U.S.EPA's

Clean Power Plan

Presenter

- Ken Snell, J.D., P.E.

S&L's Clean Power Plan Panel

- Andrew Carstens, P.E.
- Matt Thibodeau, P.E.
- Mark Lemmons, P.E.
- Dave Helm, P.E.

Agenda:

- Overview of EPA's Clean Power Plan
  - Performance Standards
  - State-Specific Goals
- Implementation
- Compliance Planning
- Questions / Answers

- **Overview of EPA's Clean Power Plan**
  - **Performance Standards**
  - **State-Specific Goals**
- **Implementation**
- **Compliance Planning**
- **Questions / Answers / Panel Discussion**

August 3, 2015, EPA signed for publication:

- **Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units Final Rule §111(b)**
- **Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units - Final Rule §111(d) – the "Clean Power Plan"**

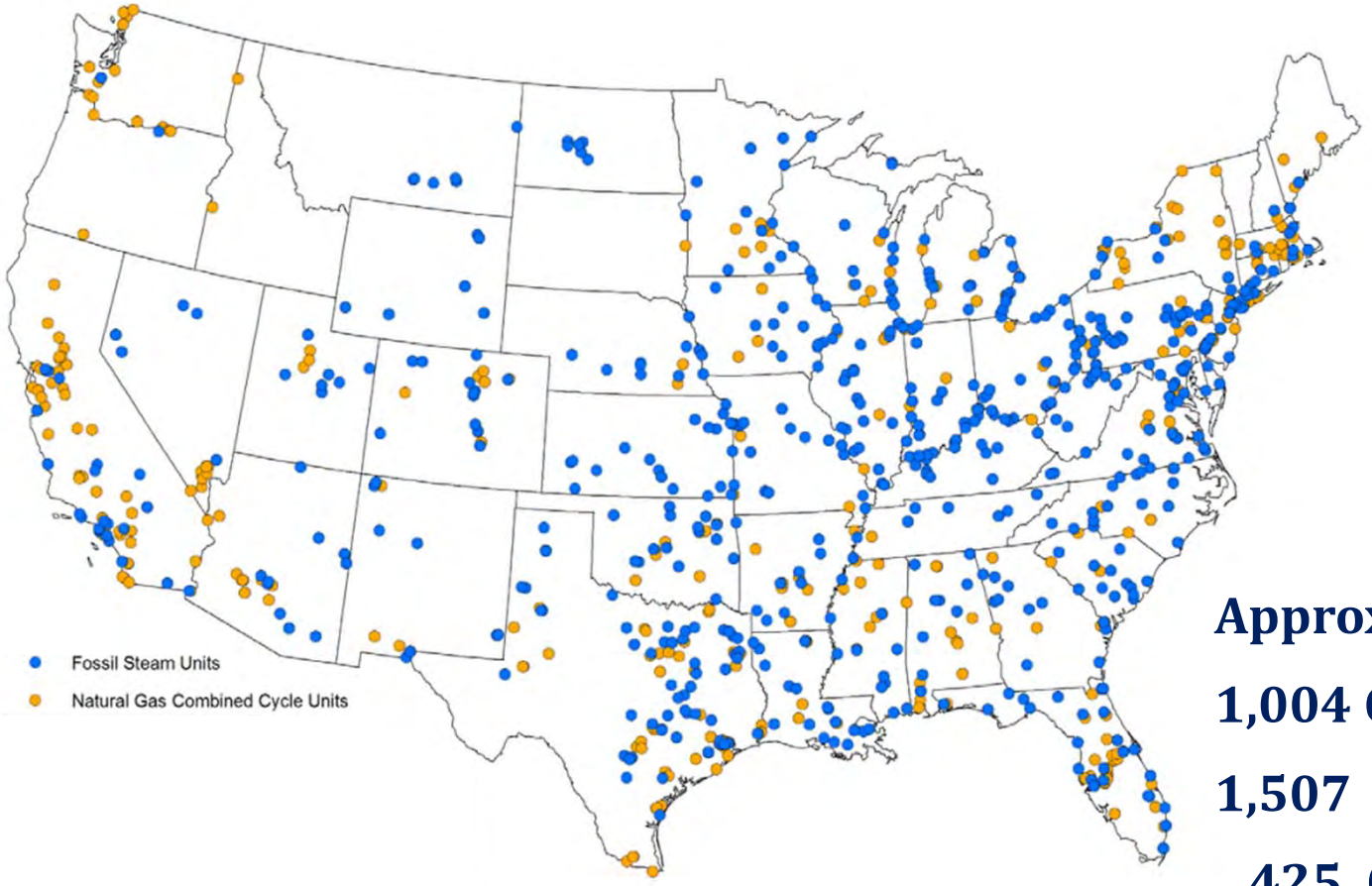
Clean Power Plan

- **Applies to:**
  - **Existing fossil fuel-fired steam electric generating units (EGUs) (coal, oil, and gas-fired boilers);**
  - **IGCC Units;**
  - **Natural Gas Combined-Cycle (NGCC) and Combined-Heat and Power (CHP) Units**

...capable of selling >25 MW to a utility power distribution system and was in operation or had commenced construction as of January 8, 2014.

A New Source Performance Standard for Existing Units

Clean Power Plan – Affected Units



Approximately:

1,004 Coal-fired EGUs

1,507 NGCC Units

425 Oil/Gas EGUs

Source: U.S.EPA

Clean Power Plan

- "Affected Units" do not include:
  - Units <25 MW
  - Simple-cycle combustion turbines
  - Non-fossil fuel fired generating units
  - Existing renewable energy generating units
  - Existing nuclear generating units
  - New Units that are subject to the §111(b) New Source Performance Standards for Greenhouse Gas Emissions

Clean Power Plan

Very simply, the CPP applies CO_2 performance standards to affected EGUs that must be achieved by 2030:

EGU Subcategory	Final Rate lb CO_2/MWh-net	2012 Baseline Data lb CO_2/MWh-net	% Reduction
Fossil Steam EGU or IGCC	1,305	2,204	41%
NGCC	771	894	16%

Clean Power Plan

Performance Standards are based on EPA's assessment of Best System of Emission Reduction (BSER):

Building Block 1

Heat Rate improvement at existing coal-fired power plants

Building Block 3

Shifting electricity generation from existing coal-fired power plants and existing NGCC units to NEW zero-CO_2 emitting resources

Building Block 2

Shifting electricity generation from existing coal-fired power plants to existing NGCC units

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BSER Determination:

$$FS_{Goal}\ (lb/MWh) = \frac{(Coal_{CO_2\ -BB1} + OGFS_{CO_2}) - RE_{CO_2} - \Delta NGCC_{CO_2}}{Baseline\ FS_{MWh}}$$

$$NGCC_{Goal}\ (lb/MWh) = \frac{NGCC_{CO_2} - RE_{CO_2}}{NGCC_{Baseline\ MWh}}$$

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BSER Determination:

Building Block 1: Improved Heat Rate

- Applied to existing coal-fired EGUs
- Based on Heat Rate Improvements of:
  - 4.3% in Eastern Interconnect
  - 2.1% in Western Interconnect
  - 2.3% in Texas
- Reduced baseline CO_2 emission rate from 2,204 lb/MWh to 2,109 lb/MWh (Eastern Interconnect)
- Reduced total baseline CO_2 emissions by approximately 66,105,000 tons/year (2.9%)

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BSER Determination:

Building Block 3: New RE Generation

- Substituted existing FS and NGCC generation with new RE generation.
- New RE Generation was calculated by:
  - Applying 2010-2014 capacity increases (MW) going forward through 2030 and applying "representative" capacity factors
- EPA concluded that:
  - RE generation will increase by:
    - 28,796,222 MWh/year (2013 – 2023) and
    - 62,796,222 MWh/year (2024 – 2030)

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BSER Determination:

Building Block 3: New RE Generation

$$FS_{Goal}\ (lb/MWh) = \frac{(Coal_{CO_2\ -BB1} + OGFS_{CO_2}) - RE_{CO_2}}{\text{Baseline } FS_{MWh}}$$

$$NGCC_{Goal}\ (lb/MWh) = \frac{NGCC_{CO_2} - RE_{CO_2}}{NGCC_{\text{Baseline MWh}}}$$

- **Reduced total baseline CO_2 emissions by approximately 530,889,000 tons/year (24%)**

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BSER Determination:

Building Block 2: Incremental NGCC ("ΔNCGG")

- Substituted existing FS generation with ΔNGCC generation
- ΔNGCC Generation

$$= NGCC_{MWh} \text{ @ } 75\% \text{ CF} - \text{Baseline } NGCC_{MWh} \text{ (post-BB3)}$$

$$FS_{Goal}\ (lb/MWh) = \frac{(Coal_{CO_2\,-BB1} + OGFS_{CO_2}) - RE_{CO_2} - \Delta NGCC_{CO_2}}{\text{Baseline } FS_{MWh}}$$

- Reduced total baseline CO_2 emissions by approximately 123,617,000 tons/year (8.1%)

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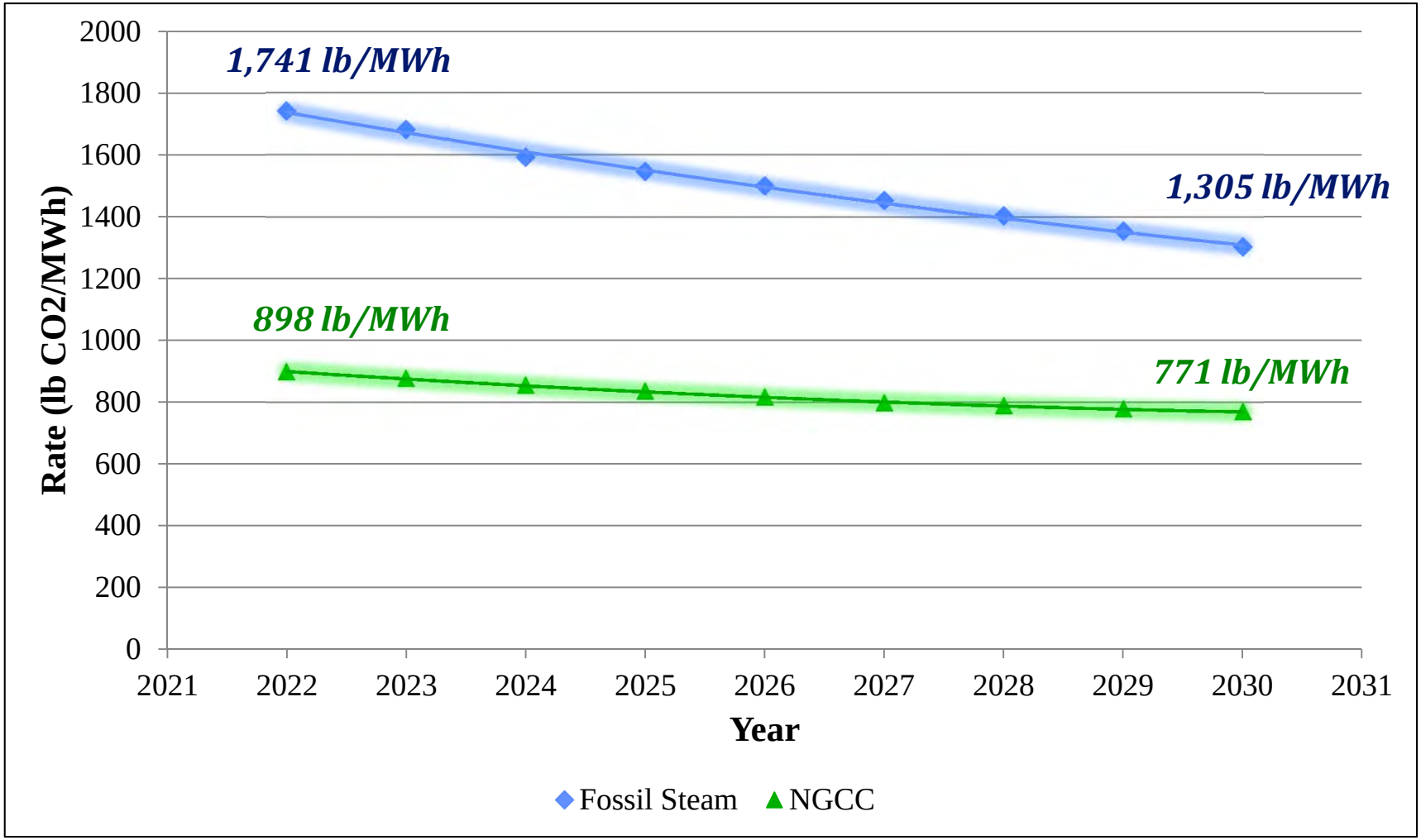
BSER Determination:



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BSER Determination:

- **Building Block 1: 2.9% reduction in total CO_2 emissions**
- **Building Block 3: 24% reduction in total CO_2 emission**
- **Building Block 2: 8.1% reduction in total CO_2 emissions**

Clean Power Plan

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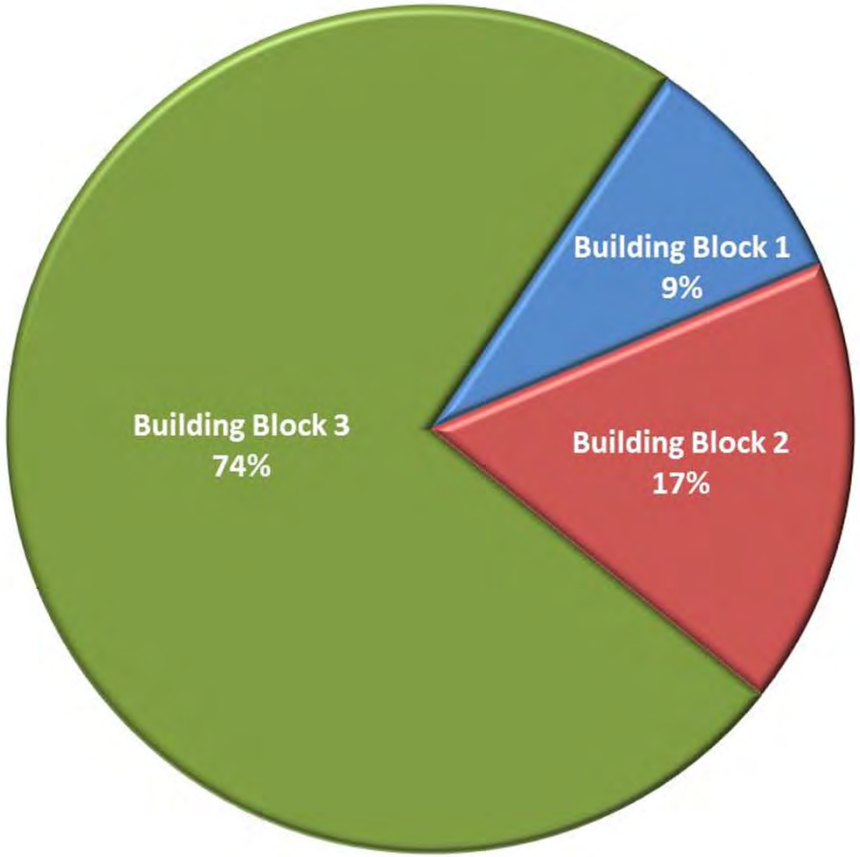
BSER Determination:



Baseline CO_2 = 2,265,735,254 tons

Reductions from Baseline:

- Building Block 1: 66,105,000
- Building Block 2: 123,617,000
- Building Block 3: 530,889,000

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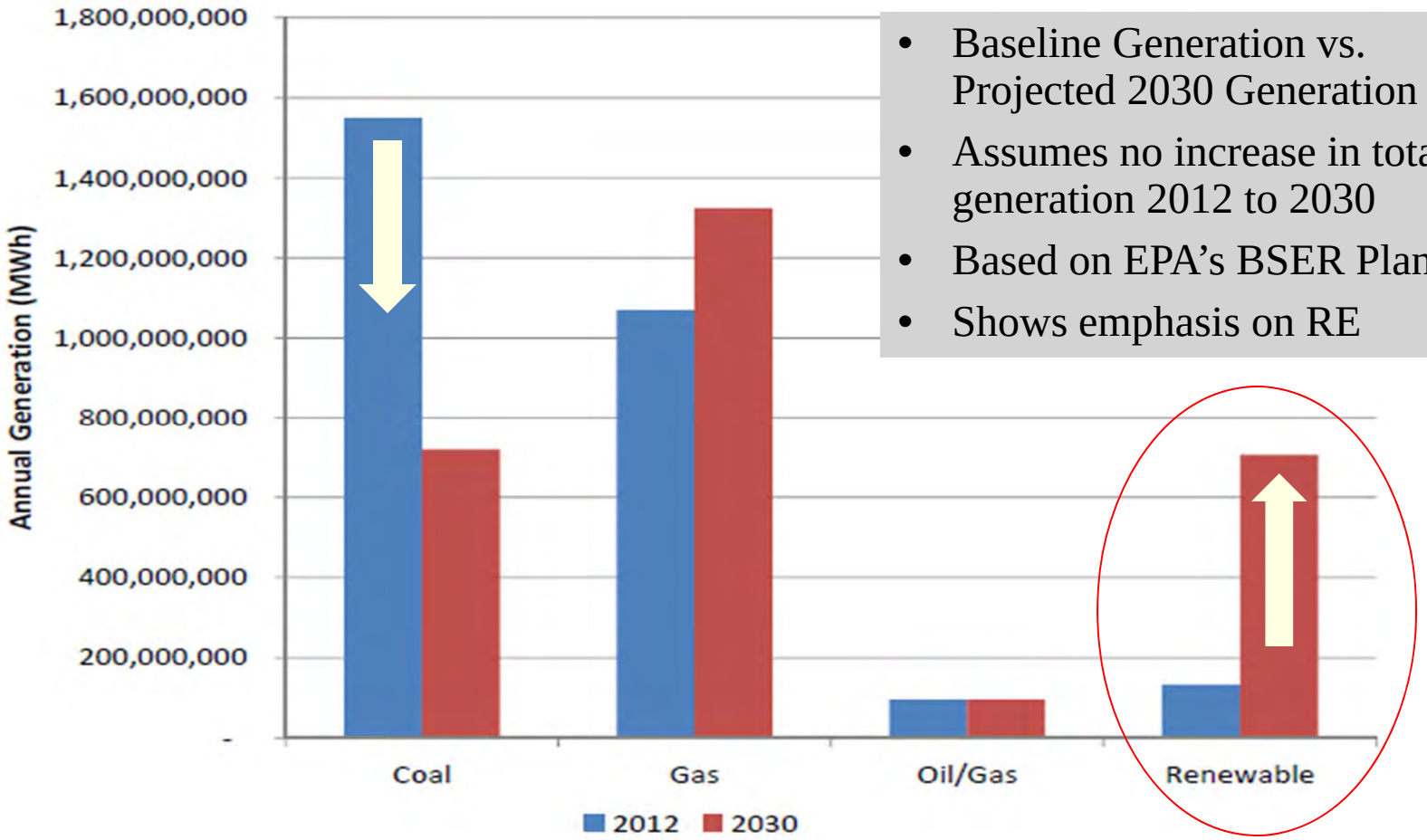
- **Renewable Energy will play a significant rule in either a rate-based or mass-based program:**



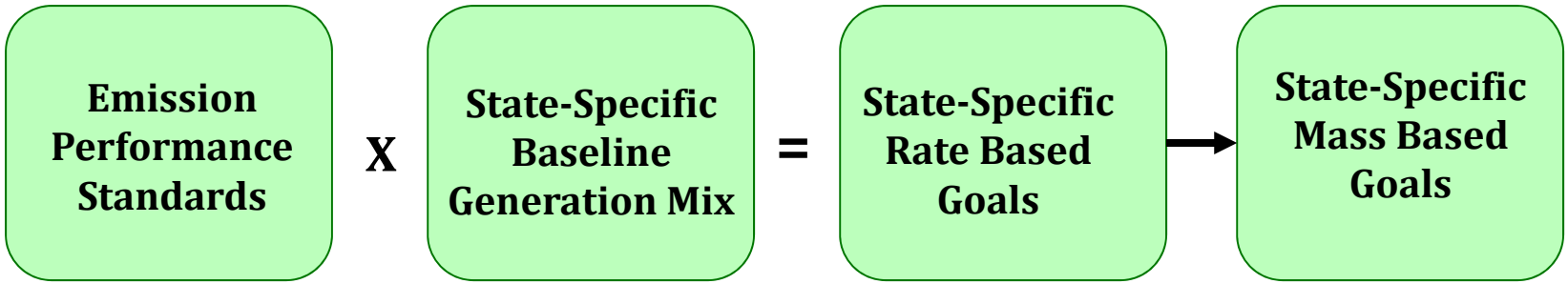
- Baseline Generation vs. Projected 2030 Generation
- Assumes no increase in total generation 2012 to 2030
- Based on EPA's BSER Plan
- Shows emphasis on RE

Source: U.S.EPA

Clean Power Plan

In addition to the subcategory specific performance standards, the Clean Power Plan also includes state-specific emission rate goals:

- **Rate-based goal (lb/MWh)**
- **Mass-based goal (total tons of CO_2)**



Source: U.S.EPA

Rate-Based Goals

- **EPA applied the subcategory-specific emission rates to each states' baseline generation levels.**

Example: Arkansas

$FS_{Baseline}$ = 32,154,992 MWh

$NGCC_{Baseline}$ = 15,615,185

Arkansas Generation Mix: 67% FS and 33% NGCC

2030 Rate-Based Goal:

(1,305 lb/MWh x 0.67) + (771 lb/MWh x 0.33) = 1,131 lb/MWh

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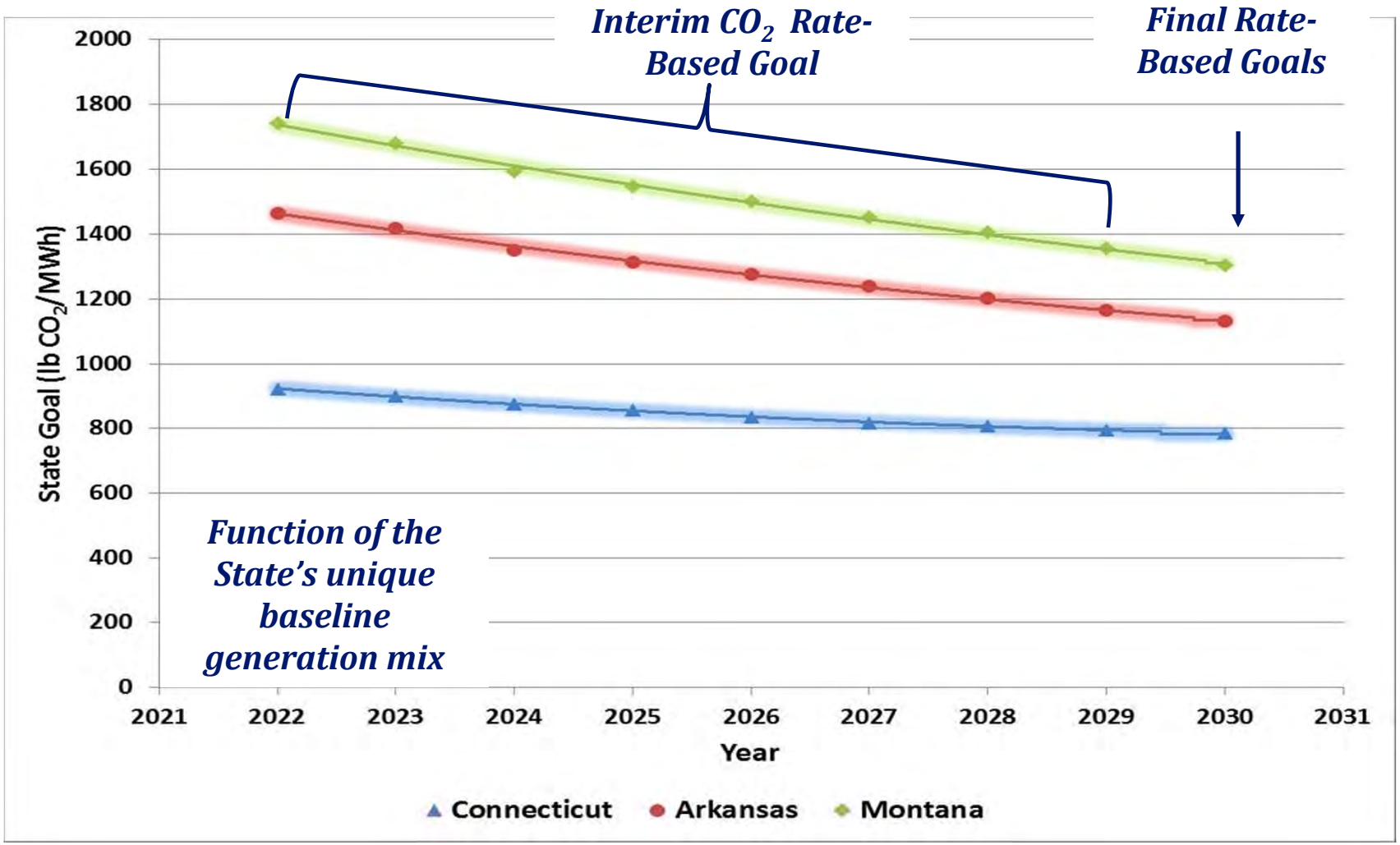
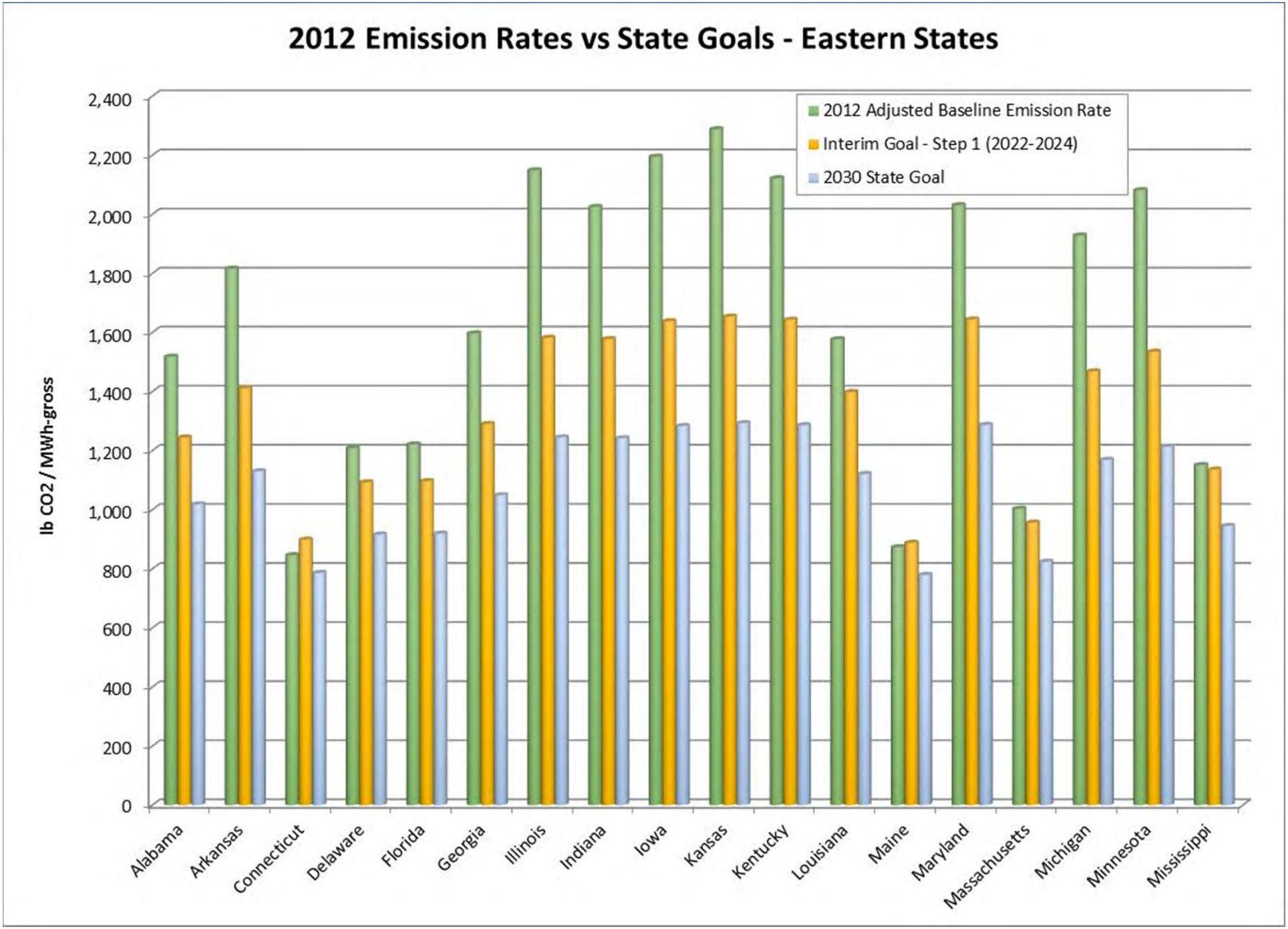
State-Specific Rate-Based Goals:




2012 Emission Rates vs State Goals - Eastern States
lb CO2 / MWh-gross
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
2012 Adjusted Baseline Emission Rate
Interim Goal - Step 1 (2022-2024)
2030 State Goal
Alabama
Arkansas
Connecticut
Delaware
Florida
Georgia
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi

Mass-Based Goals

- EPA applied the subcategory-specific rates to each states' baseline generation levels; and
- added back a portion of Building Block 3 that was not needed for compliance in the Western & Texas interconnections.

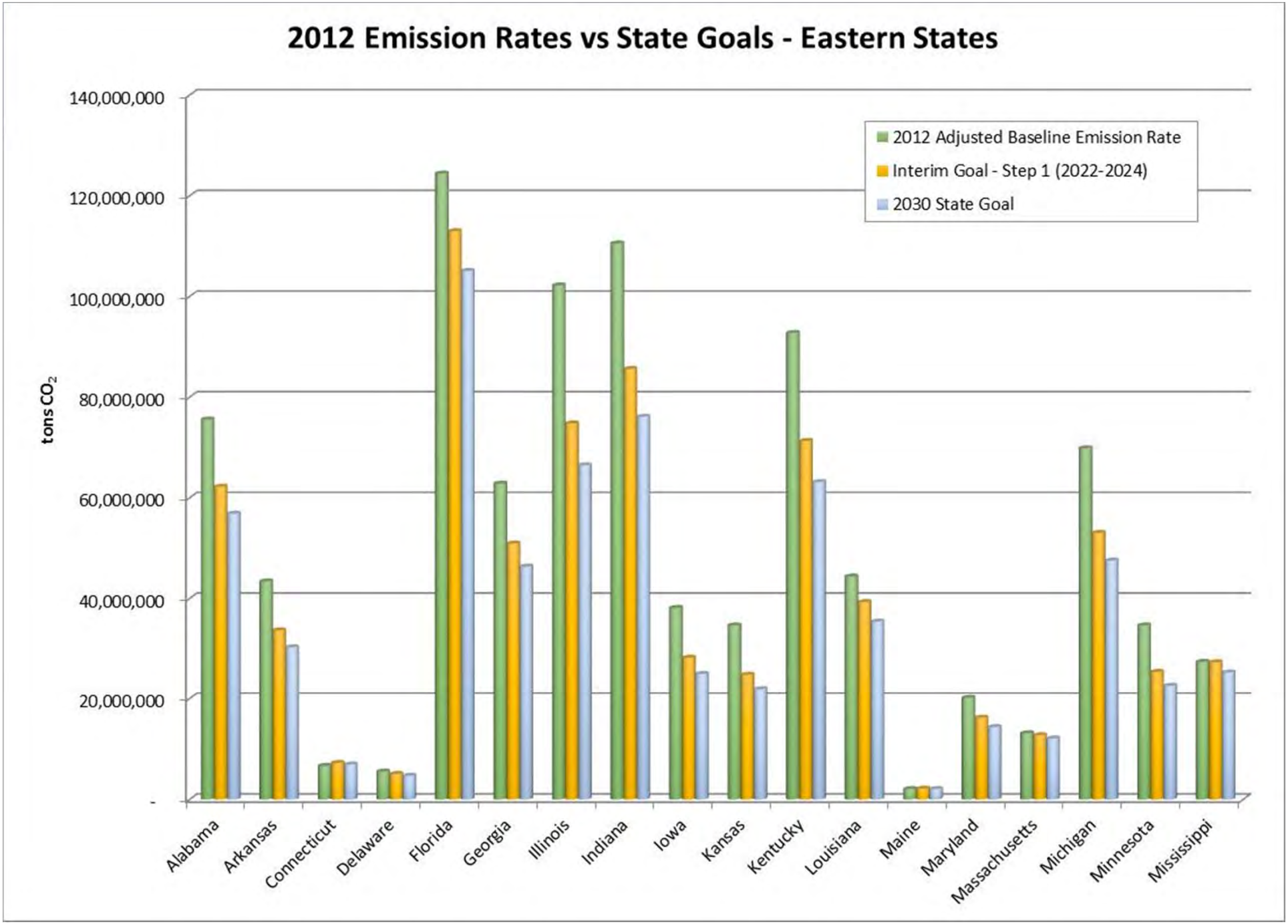
Example: Arkansas

$$(FS_{Baseline} \times FS_{Rate}) + (NGCC_{Baseline} \times NGCC_{Rate}) + BB3\ Adj$$

Baseline Mass Emissions: 47,806,056 tons

1st Interim Period Mass-Based Goal: 35,189,232 tons

Final Mass-Based Goal: 30,170,750 tons


2012 Emission Rates vs State Goals - Eastern States
140,000,000
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
-
tons CO_2
2012 Adjusted Baseline Emission Rate
Interim Goal - Step 1 (2022-2024)
2030 State Goal
Alabama
Arkansas
Connecticut
Delaware
Florida
Georgia
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi

- Overview of EPA's Clean Power Plan
  - Performance Standards
  - State-Specific Goals
- **Implementation**
- Compliance Planning
- Questions / Answers / Panel Discussion

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Implementation

1. **The Clean Power Plan will be implemented through State Implementation Plans (SIPs)**

2. **SIPs must:**

   "Include emission standards for each affected EGU to ensure that the power plants – either individually, together, or in combination with other measures – achieve the interim CO_2 emission performance rates over the period of 2022 – 2029 and the final CO_2 performance rates, rate-based goals, or mass-based goals by 2030."

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Implementation – Timeline

Fall 2015	August 3: EPA Signed Clean Power Plan for Publication
Sept. 6 2016	States make initial SIP submittal with extension request or submit Final Plan
Sept. 6 2018	States with an extension submit Final Plan FIP for states that fail to submit an approvable plan
Jan. 1 2022	First Compliance Period begins
Jan. 1 2030	Final CO_2 Emission Goals

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Implementation – Proposed FIP

August 3, 2015, EPA also signed for publication:

Federal Plan Requirements for Greenhouse Gas Emissions from Electric Utility Generating Units Constructed on or Before January 8, 2014:
Model Trading Rule

Implementation – Proposed FIP

- **EPA's proposed FIP includes two alternative compliance programs based on emissions trading:**
  - **Rate-based trading program**
    - **Affected EGUs purchase emission reduction credits (ERCs) from units that emit below a specified emission rate.**
  - **Mass-based trading program**
    - **Affected EGUs can purchase emission allowances (tons) from units that emit below their allowance allocation.**

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Implementation
EPA's Proposed Rate-Based Trading

Clean Power Plan

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Proposed Rate-Based Program:

$$\frac{\text{lb } CO_2}{\text{MWh}} \Rightarrow \frac{\text{Reduce } CO_2}{\text{MWh}} \Rightarrow \frac{\text{lb } CO_2}{\text{MWh} + \text{ERCs}}$$

State-Specific Rate-Based Goal

- **Existing units are required to reduce CO_2 emissions or purchase ERCs from units that emit below a specified emission rate.**
- **ERCs would be issued for:**
  - **Measures that provide substitute generation, and**
  - **Measures that avoid the need for generation.**

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Proposed Rate-Based Program:

Potential measures to reduce CO_2 Emissions (lb/MWh):

- Heat Rate Improvements
- Natural Gas Co-firing;
- Natural Gas Conversion
- Qualified Biomass Co-firing
- Partial Carbon Capture
- Carbon Capture & Sequestration…

Proposed Rate-Based Program

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Measures to Reduce CO_2 Emissions (lb/MWh)

- **Heat Rate Improvements:**

  Assume 4.5% heat rate improvement

Facility	Coal 1	Coal 2	Total
Capacity(MW)	580	720	1,300
Generation (MWh)	3,971,000	4,366,500	8,157,500
CO_2 Emissions (tons)	3,964,300	4,722,500	8,686,800
CO_2 Rate (lb/MWh)	2,091	2,163	2,130

408,250 ton/year reduction in CO_2 emissions.

1st Interim State Goal = 1,411 lb/MWh
Final State Goal = 1,130 lb/MWh

Proposed Rate-Based Program

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Measures to Reduce CO_2 Emissions (lb/MWh)

- **Natural Gas Conversion:**
  Unit 1: 100% NG Conversion

Facility	Unit 1	Unit 2	Total
Capacity(MW)	580	720	1,300
Generation (MWh)	3,971,000	4,366,500	8,157,500
CO_2 Emissions (tons)	2,407,200	4,722,500	7,129,700
CO_2 Rate (lb/MWh)	1,270	2,163	1,748

2,561,605 ton/year reduction in CO_2 emissions (from baseline).

1st Interim State Goal = 1,411 lb/MWh
Final State Goal = 1,130 lb/MWh

Proposed Rate-Based Program

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Measures that provide substitute generation:

- **Incremental NGCC Generation**
  - **Increased generation (MWh) from existing NGCC units above 2012 baseline ("Gas Shift")**
- **New RE generation**
  - **Wind, solar, geothermal, hydropower, biomass, wave and tidal power**
- **New Nuclear Generation**
- **Existing RE or nuclear uprates (added after 2012)**
- **Combined Heat & Power Projects**
- **International RE imports**

Proposed Rate-Based Program

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Emission Reduction Credits

- **Gas-Shift ERCs (GS-ERCs)**
  - **Credited to existing NGCC Units**
  - **Calculated to represent CO_2 emission reductions from incremental NGCC generation.**

- **Renewable Energy ERCs (RE-ERCs)**
  - **Credited to eligible Renewable Energy resources**

Proposed Rate-Based Program

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Gas-Shift ERCs (GS-ERCs)

$$\text{GS-ERC} = \text{NGCC}_{\text{MWh}} \times \text{Incremental Generation Factor} \times \text{GS-ERC Emission Factor}$$

$$\text{Incremental Generation Factor} = \frac{\text{Baseline NGCC}_{\text{MWh}}}{\text{NGCC}_{\text{MWh}} @ 75\% \text{ CF}} \Rightarrow \text{0.22 in first compliance period}$$

$$\text{GS-ERC Emission Factor} = 1 - \frac{\text{NGCC}_{\text{Rate}}}{\text{FS}_{\text{Standard}}} \Rightarrow \text{approximately 0.45}$$

E.g., 1,000,000 MWh x 0.22 x 0.45 = 99,000 ERCs

Proposed Rate-Based Program

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Rate-Based Example:

	Unit 1	Unit 2	Total
Baseline Generation (MWh)	3,791,000	4,366,500	8,157,500
Baseline Emissions (tons)	3,964,157	4,721,616	8,685,733
Baseline Rate (lb/MWh)	2,091	2,163	2,130
ΔNGCC Generation (MWh)	1,000,000	1,000,000	2,000,000
Remaining Coal (MWh)	2,791,000	3,366,500	6,167,500
CO_2 Emissions (tons)	2,918,481	3,640,288	6,558,770
GS-ERCs (tons)	99,000	99,000	198,000
New Rate (lb/MWh)	2,020	2,101	2,060

- CO_2 Emissions = Remaining Coal x Baseline Rate
- GS-ERC = 2,000,000 x 0.22 x 0.45 = 198,000 allowances
- New Rate = Emissions / MWh + ERC

Proposed Rate-Based Program

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Renewable Energy ERCs (RE-ERCs)

- **RE-ERCs will be credited to eligible RE resources**
- **Eligible RE resources include <u>new</u> wind, solar, geothermal, hydropower, biomass, wave and tidal power…**
- **1 ERC / zero CO_2-emitting MWh**

<u>Example:</u>

$$\frac{6{,}558{,}770 \text{ tons}}{6{,}167{,}500 \text{ MWh} + 198{,}000 \text{ GS-ERCs} + \text{RE-ERCs}} = 1{,}045 \text{ lb/MWh}$$

$$\text{RE-ERCs} = 6{,}187{,}000 \text{ MWh}$$

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Implementation
EPA's Proposed Mass-Based Trading

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Proposed FIP Mass-Based Program:

Proposed Mass-Based Program

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Renewable Energy (RE) Set-Aside:

- Reserve a percentage of each states' allowances in a RE set-aside
- EPA proposed the following specific RE measures for eligibility:
  - on-shore wind,
  - solar,
  - geothermal power, and
  - hydropower

- New nuclear units and capacity uprates at exiting nuclear units are not proposed to be eligible to receive set-aside allowances.

Proposed Mass-Based Program

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Renewable Energy (RE) Set-Aside:

- **Only RE measures installed, or capacity increases, after 2012 are eligible for set-aside allowances.**
- **EPA proposed 5% of each states' allowances will be reserved for the RE set-aside.**
- **EPA proposed to issue RE set-aside allowances based on projected generation (MWh) from eligible RE capacity.**
- **EPA requested comment on inclusion of other RE measures**

Proposed Mass-Based Program

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Output-Based Set-Aside (ΔNGCC Set-Aside):

- **Set-aside for increased generation from existing NGCC Units**
- **Set-aside calculated for each state as:**

  State's NGCC capacity (MW) x 10% Capacity Factor

- **Allowances will be allocated to exiting NGCC units based on their level of electricity generation in the previous compliance period**
- **Allocation rate will be calculated as:**

$$NGCC_{Capacity}\ (MW) \times (CF - 0.5) \times 8{,}760 \times 1{,}030/2{,}000$$

Capacity Factor above 50%

§111(b) NSPS (lb/MWh)

Proposed Mass-Based Program

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Mass-Based Example (State Allowance Pool):

	1st Interim Period	2nd Interim Period	Final
Total Allowances	35,189,232	32,953,521	30,170,750
RE Set-Aside	1,801,634	1,647,676	1,516,132
CEIP Set-Aside	2,187,230	-	-
ΔNGCC Set-Aside	-	2,102,538	2,102,538
Remainder	31,200,368	29,203,307	26,552,080

- RE Set-Aside calculated at 5% of state budget
- Clean Energy Incentive Program in first compliance period.
- OB Set-Aside calculated at 10% of state's NGCC capacity

Proposed Mass-Based Program

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Mass-Based Example (Coal-Fired EGU):

	Coal 1	Coal 2
Baseline Generation (MWh)	3,791,000	4,366,500
Baseline CO_2 Emissions (tons)	4,150,950	4,944,100
% of Total State Generation	7.93%	9.13%
2030 Allowances	2,105,569	2,425,209
Surplus / (Deficit)	(2,045,381)	(2,518,891)
% of Allowances Needed	51%	49%

- Total Baseline State Generation: 47,806,056 MWh
- 2030 Allowance Pool (after set-asides): 26,552,080
- Need to acquire additional compliance allowances

Proposed Mass-Based Program

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Mass-Based Example (NGCC Units):

NGCC Example:	NGCC 1	NGCC 2	NGCC 3
Capacity (summer) MW	47	145	170
Baseline Generation (MWh)	30,316	718,446	142,924
Baseline CO_2 Emissions (tons)	15,348	311,844	62,930
CO_2 Emission Rate (lb/MWh)	1,013	868	881
Baseline Capacity Factor	7%	56%	10%
% of State Generation	0.063%	1.5%	0.30%
Allowance Pool Allocation	16,838	399,034	79,282

- Total Baseline State Generation: 47,806,056 MWh
- 2030 Allowance Pool (after set-asides): 26,552,080
- NGCC Units will require allowances for increased generation

Proposed Mass-Based Program

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Mass-Based Example (NGCC Units):

NGCC Example:	NGCC 1	NGCC 2	NGCC 3
Capacity (summer) MW	47	145	170
Generation @ 70% CF (MWh)	308,790	952,650	1,116,900
CO_2 Emissions @ 70% (tons)	156,329	413,500	491,770
Allowance Pool Allocation	16,838	399,034	79,382
ΔNGCC Set-Aside Allowances	42,407	130,831	153,388
Surplus / (Deficit)	(97,084)	116,365	(259,005)

- OB Allowances = MW_{Cap} x (0.7 – 0.5) x 8,760 x 1,030 / 2,000
- Assumes that OB Allowances are available
- NGCC Units with low baseline capacity factors will need to acquire additional compliance allowances

Proposed Mass-Based Program

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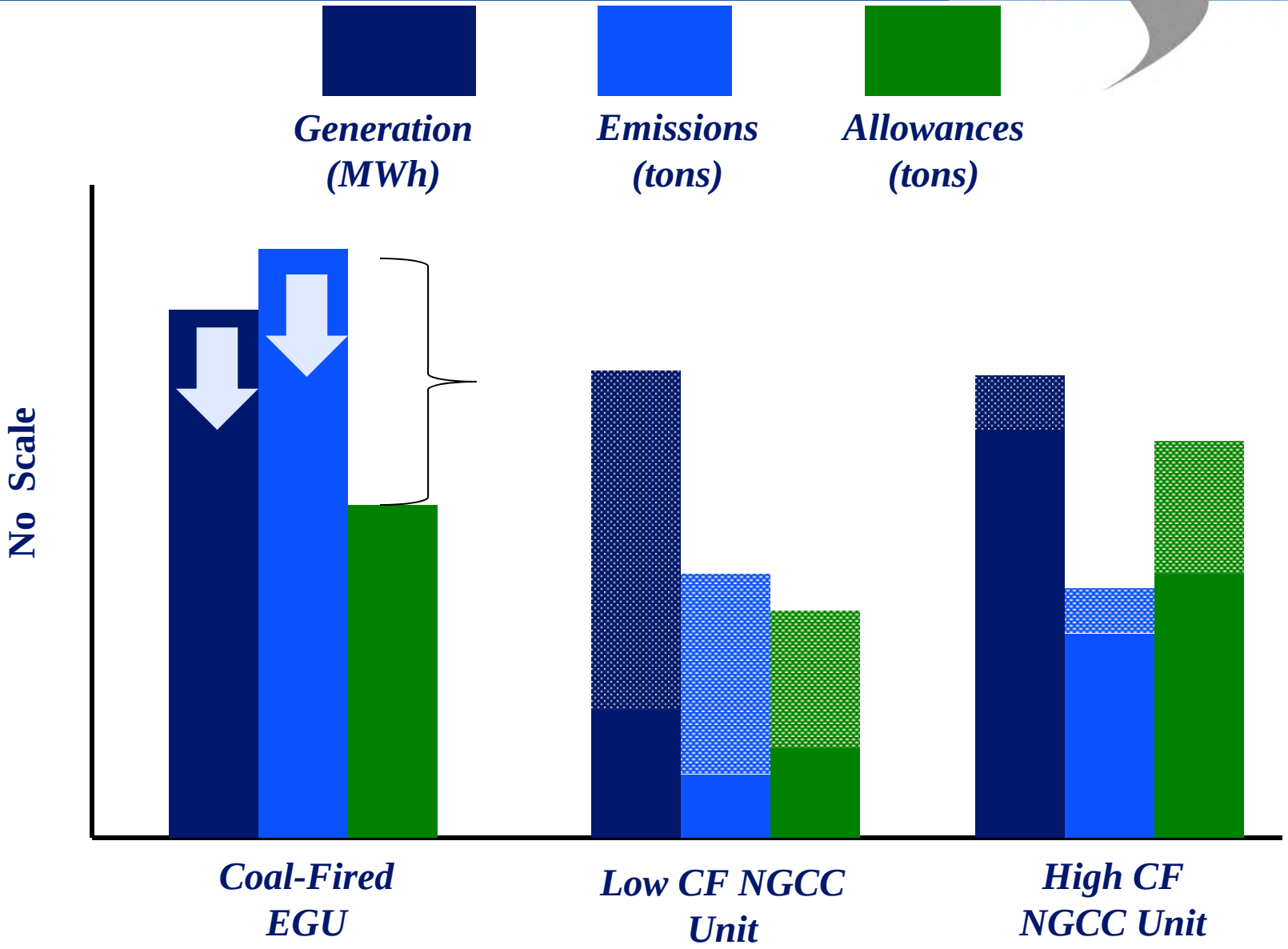

- Overview of EPA's Clean Power Plan
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- **Questions / Answers / Panel Discussion**

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General Conclusions:

1. Heat Rate improvements will play only a minor role in compliance at existing coal-fired EGUs under either a rate-based or mass-based program.
2. Other CO_2 emission reduction measures, including natural gas co-firing and natural gas conversion, could provide significant CO_2 emission reductions for existing coal-fired EGUs and should be evaluated as a part of either program.
3. Renewable Energy will play a significant role in overall compliance with either a rate-based program (RE-ERCs) or mass-based program (RE Set-Aside Allowances)

General Conclusions:

Rate-Based ERCs

1. **GS-ERCs may be limited based on the methodology used to calculate the ERCs.**
2. **GS-ERCs cannot by used by NGCC units for compliance with a rate-based program.**
3. **RE-ERCs will likely be needed by coal-fired units and NGCC units for compliance.**

Mass-Based Allowances

1. **Output Based (ΔNGCC) set-aside allowances may be needed to offset increased CO_2 emissions from NGCC units, especially units with low baseline capacity factors.**
2. **RE set-aside allowances will likely be needed by coal-fired EGUs and low capacity factor NGCC units for compliance.**

Clean Power Plan

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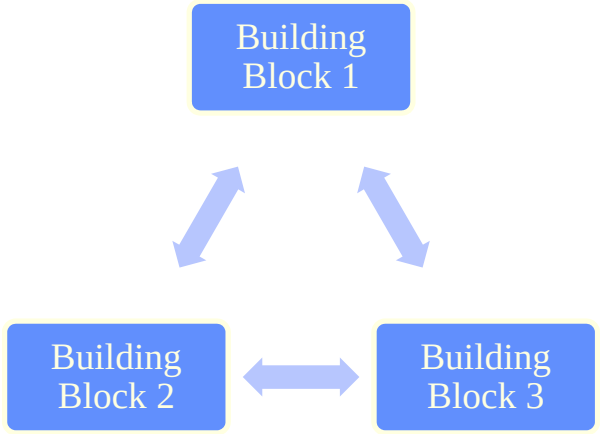
Planning for Compliance:

Building Block 1

- **Identify potential CO_2 emission reduction opportunities: heat Rate improvements, fuel co-firing, natural gas-conversion, carbon capture.**



Building Block 2

- **Identify opportunities to increase NGCC generation and generate GS-ERCs or OB Set-Aside Allowances**

Building Block 3

- **Evaluate potential NEW RE capacity and generating opportunities**

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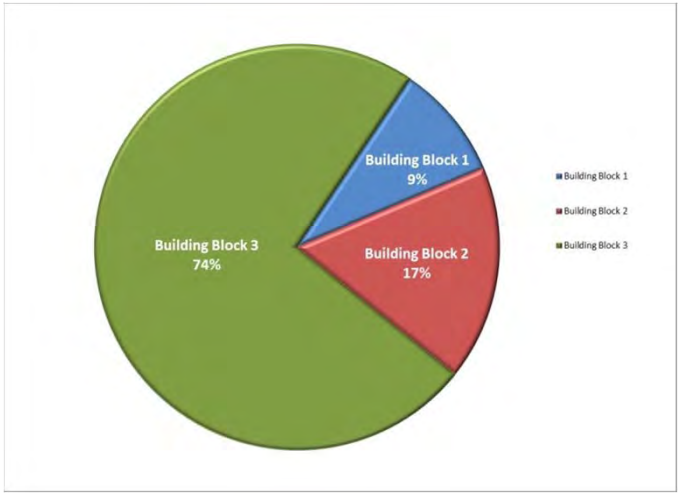
Planning for Compliance

RE Generation - General Eligibility Requirements:

- Only RE measures installed after 2012 are eligible for adjusting CO_2 emission rates or generating CO_2 allowances.

- Only the quantifiable and verifiable MWh of RE generation produced in 2022 and future years may be applied to adjusting CO_2 emission rates or generating allowances.



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Planning for Compliance:

Compliance Plans Need to Integrate an Evaluation of:

- Overall impacts on generation:
  - Unit Retirements
  - Meeting Demand
  - Meeting Peak Demand
- Unit Dispatch
- Reliability and Grid Stability
- Operations
  - Operating baseload unit as cycling unit
  - Responding to fluctuation in RE generation
- Cost of Electricity

Planning for Compliance:

Preliminary Evaluations

- Review existing generating portfolio: Affected Units, NGCC capacity and capacity factors, baseline emissions & emission rates
- Review and understand the proposed FIP Rate-Based and Mass-Based trading programs
- Evaluate pros / cons of the Rate-Based and Mass-Based trading options, as well as other alternatives
- Participate in stakeholder meetings and closely follow development of your State's SIP
- Work with your state to develop SIP requirements that are most advantageous

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Questions/Answers

For additional information, please contact:

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