



U.S.EPA's Clean Power Plan



Presenter

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S&L's Clean Power Plan Panel

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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**
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- 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”**

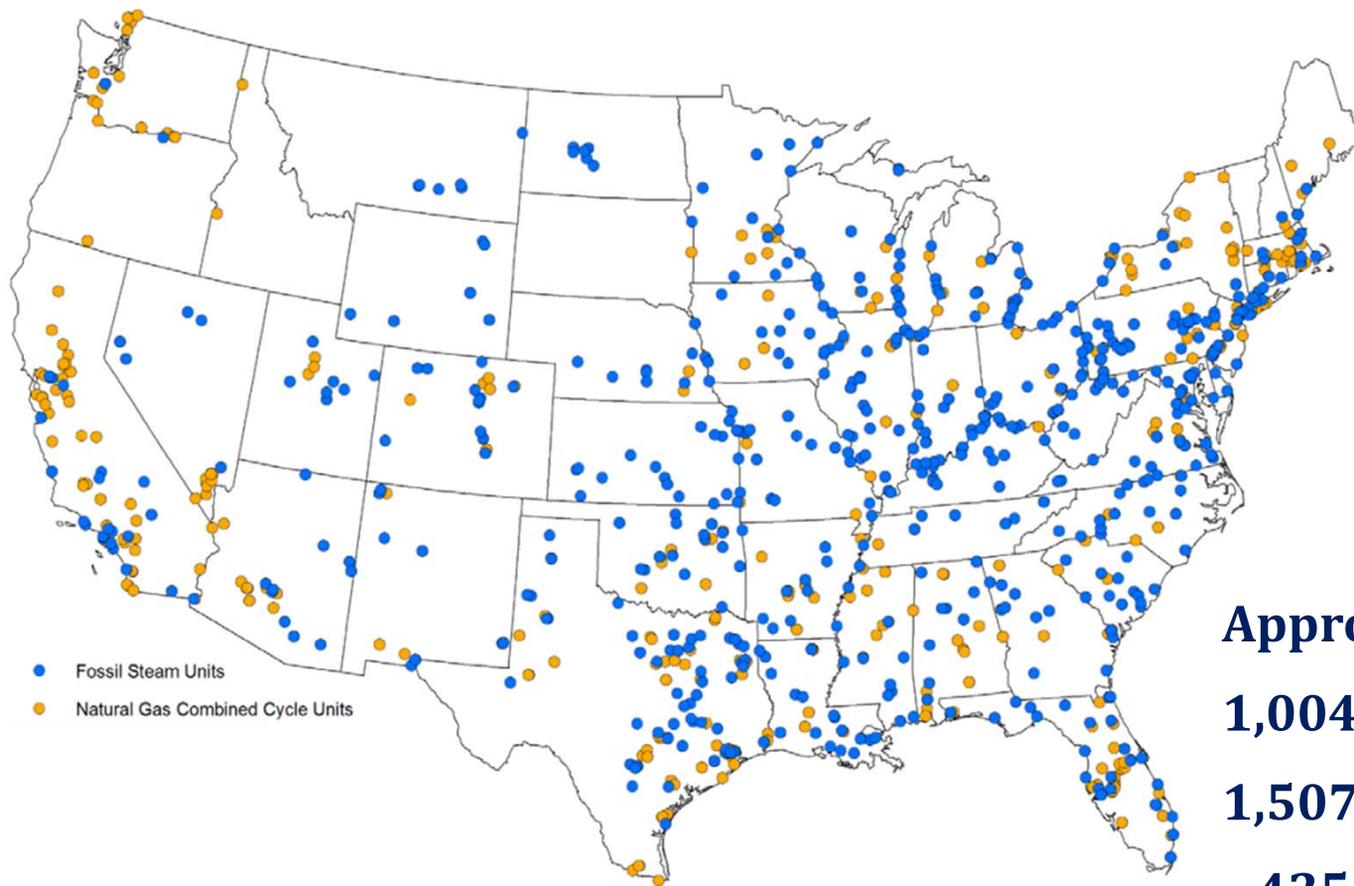
Clean Power Plan

- **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



- Fossil Steam Units
- Natural Gas Combined Cycle 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 CO₂ performance standards to affected EGUs that must be achieved by 2030:

EGU Subcategory	Final Rate lb CO₂/MWh-net	2012 Baseline Data lb CO₂/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-CO₂ emitting resources

Building Block 2

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

BSER Determination:

$$FS_{\text{Goal}} \text{ (lb/MWh)} = \frac{(\text{Coal}_{\text{CO}_2\text{-BB1}} + \text{OGFS}_{\text{CO}_2}) - \text{RE}_{\text{CO}_2} - \Delta\text{NGCC}_{\text{CO}_2}}{\text{Baseline } FS_{\text{MWh}}}$$


$$\text{NGCC}_{\text{Goal}} \text{ (lb/MWh)} = \frac{\text{NGCC}_{\text{CO}_2} - \text{RE}_{\text{CO}_2}}{\text{NGCC}_{\text{Baseline MWh}}}$$


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 CO₂ emission rate from 2,204 lb/MWh to 2,109 lb/MWh (Eastern Interconnect)
- Reduced total baseline CO₂ emissions by approximately 66,105,000 tons/year (2.9%)

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)**

BSER Determination:

Building Block 3: New RE Generation

$$FS_{\text{Goal}} \text{ (lb/MWh)} = \frac{(\text{Coal}_{\text{CO}_2\text{-BB1}} + \text{OGFS}_{\text{CO}_2}) - \text{RE}_{\text{CO}_2}}{\text{Baseline } FS_{\text{MWh}}}$$


$$NGCC_{\text{Goal}} \text{ (lb/MWh)} = \frac{\text{NGCC}_{\text{CO}_2} - \text{RE}_{\text{CO}_2}}{\text{NGCC}_{\text{Baseline MWh}}}$$


- **Reduced total baseline CO₂ emissions by approximately 530,889,000 tons/year (24%)**

BSER Determination:

Building Block 2: Incremental NGCC (“ΔNGCC”)

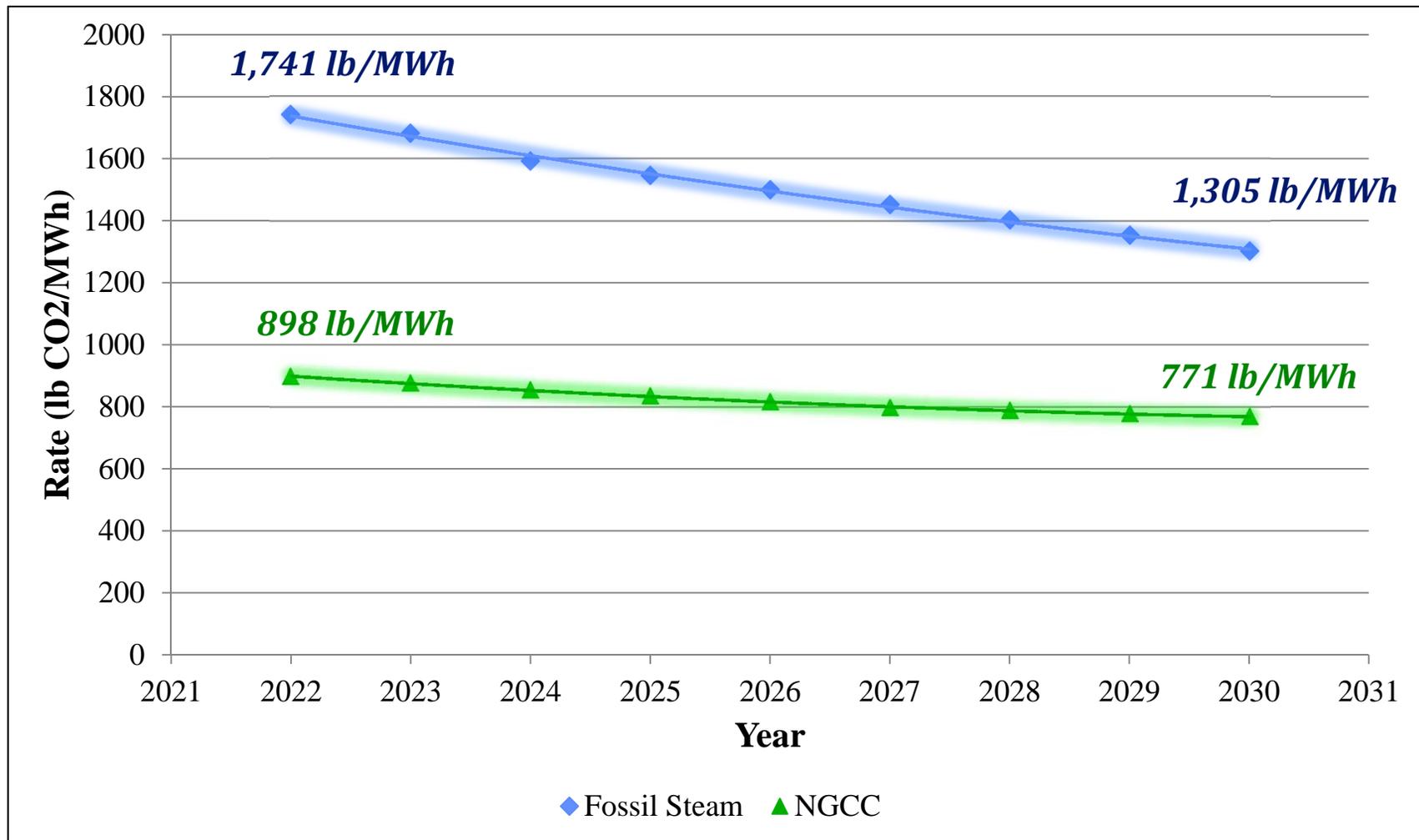
- Substituted existing FS generation with ΔNGCC generation
- ΔNGCC Generation

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

$$\text{FS}_{\text{Goal}} (\text{lb/MWh}) = \frac{(\text{Coal}_{\text{CO}_2\text{-BB1}} + \text{OGFS}_{\text{CO}_2}) - \text{RE}_{\text{CO}_2} - \Delta\text{NGCC}_{\text{CO}_2}}{\text{Baseline FS}_{\text{MWh}}}$$


- Reduced total baseline CO₂ emissions by approximately 123,617,000 tons/year (8.1%)

BSER Determination:

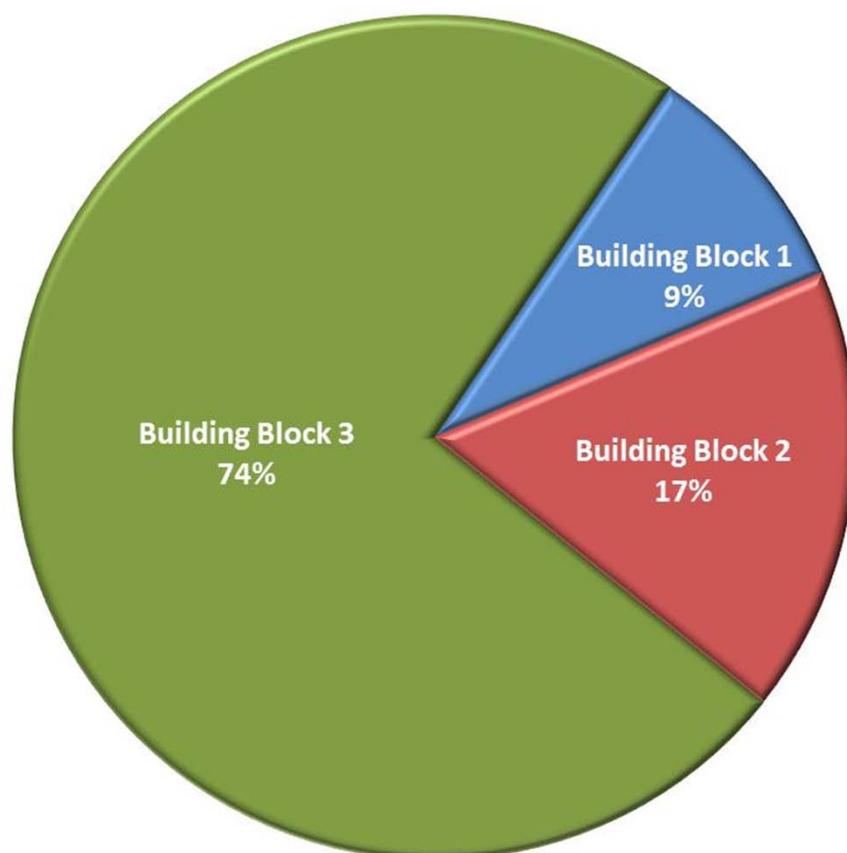


BSER Determination:

- **Building Block 1: 2.9% reduction in total CO₂ emissions**
- **Building Block 3: 24% reduction in total CO₂ emission**
- **Building Block 2: 8.1% reduction in total CO₂ emissions**



BSER Determination:



Baseline CO₂ = 2,265,735,254 tons

Reductions from Baseline:

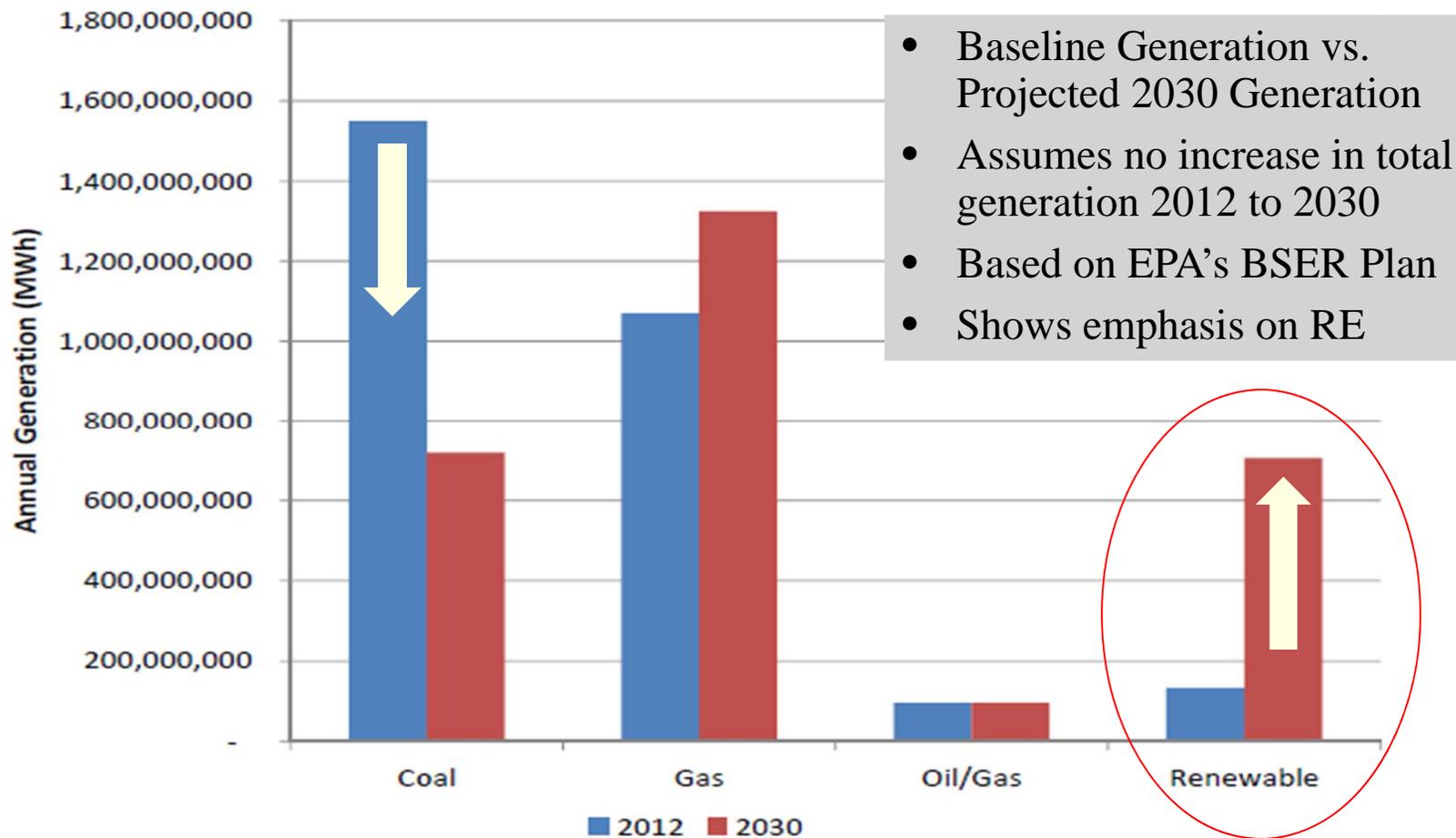
Building Block 1: 66,105,000

Building Block 2: 123,617,000

Building Block 3: 530,889,000

Clean Power Plan

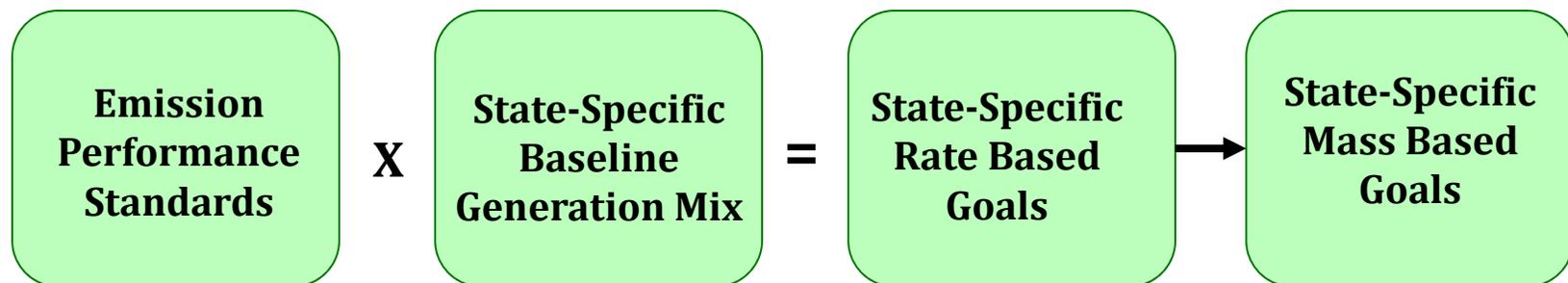
- **Renewable Energy will play a significant role in either a rate-based or mass-based program:**



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 CO₂)



Rate-Based Goals

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

Example: Arkansas

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

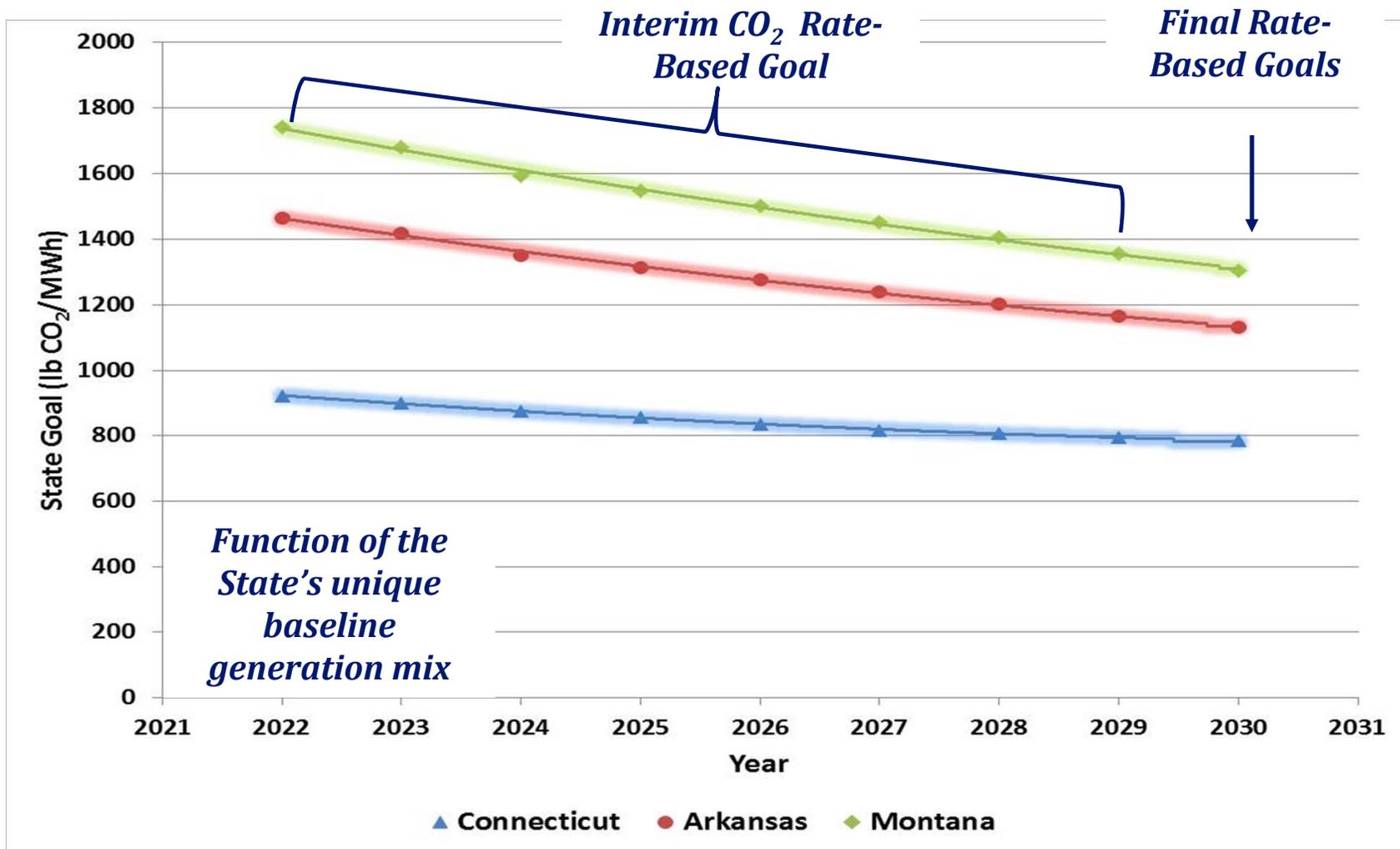
$NGCC_{\text{Baseline}} = 15,615,185$

Arkansas Generation Mix: 67% FS and 33% NGCC

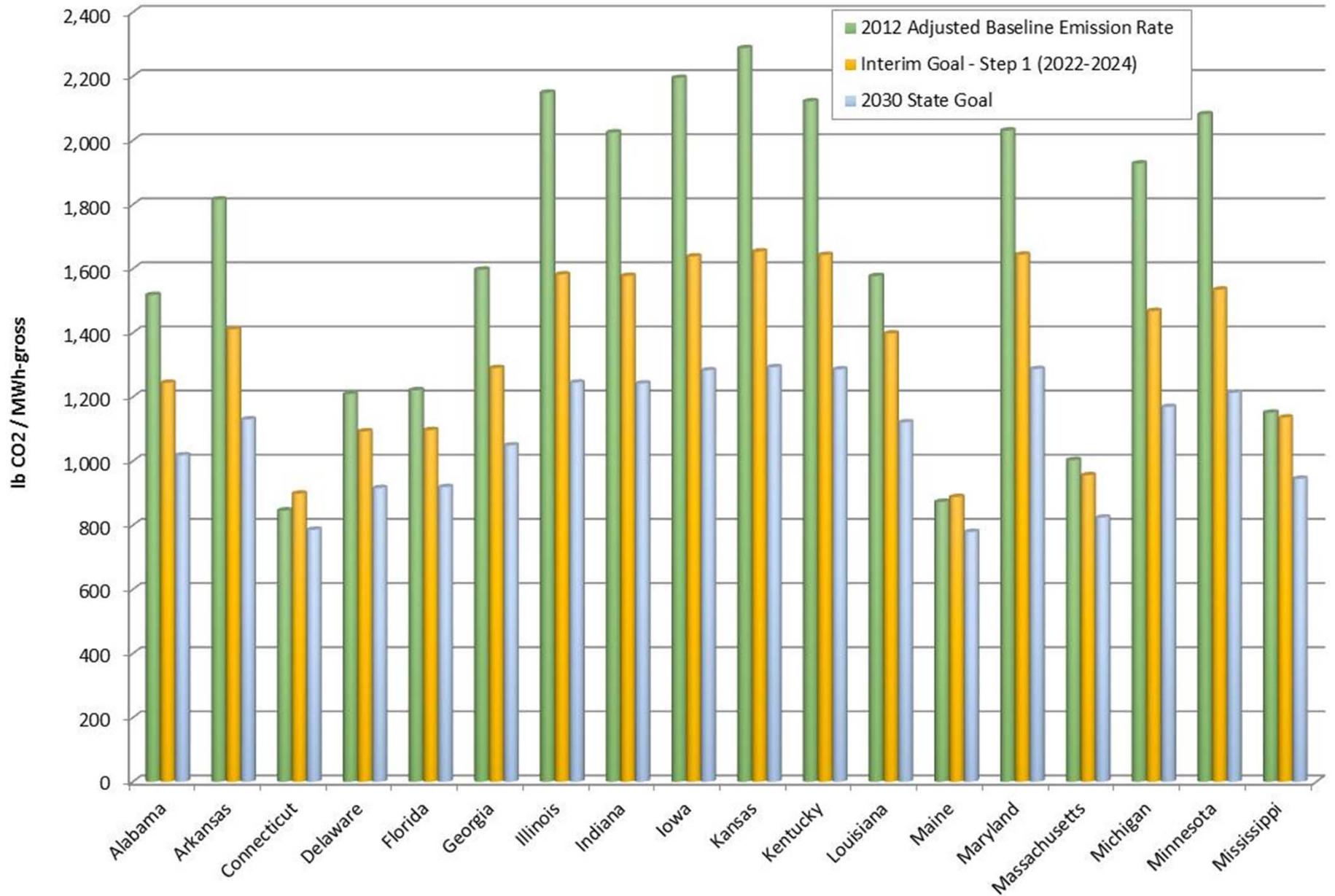
2030 Rate-Based Goal:

$$(1,305 \text{ lb/MWh} \times 0.67) + (771 \text{ lb/MWh} \times 0.33) = 1,131 \text{ lb/MWh}$$

State-Specific Rate-Based Goals:



2012 Emission Rates vs State Goals - Eastern States



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

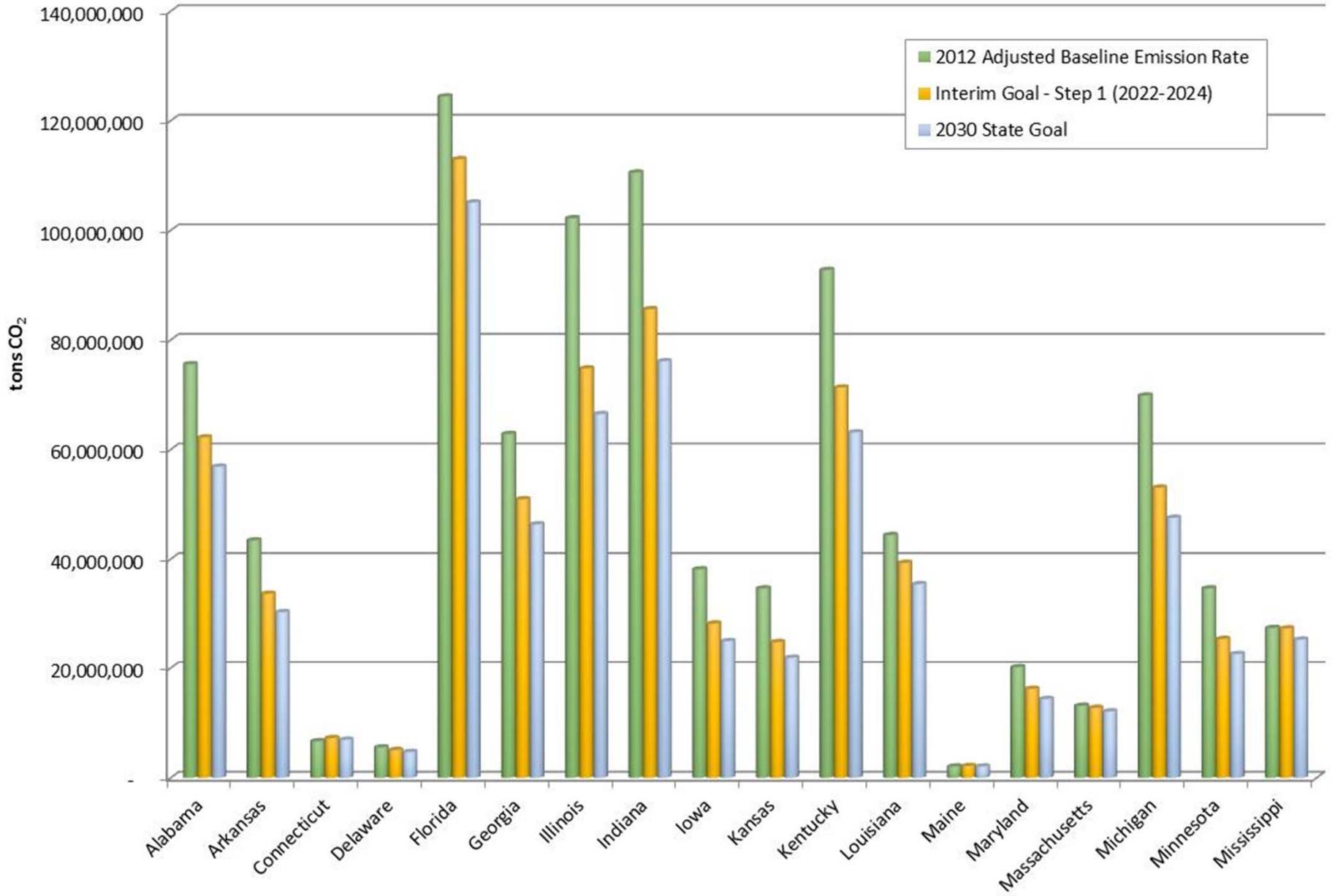
$$(FS_{\text{Baseline}} \times FS_{\text{Rate}}) + (NGCC_{\text{Baseline}} \times NGCC_{\text{Rate}}) + \text{BB3 Adj}$$

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



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

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 CO₂ emission performance rates over the period of 2022 – 2029 and the final CO₂ performance rates, rate-based goals, or mass-based goals by 2030.”

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 CO₂ Emission Goals

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.

Implementation EPA's Proposed Rate-Based Trading



Proposed Rate-Based Program:



↑
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.

Proposed Rate-Based Program:

Potential measures to reduce CO₂ 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

Sargent & Lundy ^{LLC}

Measures to Reduce CO₂ 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 CO₂ 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 CO₂ 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 CO₂ emissions (from baseline).

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

Final State Goal = 1,130 lb/MWh

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**

Emission Reduction Credits

- **Gas-Shift ERCs (GS-ERCs)**
 - Credited to existing NGCC Units
 - Calculated to represent CO₂ emission reductions from incremental NGCC generation.

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



Gas-Shift ERCs (GS-ERCs)

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

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

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

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
Δ NGCC 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

- **CO₂ 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**

Renewable Energy ERCs (RE-ERCs)

- RE-ERCs will be credited to eligible RE resources
- Eligible RE resources include new wind, solar, geothermal, hydropower, biomass, wave and tidal power...
- 1 ERC / zero CO₂-emitting MWh

Example:

6,558,770 tons

= 1,045 lb/MWh

6,167,500 MWh + 198,000 GS-ERCs + RE-ERCs

RE-ERCs = 6,187,000 MWh

Implementation EPA's Proposed Mass-Based Trading



Proposed FIP Mass-Based Program:



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.



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



Output-Based Set-Aside (Δ NGCC 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 existing NGCC units based on their level of electricity generation in the previous compliance period
- Allocation rate will be calculated as:

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

Capacity Factor
above 50%

§111(b) NSPS
(lb/MWh)

Proposed Mass-Based Program

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Mass-Based Example (State Allowance Pool):

	1 st Interim Period	2 nd 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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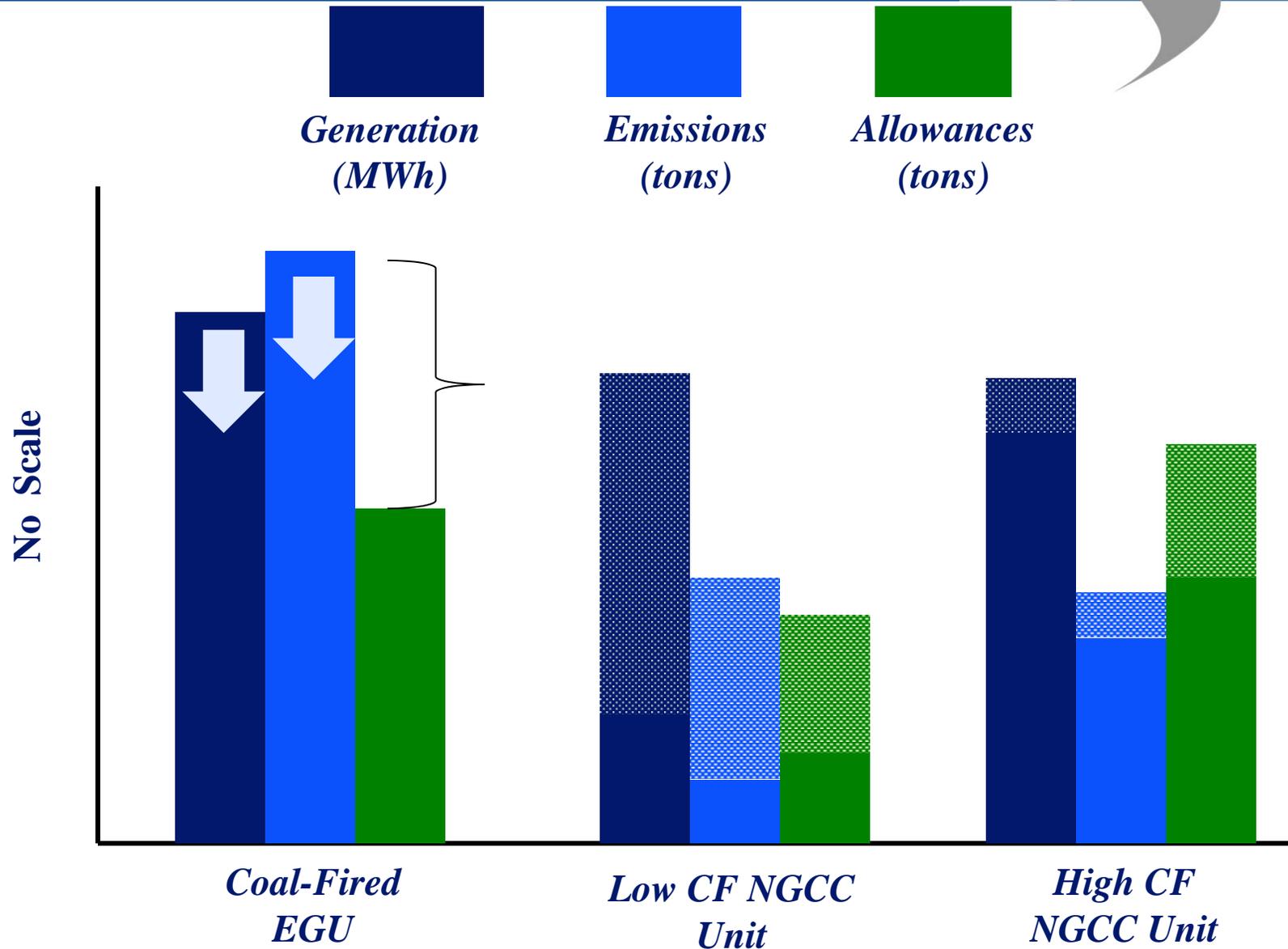
Mass-Based Example (NGCC Units):

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 = $MW_{Cap} \times (0.7 - 0.5) \times 8,760 \times 1,030 / 2,000$**
- **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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- **Compliance Planning**
- **Questions / Answers / Panel Discussion**

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 CO₂ emission reduction measures, including natural gas co-firing and natural gas conversion, could provide significant CO₂ 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 be 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 (Δ NGCC) set-aside allowances may be needed to offset increased CO₂ 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.

Planning for Compliance:

Building Block 1

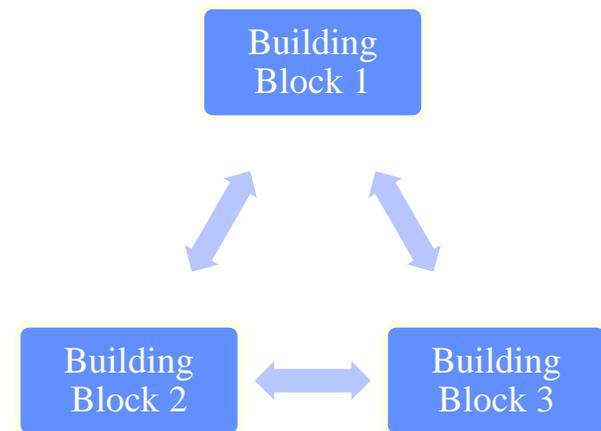
- Identify potential CO₂ emission reduction opportunities: heat Rate improvements, fuel co-firing, natural gas-conversion, carbon capture.

Building Block 2

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

Building Block 3

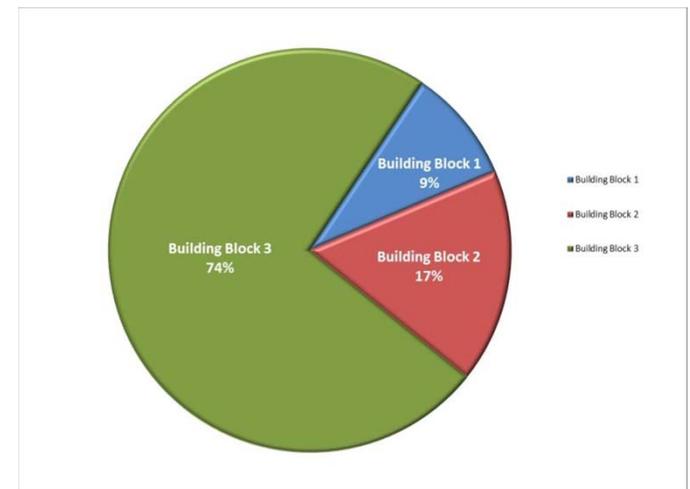
- Evaluate potential NEW RE capacity and generating opportunities



Planning for Compliance

RE Generation - General Eligibility Requirements:

- Only RE measures installed after 2012 are eligible for adjusting CO₂ emission rates or generating CO₂ allowances.
- Only the quantifiable and verifiable MWh of RE generation produced in 2022 and future years may be applied to adjusting CO₂ emission rates or generating allowances.



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**

Questions/Answers

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