Implications of EPA's Clean Power Plan under Clean Air Act Section 111(d)

PRESENTED TO

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THE Brattle GROUP

Contents

What are the Key Rule Provisions?

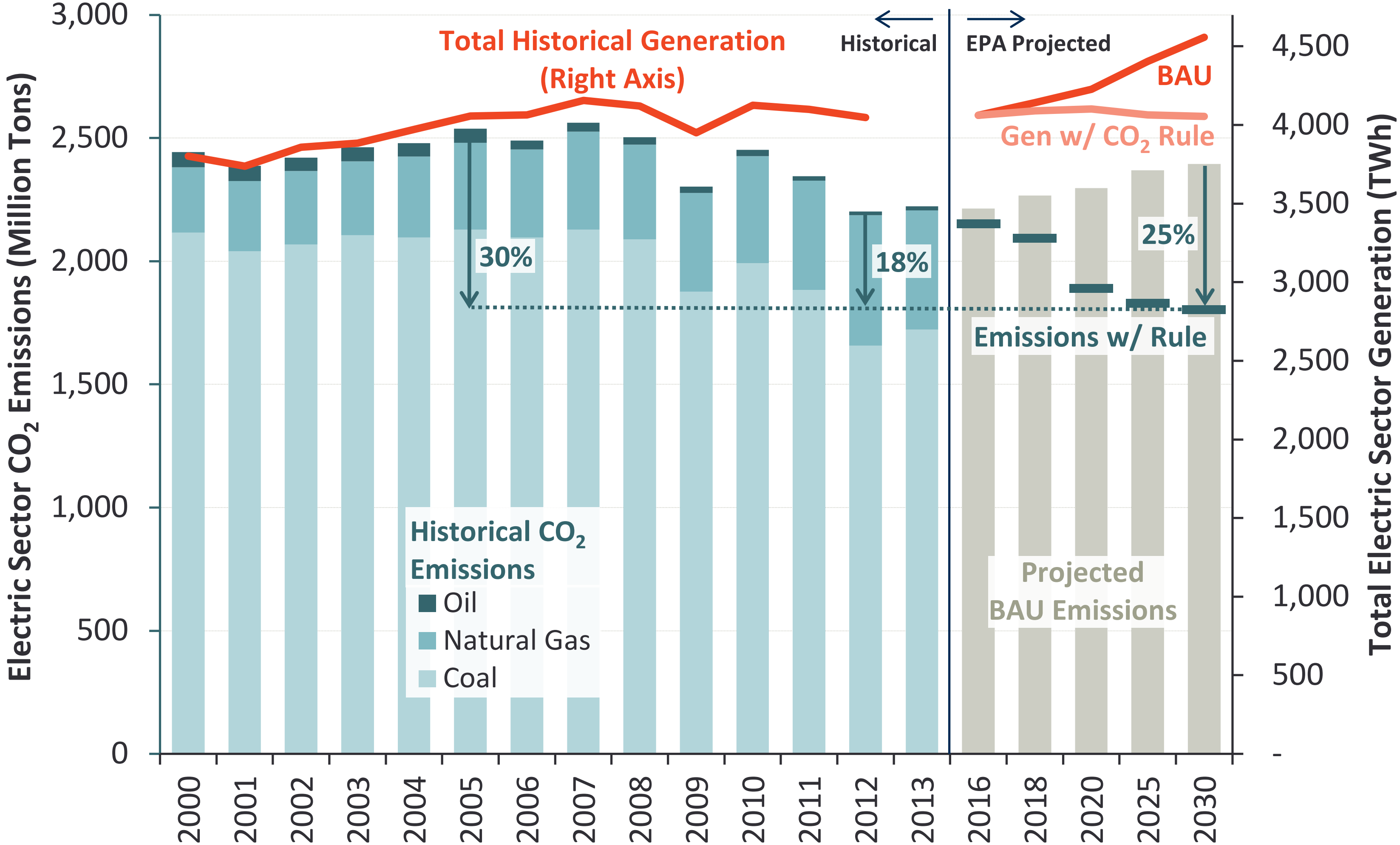
On June 2, the EPA under Section 111(d) set CO_2 emissions standards on existing fossil electric generation units (EGUs)

- EPA reviewed existing emissions reductions methods to establish the Best System of Emissions Reduction (BSER)
- BSER is applied to each state's current fossil EGU emissions rate to set state-specific fossil emissions rate standards for 2020 – 2030
- Option 1: interim goal for 2020 – 2029 (to meet on average) and a final goal for 2030 and beyond; EPA is also considering Option 2: less stringent but sets earlier goals over 2020 – 2024 with final goal for 2025 and beyond
- States given flexibility in how to meet the standards

Timeline for Compliance	
2014	Proposed Rule – Comment period ends December 1, 2014 (just extended)
2015	Final Rule
2016	Initial report on State Implementation Plans (SIPs)
2017	Final SIPs (for single-state plans)
2018	Final SIPs (for multi-state plans)
2020-30	Compliance period

Projected Effect of Standards on CO_2 Emissions

The proposed standards are designed to bring emissions to 30% below 2005 levels.



Sources: CO_2 from EPA CEMS, EIA total generation, and projections from EPA IPM results under Option 1 No Cooperation.

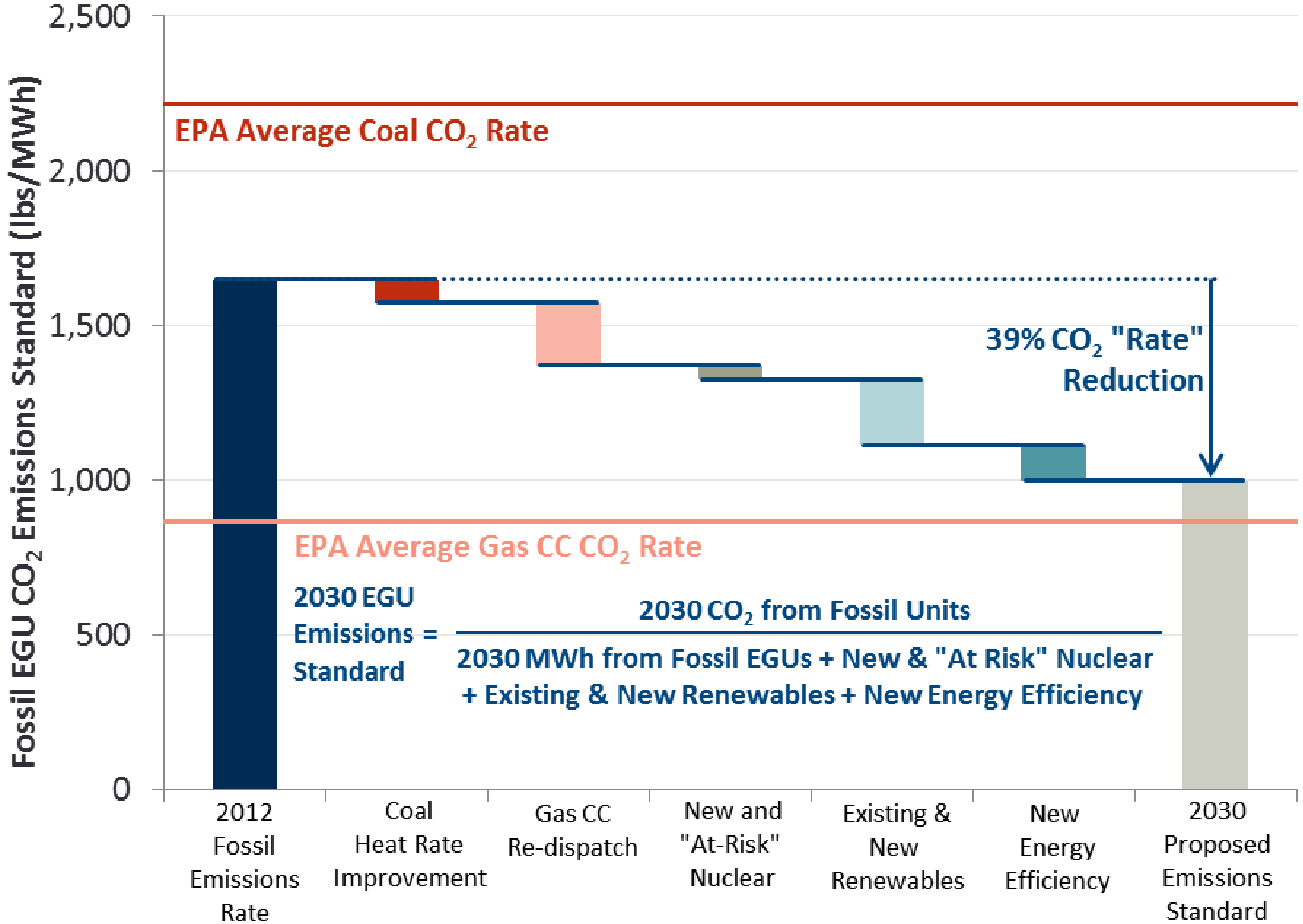
EPA's Best System of Emissions Reductions (BSER)

BSER includes four methods of emissions reduction, assessed for feasibility in each state.

BSER Building Block	EPA Basis for BSER Determination	EPA Estimated Average Cost	% of BSER CO_2 Reductions
1. Increase efficiency of fossil fuel power plants	EPA reviewed the opportunity for coal-fired plants to improve their heat rates through best practices and equipment upgrades, identified a possible range of 4–12%, and chose 6% as a reasonable estimate. BSER assumes all coal plants increase their efficiency by 6%.	$6–12/ton	12%
2. Switch to lower-emitting power plants	EPA determined for re-dispatching gas for coal that the average availability of gas CCs exceeds 85% and that a substantial number of CC units have operated above 70% for extended periods of time, modeled re-dispatch of gas CCs at 65–75%, and determined 70% to be technically feasible. BSER assumes all gas CCs operate up to 70% capacity factor and displace higher-emitting generation (*e.g.* , coal and gas steam units).	$30/ton	31%
3. Build more low/zero carbon generation	EPA identified 5 nuclear units currently under construction and estimated that 5.8% of all existing nuclear capacity is "at-risk" based on EIA analysis. BSER assumes the new units and retaining 5.8% of at-risk nuclear capacity will reduce CO_2 emissions by operating at 90% capacity factor.	Under Construction: $0/ton "At-Risk": $12–17/ton	7%
	EPA developed targets for existing and new renewable penetration in 6 regions based on its review of current RPS mandates, and calculated regional growth factors to achieve the target in 2030. BSER assumes that 2012 renewable generation grows in each state by its regional factor through 2030 (up to a maximum renewable target) to estimate future renewable generation.	$10–40/ton	33%
4. Use electricity more efficiently	EPA estimated EE deployment in the 12 leading states achieves annual incremental electricity savings of at least 1.5% each year. BSER assumes that all states increase their current annual savings rate by 0.2% starting in 2017 until reaching a maximum rate of 1.5%, which continues through 2030.	$16–24/ton	18%

CO_2 Rate Standards on Existing Fossil Units

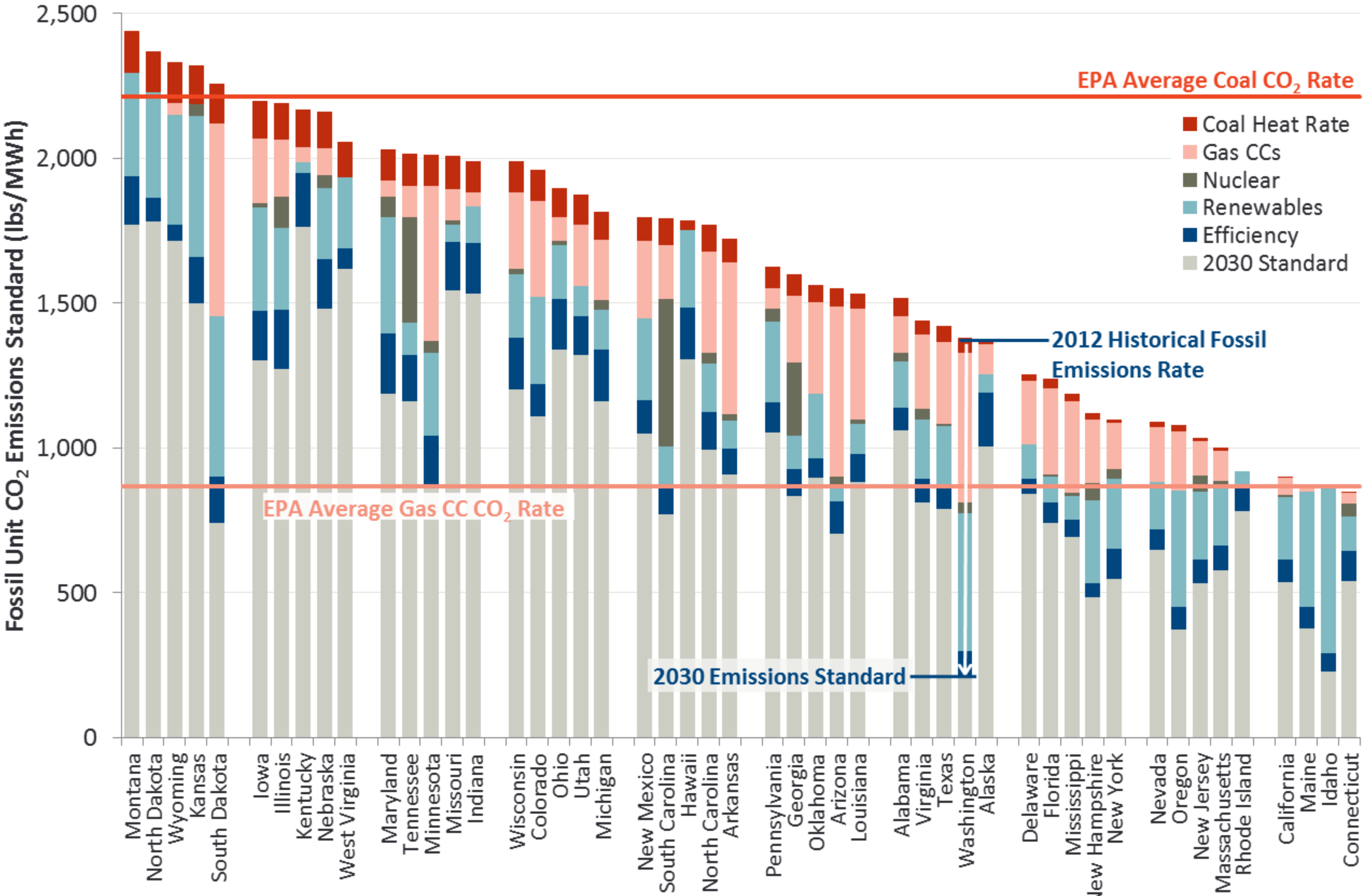
The EPA standards are not intuitive emission rates. Some BSER blocks reduce the numerator (CO_2 emissions) and others increase the denominator (qualified MWh).



Source: Derived from EPA 111(d) technical support document: rate calculation for Option 1.

Rule Provisions

Fossil Unit Emission Rate Standards by State



Source: Derived from EPA 111(d) technical support document: rate calculation for Option 1.

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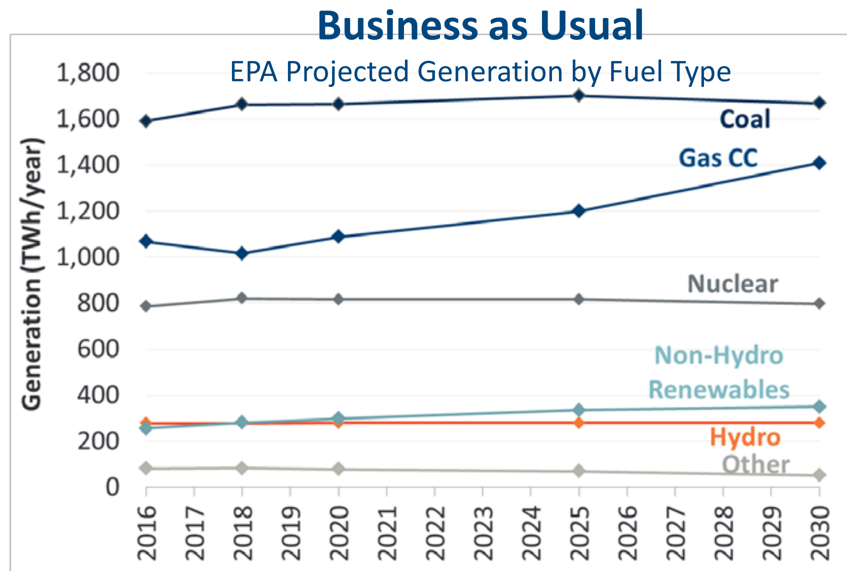
EPA's Projected Impacts

2030 Fleet Capacity and Generation Mix

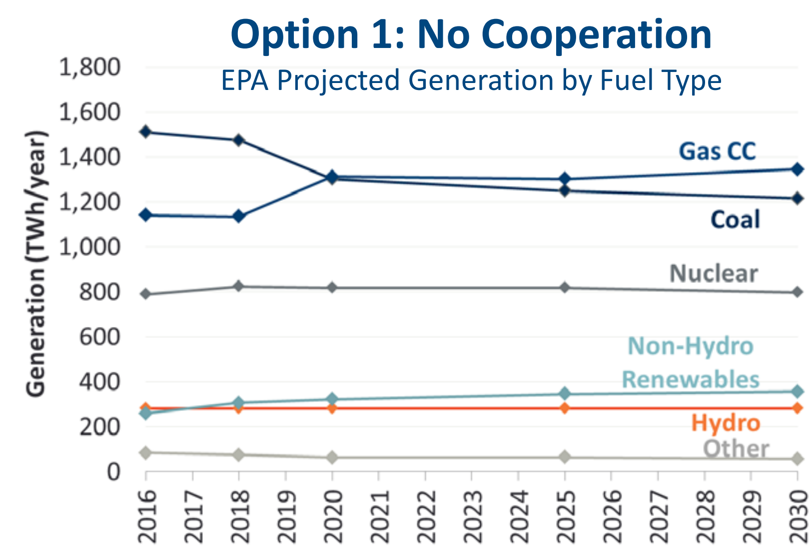
- Even though non-hydro renewables are 33% of the BSER blocks, IPM projections add only 2% more non-hydro renewables by 2030 vs. BAU
- Assumed energy efficiency and coal-to-gas re-dispatch dominate



EPA Projected Generation (TWh) by 2030

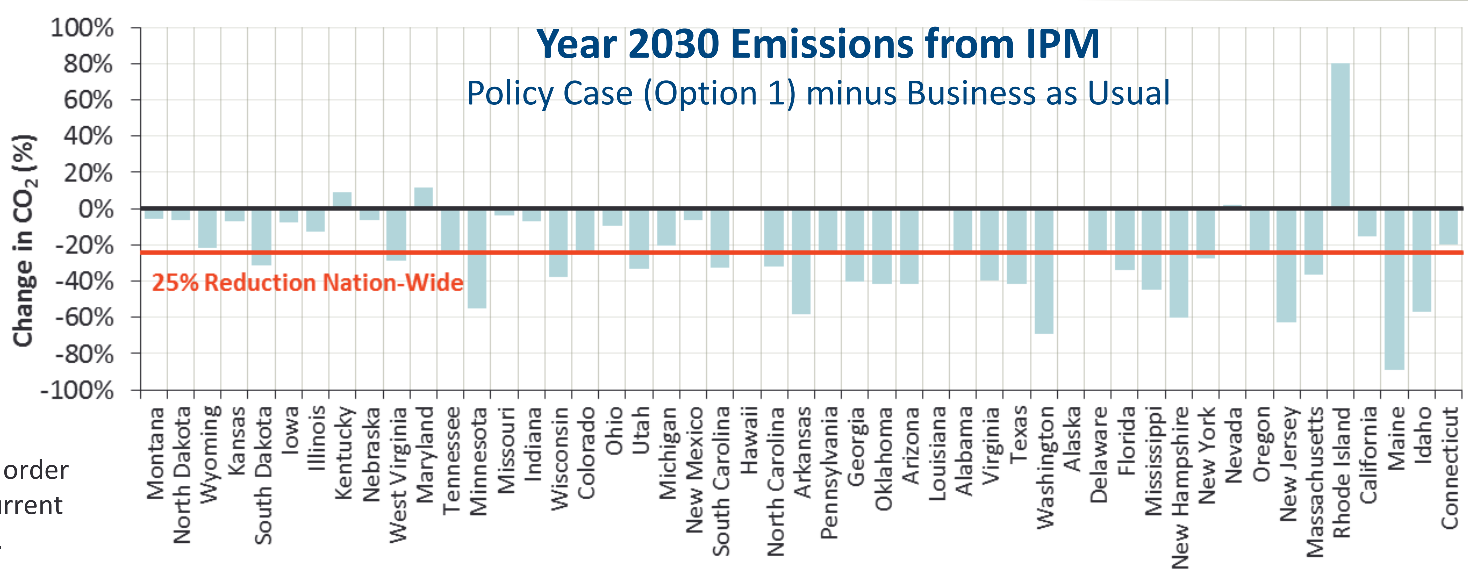
Generation	BAU (TWh)	Option 1: No Cooperation (TWh)	Change (TWh)
Coal	1,668	1,216	(452)
Gas CC	1,409	1,345	(64)
Hydro	280	280	0
Non-Hydro RE	350	356	6
Nuclear	797	797	0
Others	52	57	5
Total	**4,557**	**4,051**	**(506)**

Source: EPA IPM

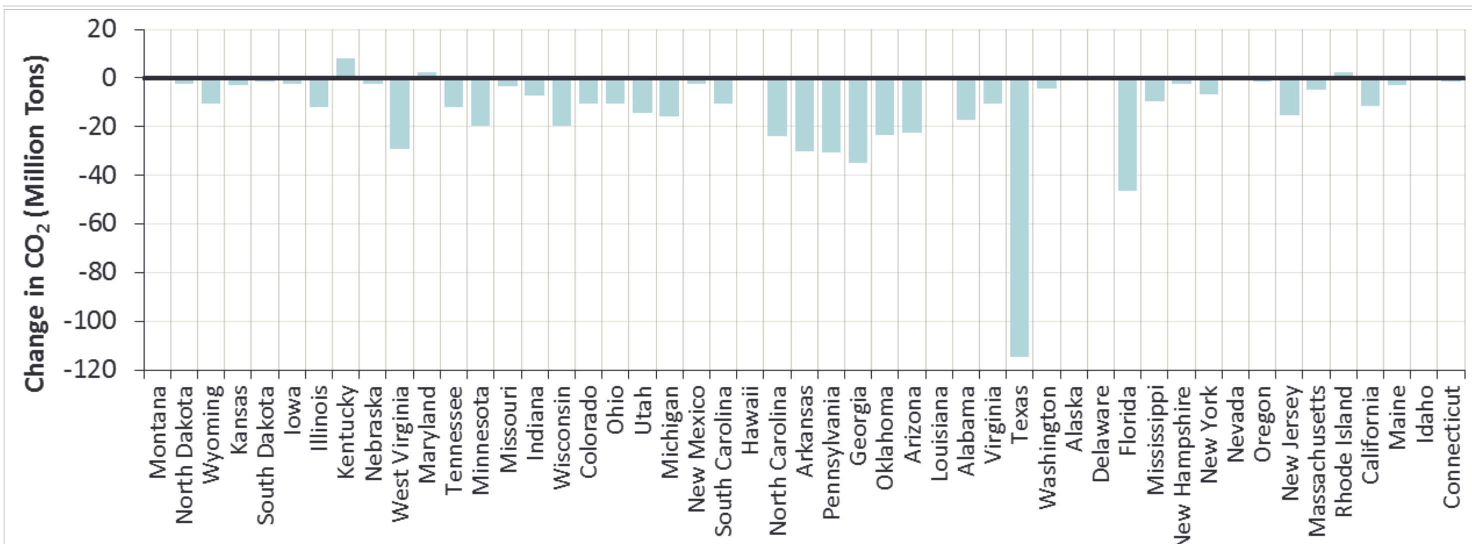


EPA's Projected Impacts

Projected 2030 Emissions Reductions

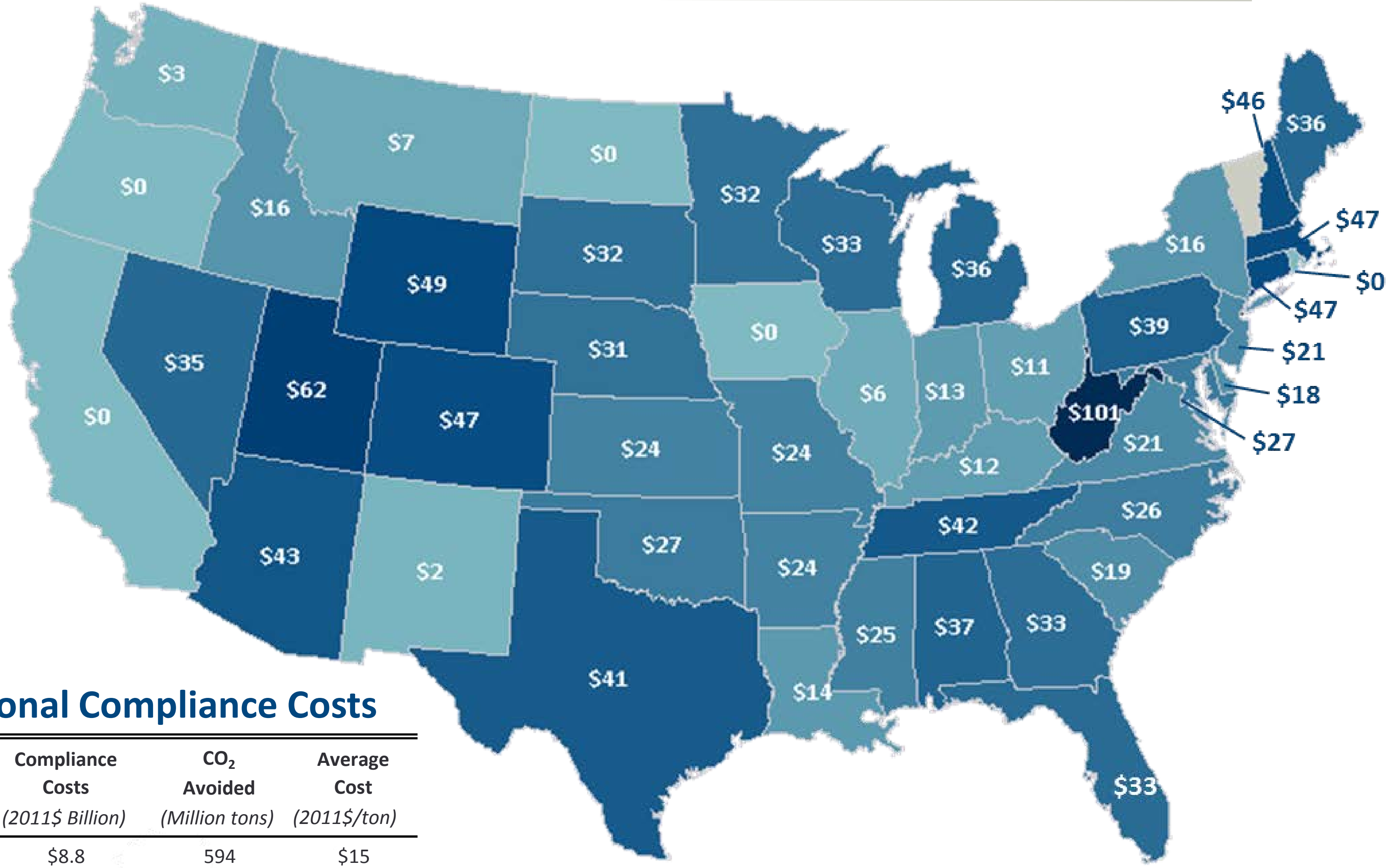


States listed in order of declining current emission rates.



Source: EPA IPM

EPA Indicative CO_2 Prices (No Cooperation)



Annual National Compliance Costs

Scenario	Compliance Costs *(2011$ Billion)*	CO_2 Avoided *(Million tons)*	Average Cost *(2011$/ton)*
Non-Cooperation	$8.8	594	$15
Regional Cooperation	$7.3	575	$13

Sources and Notes:

EPA IPM Option 1, No Cooperation scenario. Map shows "shadow prices" on emissions rate constraint, expressed in $/ton of CO_2. Table reports total compliance costs.

Market-Based Trading Approaches

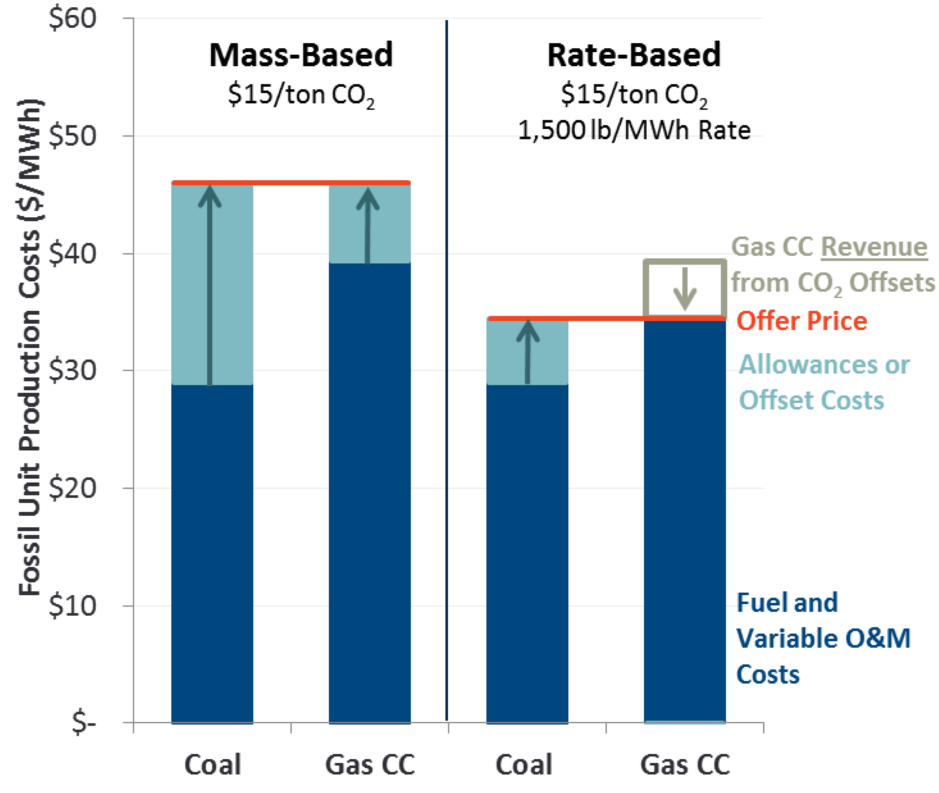
	CO_2 Allowances (Mass-Based)	CO_2 Offsets (Rate-Based)	Zero-CO_2 MWh (Rate-Based)
Definition of Trading Product	• 1 ton of CO_2	• 1 ton of CO_2	• 1 MWh of generation from a zero-CO_2 resource (like a Renewable Energy Credit)
How Does a Fossil Plant Comply?	• Purchase 1 allowance for every ton of CO_2 emitted	• Purchase enough offsets to meet rate formula: $\frac{\text{CO}_2\text{ Emitted} - \textbf{CO}_2\textbf{ Offsets}}{\text{MWh Generated}}$	• Purchase enough allowances to meet rate formula: $\frac{\text{CO}_2\text{ Emitted}}{\text{MWh Gen} + \textbf{MWh Credits}}$
How are Credits Allocated or Created?	• Fixed quantity is pre-set • Auctioned to highest bidder or allocated to specific entities	• Gas units create credits when running if they are under the state rate standard (coal units consume credits)	• 1 REC is created whenever a qualified zero-emitting resource produces power
Similar Existing Programs	• RGGI, California AB32, Europe, Quebec	• Alberta (somewhat similar)	• REC programs under existing state RPS

Big Difference in Mass- and Rate-Based Trading

Wholesale prices would be higher under mass-based CO_2 trading:

- **Mass-based**:
  - Fossil generators must pay for every ton of carbon produced, increasing dispatch costs and wholesale prices
  - They or consumers could be compensated through allowance auction revenues
- **Rate-based**:
  - Fossil units only have to pay for enough CO_2 to reduce their emissions rate to the standard
  - In many states, the rate exceeds that of gas CCs, so they will earn revenue from creating offsets when they run (reducing energy their offer price!)

Coal and Gas Dispatch Price



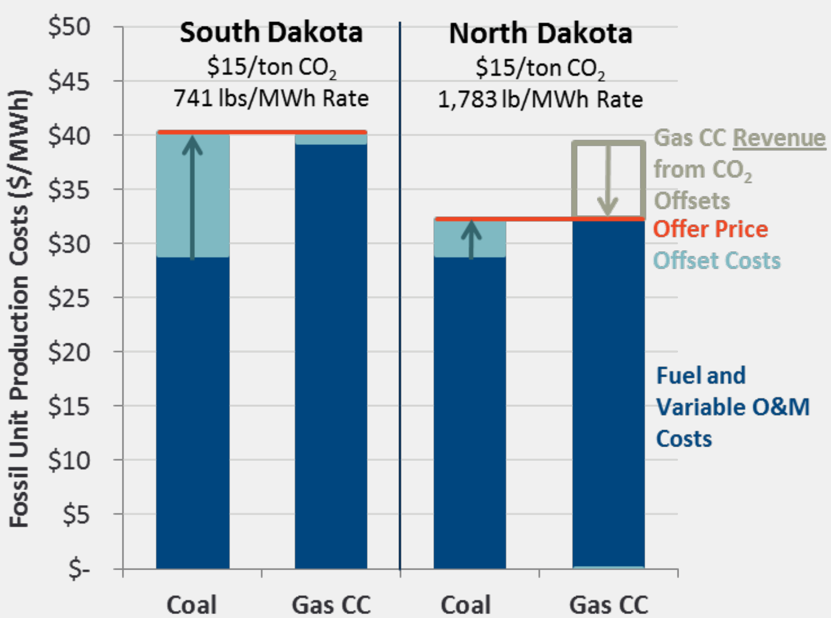
Sources and Notes:
Illustrative calculation assumes that coal-to gas switching is the marginal CO_2 abatement opportunity, resulting in equal coal and gas dispatch prices.

Inefficiencies Under Rate-Based Trading

Rate-based approaches will create substantial dispatch inefficiencies between states and some resource types. Two examples:

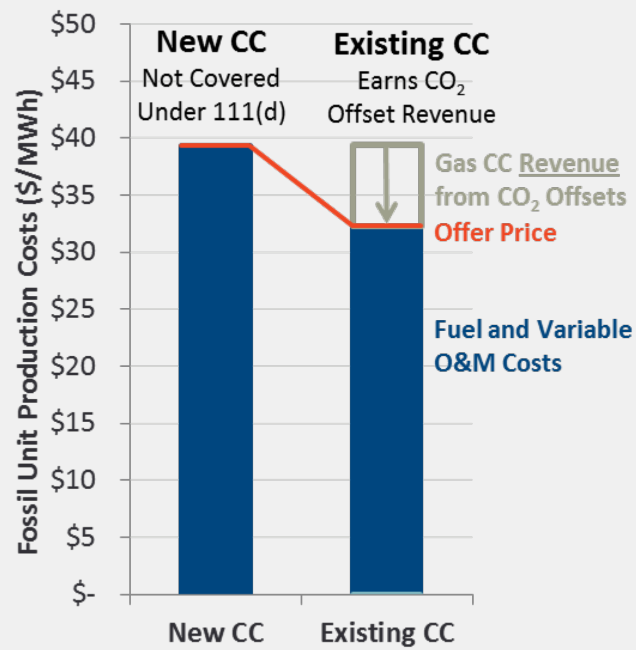
Different Dispatch Prices for Identical Plants in Neighboring States

Production shifts into the state with a more lax standard



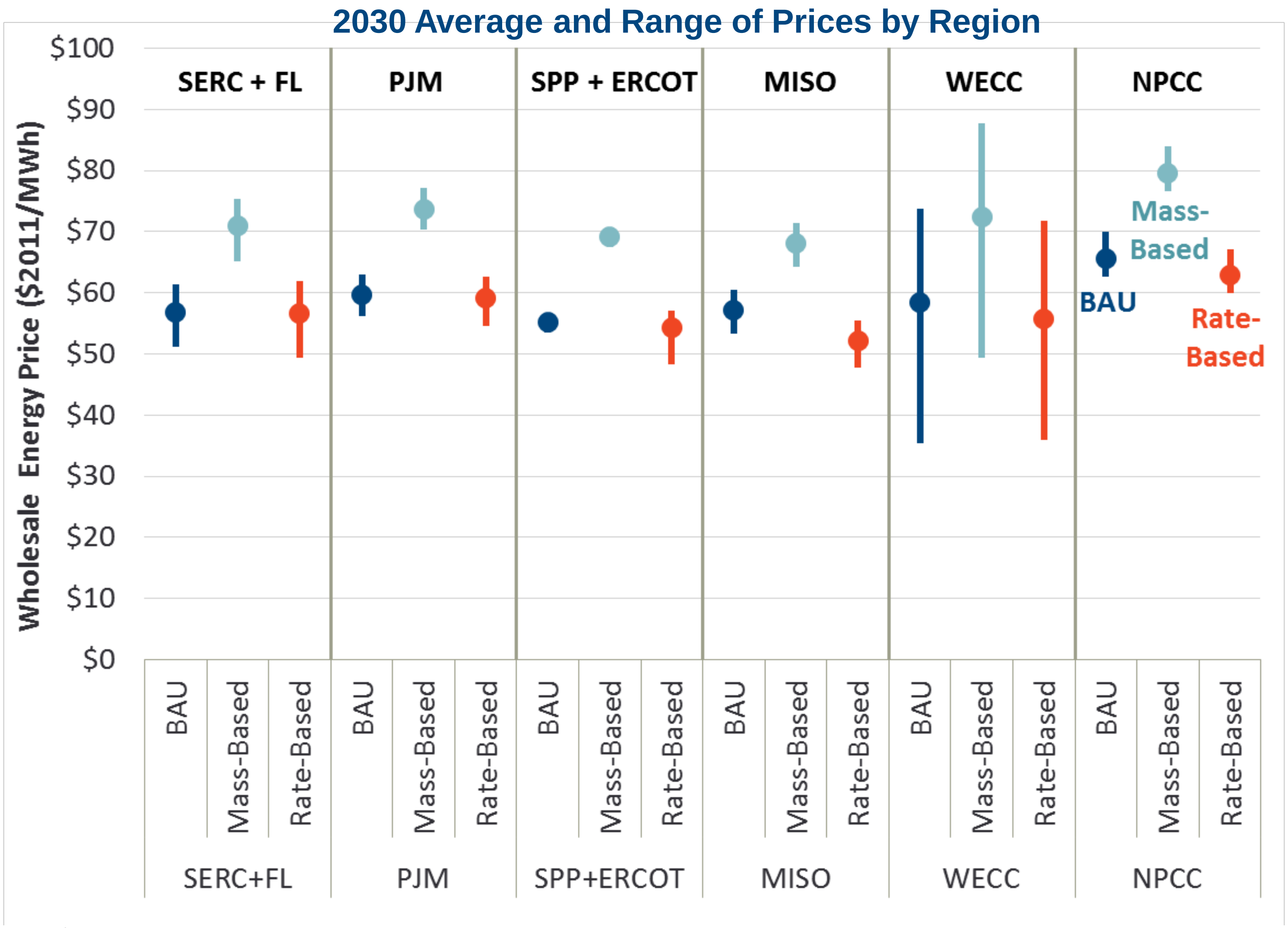
Identical "New" and "Existing" Gas CCs

Existing CCs at advantage compared to new.



State Compliance: Rate vs. Mass

Potential 2030 Energy Price Impacts



Sources and Notes:

BAU and Rate-based prices are from EPA IPM results for year 2030 under Option 1: Regional cooperation, showing simple average and range of prices by region. Mass-based prices are approximate, starting with the BAU price and adding regional CO_2 price assuming a gas CC is the marginal energy resource.

Takeaways

- **EPA's Proposed Rule**
  - Will achieve substantial emissions reductions within the confines of EPA's authority
  - Standards vary widely across states based on numerous assumptions about sources of potential target reductions, which many states are questioning (e.g. Texas)
  - Individual state standards don't directly indicate relative compliance burdens
  - The rule treats resources with similar emissions asymmetrically
- **Key Compliance Questions for States** (other than disputing their standards)
  - Whether and how to cooperate with other states to reduce compliance costs
  - Whether to convert to mass-based compliance or at least *mass-based trading*, which efficiently puts all carbon abatement options on a level playing field. Higher wholesale prices are not worse for consumers if they own allowance auction revenues.
  - If not converting to mass-based, find other ways to remedy inefficiencies caused by the rate's exclusion of new CCs, most nuclear, and hydro
- **Implications for Asset Values**
  - Nuclear: value highly depends on the rate-based vs. mass-based trading
  - Coal: loses substantial value
  - Gas: a slight winner, esp. with rate-based trading that inefficiently excludes new

Presenter Information

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Dr. Kathleen Spees is a senior associate at The Brattle Group with expertise wholesale electric energy, capacity, and ancillary service market design and analysis. Dr. Spees has worked with system operators in the U.S. and internationally to improve their market designs with respect to capacity markets, scarcity and surplus event pricing, ancillary services, wind integration, and energy and capacity market seams.

For other clients, Dr. Spees has engaged in assignments to support business and investment decisions related to demand response penetration potential, virtual trading, FTRs, ancillary service markets, impacts of environmental regulations on coal retirements, tariff mechanisms for accommodating merchant transmission upgrades, renewables integration approaches, and market treatment of storage assets.

Kathleen earned a B.S. in Mechanical Engineering and Physics from Iowa State University. She earned an M.S. in Electrical and Computer Engineering and a Ph.D. in Engineering and Public Policy from Carnegie Mellon University.

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