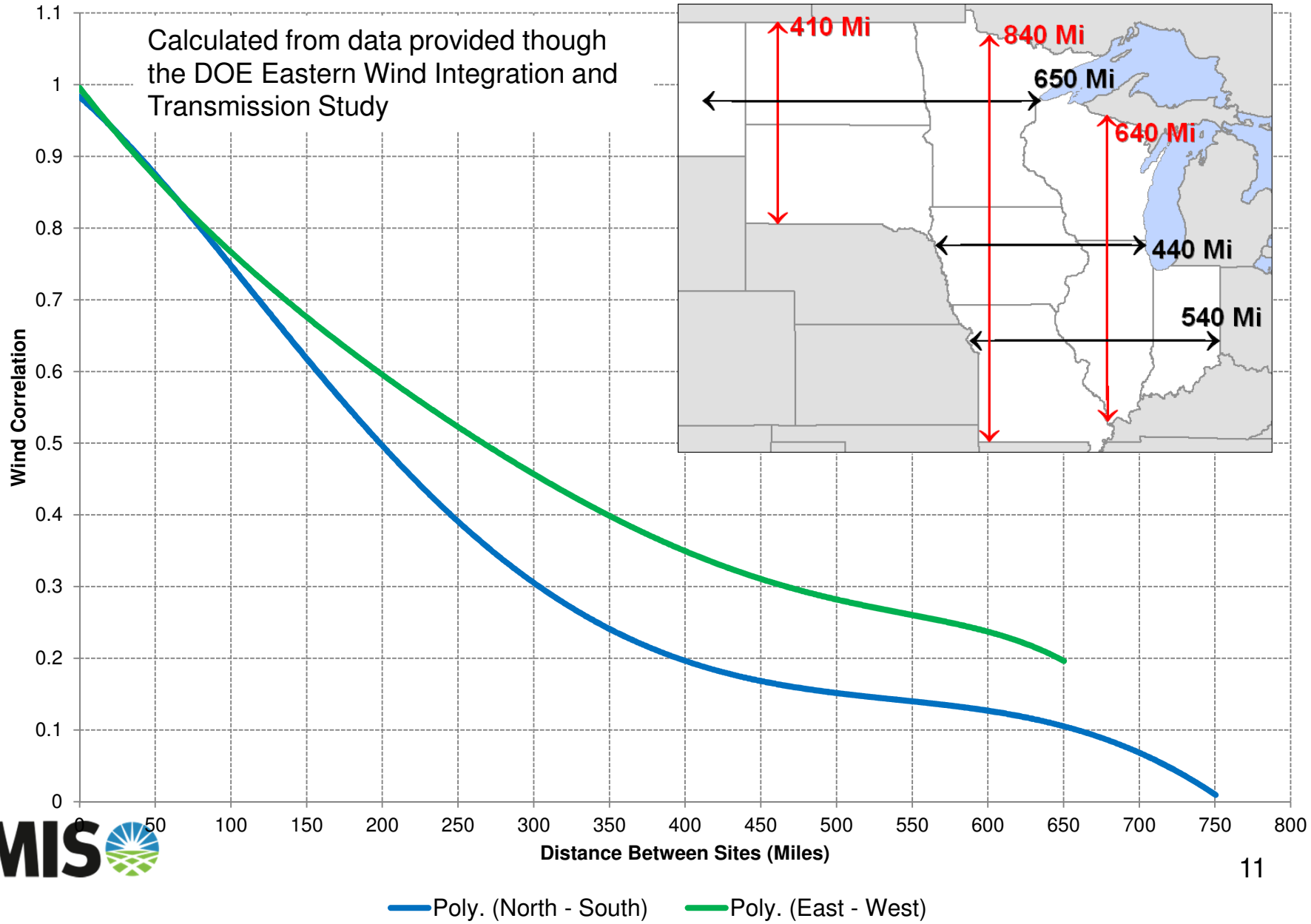
MISO Transmission Cost Allocation Approach seeks to match the business case with the allocation method

Allocation Category	Driver(s)	Allocation to Beneficiaries
Participant Funded ("Other")	Transmission Owner identified project that does not qualify for other cost allocation mechanisms.	Paid by requestor (local zone)
Generator Interconnection Project	Interconnection Request	Paid for by requestor; 345 kV and above 10% postage stamp to load
Market Efficiency Project[1]	Reduce market congestion when benefits are 1.2 to 3 times in excess of cost	Distribute to planning regions commensurate with expected benefit; 345 kV and above 20% postage stamp to load
Baseline Reliability Project	NERC Reliability Criteria	Primarily shared locally through Line Outage Distribution Factor Methodology; 345 kV and above 20% postage stamp to load
Multi Value Project	Address energy policy laws and provide widespread benefits across footprint	100% postage stamp to load

1. Market Efficiency Project cost allocation methodology currently under review by stakeholders

Diversity – Important Integration Component

Wind Correlation vs Distance



Market Initiatives - Dispatchable Intermittent Resource (DIR)

- **A DIR is very similar to a standard generation resource**
  - Difference: Generation resource supplies Max Limit as a portal offer-parameter; Dispatchable Intermittent will provide a forecast that will be used as Max Limit
- **The resource is included in the day-ahead and real-time co-optimization, and is eligible to set price**
- **The resource can submit offers for Energy, and will clear between Min and Max Limits, based on Economics**
- **The resource cannot submit offers for Operating Reserves (reg, spin or supp), and will not clear Operating Reserves in day-ahead or real-time**

Dispatchable Intermittent Forecast

- **Primary source for Max Limit will be the participant-submitted forecast**
  - CP-Node Level Forecast to have **five-minute** granularity; rolling 12 periods will be submitted via XML
  - Forecast needs to be **independent of dispatch**.

    Example: if wind has been dispatched down to 0, but the resource could produce 100MW if dispatched up, the forecast submittal must be 100MW.

- **Midwest ISO will have a CP-Node Level Forecast that will be used as a backup under scenarios where the participant forecast is unavailable**

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Questions

- **Contact John Lawhorn at jlawhorn@misoenergy.org or 651-632-8479**