# MISO's Analysis of the EPA's Clean Power Plan: Initial Results

## Iowa DNR 111(d) Stakeholder Meeting
## January 14, 2016

# The Clean Power Plan is one of several major EPA regulations affecting the electric power industry

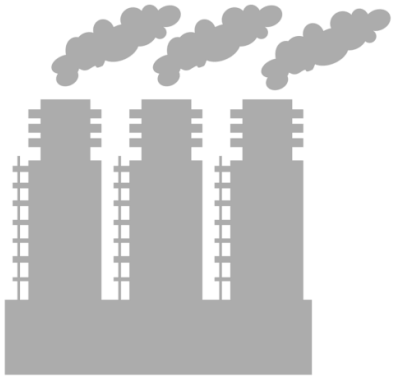
| | MATS | CSAPR & CWIS | Clean Power Plan & New Source $CO_2$ Standards | Ozone |
|---|---|---|---|---|
| Regulation | Mercury and Air Toxics Standards | Cross State Air Pollution Rule & cooling water intake structure rule (316(b)) | $CO_2$ limits for existing & new power plants | National Ambient Air Quality Standard (NAAQS) for ozone |
| Compliance Dates | In effect | Both in effect | Existing: Beginning 2016[1]<br>New: Beginning in 2015 | In effect; EPA finalized a more stringent version in Oct. 2015 |
| Impacts | • Significant coal retirements<br>• Outage coordination challenges<br>• Shrinking reserve margins around MISO<br>• Growing dependence on natural gas | • NOx requirements tightened<br>• Higher compliance costs influence plant retirement decisions | • Significant coal retirements<br>• Greater dependence on gas and $CO_2$-neutral resources<br>• Possible impacts on economic dispatch<br>• New coal builds much more expensive & unlikely | • Existing units could have to install new controls or modify their operations<br>• Possible retirement of coal and/or gas units<br>• Harder to build new coal & gas-fired generation in 'nonattainment' areas |

1 - States must submit "initial" implementation plans by Sept. 6, 2016, and final plans by Sept. 6, 2018.

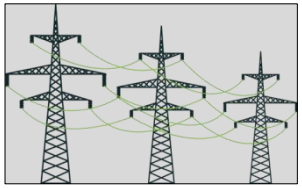
# The CPP will have multiple impacts on the MISO region and the electric utility industry as a whole

## Generation Impacts

- Less coal generation
- More gas generation
- Siting questions: Near existing transmission, or gas pipelines?
- More renewables & energy efficiency



## Infrastructure Impacts



- More transmission and gas pipeline capacity likely needed
- Siting of infrastructure driven by location of new generation & other factors
- Cost-allocation issues

## Reliability Impacts

- Will the rule jeopardize resource adequacy at a local/regional level?
- Will states and utilities have enough time to build & permit new resources?
- Will ancillary services continue to be sufficient?

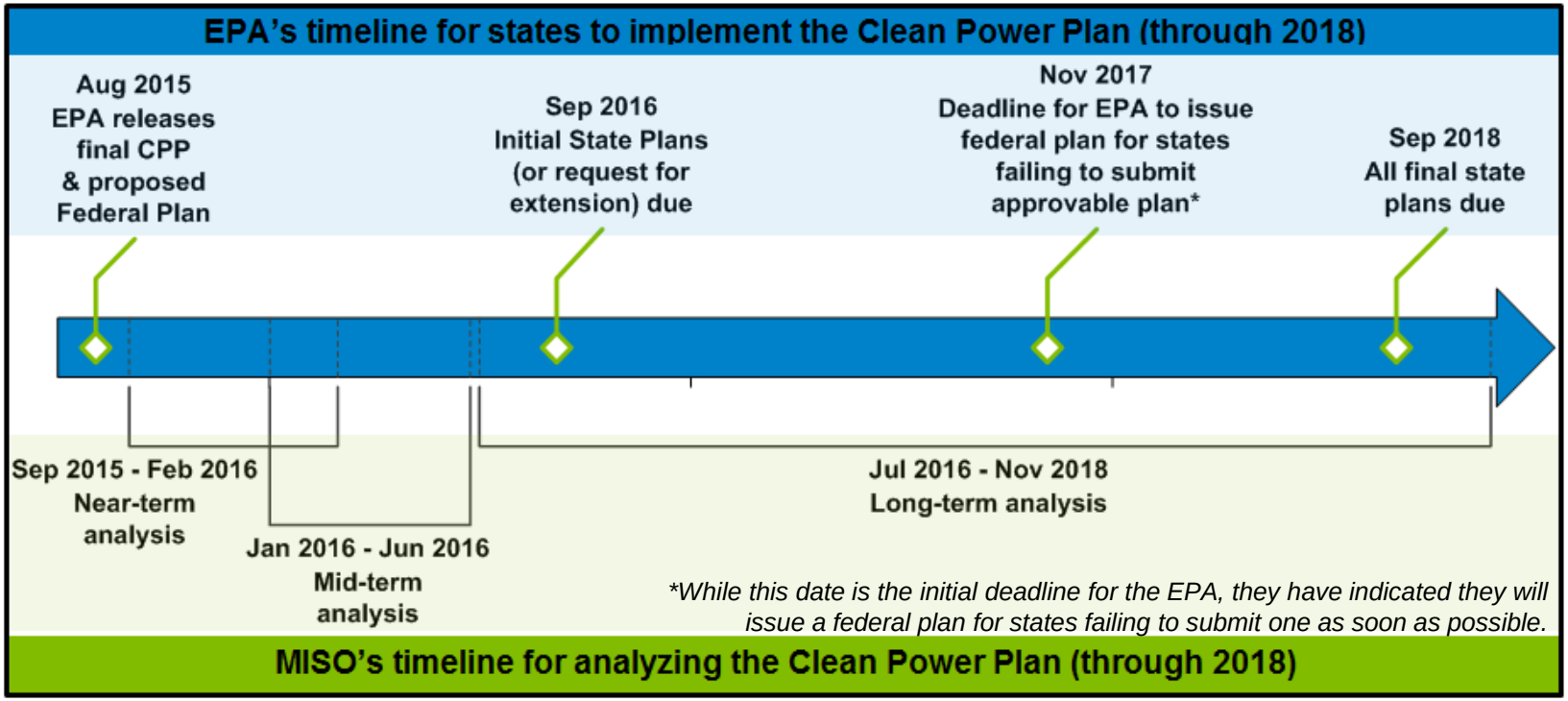
## Economic Dispatch Impacts

- Which compliance approaches would preserve economic dispatch cost savings?
- How can load growth be accommodated in rate and mass-based compliance plans?
- How can compliance costs best be monetized?

# MISO's analysis will report key findings ahead of upcoming state CPP compliance deadlines

**MISO's Goals:**

- Inform policymakers as they formulate compliance strategies
- Enable the reliable, efficient implementation of CPP-related policy decisions made by our member-states and asset-owners



# MISO's CPP analysis will evaluate compliance pathways and inform the transmission planning process

## Near-Term Modeling
**(Understanding compliance pathways)**

- Rate vs. mass comparison
- Rate and mass interactions
- State vs. regional compliance
- Trading options
- Federal plan
- Range of compliance sensitivities
- Relative compliance costs

Using Existing PLEXOS and EGEAS models*

**Existing draft rule models will be updated with final rule parameters.*

## Mid-Term Modeling
**(Preparing for transmission overlay development)**

- Potential generation retirements
- Optimal resource expansion
- Wind/solar zones
- Renewables penetration/mix
- Renewables siting
- Thermal siting with new ozone rule

Using new EGEAS models* and external research

**Evaluated using three proposed CPP futures.*

## Long-Term Modeling
**(Developing transmission overlay)**

- Will be informed by state compliance plans
- Will use futures formulated through MTEP17 process
- Updates to assumptions as needed over MTEP18 and '19 cycles

Using new EGEAS, PLEXOS and PROMOD models

***MISO's CPP Final Rule Study***

# MISO is using EGEAS, a resource forecasting model, to examine potential impacts of the CPP

### OPTIMIZATION CONSTRAINTS

- Planning Reserve Margin
- $CO_2$ emission constraint (mass-based)
- Resource availability

### INPUT DATA ASSUMPTIONS

- Demand and energy forecast
- Fuel forecasts
- Retirements
- $CO_2$ costs
- RPS requirements

### EXISTING RESOURCES DATA

- Unit capacity
- Heat rate
- Outage rate
- Emissions rate
- Fuel and O&M costs

## EGEAS

### NEW RESOURCES DATA

- Capital cost
- Construction cash flow
- Fixed charge data
- Years of availability

### OPTIMIZED RESOURCE PLAN

- 20-year resource expansion forecast
- Amount, type and timing of new resources
- Total system Net Present Value (NPV) of costs
- Annual production costs for system
- Annual fixed charges for new units
- Annual tonnage for each emissions type
- Annual energy generated by fuel type
- Annual system capacity reserves and generation system reliability

EGEAS stands for Electric Generation Expansion Analysis System

Total System Costs = Sum of Production Cost + Fixed O&M Cost + Capital Carrying Costs

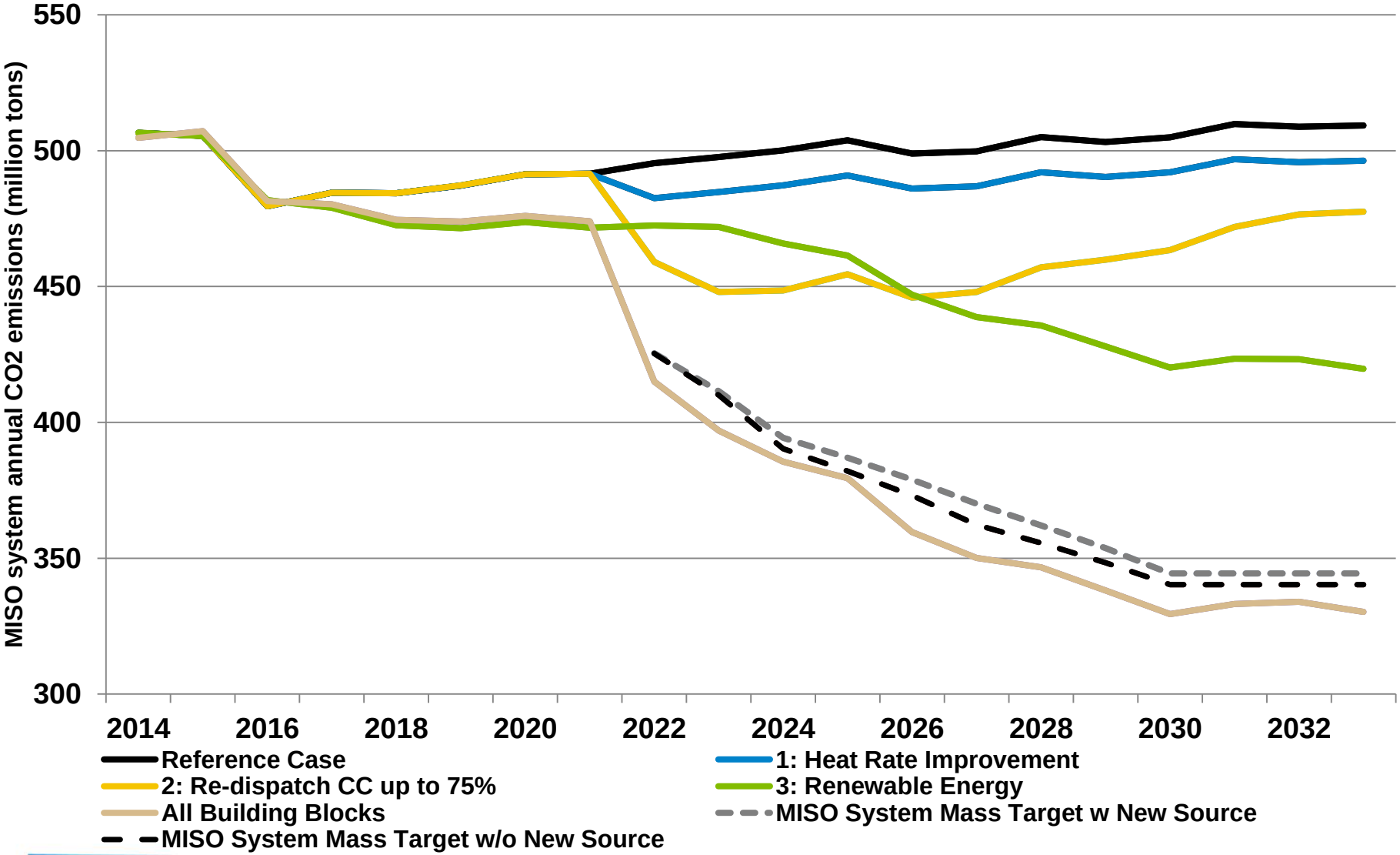
# A range of sensitivities was modeled using EGEAS to provide insight into various compliance strategies

| Modeling Parameter | Sensitivities Modeled |
|---|---|
| **Demand and energy growth rates** | 0.8% (reference) |
| **Natural gas prices*** ($/MMBtu) | 4.30 (reference), +/- 2.00 |
| **Renewable Portfolio Standards** | Existing RPS mandates (reference, ~14%), 20% Regional RPS, 30% Regional RPS |
| **$CO_2$ costs** ($/ton $CO_2$) | 0 (reference), 10, 25, 50, 100 |
| **Incremental coal retirements**** (% of nameplate capacity) | No additional retirements (reference), 12.5% (7 GW), 25% (14 GW), 37.5% (21 GW), 50% (28 GW) |
| **Energy efficiency** (as a % of total energy sales) | Base (reference, EE mandates and goals), economic EE potential in BAU, economic EE potential in CPP |

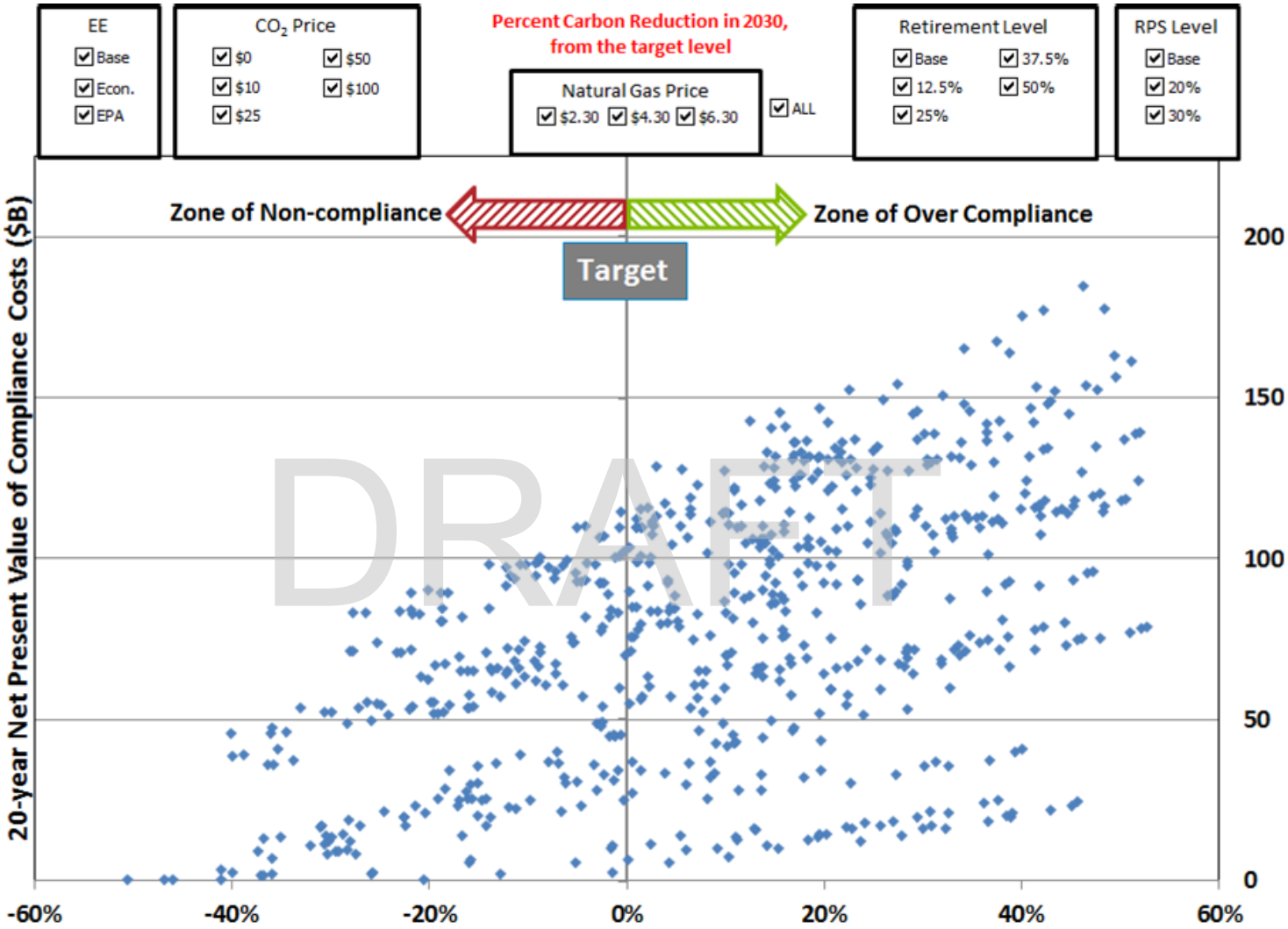
*Every combination of the above sensitivities was modeled, totaling **675** simulations.*

** Will be updated with current forecasts in mid-term modeling*
***Beyond 12.6 GW of assumed MATS retirements*

# MISO also validated its CPP EGEAS model by confirming the $CO_2$ reduction potential of EPA's building blocks

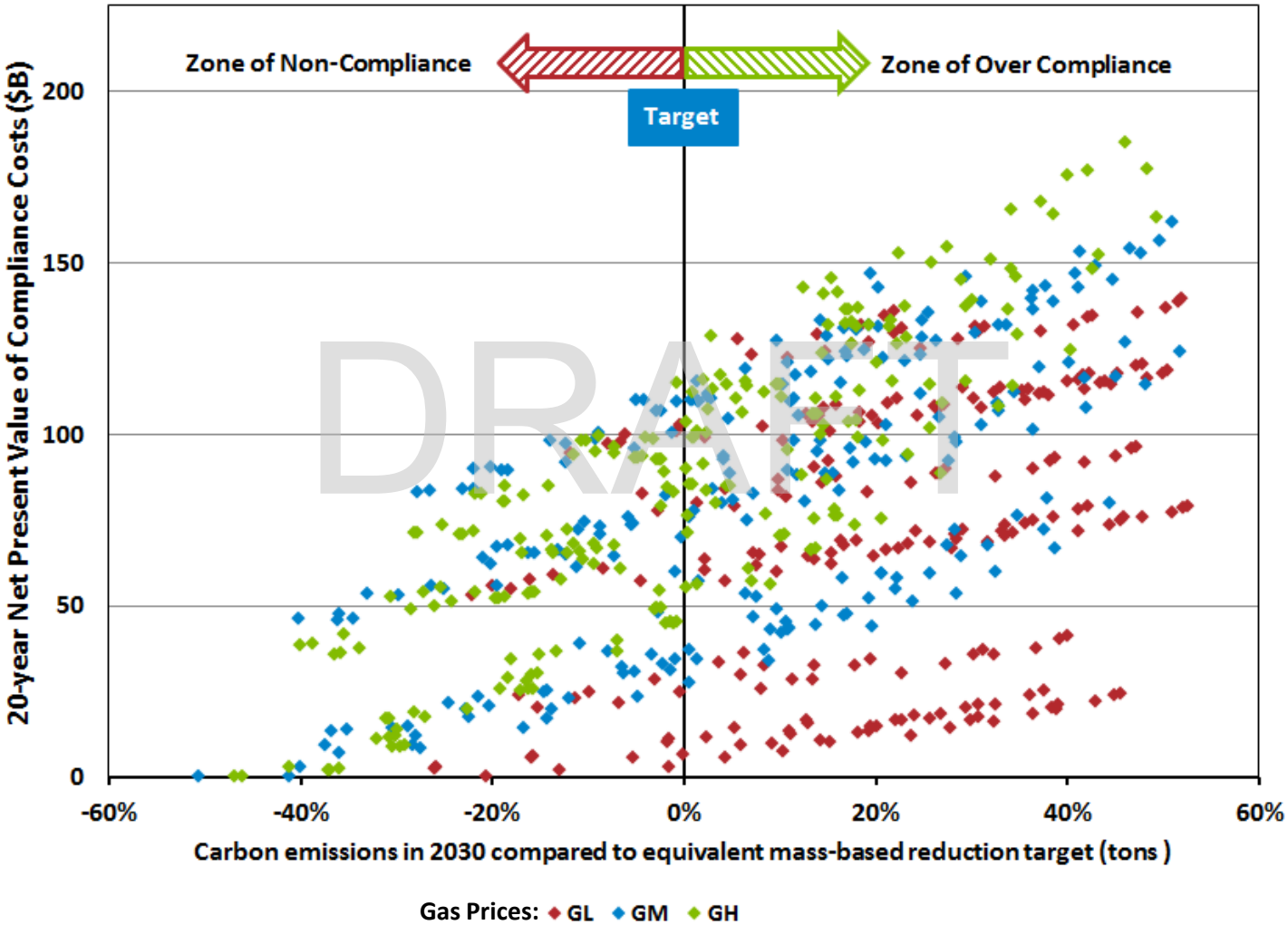


# Results indicate flexibility in compliance strategies allows for lower compliance costs*




*Compliance costs are the difference between production and supply/demand side resource costs from reference case costs. This does not include electric and gas infrastructure costs. $CO_2$ costs are used solely as dispatch modifiers and are not included here.*

# Costs of compliance strategies are greatly influenced by natural gas prices

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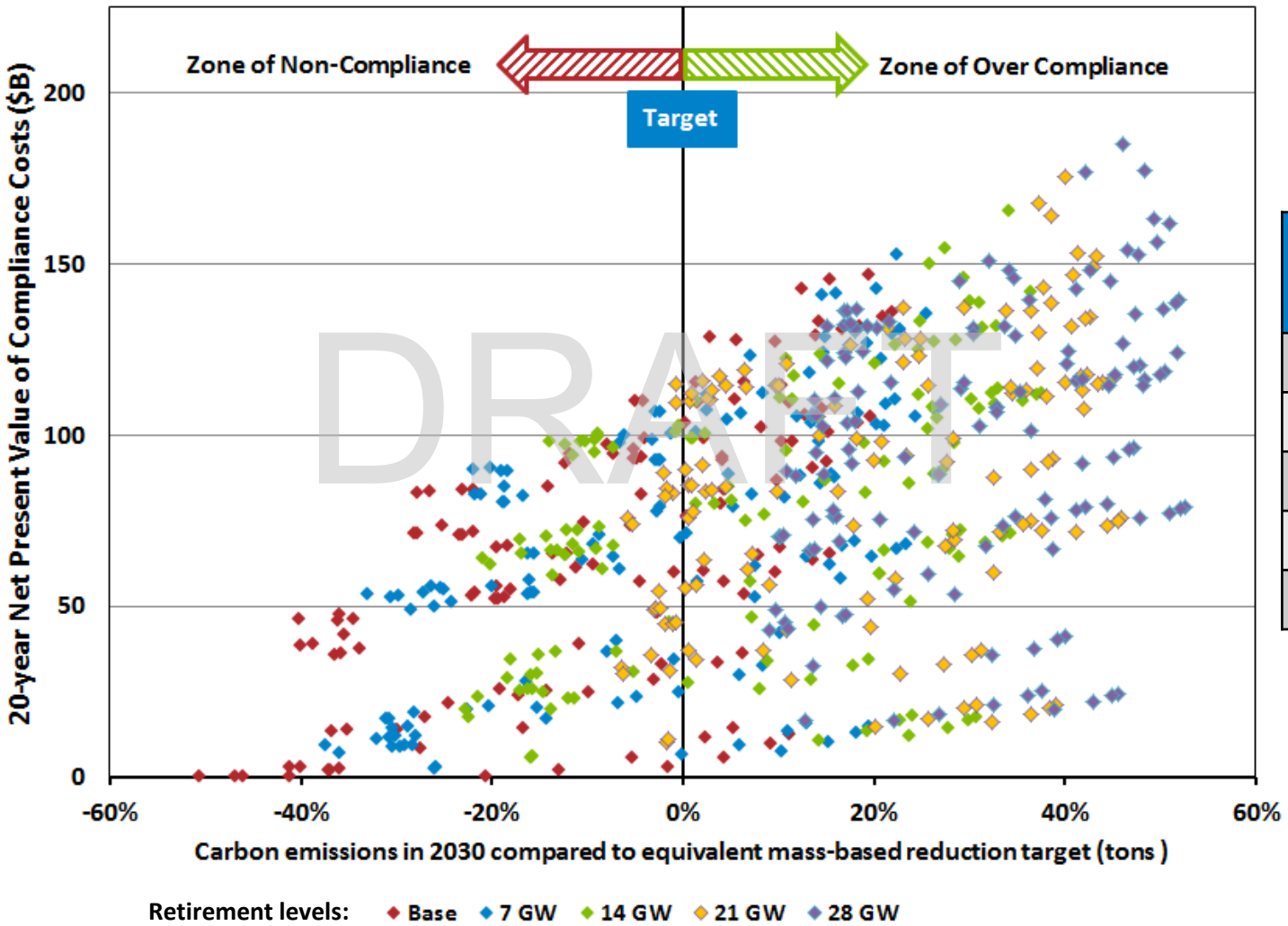
# Coal capacity retirements may be likely, but depend significantly on other variables




| Average compliance cost per retirement level ($B) | |
|---|---|
| Base | 90.74 |
| 7 GW | 87.29 |
| 14 GW | 87.62 |
| 21 GW | 92.20 |
| 28 GW | 97.40 |

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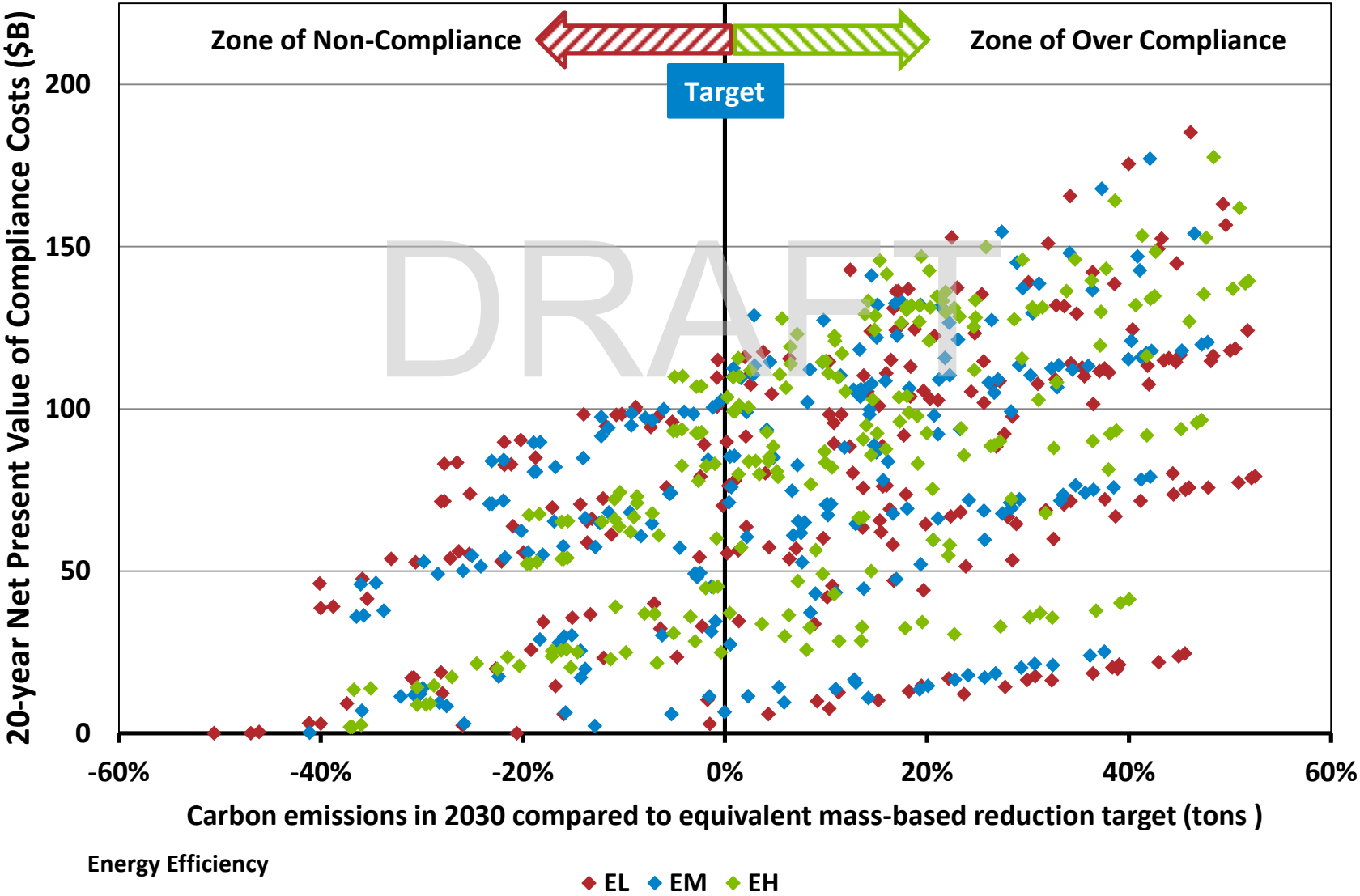
# Color-coded by level of energy efficiency modeled

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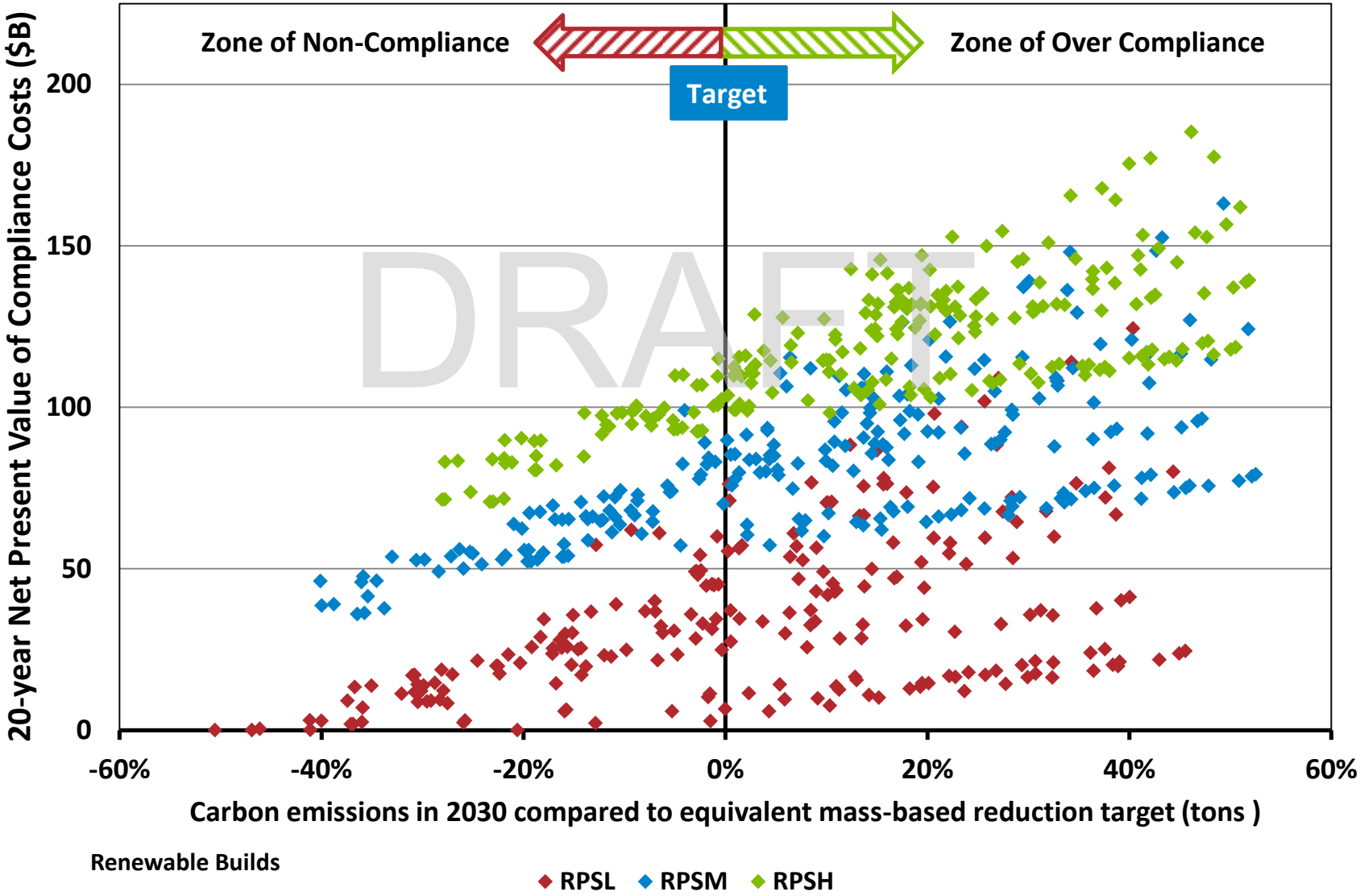
# Color-coded by level of Renewable Portfolio Standard

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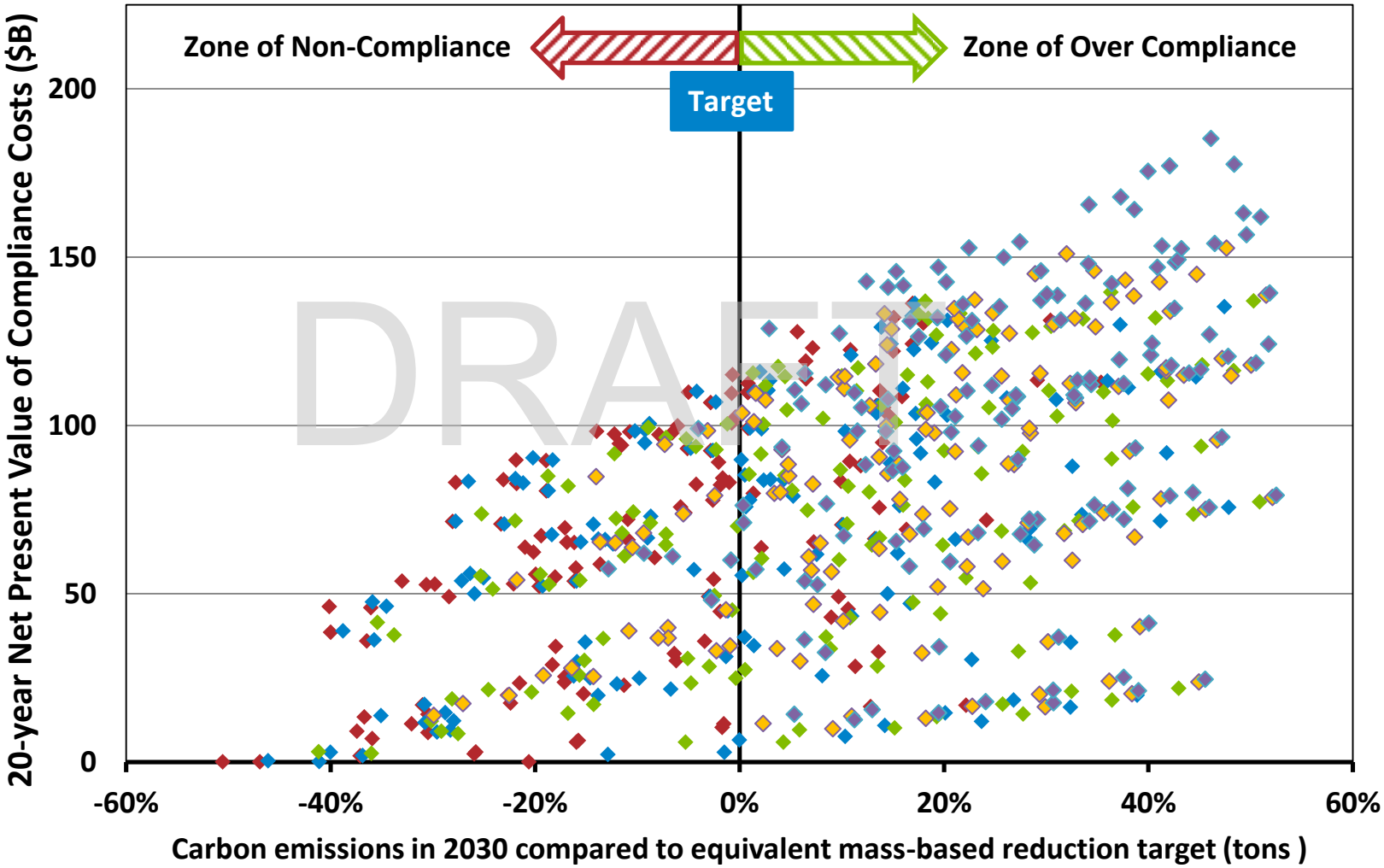
# Color-coded by $CO_2$ price




**Carbon Prices**

C0 C10 C25 C50 C100

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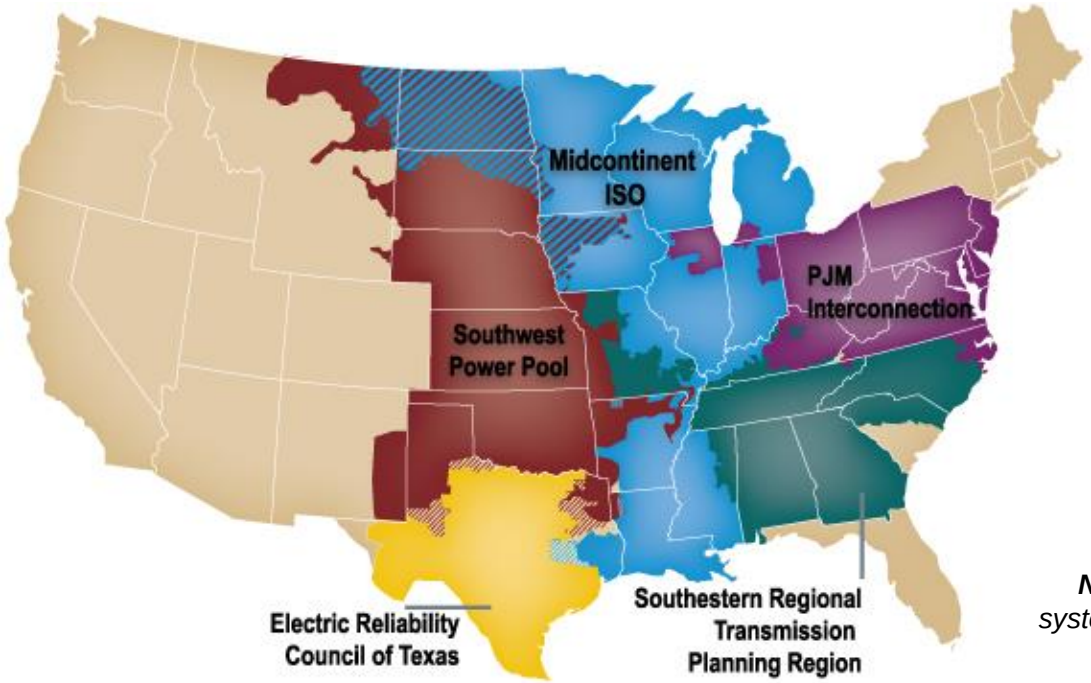
# MISO is talking with neighboring system operators about our collective efforts to analyze the Clean Power Plan




***Note:*** *Areas with interspersed system boundaries are illustrated with a crosshatch pattern.*

**These talks reflect the following realities about the grid system and the CPP**

- Due to the interconnected nature of the grid system, conditions that affect the MISO-controlled portion of the grid may also impact neighboring system operators.
- The impacts of the CPP will be national in scope, reaching beyond MISO's borders and the borders of any other single system operator.

# Thank you!

- MISO's Planning Advisory Committee is the forum for learning more about MISO's CPP study and for participating in study discussions.
  - https://www.misoenergy.org/STAKEHOLDERCENTER/COMMITTEESWORKGROUPSTASKFORCES/PAC/Pages/home.aspx

- **EPA regulations webpage**

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

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# APPENDIX

# PLEXOS is also used in MISO's near-term CPP analysis, to investigate dispatch impacts under various CPP scenarios

| PLEXOS Inputs | Details |
|---|---|
| Generator characteristics | capacity, heat rate, max ramp capability, O&M cost, capital cost |
| Electric transmission topology (powerflow) | min/max/overload ratings, resistance, reactance |
| Load profiles, demand and energy (D&E) | 8760 load profile per company<br>D&E varies by scenario |
| Renewable energy profiles | 8760 load profile per site (site could be grouping of turbines at given development) |
| Electric system contingencies | Bus name and number, min/max rating, winter/summer ratings, overflow penalty |

*The PLEXOS production cost model allows for simulation of hourly chronological dispatch of resources across a user-defined footprint, accounting for physical and financial resource characteristics, as well as transmission congestion.*

# Breakdown of PLEXOS data outputs

| PLEXOS Outputs | What can we learn from this data? |
|---|---|
| Generator dispatch, outages, emissions, etc. | How market operations, such as which units runs, fuel type usage, generator cycling, etc., may change over time under various scenarios |
| Transmission flows, binding hours, shadow price | How transmission flows change; indicates future transmission expansion needs based on system congestion |
| Locational Marginal Prices (LMP) | How LMP prices may change under various scenarios; indicates areas of congestions |
| Cost to load, cost of production, total system costs | The economic impacts of various scenarios, e.g. What would be the cost to implement the Clean Power Plan? |

# Near-term CPP analysis uses existing models to allow for quick delivery of results

## Steps for near-term analysis:

1. Evaluate implementation of EPA's three building blocks
2. Perform sensitivity analysis to show the relative costs and effectiveness of different compliance strategies
3. Assess resource implications of CPP compliance implementations
4. Examine market dispatch and transmission utilization using draft rule scenarios under the following compliance pathways:

| | | |
|---|---|---|
| **Rate compliance** | **Mass compliance** | **Mixed rate- and mass-compliance** |
| **Leakage mitigated via new source complement** | | **Leakage mitigated through set-asides** |
| **Trading platforms** | | **No trading platforms** |

# Mid-term CPP analysis examines potential resource additions and retirements under three futures

- **Modeling assumptions will be based on the results of near-term analysis**
- **Exact compliance pathways will be determined in consultation with stakeholders**
- **Analysis will incorporate updates to renewable generation mix, profiles, penetration, and siting, based on results of Vibrant Clean Energy (VCE) study***
- **Analysis will also examine potential resource retirements**
  - Actual retirements driven by the EPA's Mercury and Air Toxics Standard (MATS) rule are now mostly known and are included in the base dataset.
  - A detailed analysis will be conducted for each future to determine the magnitude of potential resource retirements.

MISO has commissioned Vibrant Clean Energy (VCE) to perform a study on co-optimizing renewables, natural gas and transmission, to be completed by the end of 2015.

# Mid-term CPP analysis will also update renewable energy zones and DR/EE/DG assumptions

- **Renewable energy zones**
  - Based on results of the VCE study, MISO will produce initial renewable energy zones.
  - These zones will be further developed in collaboration with stakeholders.
- **Magnitude and distribution of demand response (DR) / energy efficiency (EE) / distributed generation (DG)**
  - Input assumptions will be based on the on-going MISO-commissioned Applied Energy Group (AEG) study.
  - AEG study results will be included along with other planning alternatives in the economic resource forecast.