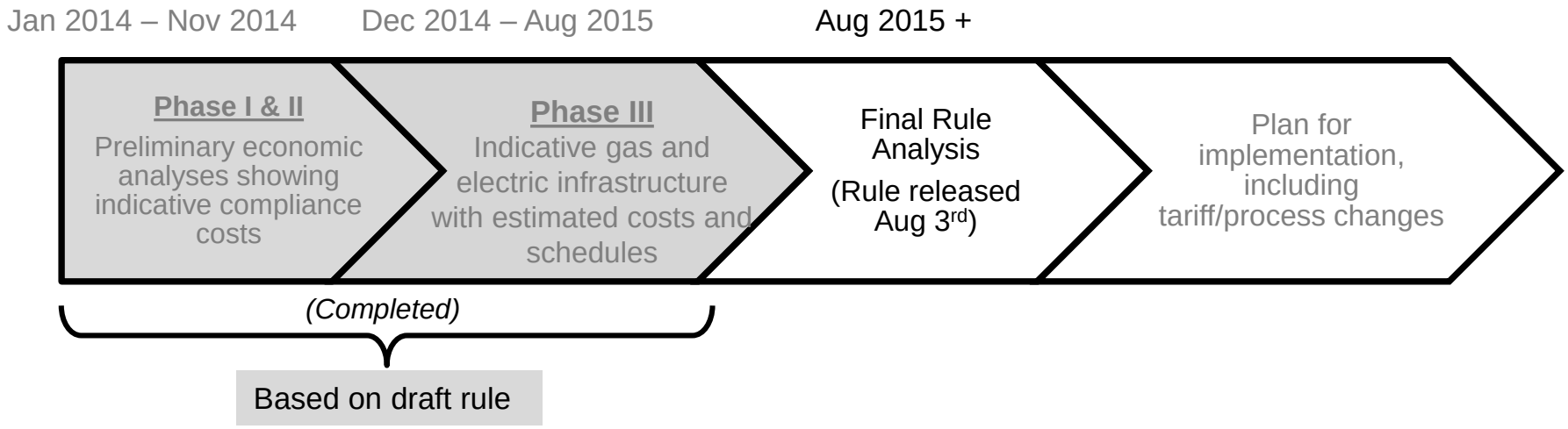
Lessons Learned from MISO's Clean Power Plan (CPP) Draft Rule Study

Planning Advisory Committee
August 19, 2015

Lessons learned from draft rule analysis help us prepare for study of the final rule



- Draft rule analysis was developed to understand potential impacts of the CPP and create a framework for analysis of the final rule.
- The presentation today will focus on lessons learned from draft rule analysis, as we prepare for analysis of the final rule.
- Stakeholder feedback is requested by September 4th.

Key takeaways from draft CPP analysis

- Regional compliance produces cost savings versus state and sub-regional approaches.
- Multi-billion dollar transmission build-out would be necessary for compliance in the scenarios studied.
- Transmission expansion will be needed to mitigate reliability impacts of compliance, largely driven by coal retirements.
- CPP constraints significantly increase congestion regardless of compliance approach.
- Generation dispatch would change dramatically from current practices, requiring additional study to fully understand the ramifications.

Draft rule lessons learned: infrastructure expansion needs

- Regardless of siting assumptions, electric and gas infrastructure costs for interconnection of new or converted gas units are comparable.
- Both the level of retirements and the location and type of replacement capacity will drive the need for additional transmission.
  - Siting all replacement gas capacity at retiring coal sites mitigates some of the need for incremental transmission
  - Siting new gas capacity near the existing natural gas system increases the need for incremental transmission.
- Renewables build-out furthers this need as renewable generation is usually sited in locations with better renewable resources but weaker transmission ties.

Candidates studied to relieve congestion identified in the draft rule analysis

June

- Identified **107** congested flowgates/areas for potential economic transmission expansion

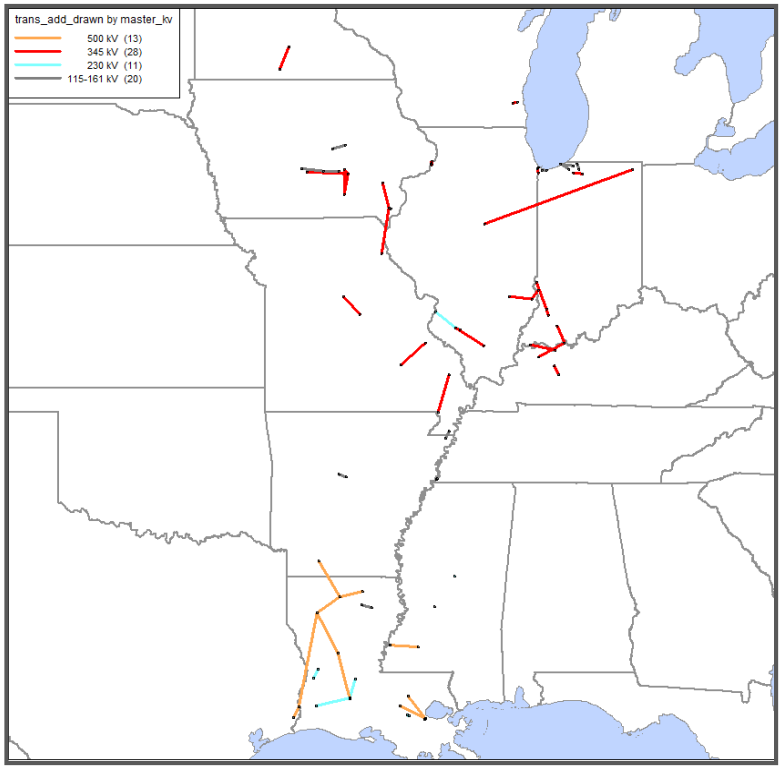
July

- Reviewed stakeholder-submitted and previous MCPS* projects
- Matched 34 transmission projects with congested areas across MISO
- Combined individual projects to formulate 10 transmission portfolios

July/August

- Tested transmission portfolios for production cost impacts
- Summarized portfolio costs and benefits

Map of all 34 transmission projects



*MCPS = MISO Market Congestion Planning Study

Draft rule lessons learned: study design

- **Phase III scenarios focused on one or two compliance actions (e.g. coal retirements, renewables build-out, re-dispatch).**
  - This examination of individual impacts allowed for a better understanding of these compliance actions.
  - Individual compliance actions can be combined to produce holistic futures definitions for use in the final rule analysis.
- **The PLEXOS model is a good fit for analysis of the CPP.**
  - Allowing for modeling state-level compliance, CO_2 mass or rate constraints and integrated gas-electric system dispatch.

Draft rule lessons learned: study process

- **The draft CPP rule is a complex regulation requiring significant time to understand and analyze.**
  - The final rule analysis will require a similar timeframe but our work to date allows us to “hit the ground running”.
- **Stakeholder feedback was essential to producing relevant outputs.**
  - We will continue to engage stakeholders throughout analysis of the final rule.
- **A phased study approach produced valuable information prior to completion of the entire analysis.**
  - A similar approach may be needed to fully understand the final rule and prepare for its implementation.

Moving forward: challenges and considerations

- **Ambiguity in the draft rule and uncertainty around compliance strategies required us to make many assumptions.**
  - Reliability analysis is especially sensitive to assumptions on resource additions and retirements, making it difficult to accurately model reliability impacts.
  - For the final rule analysis, we'll work closely with stakeholders, state regulators and neighboring ISOs to model intended implementation plans.
- **The draft rule analysis indicated material changes in system operations.**
  - The final rule analysis will take a closer look at the operational issues, e.g. unit cycling or sharply increased utilization of peaking resources, under CPP compliance.
- **It also signaled the need for significant transmission expansion and served as a first step towards identifying targeted transmission plans for CPP compliance.**

Next steps

- The Phase III report has been posted.
- Feedback is requested on how to adjust the study scope from the draft rule for the analysis of the final rule.
- Feedback due by September 4th.
- We plan to be back to the PAC in September with a straw proposal for final rule study scope.

Contact info

- **EPA regulations webpage**
  https://www.misoenergy.org/WhatWeDo/EPARegulations/Pages/111(d).aspx
- **Additional questions? Please contact:**
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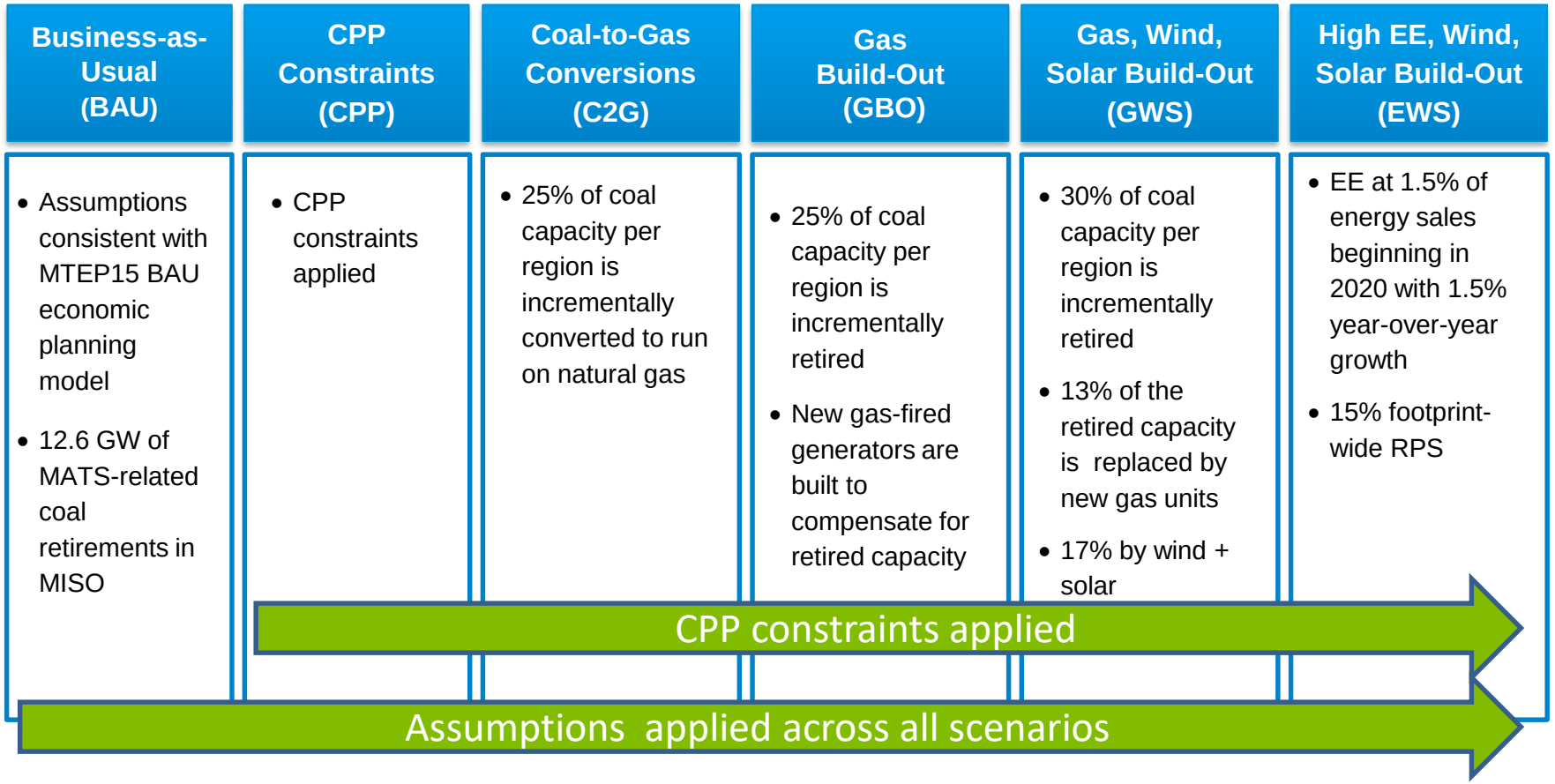
Appendix

For Reference – Phase III Scenarios



Comprehensive compliance costs for the MISO region based on the draft rule, accounting for both capital and energy production

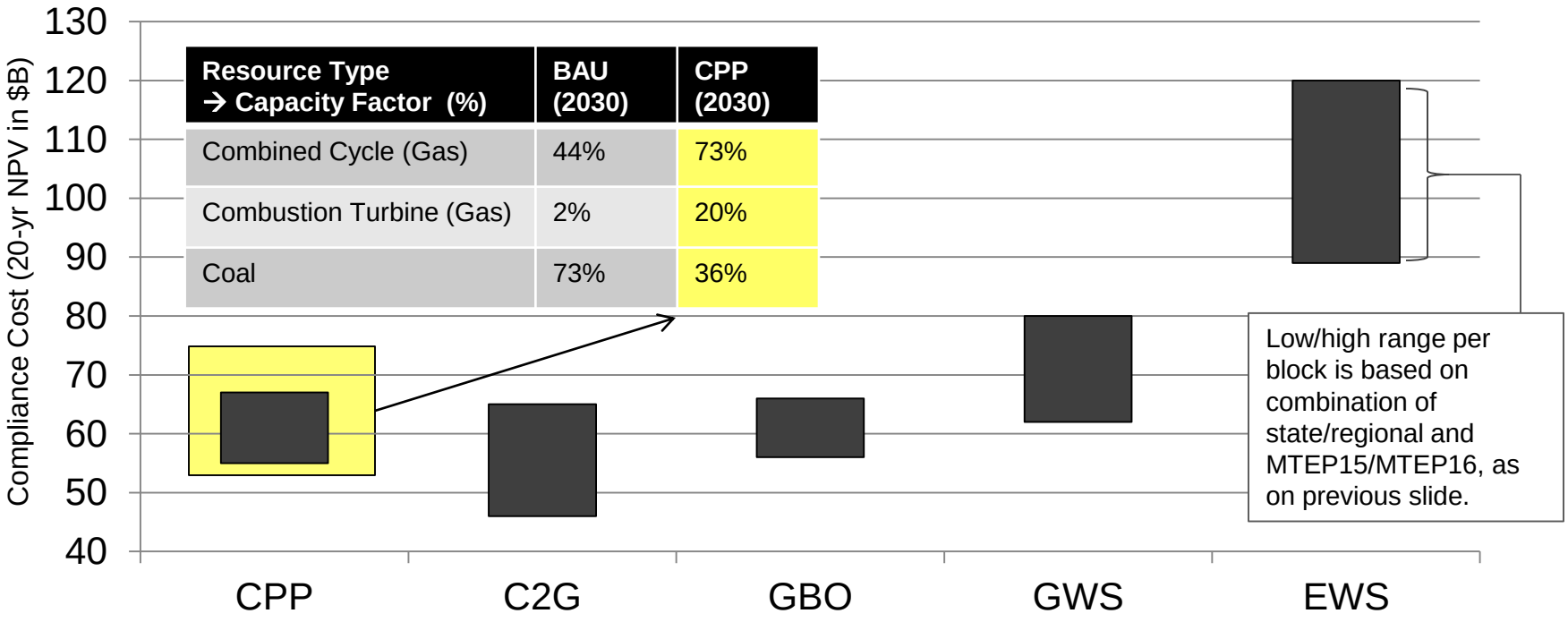
Cost for State / Regional Compliance Approaches (20-yr NPV in $B) Incremental Resource Capital Costs for MTEP15 | MTEP16 (difference from BAU)					
	CPP	**C2G**	**GBO**	**GWS**	**EWS**
Production Costs	**64 / 53**	**48 / 40**	**54 / 45**	**26 / 21**	**-27 / -31**
Resource Capital Costs		**13 | 4**	**9 | 9**	**51 | 39**	**131 | 105**
Transmission Portfolio Capital Costs (Reliability upgrades excluded)	**2.6 / 1.8**	**2 / 1.5**	**2.2 / 1.7**	**3.3 / 2.4**	**1.7 / 1.4**
Pipeline Lateral Capital Costs (Mainline costs excluded)		**1.3**	**0.5**	**0.1**	
Total System Compliance Cost Range	**55 - 67**	**46 - 65**	**56 - 66**	**62 - 80**	**75 - 106**

Total system cost = **production costs + resource capital costs + transmission capital costs + pipeline capital costs**

Capital costs = Fixed O&M Cost + Capital Carrying Cost

Production costs = Variable O&M Cost + Energy Production * Fuel Cost

As modeled, the CPP scenario is a lower cost compliance option but can the system perform like the model?



Resource Type → Capacity Factor (%)	BAU (2030)	CPP (2030)
Combined Cycle (Gas)	44%	73%
Combustion Turbine (Gas)	2%	20%
Coal	73%	36%

- Twice as many starts and ramps by coal units in CPP versus BAU, for generators in the MISO footprint

Resource capital costs under CPP compliance

- The same resource forecasts were used in modeling state and regional compliance approaches.
  - This may undervalue capital costs under state or sub-regional compliance approaches, as the Planning Reserve Margin could be higher, resulting in greater resource investment.
- Assumptions from both MTEP15 and MTEP16 were used to develop a range of capital costs.

Resource Capital Costs using MTEP15 | MTEP16 (20-yr NPV in $B, incremental from BAU)					
	CPP	C2G	GBO	GWS	EWS
Resource capital costs	0	13 | 4	9 | 9	51 | 39	131 | 105

Indicative MISO economic transmission expansion under CPP compliance

- Transmission portfolios were designed to address the most congested areas per scenario, the mitigation of which would produce the largest value.
- The “budget for economic transmission” represents the potential for economic transmission expansion per scenario.
- These two metrics approximate bookends for economic transmission expansion under the scenarios modeled.
  - Additional transmission expansion will be likely be needed to address reliability concerns.
- Benefit analysis indicates that all of the portfolios studied would pass the B/C threshold of 1.25 within the context of Phase III.

Cost for State / Regional Compliance Approaches (20-yr NPV in $B)					
	CPP	C2G	GBO	GWS	EWS
Transmission Portfolio Capital Costs	2.6 / 1.8	2 / 1.5	2.2 / 1.7	3.3 / 2.4	1.7 / 1.4
Budget for Economic Transmission	8.7 / 7.4	8.8 / 6.6	8.7 / 6.8	10.6 / 8.5	13.5 / 10.8

Gas pipeline laterals used as proxy for gas infrastructure expansion in Phase III

- Gas pipeline lateral lengths and diameters were determined per scenario based on unit capacity, pipeline proximity and year of implementation

  Lateral cost = [distance from nearest pipeline (miles)] x [lateral diameter (in)] x [inch-mile cost*]

- These figures *are indicative*, *are dependent upon siting* and are *intended to inform* the total cost of compliance.

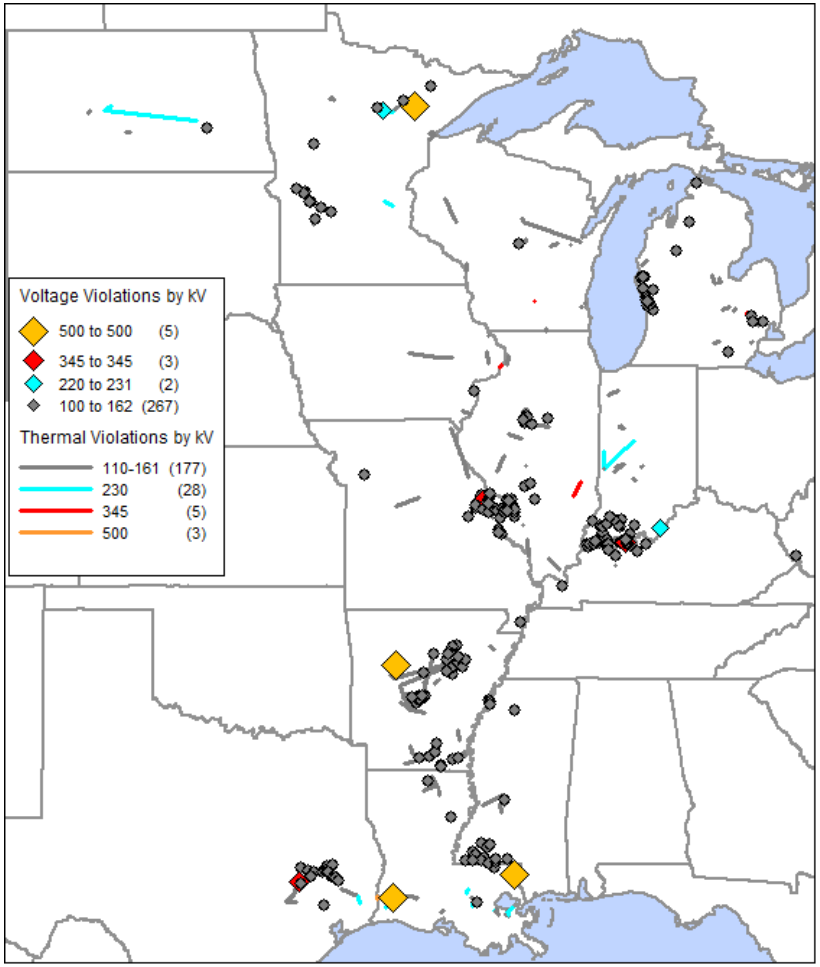
- Final rule analysis will include gas-electric modeling and attempt to identify both lateral and mainline costs.

Cost for State / Regional Compliance Approaches (20-yr NPV in $B)					
	CPP	**C2G**	**GBO**	**GWS**	**EWS**
Pipeline Lateral Capital Costs (Mainline costs excluded)	**-**	**1.3**	**0.5**	**0.1**	**-**

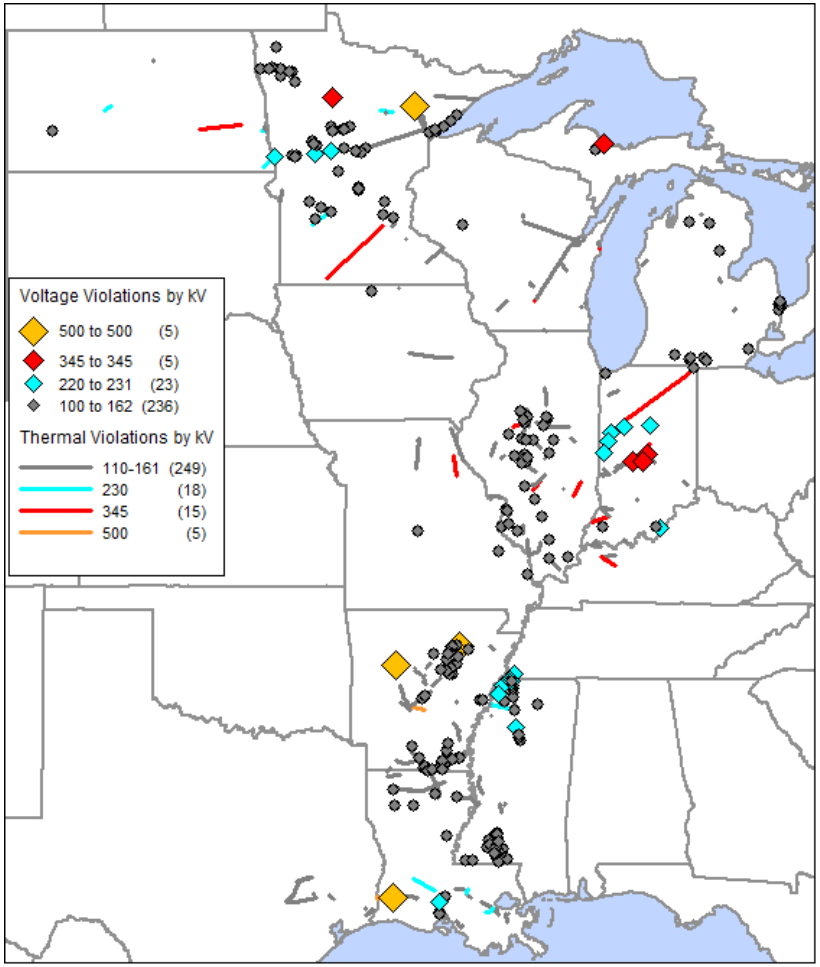
*See http://www.naruc.org/Grants/Documents/ICF-EISPC-Gas-Electric-Infrastructure-FINAL%202014-12-08.pdf

Reliability analysis indicates numerous violations under draft rule CPP compliance

2025 GBO

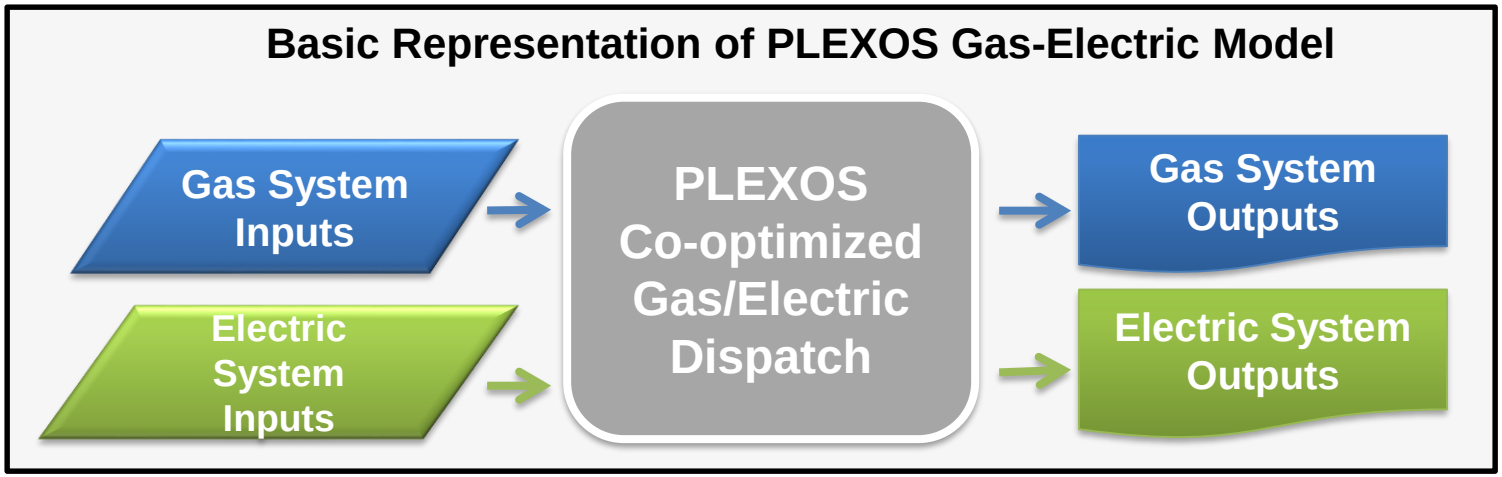


2025 GWS



Maps show reliability impacts in 2025 for Gas Build Out (GBO) and Gas Wind and Solar (GWS) scenarios. Violation more than double between the 2020 and 2025 cases.

Proof-of-concept gas-electric modeling is underway in preparation for final rule analysis



- Database preparation and test runs on-going
- Planned application of gas-electric model in analysis of final CPP
  - Outputs will be used to characterize pipeline utilization trends and identify gas system expansion needs under various CPP compliance scenarios
  - MISO will work with stakeholders and gas industry to develop gas infrastructure solutions, including timing and cost of implementation