



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

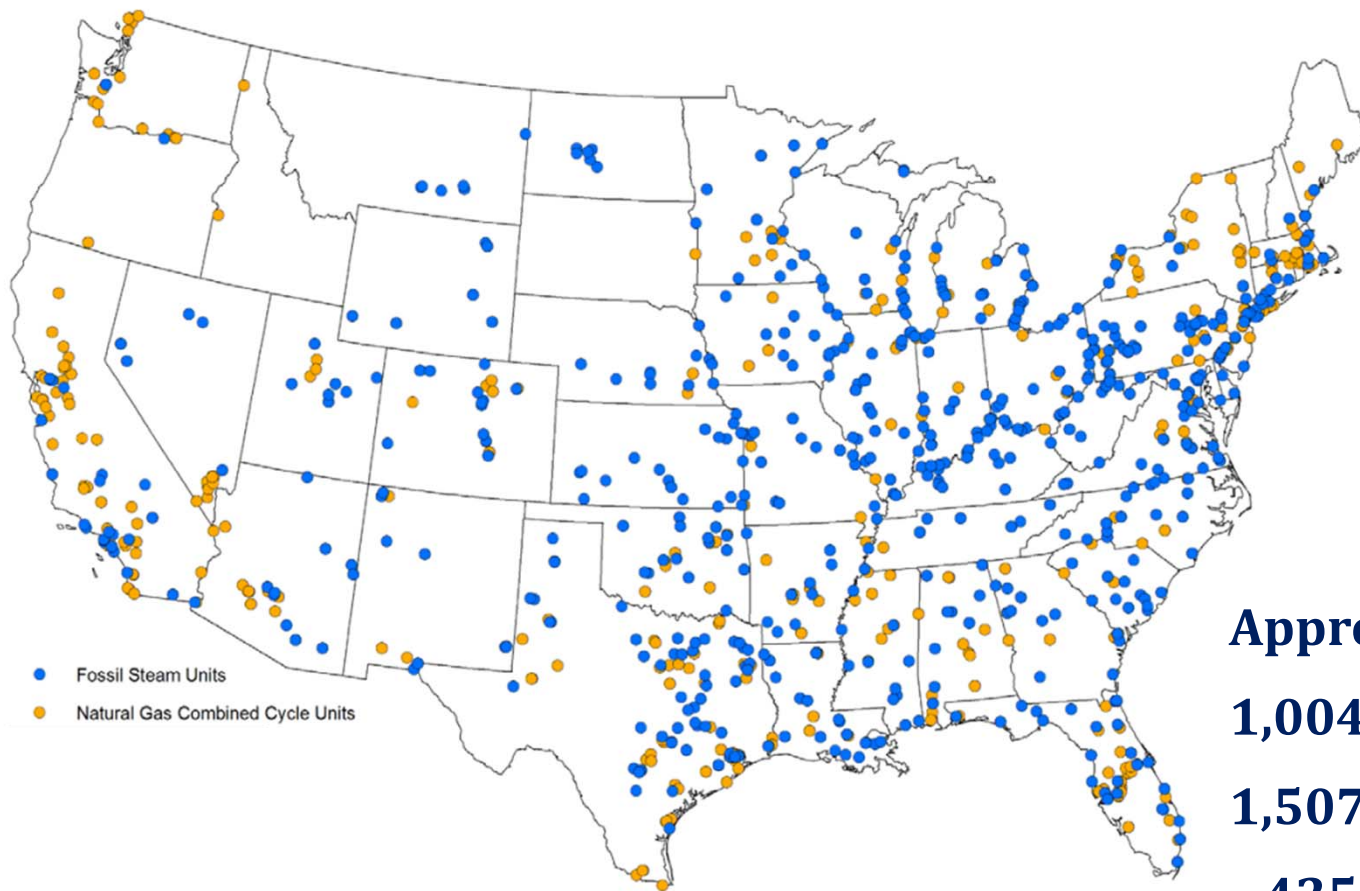
➤ **Applies to:**

- **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



● 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

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


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


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

BSER Determination:

Building Block 2: Incremental NGCC (“ΔNGCC”)

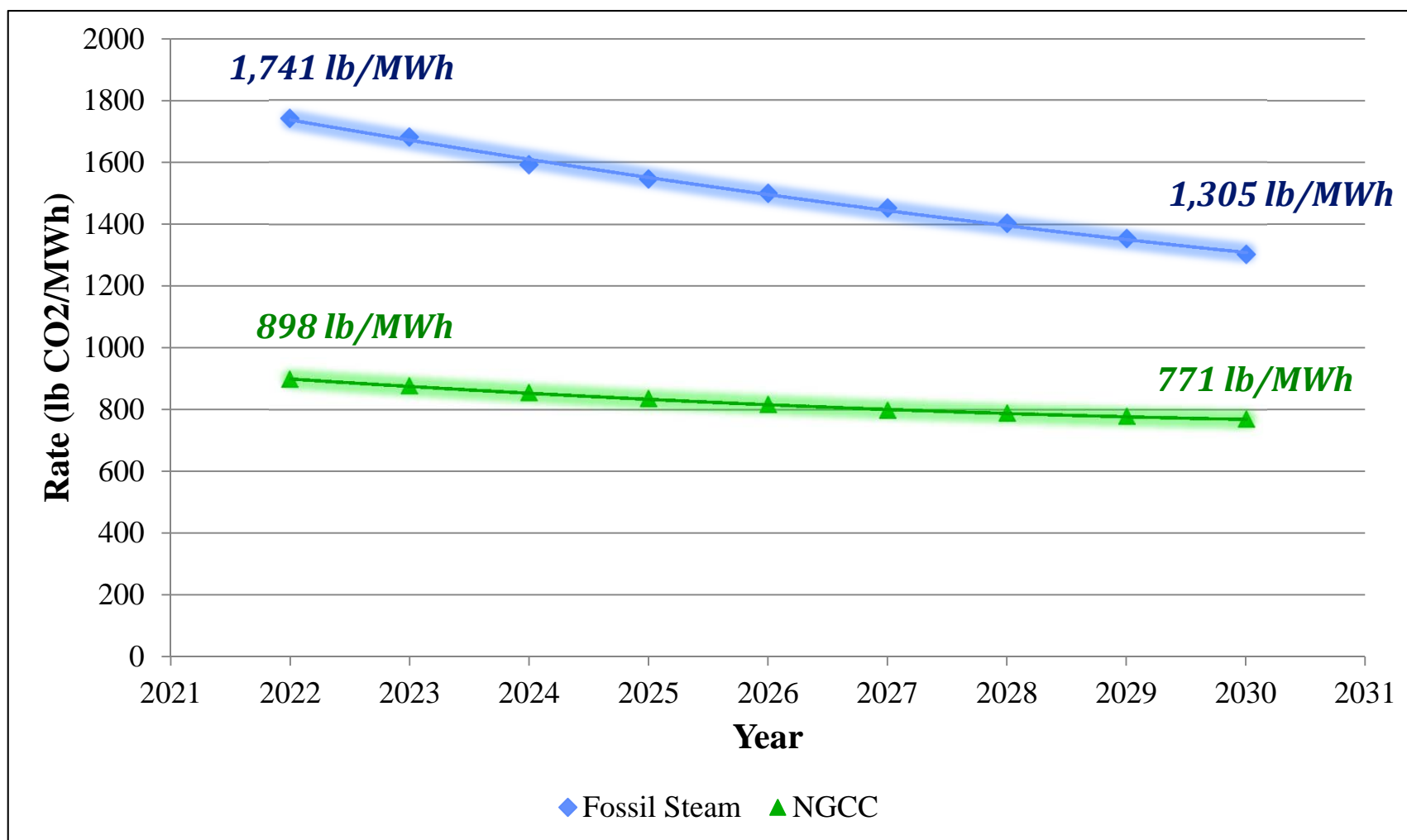
- Substituted existing FS generation with ΔNGCC generation
- ΔNGCC Generation

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

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


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

BSER Determination:

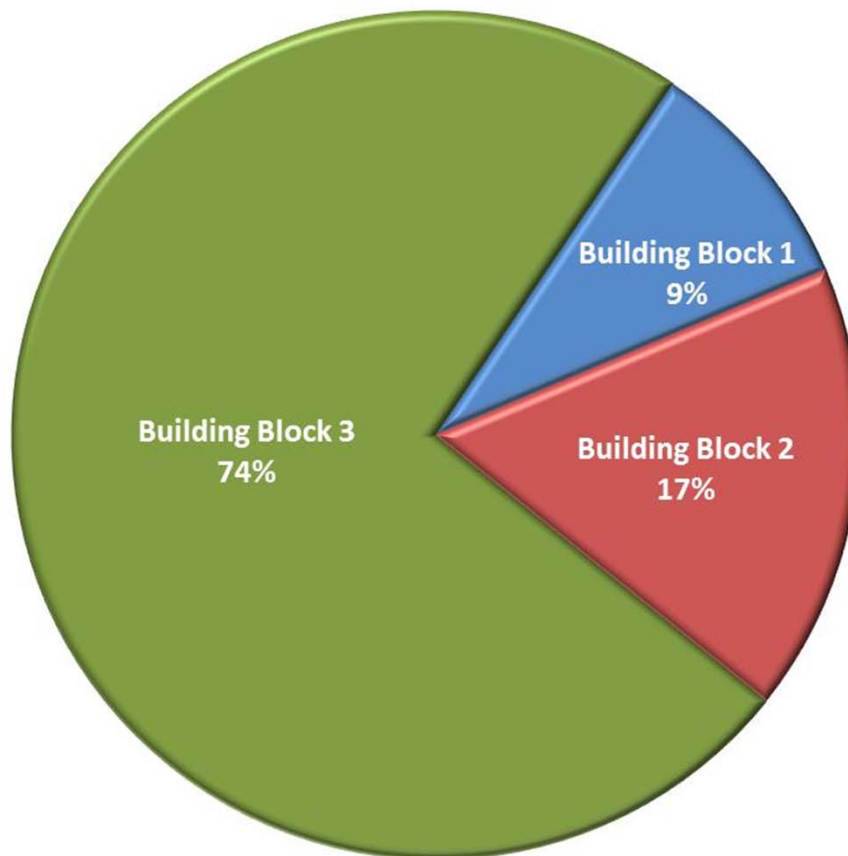


BSER Determination:

- **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

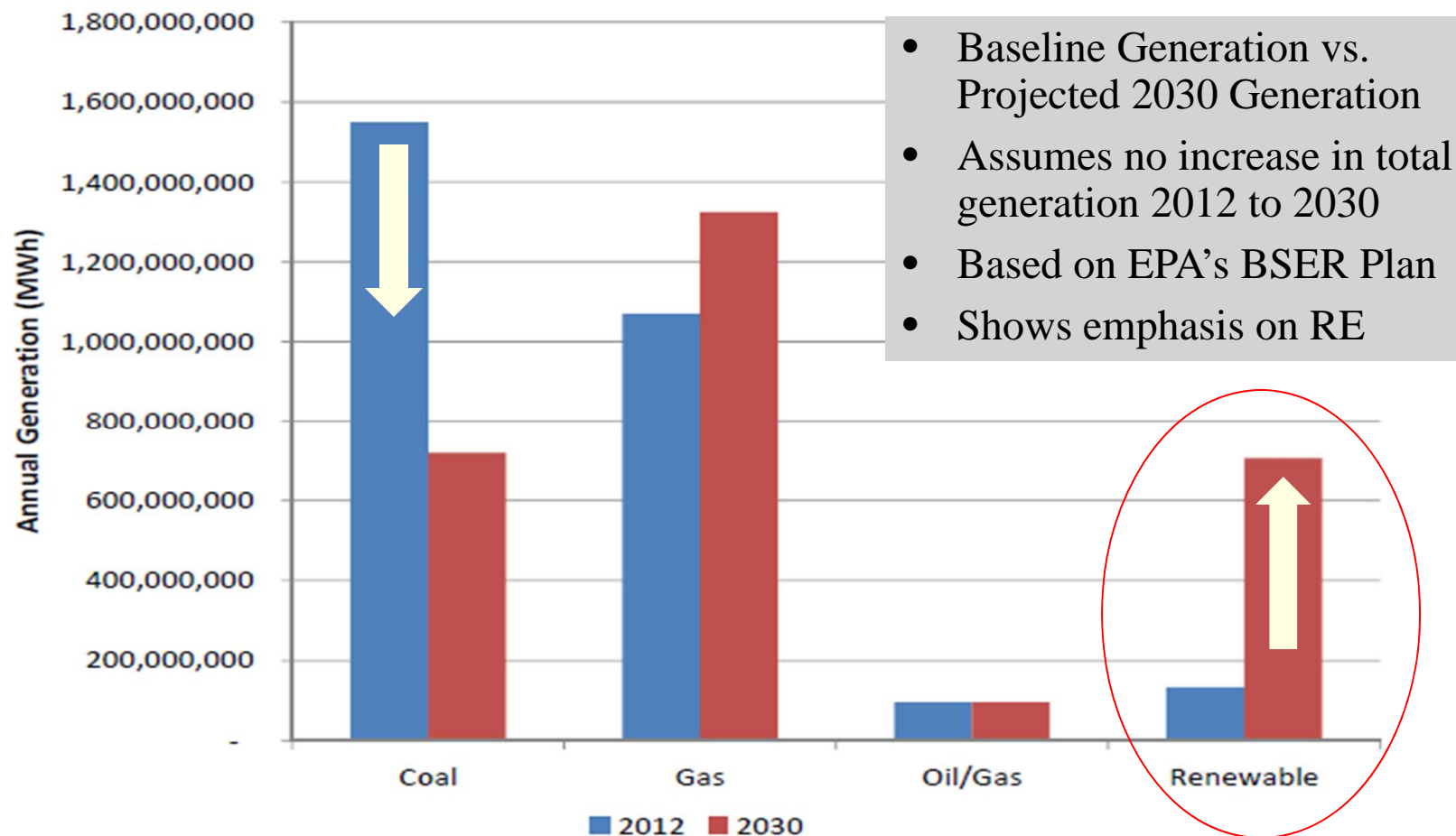
Building Block 2: 123,617,000

Building Block 3: 530,889,000

Clean Power Plan

Sargent & Lundy LLC

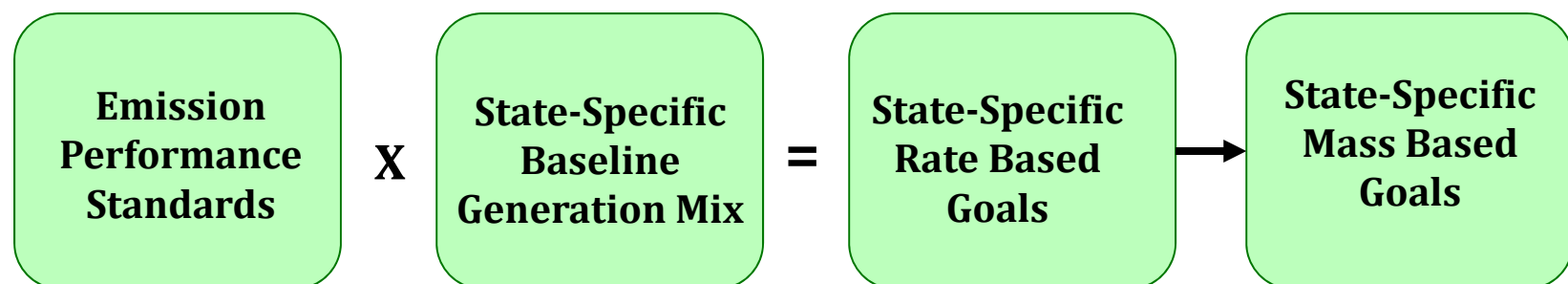
- **Renewable Energy will play a significant role in either a rate-based or mass-based program:**



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

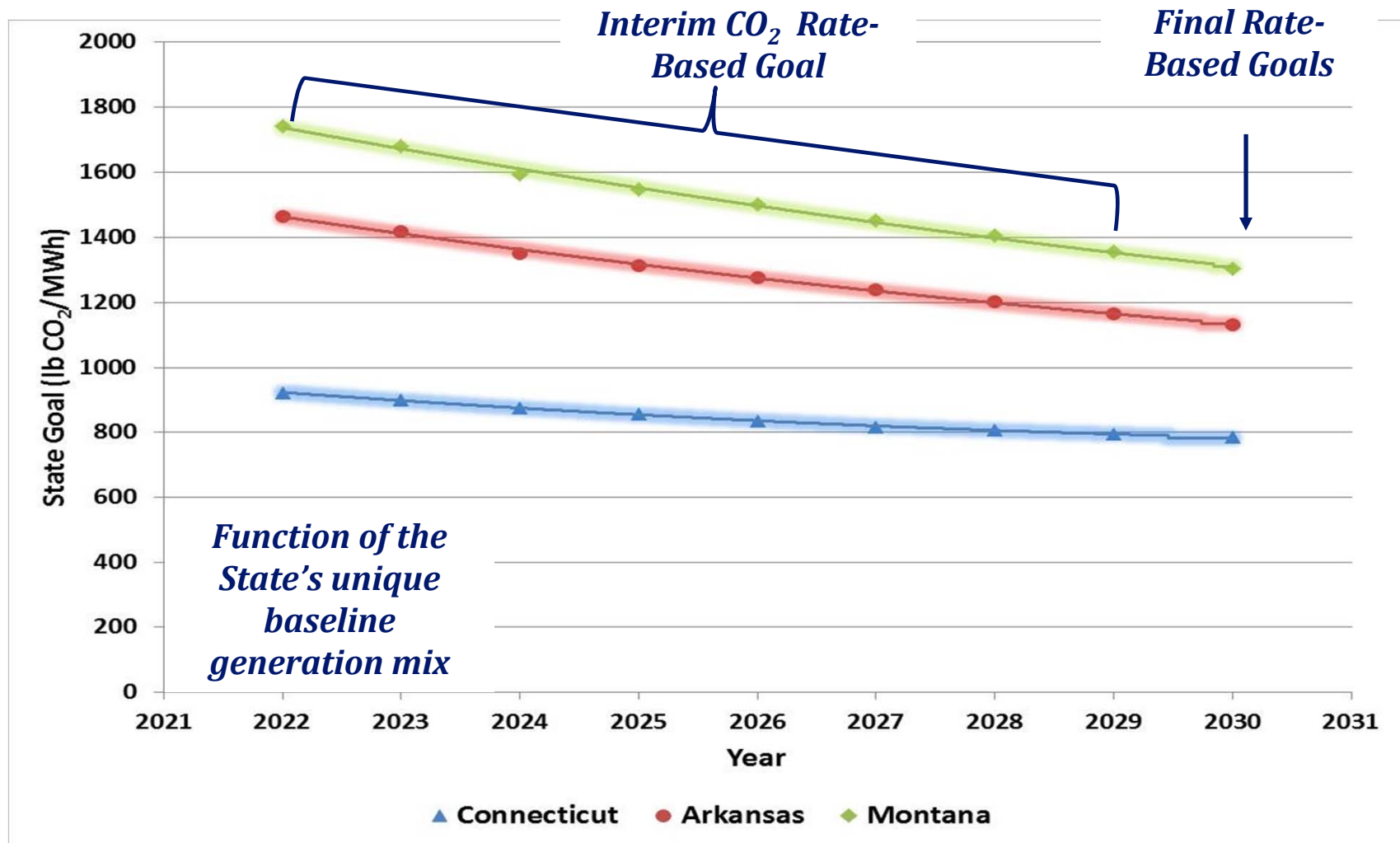
2030 Rate-Based Goal:

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

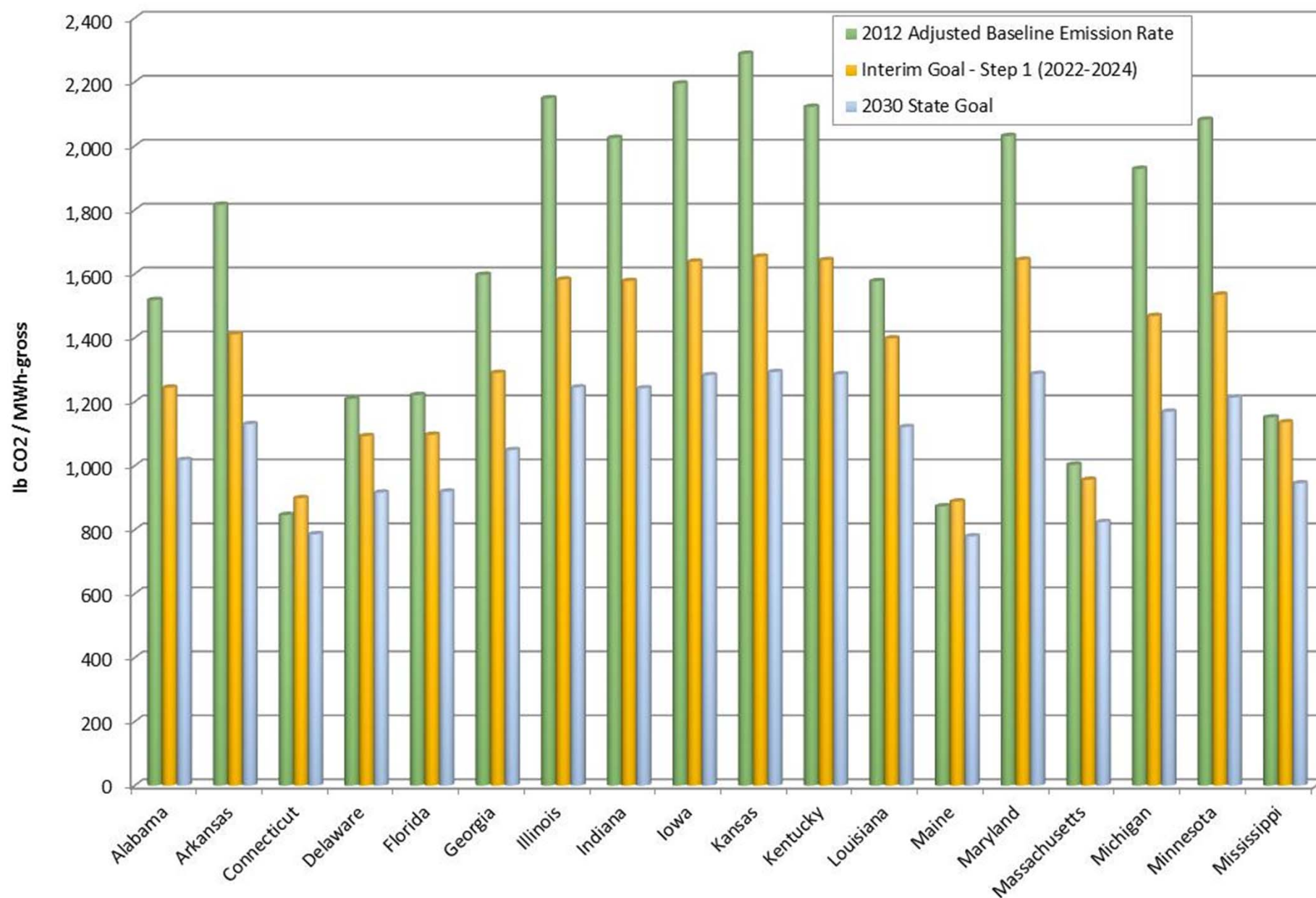
Clean Power Plan

Sargent & Lundy ^{LLC}

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

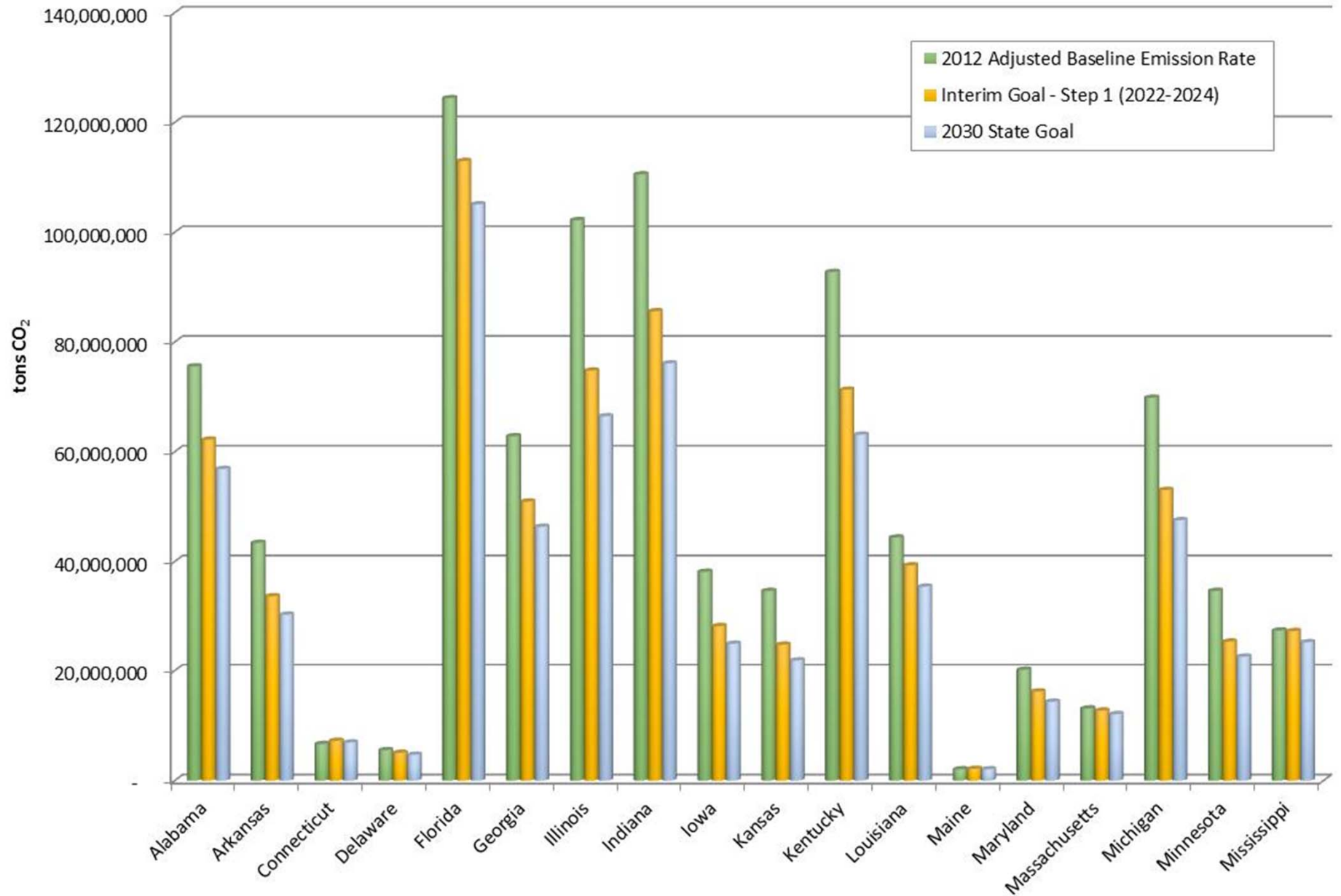
$$(\text{FS}_{\text{Baseline}} \times \text{FS}_{\text{Rate}}) + (\text{NGCC}_{\text{Baseline}} \times \text{NGCC}_{\text{Rate}}) + \text{BB3 Adj}$$

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

Sargent & Lundy LLC

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**

Proposed Rate-Based Program

Sargent & Lundy ^{LLC}

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



Proposed Rate-Based Program

Sargent & Lundy ^{LLC}

Gas-Shift ERCs (GS-ERCs)

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

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

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

$$\text{E.g., } 1,000,000 \text{ MWh} \times 0.22 \times 0.45 = 99,000 \text{ ERCs}$$

Proposed Rate-Based Program

Sargent & Lundy ^{LLC}

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

- $\text{CO}_2 \text{ Emissions} = \text{Remaining Coal} \times \text{Baseline Rate}$
- $\text{GS-ERC} = 2,000,000 \times 0.22 \times 0.45 = 198,000 \text{ allowances}$
- $\text{New Rate} = \text{Emissions} / \text{MWh} + \text{ERC}$

Proposed Rate-Based Program

Sargent & Lundy LLC

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

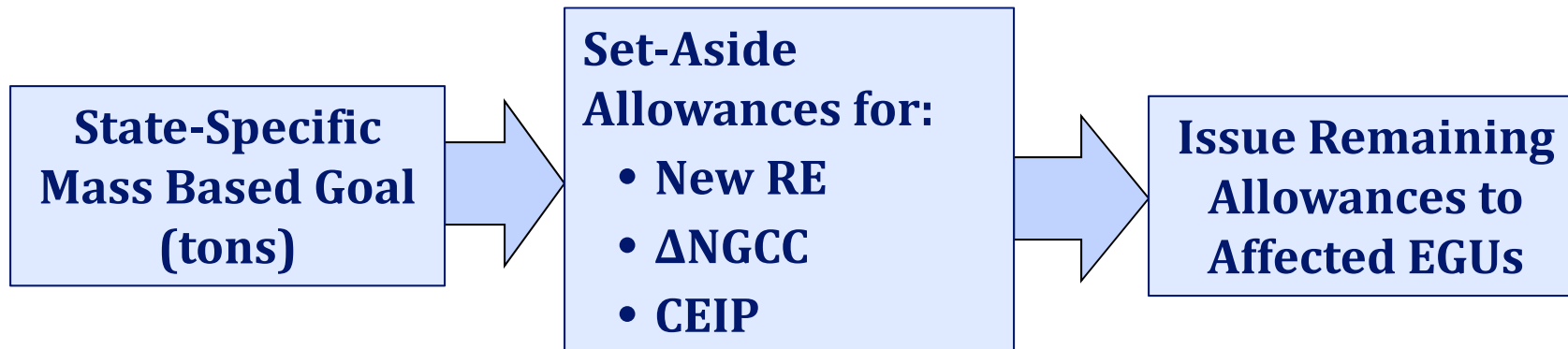
Example:

$$\frac{6,558,770 \text{ tons}}{6,167,500 \text{ MWh} + 198,000 \text{ GS-ERCs} + \text{RE-ERCs}} = 1,045 \text{ lb/MWh}$$
$$\text{RE-ERCs} = 6,187,000 \text{ MWh}$$

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 existing 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



Proposed Mass-Based Program

Sargent & Lundy LLC

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 exiting 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

Sargent & Lundy LLC

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

Sargent & Lundy LLC

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

Sargent & Lundy LLC

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

Sargent & Lundy LLC

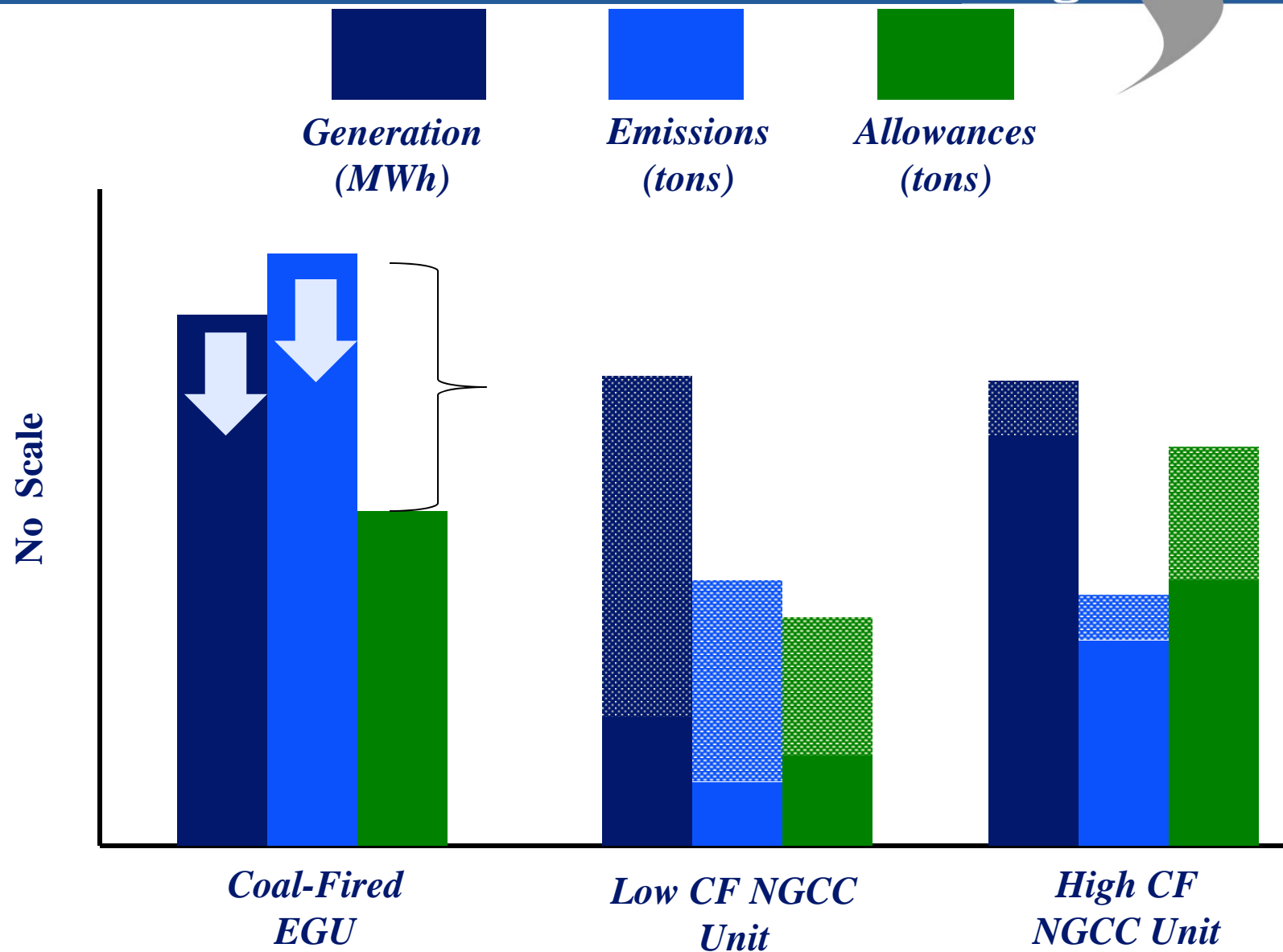
Mass-Based Example (NGCC Units):

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

Sargent & Lundy ^{LLC}



- Overview of EPA's Clean Power Plan
 - Performance Standards
 - State-Specific Goals
- Implementation
- **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

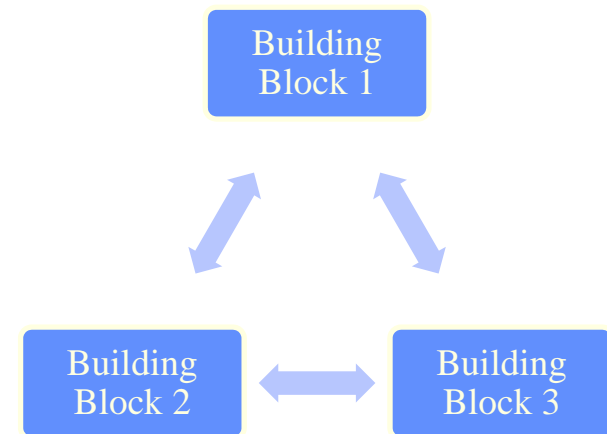
- Identify potential CO₂ emission reduction opportunities: heat Rate improvements, fuel co-firing, natural gas-conversion, carbon capture.

Building Block 2

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

Building Block 3

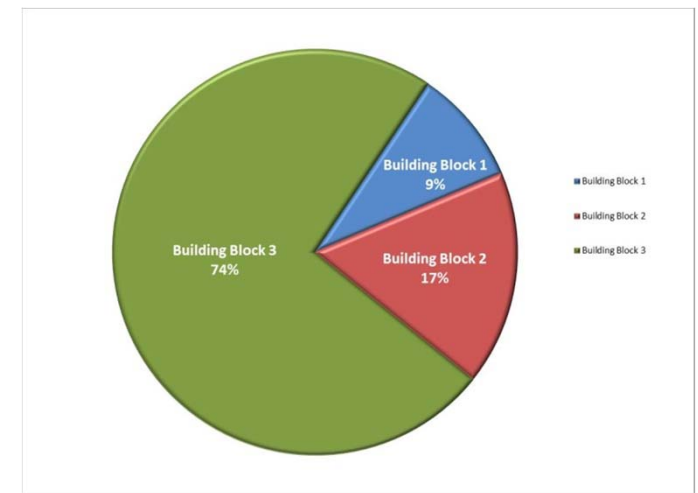
- Evaluate potential NEW RE capacity and generating opportunities



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

For additional information, please contact:

Andrew Carstens
Director Environmental Services
312-269-3640

andrew.j.carstens@sargentlundy.com

Ken Snell
Sr. Manager Environmental
312-269-2318

kenneth.j.snell@sargentlundy.com

The information provided by Sargent & Lundy ("S&L") in this presentation is intended to provide general information on a particular topic and is not intended to be a substitute for a discussion, consultation, or advice with an appropriate professional. There are no express or implied representations or warranties related to the information presented or contained in any presentation materials, nor is there any guarantee that the information is error-free, or that it meets any sort of performance or quality criteria. In no event shall S&L be held liable to any party for any direct, indirect, implied, punitive, special, incidental or other consequential damages arising directly or indirectly from any use of this information and material, which is provided as is. S&L, its affiliates, officers, and employees, shall not be liable for any decision made or action taken in reliance on the information provided. The materials provided are owned by S&L and may only be used for personal or internal use, and may not be copied, redistributed, or otherwise provided to third parties without the express written authorization of S&L.