In mid-2013, MISO commissioned EnVision Energy to analyze historical gas pipeline flow trends and to forecast capacity availability on natural gas infrastructure in the MISO footprint. This investigation is the third in a series of MISO studies aimed at building a better understanding of a transitioning electric generation fleet in the context of evolving natural gas infrastructure and operations.
BACKGROUND

In October 2011, MISO published the results of its year-long look into the potential impacts of four proposed, power industry-centric Environmental Protection Agency (EPA) regulations. Study findings indicated that over 60% of the coal-fired units in the MISO Midwest footprint would be affected by at least three of the four proposed rules. Additionally, the investigation identified a range of potential coal fleet capacity at-risk for retirement, with an expected value of around 12,000 megawatts (MW). This meant that many coal asset owners in the MISO footprint would be weighing decisions over the next few years of whether to install emissions control equipment, adjust operations to meet emissions targets, or retire units.

To increase transparency around forward-looking resource availability, MISO initiated a Quarterly Survey of asset owners’ strategies for compliance with the proposed regulations. In addition to decisions on unit retirements, the Survey encompasses progress on outages for retrofits, as well as the status of air permit applications and compliance extension requests. Survey results over the past two years have built upon the conclusions of the EPA Impact Analysis and helped inform the discussion around the transforming generation resource mix in the Midwest.

PHASE I & II GAS INFRASTRUCTURE ANALYSES

Increasing gas supply, competitive gas prices, and the potential for a significant loss of coal capacity in the Midwest set the stage for the natural gas infrastructure analyses MISO commissioned at the end of 2011 and beginning of 2012, respectively. These studies, executed by EnVision Energy, were static, pipeline-by-pipeline looks at historical flows in the context of increasing power burn demand for gas from existing and forecasted units in the MISO Midwest footprint. A modified backcast analysis (MBA) was selected as the study methodology.

The foundation of the MBA is the Daily Insufficiency Analysis (DIA). The DIA is based on publically-available Electronic Bulletin Board (EBB) pipeline flow data, compiled for select market entry points into the MISO Midwest footprint. Capacity availability on a daily basis is examined by overlaying historical pipeline flows with projected demand from power burn. Using this methodology, the Phase I study identified concerns around gas storage and future pipeline capacity, as well as the timing of infrastructure build-out. The Phase II added another perspective, modeling downward trends in gas prices in a High Demand Scenario; results indicated potential constraints on almost 90% of the major interstate pipelines in the Midwest.

These findings spurred an on-going conversation with MISO Stakeholders and the natural gas industry that led to the creation of MISO’s Electric and Natural Gas Coordination Task Force (ENGCTF) in late 2012. During this time, MISO worked with the natural gas industry, including individual pipeline companies, to address aspects of the approach used to determine pipeline capacity availability in the Phase I and II studies. Valuable feedback was received, largely regarding the use of insular metrics to characterize dynamic pipeline environments. Many reviewers also noted
the importance of factoring secondary market capacity release, gas storage, and short-haul/backhaul operations into pipeline capacity calculations.

The Phase I and II studies were intended to be high-level, preliminary screenings of pipeline capacity. MISO recognized the limitations of its initial analyses and commissioned EnVision Energy to perform a follow-up analysis.

PHASE III GAS STUDY

METHODOLOGY & MODELING ASSUMPTIONS

For consistency with MISO’s previous gas infrastructure studies, the Phase III methodology included a modified backcast analysis (MBA) of the major interstate pipelines in the MISO Midwest footprint. The demand piece of the analysis is an output of EGEAS, an NG Planning optimization tool for resource forecasting. The EGEAS model forecasts the most economical way to meet energy and capacity needs on an annual basis, given various generation alternatives, for a user-defined study footprint and planning horizon.

EGEAS outputs include generation additions over the study period by type and in-service year, as well as energy dispatch per unit. MISO then sites this forecasted capacity throughout the footprint, on a zonal basis, using a methodology that identifies probable and/or favorable locations for power plant construction.

In total, 22 new gas-fired power plants (13,200 MW) were projected to be built in the MISO Midwest footprint in the Phase III Base Demand Scenario over the next 20 years. Monthly generation dispatch from EGEAS was averaged to determine annual megawatt-hour (MWh) production for each existing and forecasted gas-fired unit. This annual energy production figure was then aggregated per pipeline (in cases of multiple embedded and/or forecasted CCs/CTs per pipeline) and converted to a fuel requirement in million BTUs per day (MMBtu/d).

This estimate of future gas demand growth from electric generation fed into the pipeline capacity calculation of the modified backcast.

MISO’s Planning Reserve Margin (PRM) is rooted in the 1-day-in-10 years electric industry reliability standard. This is generally interpreted as an acceptable level of service interruption of 1 event every 10 years.

The PRM aims to ensure that load can reliably be served on a forward-looking basis; it is a key modeling input for MISO’s resource forecasting process.

EGEAS, short for Electric Generation Expansion Analysis System, is the optimization software MISO uses to perform regional resource forecasts. This modeling tool identifies least-cost generation options to meet the PRM target and serve energy needs throughout the footprint.
In response to feedback received on the Phase I and II study efforts, MISO expanded its methodology to include a dynamic modeling component. EnVision Energy subcontracted with Bentek Energy, whose proprietary **forward balancing model** complements the use of the modified backcast. The forward balancing approach starts at the well-level, with production trend estimations. Production profiles are aggregated, up to national-level, for both existing and new wells. Well production is just one aspect of the supply question, which also includes infrastructure constraints and infrastructure expansion. The demand side of the forward balancing equation is driven by weather, market share (generation capacity additions and retirements, EPA regulations, etc.) and market growth (economic indicators), and demand is forecast on a regional level. Using these foundational components, the model balances gas inflows and outflows regionally, taking into account gas storage requirements and pipeline transportation dynamics.

**FUEL PRICE**

Gas price assumptions were consistent across methodologies, with base year prices modeled at $3.84/MMBtu (Base Demand) and $2.50/MMBtu (High Demand), and escalated over the study period.

**Phase III Gas Study Nominal Gas Price Trends with MISO’s 2013 Regional Transmission Planning (MTEP13) Gas Prices for Comparison**

The multi-methodology approach to analysis for the Midwest was selected to provide robust results for a region across which access to gas supply, storage and transportation varies; conversely, the MISO South footprint sits atop an extensive, heavily networked pipeline system, where individual gas-fired power plants may have interconnections with more than five supply sources.
The nature of the system configuration, along with MISO’s relative unfamiliarity of gas infrastructure in this new, southern portion of the footprint called for a different analytical approach. To meet this need, Bentek performed a corridor flow assessment, gathering baseline data and characterizing pipeline flow trends by corridor (groupings of 5 or 6 pipes in proximity).

**PHASE III STUDY FINDINGS**

**MIDWEST SUPPLY CONSIDERATIONS**

Results from the modified backcast analysis and the forward balancing analysis both point to adequate pipeline capacity in the near-term for the Midwest footprint under the Base Demand Scenario. Isolated exceptions to this trend exist, most notably on pipelines routing through Southern Minnesota/Northern Iowa. This region may have limited capacity availability for peak day needs and electric generation demand growth going forward.

*Supply Outlook for MISO Midwest*  
(Source: Bentek Energy)

The balancing model also provides insight into supply trends for the region, forecasting an increasingly diversified supply portfolio. Canadian gas will play less of a role in meeting Midwest fuel needs over time, as the Bakken and basins in the Northeastern US ramp up production. The Midwest is projected to turn into a net importer of gas from the Northeastern US but needs approximately 2.0 bcf/d worth of new or converted infrastructure to do so. Without this buildout, the Midwest will have to source this supply from another region, which would significantly alter the balance of flows.
Currently, Spectra Energy Partners (Nexus, TETCO-Uniontown to Gas City), ANR Pipeline Company (Lebanon Lateral), and Kinder Morgan (REX NE Express) have all proposed projects to move gas out of the northeast, with varied in-service dates and capacities. Below: *Midwest to Northeast Flow Dynamics & Proposed Projects* (Source: Bentek Energy)

![MW to NE Flow Dynamics](image)

**MIDWEST DEMAND CONSIDERATIONS**

Demand from all sectors is projected to increase over the next few decades, with fuel needs for residential and commercial applications still accounting for the greatest portion of demand in the Midwest. Average daily demand is forecasted to grow to 13.4 billion cubic feet (bcf) /day in 2032 from 11.1 bcf in 2013. The forward balancing analysis also identified the potential for an additional 1.1 bcf/d of demand growth from industrial users. Gas production growth and the proximity to agricultural customers have drawn interest to the Midwest region, with planned in-service dates over the next few years for a handful of agrochemical projects.

**Demand Forecast for MISO Midwest** (Source: Bentek Energy)

![Demand Forecast for MISO Midwest](image)
Historically, the Midwest has served as a waypoint for gas en route to major load centers in the Northeastern U.S. and Eastern Canada, but new and increasing supplies from shale gas basins are changing pipeline flow patterns across the country.

- Continued Northeast production growth will help feed incremental demand growth in the Midwest region and will also “re-invent” the Midwest’s relationship with the cross-continent Rockies Express pipeline (REX).
- Production growth in the Upper Great Plains (Bakken shale) will displace Canadian imports into the Midwest.
- As Southeastern U.S. gas demand grows, more local supply will stay in the MISO South region and inflows to the Midwest from the Southeastern U.S. will become increasingly seasonal.

**MISO SOUTH SUPPLY CONSIDERATIONS**

The MISO South region has historically been at the heart of U.S. gas production, with access to over 90 interstate and intrastate pipeline systems. However, the traditional movement of gas, from south-central production areas to markets in the upper Midwest, and East and West coasts, is in transition, driven by shale gas production growth.

**Southeast Production Breakdown for 2005 and 2012** (Source: Bentek Energy)

Production in the southeastern U.S. since 2005 has migrated from offshore to onshore at a steady pace. Local production outlooks are varied with projected growth at Eagle Ford, flat production at Fayetteville and decreasing production from Haynesville; however, local production would likely respond quickly to a premium price.
environment which may evolve late in the decade due to demand growth. Finally, flows from Texas and Northeast Louisiana into the MISO South region will continue to decline as production growth in the northeast outpaces demand growth in the Southeast.

**MISO SOUTH DEMAND CONSIDERATIONS**

Forecasted demand growth in the Southeastern U.S. is led primarily by Liquefied Natural Gas (LNG) exports, gas-to-liquids production, petrochemical and fertilizer manufacture, and power generation. There are also a large number of industrial projects planned in the region that will also add base-load demand growth.

*Growing Southeast Demand* (Source: Bentek Energy)

**MISO SOUTH MARKET DYNAMICS**

Flow patterns in the southeastern U.S. have also been impacted by the boom in shale production. Outflows to the Ohio Valley have significantly decreased over the past five years; flows to the East from the MISO South region have also weakened and become more seasonal; and while both gas inflows and outflows of the Southeastern U.S. are in decline, net flows into the Southeast have risen over the past few years. Several proposed North-to-South pipeline projects play into southeastern market corridor projections for the next few years, including: Texas Eastern Transmission Company’s (TETCO) OPEN to link Gulf Coast demand to Northeast producers and Renaissance, which targets demand markets in Georgia, Northeast Alabama and Tennessee; and Transco’s proposed Atlantic Access pipeline, to move gas from the Marcellus and Utica shales to demand centers along the coast and down to Louisiana.

*Increasing Net Flows into the Southeast* (Below) & *Demand Pull Draws Supply from Other Regions* (Left) (Source: Bentek Energy)
TAKEAWAYS

Significant changes have occurred over the past few years in the gas industry, driven by major production growth in shale basins. The physical infrastructure is expanding and gas flow patterns have shifted on a national scale. Gas pipeline modes of operation, both physical and contractual, are likewise adjusting. The following takeaways from the Phase III study highlight how these developments have and will continue to impact the MISO footprint.

• There is a clear trend of decreasing sub-regional constraints and increasing interconnectivity in the MISO Midwest footprint, with isolated exceptions.

• Shifting supply and demand fundamentals outside and inside the Midwest Market will increasingly position the region as a destination rather than a waypoint for gas en route to other markets.

• Increased retention of supply passing through the Midwest region, greater diversity of supply options and growth in Bakken production will provide end users with opportunities to reassess asset portfolios.

• Strong supply basins in the Northeastern U.S. will continue to impact Midwestern flow patterns and increasingly help serve Midwestern demand; however, infrastructure expansion is still needed to move gas into the region and to address area-specific constraints.

• End users in the MISO South Region will continue to have access to numerous supply sources due to an exceptionally well-connected pipeline network.

NEXT STEPS

Over the past two years, MISO has worked with its stakeholders, state and federal regulators, and with members of the natural gas industry to better understand a transitioning electric generation fleet in the context of evolving natural gas infrastructure and operations. The results of the Phase III study build upon these efforts and help to identify opportunities for future progress via a framework for next steps:

• **Continue to improve communications with the natural gas industry and to further develop coordination efforts** – To-date, significant time and energy has been invested by members of the gas industry to help MISO understand gas pipeline and storage mechanics, as well as business operations and regulatory constructs. MISO continues to work to engage the gas industry and to create coordination opportunities. In October 2013, MISO initiated a 6-month Coordination Field Trial with ANR Pipeline Company. This effort includes a monthly conference call to review planned outages and/or maintenance work on both the gas and electric systems, as well as other potential operational impacts (e.g. extreme weather). The Trial serves as a first step towards establishing open lines of communication between gas system operators and MISO control room operators.

• **Continue to consolidate natural gas industry data, to create valuable information and enhance MISO operators’ system awareness** – With 21 major interstate pipelines routing through the MISO Midwest footprint and over 90 interstate and intrastate pipeline in MISO South, the task of soliciting and/or gathering gas system data is substantial. While data in-hand is the first step, the next is to provide context and to create valuable information for MISO’s operators and planners.

    Several projects are underway at MISO with this goal including: 1) building a database that links gas infrastructure to electric generators, 2) creating an online platform for gas pipeline critical notices and operational flow orders, and 3) adding an overhead control room display of electric transmission/generation and natural gas infrastructure.
• **Quantify fuel risk and incorporate into system models, as well as planning and market constructs** – In April 2013, MISO’s Electric and Natural Gas Coordination Task Force (ENGCTF) approved a stakeholder motion to scope and execute a pilot study to better capture fuel risk in MISO’s Loss of Load Expectation study process. This on-going effort has helped to highlight the challenges of quantifying the risk related to fuel unavailability. Specifically, there are barriers to procuring consistent, locational data for both historical and projected fuel risk across a geographically and operationally diverse infrastructure footprint.

• **Address the need for integrated contingency analysis** – MISO’s current practices do not explicitly account for gas system contingencies; historically, there has not been a need. The shift towards a greater reliance on natural gas for power burn may call for the incorporation of gas system contingencies into MISO’s electric system models.

• **Address areas of congestion identified within the study** – Several areas were identified by the Phase III study as either capacity constrained currently (Southern Minnesota/Northern Iowa) or in need of future buildout (to handle imports to the Midwest from the Northeast). The Phase III analysis provided high-level congestion analysis. More granularity will be needed to fully understand and assess these potential problem areas.

• **Encourage involvement from regulators in on-going gas-electric efforts, including quantification of future gas demand and identification of ways to efficiently minimize fuel risk** – Planning for a future in which gas is a key fuel for power burn and significant potential for gas demand growth from other sectors exists, it will be essential to understand the aggregate demand for natural gas within the MISO footprint. As resource planning is the purview of the states, MISO must work with state regulators to determine how best to understand the total energy picture going forward.

This framework aligns with MISO’s objective of ensuring reliable, safe and efficient operation of the electric transmission system. In the coming months, MISO will continue to work through the Electric and Natural Gas Coordination Task Force to determine how these recommendations can be realized and whether tariff changes will be required.

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