Gas-Electric Planning Update

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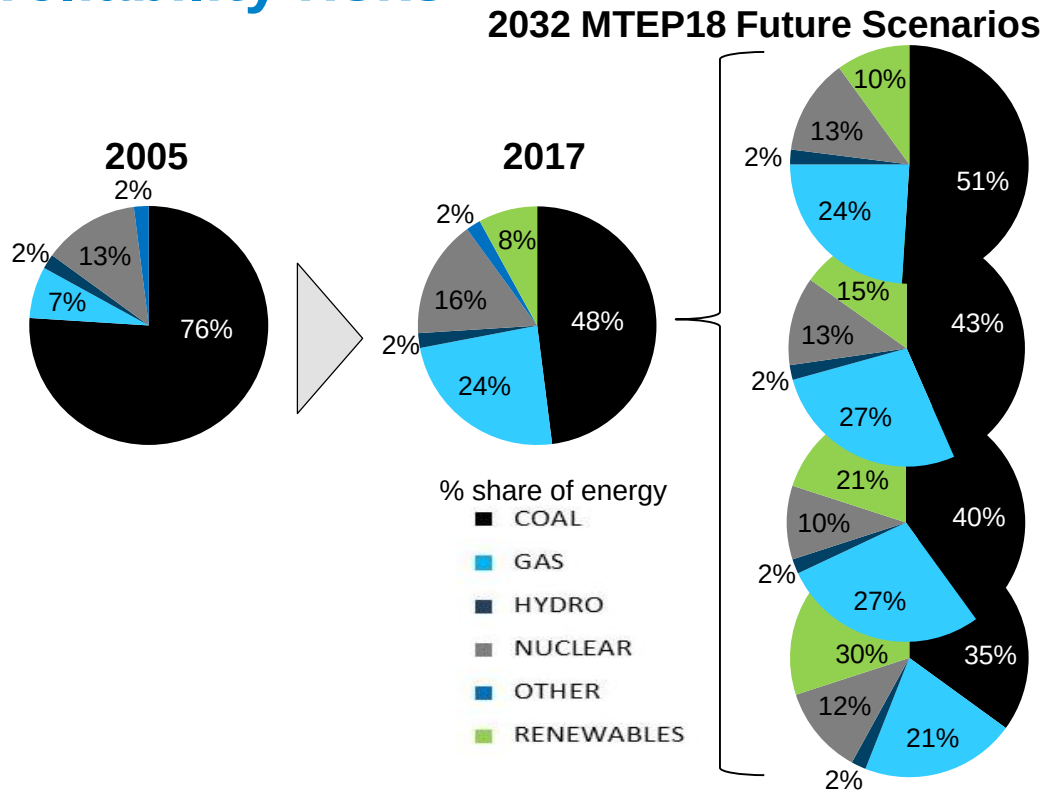
April 18, 2018

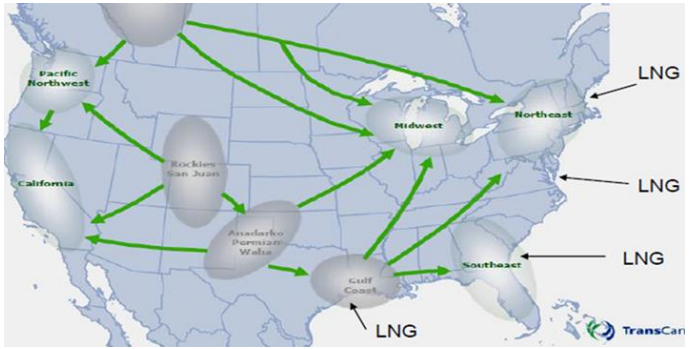
Planning Advisory Committee

- Review NERC Report
- Discuss MISO actions

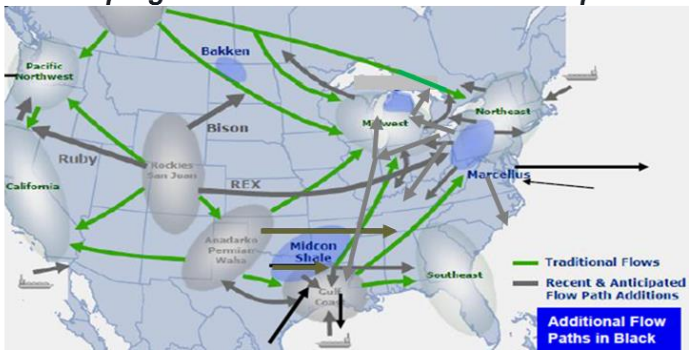
Gas usage in MISO is growing potentially increasing reliability risks



Historic Flow Patterns and LNG Imports



Developing "Grid" Flow Patterns & LNG Exports



NERC: dependence on natural gas requires new planning approach for reliability

- NERC conducted an assessment to analyze potential reliability impacts from disruption of natural gas delivery. NERC's assessment found that the impacts vary depending on the location and infrastructure density, and that mitigation strategies to reduce potential impacts are available.
- Increased dependence on natural gas can amplify vulnerability to disruptions in fuel supply, transportation, and delivery

NERC Special Reliability Assessment:
Potential Bulk Power System Impacts Due to Severe Disruptions on the Natural Gas System, November 2017

https://www.nerc.com/news/Headlines%20DL/SPOD%2014NOV17.pdf

https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_SPOD_11142017_Final.pdf

NERC found 2 regions in MISO with stability risks

- NERC identified 24 geographic clusters with more than 2,000 MW of gas-fired generation
  - 18 areas found with a reliability risk
- Two of these regions are in MISO's footprint: one on the Missouri/Illinois border, and the other around the Amite South load pocket in Southeast Louisiana

Figure 6.2: Clusters Where Power Flow Issues were identified

NERC | Single Point of Disruption to Natural Gas Infrastructure | November 2017, Page 20

MISO has assessed the two regions and found that they were not single source (n-1 type) issues, and do not account for a generators ability to procure fuel from an alternate pipeline connection

NERC: MISO was found to not be at risk of electric disruption due to loss of natural gas pipelines

- Analysis conducted by Argonne National Laboratory for NERC report
- Looked at 100% loss of single pipeline using flow model

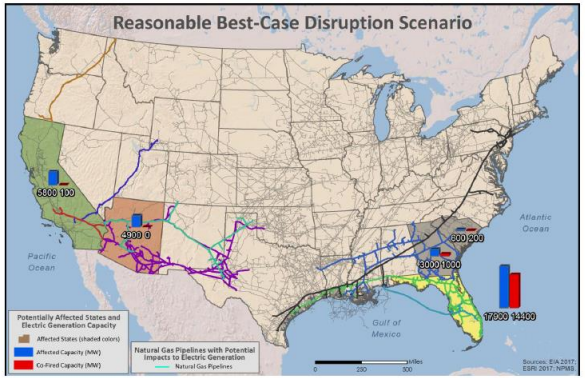


Figure E.3: Summary of NGfast Simulation Results for the Reasonable Best-Case Scenario

- Dual-fuel maintained on-site
- Firm fuel agreements
- Multiple pipeline connections

- Dual-fuel capable
- Part of firm fuel portfolio
- Multiple pipeline connections

- Dual-fuel capable, no inventory
- Interruptible fuel, spot
- Single pipeline connection

- Not dual-fuel capable
- Interruptible fuel, spot
- Single pipeline connection

Higher individual reliability

Lower individual reliability

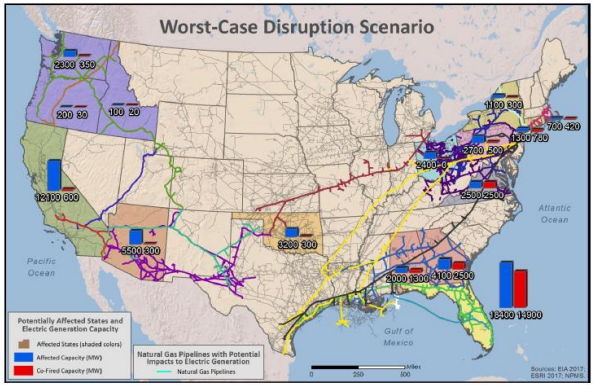


Figure E.2: Summary of NGfast Simulation Results for the Worst-Case Scenario

Best case scenario assumes gas can be redirected from available source

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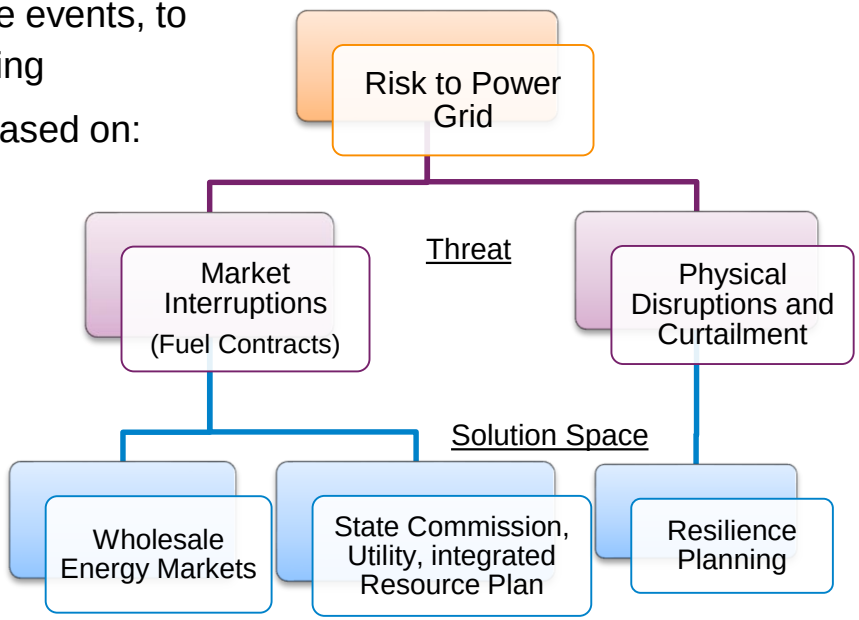
Worst case scenario assumes no mitigation were possible

NERC recommends industry take three actions

1. Registered entities should consider loss of key natural gas infrastructure in planning studies
   - **MISO since 2015 included natural gas infrastructure disruptions in reliability studies; has started study to assess additional disruptions**
2. Owners and operators of dual fuel capable generators must ensure operability of secondary fuel
   - **MISO plans to address testing and verification of dual fuel units in future**
3. Natural gas and electric industries must continue to advance coordination as electric industry continues to become a larger percentage of total natural gas throughput
   - **MISO regularly meets with pipelines and gas generation operators, and has implemented a pilot project to share data with pipeline operators**

Natural gas disruptions have been incorporated into MISO's reliability planning since 2015

- MISO currently uses 31 gas contingencies, as extreme events, to evaluate transmission needs and system risk in planning
- Contingencies list is reviewed and updated annually based on:
  - Geographic clustering
  - External studies
  - Historic events
  - Transmission owner/planner feedback
- ➢ No cascading resulted from gas pipeline events in MTEP15,16,17 TPL analyses
- ➢ No impact found in 2017/18 Winter CSA assessment
- ➢ No meaningful reliability limitations found in LOLE analysis of one extreme event (full pipeline outage in current resource portfolio), as annotated in FERC resilience responses*



*"Only in one scenario, under the extreme and long-term event of the loss of the largest natural gas pipeline for the entire summer peak season, was a slightly elevated regional loss of load risk observed." MISO response in AD18-07 Page 27, Filed 03/09/2018

MISO study to assess additional disruptions

- Collaborating with ICF to assess 4 topics
  - Detailed cataloguing of historical events
  - Develop a gas system contingency list
  - Estimate probability and impact
  - Identify possible mitigations
- Project is scheduled to be complete November 2018
- Stakeholders will be updated as applicable

Current studies have found no major risk of natural gas disruption causing reliability issues in MISO

Next Steps

- Continue reviewing relevant industry studies
- Collect additional information on reliability risks, from loss of gas supply, through currently active studies
- Continue conversation with all parties, and start analysis examining potential future risks as gas capacity grows, and its usage patterns change

Want to know more about MISO Gas-Electric Planning?
https://cdn.misoenergy.org/20170818%20Gas%20Electric%20Planning%20Workshop%20Materials128847.pdf

Questions?

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