Midwest ISO Overview

The Midwest ISO is an independent, non-profit 501(C)(4) organization. We serve as the reliability coordinator for the transmission of high voltage electricity via a security constrained economic dispatch across all or parts of 14 states and Manitoba.

- Control centers in Carmel, Indiana and St. Paul, Minnesota
- Reliability Operations since Dec. 15, 2001
- Tariff Administration and Scheduling Operations since February 1, 2002
- Energy Market Operations since April 1, 2005
- ASM Operations since January 6, 2009
- Large footprint (~947,000 square miles)
- 133,000+ MW of generating capacity
- 97,000 miles of transmission lines
- Over $12 billion installed assets
- Wholesale power transactions = $40+ billion (2008)
- Annual Budget = $250 million
## The Midwest ISO’s Role

<table>
<thead>
<tr>
<th>What We Do</th>
<th>Implications</th>
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<tbody>
<tr>
<td>• Provide Independent Transmission System Access</td>
<td>• All parties have equal and non-discriminatory access</td>
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<tr>
<td>• Deliver Improved Reliability Coordination</td>
<td>• Substantial regional reliability improvements</td>
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<tr>
<td>• Perform Efficient Market Operations</td>
<td>• Lower cost unit commitment, dispatch and congestion management</td>
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<tr>
<td>• Coordinate Regional Planning</td>
<td>• Integrated system planning</td>
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<tr>
<td>• Foster Platform for Wholesale Market Development</td>
<td>• Encourage infrastructure investment and facilitate regulatory initiatives</td>
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Electric System Development – Historical View

• Traditional Electric System Development (Generation and Transmission)
  – Planned at a single company level
  – Designed for single company use
  – Funded at company / state level

• Decision basis
  – Meet local requirements (i.e., load growth)
  – With local natural resources
  – Few national policy issues
  – Limited regional use

• Last major build out of baseload capacity and transmission ended in the early 1980s
Generation Portfolios Vary Greatly by Region Reflecting the Nature Resources of the Region

- **MISO**
  - Coal: 26%
  - Gas: 32%
  - Nuclear: 4%
  - Hydro: 0%
  - Wind: 4%
  - Other: 0%

- **ISO-NE**
  - Coal: 42%
  - Gas: 13%
  - Hydro: 10%
  - Nuclear: 0%
  - Wind: 5%
  - Other: 0%

- **NYISO**
  - Coal: 30%
  - Gas: 41%
  - Hydro: 15%
  - Nuclear: 0%
  - Wind: 5%
  - Other: 0%

- **SPP**
  - Coal: 47%
  - Gas: 26%
  - Hydro: 19%
  - Nuclear: 5%
  - Wind: 0%
  - Other: 3%

- **PJM**
  - Coal: 58%
  - Gas: 30%
  - Hydro: 7%
  - Nuclear: 2%
  - Wind: 2%
  - Other: 0%

- **ERCOT**
  - Coal: 70%
  - Gas: 6%
  - Hydro: 2%
  - Nuclear: 2%
  - Wind: 2%
  - Other: 0%

- **WEST**
  - Coal: 62%
  - Gas: 20%
  - Hydro: 7%
  - Nuclear: 3%
  - Wind: 4%
  - Other: 0%

- **CALISO**
  - Coal: 4%
  - Gas: 7%
  - Hydro: 4%
  - Nuclear: 20%
  - Wind: 3%
  - Other: 0%
… and the sources of each regions’ electrical energy reflects those generation portfolios and resources
In recent (and future) years, the focus has shifted

- Planning, design, funding and operation has become more regionally focused
  - Evidenced by the growth of regional markets

- Operational efficiencies have increased (while maintaining reliability) as a result of that regional focus
  - Planning reserve margin reductions
  - Improved unit availabilities
  - Commitment and dispatch done on a regionally economic basis

- Steady growth has continued

- National policy issues have taken center stage
  - Climate change
  - Renewable power
We must effectively manage our current infrastructure while carefully planning and developing our future infrastructure

### Current Infrastructure

- 60% of the electric grid infrastructure (T/D/G) is at or near the end of original planned life
- 20% of T/D/G is past original planned life
- In the Midwest, the average age of infrastructure is very high
  - Baseload generation = 42 years
  - Transmission = 40+ years
- The region use of the electric system is also increasing the transmission congestion

### Future Infrastructure

- Planning must balance many issues
  - Use of existing generation fleet
  - National policy issues
  - Efficient use of natural resources
  - Demand response
  - Costs
    - Construction
    - Operating
    - Fuel
    - Decommissioning
    - Environmental
- Regional / national use of the electric system must be considered as the planning is done
- Unknowns (policy and financial) challenge planning
In the Midwest, we have two primary natural resources for electric generation – coal and wind

- **Coal**
  - Existing Midwestern fleet relies heavily on coal:
    - Half of our capacity
    - 80% of our energy
  - National climate change policy will disproportionately impact the region’s electric costs

- **Wind**
  - The plains states have the highest capacity (most economic) wind in the eastern interconnect
  - However, it is located away from the urban areas
  - National renewable energy policy will create operational and transmission issues
Joint Planning Initiatives – Wind Integration

- Joint Coordinated System Plan (JCSP 2008)
  - Midwest ISO
  - SPP
  - PJM
  - TVA
  - MAPP
  - Other Interested parties

- Performed in Coordination with DOE Eastern Wind Integration Transmission Study (EWITS)

- Reference Future
  - Models the Status Quo. This future models the power system as it exists today with reference values and trends based on recent historical data while preserving existing standards for resource adequacy, existing renewable mandates and environmental legislation.

- 20% Wind Mandate Future
  - Requires 20% of the energy consumption come from wind by 2024. Regional Capacity Factors of new units applied toward mandate, and 15% of Maximum Capacity counted toward Reserve Margin Calculations. Existing Wind mandates accounted for in Reference Future are applied to all futures.
Capacity Additions By Resource Type

Generation Nameplate Expansion 2008-2024

Eastern Interconnect Base Line/Planned Queue
- 70,909 MW

Eastern Interconnect Reference Scenario
- 256,229 MW
  - 57,000 MW (Queue/Planned)
  - 40,800 MW (Base Load Steam)
  - 6,000 MW (Coal)
  - 75,600 MW (Nuclear)
  - 12,343 MW (CC)
  - 34,915 MW (CT)
  - 6,000 MW (Wind)
  - 70,909 MW (IGCC)
  - 5,920 MW (IGCC/Seq)
  - 2,748 MW (DR)

Eastern Interconnect 20% Wind Energy Scenario
- 409,029 MW
  - 229,000 MW (Queue/Planned)
  - 61,200 MW (Base Load Steam)
  - 36,000 MW (Coal)
  - 6,000 MW (Nuclear)
  - 12,343 MW (CC)
  - 34,915 MW (CT)
  - 70,909 MW (Wind)
  - 5,920 MW (IGCC)
  - 2,748 MW (IGCC/Seq)
  - 2,748 MW (DR)
20% Wind Energy - Overlay
## JCSP Highlights

<table>
<thead>
<tr>
<th>Reference Cast</th>
<th>20% Wind Energy Case</th>
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<tr>
<td><strong>Capital Costs (thru 2024)</strong></td>
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<tr>
<td>– Transmission - $50 billion</td>
<td></td>
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<tr>
<td>– Generation - $675 billion</td>
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<tr>
<td><strong>Benefit to Cost Ratio:</strong> 1.4*</td>
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<tr>
<td><strong>Transmission Constructed</strong></td>
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<tr>
<td>– AC Line Miles (70%)</td>
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<tr>
<td>• 345kV – 3,400</td>
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<tr>
<td>• 500kV – 1,100</td>
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<tr>
<td>• 765kV – 2,600</td>
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<tr>
<td>– DC Line Miles (30%)</td>
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<tr>
<td>• 400kV – 500</td>
<td></td>
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<tr>
<td>• 800kV – 2,400</td>
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<tr>
<td>– Total – 10,000 Miles (approximate)</td>
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<tr>
<td><strong>Capital Costs (thru 2024)</strong></td>
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<tr>
<td>– Transmission - $80 billion</td>
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<tr>
<td>– Generation - $1,050 billion</td>
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<tr>
<td><strong>Benefit to Cost Ratio:</strong> 1.7*</td>
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<td>• 400kV – 0</td>
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</tr>
<tr>
<td>• 800kV – 7,500</td>
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<tr>
<td>– Total – 15,000 Miles (approximate)</td>
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*Benefits and costs subject to substantial change*
Eastern Interconnection Transmission Planning
Possible Next Steps – from JCSP

- Develop formal Charter
- Expand to include Regulators
- Name change to proposed Eastern Interconnection Transmission Assessment Group
- Expand the number of scenarios
- Request funding from participants to be able to explore a broader range of scenarios
- Perform reliability assessment on the overlays
- Refine costs and benefits