Quadrennial Energy Review

September 8, 2014
MISO’s Scope

- End-use Customers: 42 million
- Maximum Demand: 133,000 MW
- Transmission (69 - 500kV): 66,000 miles
- Generation: 201,000 MW
- Market Participants: 401
- Gross Market Charges: $20.3 billion (2013)
MISO’s ultimate mission is to maintain the reliability of the power grid, so the nation’s changing energy landscape has our full attention

- Resource Adequacy / Changing Fleet
  - Renewables Integration
  - Coal Retirements
  - Nuclear Challenges
  - Gas Growth and Cost Reduction

- Gas – Electric Coordination – To address growing reliance on gas as a generation fuel

- Seams Optimization – To continue to improve the efficiency of operations between regions
The removal of resources from the system are driving an expected reserve margin shortfall in MISO in 2016…

**Central & North Regions**

- **Unclaimed Merchant Resources**: 110.1 GWh (6.6 GWh)
- **112.4 GWh** (Reserves)
- **2.3 GWh** (Expected Shortfall)

**South Region**

- **39.7 GWh** (Reserves)
- **37.2 GWh** (Demand)
- **2.5 GWh** (Expected Surplus)

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**Central & North Regions**

- **103.5 GWh** (Claimed Resources)
- **112.4 GWh** (Demand)

**Up from 2.0**

**Down from 5.5**
As a result of retirements and lower cost gas, MISO reserve margins will narrow and gas dependence will rise.

Source: MISO TAM, including 2015 MTEP “Business as Usual” case for projections

Source: Historical NERC Summer Reliability Assessments; projections from MISO and NERC 2013 Long Term Reliability Assessment for Eastern Interconnect

MISO Reserve Margin

Generally accepted reserve requirement ~15%

MISO Annual Energy Contribution by Fuel Source

Source: MISO TAM, including 2015 MTEP “Business as Usual” case for projections
Additional environmental regulations would accelerate this trend

<table>
<thead>
<tr>
<th>Nature of Regulation</th>
<th>MATS</th>
<th>CSAPR &amp; CWIS</th>
<th>Clean Power Plan 111(b) &amp; (d)</th>
<th>NAAQS &amp; Coal Ash</th>
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<tbody>
<tr>
<td>Mercury and Air Toxics Standards</td>
<td>Cross State Air Pollution Rule and Cooling Water Regulations (316(b))</td>
<td>CO₂ from existing and new power plants</td>
<td>New air quality standards/Coal ash storage</td>
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| Compliance Dates | 2015 / 2016 | As early as 2015 | 2015/16 (New) | 2020 & beyond (Existing) | ??? |

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<tr>
<th>Impacts</th>
<th>• Significant coal retirements</th>
<th>• NOₓ requirements tightened</th>
<th>• New coal requires CCS; baseload capacity options reduced</th>
<th>• Increased costs</th>
<th>• Other potential impacts depend on regulations</th>
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<tbody>
<tr>
<td></td>
<td>• Outage coordination challenges</td>
<td>• Higher plant compliance costs influence retirement decisions</td>
<td>• Significant coal retirements</td>
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<td></td>
<td>• Shrinking reserve margins around MISO</td>
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<td>• Increased dependence on gas and carbon neutral resources</td>
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As the gas demand for power generation grows...

Expected demand growth through 2025 on par with past 10-15 years:

- Coal retirements
- Nuclear retirements
- Increased capacity factors for new gas units (gas-coal prices spreads)

Gas Demand for U.S. Power Generation (Bcf per day)

Historical data and projection from CERA May 2014 Outlook; other reference forecasts in 2020 and 2025 ranges include EIA AEO2014, UBS Gas Demand Outlook June 2014 (hereafter “UBS Outlook”), Bentek per MISO Phase III: Natural Gas-Fired Electric Power Generation Infrastructure Analysis December, 2013 (hereafter “Bentek”)
... and gas basins and transportation patterns evolve...

- Legacy pipelines rapidly adding firm bi-directional flow capabilities for very large volumes (instead of previously limited “displacement” options) to enable partial reverse flows
  - Notably from Northeast markets (Marcellus/Utica shale) towards Midwest and Southeast
  - Key pipeline examples towards Midwest markets: Rockies Express, ANR, and Texas Eastern
  - Key pipeline examples towards Gulf Coast markets: Tennessee Gas Pipeline, Columbia Gulf, Texas Eastern, TRANSCO, Trunkline, and Texas Gas

- Large pipeline infrastructure is also being constructed for similar objectives and also to provide new options to the east coast

1 Graphics per TransCanada/ANR pipeline per MISO Phase I: Gas and Electric Infrastructure Interdependency Analysis, February, 2012
... which will require additional gas – electric coordination to ensure reliability and economic efficiencies

- Daily Transactional Coordination
- Informational Consolidation and Access
- Forward Outage / Maintenance Coordination
- System Operations and Optimization
- Expansion Planning
Continued enhancement of seams coordination will improve reliability and economic efficiencies – particularly as reserve margins tighten

• MISO’s goal – Enable the bi-direction flow of both energy and capacity to the location where it has the most economic value – while ensuring continuous reliability

• PJM Seam – Joint and Common Market process is making progress on a number of issues
  – Interchange Optimization
  – Coordinated Transaction Scheduling
  – Cross Border Planning

• SPP Seam – On-going efforts include
  – Transmission Capacity Sharing
  – Market-to-Market Congestion Management – Spring 2015 implementation planned
  – MISO-SPP Coordinated System Plan Study

• Active discussions are also on-going with other seams partners
Policymakers can significantly impact the effectiveness of the electric industry’s planning efforts

• Targeted at maximizing the industry’s planning capabilities, MISO offers the following for consideration:
  – Expanded coordination and consultation between EPA, FERC and DOE
  – Rule making processes and timelines that allow ample time to explore and address unintended consequences