

A large, light gray, stylized sun graphic is positioned on the left side of the slide. It consists of a semi-circle at the top with rays extending downwards, transitioning into a larger, more complex shape at the bottom that resembles a stylized sun or a power symbol. The graphic is composed of various geometric shapes like triangles and trapezoids.

An Overview of MISO's Clean Power Plan (CPP) Phase III Study

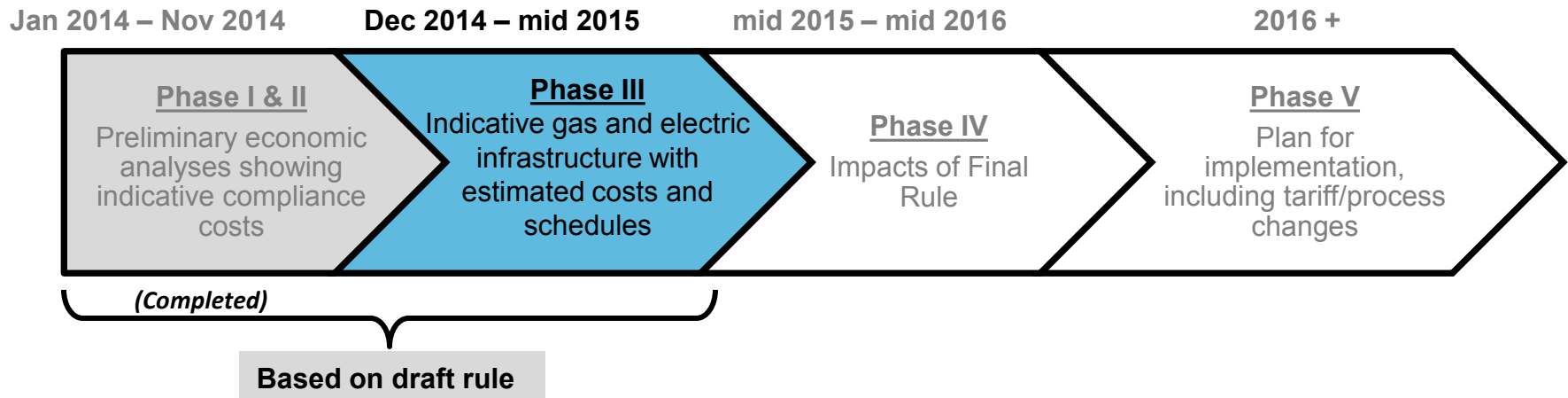
Clean Power Plan Stakeholder Group – MISO Webinar
April 15, 2015

MISO's CPP study is designed to answer key questions on reliability and economics



What are the system reliability and market economic impacts of compliance at both the state and regional levels based on these metrics?

Phase III builds upon MISO's preliminary efforts and establishes a framework for analysis of the final rule



- **What's new in Phase III?** Production cost analysis, state-level CO₂ compliance, expanded reliability assessment and *proof-of-concept integrated gas-electric modeling*
- Scope informed by Phase I/II study results and stakeholder input

Study Overview

- **The Phase III study intends to:**
 - Identify, quantify and interpret ramifications of the draft rule from a grid reliability and economics perspective
 - Develop a framework for analysis of the final rule
- **It does not intend to recommend any specific path to compliance with the final rule.**
- **The proposed scope incorporates stakeholder input:**
 - Inclusion of electric transmission
 - Detailed reliability analysis
 - State-level CO₂ modeling
 - Consideration and quantification of cost and construction timelines for gas and electric infrastructure build-out

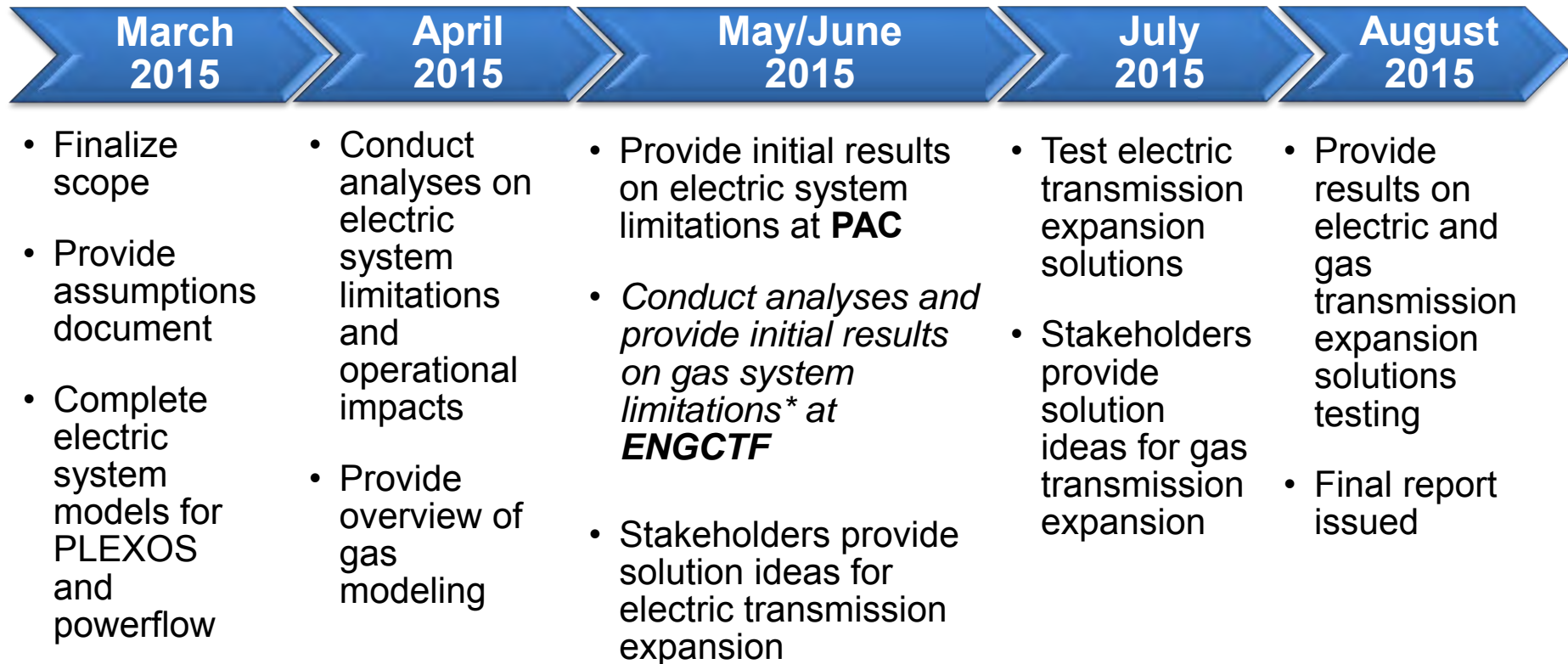
Phase III Scenarios & Sensitivities

- **The scenarios selected for Phase III are based on results from MISO's Phase I/II analyses, as well as stakeholder feedback.**
 - Represent range of feasible, materially different compliance strategies
 - Bound electric and gas infrastructure expansion costs for compliance strategies employing coal retirement/gas-build-out
- **Scenarios:**
 - Business-as-Usual (BAU)
 - Clean Power Plan Constraints (CPP)
 - Coal-to-Gas Conversions (C2G)
 - Gas Build-Out (GBO)
 - Gas, Wind and Solar Build-Out (GWS)
 - Increased Energy Efficiency, with Wind and Solar Build-Out (EWS)
- **Sensitivities:**
 - Each scenario will be modeled with state-level compliance
 - Select scenarios will be modeled with sub-regional and regional compliance

PLEXOS is a power market modeling and simulation software tool

- PLEXOS offers a flexible optimization platform with production cost modeling functionality
- Phase III modeling is based on:
 - Ability to address stakeholder requests for state-level CO₂ modeling, consideration of electric transmission impacts and natural gas infrastructure needs
 - Ability to represent rate-based emissions targets
 - Ability to simultaneously dispatch gas and electric systems

MISO will continue to engage stakeholders throughout the study process



Primary stakeholder involvement through **Planning Advisory Committee** and **Electric and Natural Gas Coordination Task Force**

Deliverables

- Indicative compliance costs considering generation, electric transmission, and gas pipeline infrastructure expansion needs under a variety of scenarios
- Estimated timelines for generation, electric transmission, and gas pipeline facilities needed to achieve CPP compliance

Summary

- Phase III of the CPP analysis is designed to meet stakeholder requests for additional analysis
- It builds upon MISO's previous (Phases I & II) CPP study by adding:
 - Transmission modeling
 - State-level CO₂ modeling
 - Natural gas infrastructure modeling
 - Detailed reliability modeling
 - Identification of indicative electric and gas transmission needs
- Analysis expected to be completed in August of 2015
- MISO will continue to collaborate with stakeholders as we learn more about the final rule and its implications.

Contact Info

- **EPA regulations webpage**

[https://www.misoenergy.org/WhatWeDo/EPARegulations/Pages/111\(d\).aspx](https://www.misoenergy.org/WhatWeDo/EPARegulations/Pages/111(d).aspx)

- **Additional questions? Please contact:**

Jordan Bakke at jbakke@misoenergy.org

Durgesh Manjure at dmanjure@misoenergy.org



Follow Us!

[@MISO_Energy](https://twitter.com/MISO_Energy)



Appendix

BAU and CPP Scenarios

- **Business-as-Usual Scenario (BAU)**
 - Consistent with MTEP15 BAU economic planning model
 - No CPP constraints applied
 - 12.6 GW MATS retirements in MISO are captured but no additional retirements are modeled
 - Each of the following scenarios also models MATS retirements and uses the MTEP15 BAU model as its base
- **Clean Power Plan Constraints Scenario (CPP)**
 - CPP constraints are applied and the system is dispatched meet the emissions targets
- Delta between BAU and CPP dispatch will highlight ability of existing fleet (inclusive of generators forecasted for a BAU future) to meet EPA targets

C2G and GBO Scenarios

- **Coal-to-Gas Conversion (C2G)**
 - 25% of the coal capacity per region is incrementally converted to run on natural gas combined cycle units (CCs)
 - Converted generators remain at the same bus; have access to existing electric transmission
- **Gas Build-Out (GBO)**
 - 25% of the coal capacity per region is incrementally retired
 - New gas-fired generators are built to compensate for retired capacity
 - 80% CCs / 20% combustion turbines (CTs)
 - New generators sited according to the MTEP methodology (consideration given to distance from gas infrastructure) but may not have access to existing electric transmission
 - Correlates with sensitivity modeled in Phase II CPP study
- Delta between C2G and GBO dispatch will help highlight a range for high electric/low gas and low electric/high gas infrastructure expansion needs

GWS and EWS Scenarios

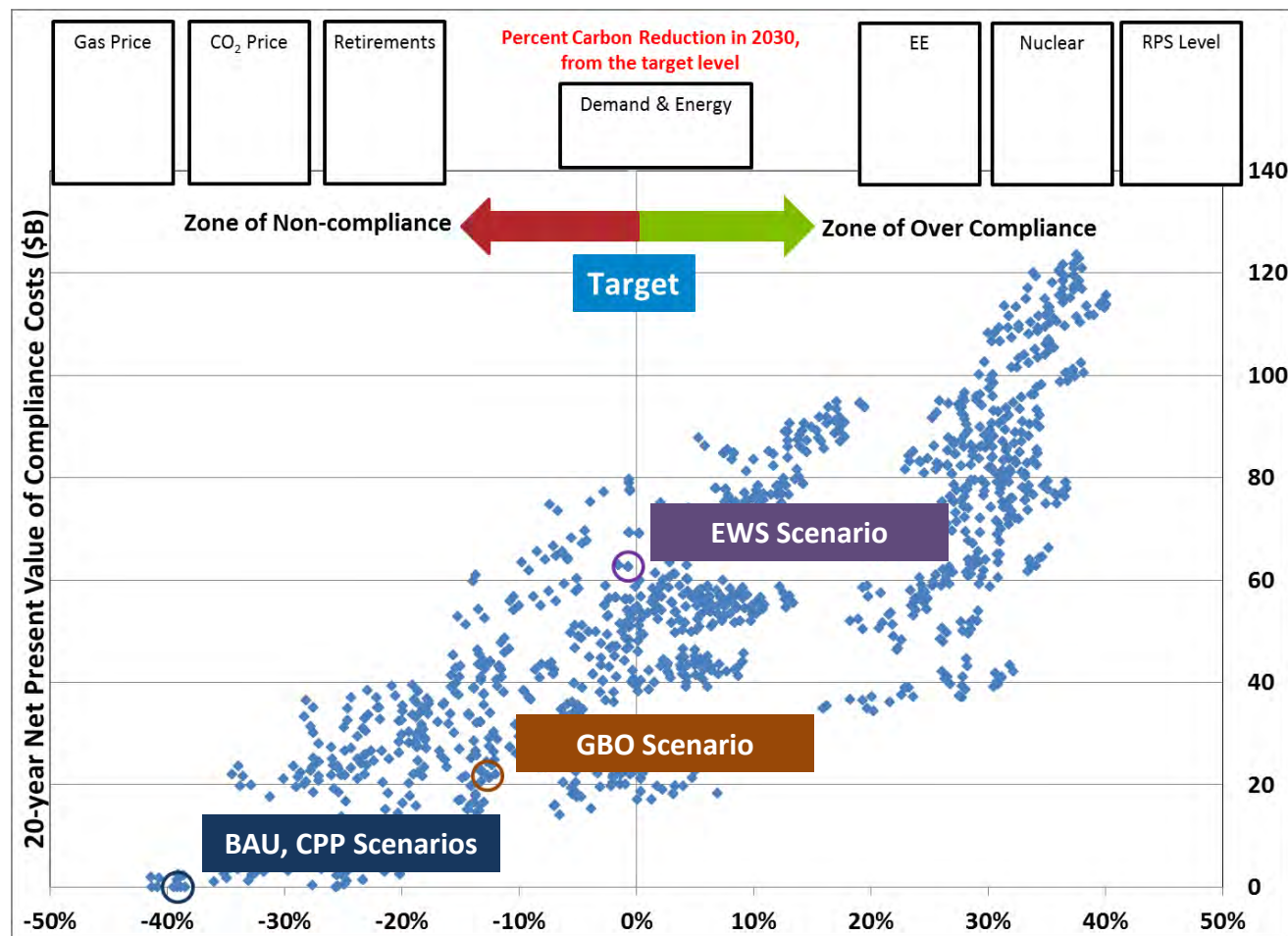
- **Gas, Wind and Solar Build-Out (GWS)**
 - 30% of the coal fleet in the EI is incrementally retired
 - 17% replaced with wind and solar resources
 - 13% replaced with gas resources
 - Used PLEXOS capacity expansion functionality to inform retirements and generation build-out
- **Increased Energy Efficiency, with Wind and Solar Build-Out (EWS)**
 - Increased implementation of energy efficiency is modeled, in line with EPA's Building Block 4
 - Wind and solar resources are built to meet a 15% pool-wide RPS
 - Approx. 96% wind/4% solar
 - Renewable build-out based on capacity expansion from correlated Phase II CPP study sensitivity
- GWS and EWS will highlight transmission and gas infrastructure impacts under compliance scenarios incorporating renewable energy and energy efficiency

Tie-in to Phase I/II CPP analyses

This graphic from the Phase I/II CPP study shows >1,000 sensitivities simulated around economic and policy conditions. (Specifics for each set of sensitivities, e.g. gas price, CO₂ price, omitted from this version.)

The three colored circles highlight those sensitivities with a correlated scenario in the Phase III study.

The BAU and CPP scenarios in Phase III have the same underlying system (capacity); the difference is the dispatch.



How are we modeling state-level CPP compliance in PLEXOS?

- PLEXOS allows for modeling customized constraints on generator dispatch.
 - Can be defined for virtually any footprint in the model (any combination of generators...pool, state, company, etc.).
- CPP compliance is represented by applying a dispatch constraint on the generation and emissions of affected generators.
 - For state-level compliance, the constraint is based on the EPA's annual CO₂ rate targets per state.
- To represent the real-world boundaries of different ISO/RTO markets in the model, a hurdle rate (essentially a cost to bias the dispatch of a unit within a pool to that pool's market) is applied.
- The model simultaneously optimizes the dispatch, takes into account the hurdle rates, and tries to comply with the state-level CO₂ constraints.

How are we modeling sub-regional and regional CPP compliance?

- Rate-based CO₂ emissions targets per sub-region/regional are determined by summing emissions and generation from state-level analysis (based on the portion of the state that's in MISO) to establish a sub-regional/regional emissions target.
- Generators within each sub-region/region will be dispatched to meet this average target.
- This methodology is used to reduce bias that may be produced by averaging historical dispatch to develop rate targets.
- It also allows for modeling combination approaches to compliance, e.g. three states pool together and the rest go alone

Work Plan & Expected Study Outcomes

Step #1 – Resource forecasts are developed and sited

Step #2 - Performed in parallel, for the years 2014, 2020, 2025, 2030

Production cost modeling (PLEXOS)

Results of the production cost analysis will include **indicative compliance costs, and gas and electric infrastructure expansion needs** based on minimizing system congestion, under various CPP compliance scenarios

Reliability Assessment (PSS/E)

Results of steady-state thermal and voltage analyses will be used to **identify indicative electric infrastructure expansion needs** to maintain reliability while ensuring cost-effective CPP compliance via generation retirement

Step #3 - Solicit potential electric and gas infrastructure solutions from stakeholders including associated costs and schedules for evaluation.

Note: Reliability analysis will be performed for select years and scenarios, using the dispatch from PLEXOS.