Assessing the Options under EPA's Clean Power Plan

Friday, January 30, 2015

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Overview

- Overview of Modeling Approach
- Discussion of the Policy Scenarios
- Description of the *DIEM-Electricity* Model
- DIEM Model Results
  - Note that we are still exploring the best ways to represent behavior of existing coal plants and construction of new NGCC in the early years of the policy. Any adjustments we make will flow through to affect all model results to some degree, but will not affect the relative orderings of the policies as such adjustments would tend to increase the costliness of rate-based approaches compared to mass-based alternatives.
- Next Steps
- Sensitivity Analysis (at the end)

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EPA CPP Proposal and Building Blocks related to Modeling

- Each state must meet an emissions rate goal (lb/MWh)
  - EPA's "Option 1" in RIA's Illustrative Analysis with goals through 2030
- Flexibility Mechanisms
  - Rate-based emissions goals
    - States go it alone (averaging across units within a state)
    - Regional trading (averaging across units within a group of states)
  - "Outside the fence" options for renewables and efficiency
  - Possibility of conversion to a mass-based system
- Four Building Blocks (are options in this analysis):
  - Heat rate improvements at coal plants
  - Redispatching from coal to existing gas plants
  - Renewables and "at risk" or under construction nuclear
  - Energy efficiency

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Clean Power Plan Policy Scenarios

- Four main sets of scenarios (*Regional vs State* Trading)
  1) Rate-based trading among existing fossil units
  2) Mass-based trading among existing fossil units
     - Using EPA's state-level estimates of mass targets
  3) Rate-based trading including new NGCC
     - Same emissions rate goal as in Scenario #1 (EPA state goals)
  4) Mass-based trading including new NGCC
     - Again using EPA's rate-to-mass conversion calculations

2030 Goals	Emissions Rate (lb/MWh)	Mass from Affected Existing (MMTCO2)	Mass including new NGCC (MMTCO2)
Alabama	1,059	50.3	59.2
Florida	740	68.2	83.3
Georgia	834	31.7	42.4
Kentucky	1,763	70.2	82.0
Mississippi	692	16.4	18.9
North Carolina	992	36.9	45.2
South Carolina	772	15.8	22.0
Tennessee	1,163	22.8	33.0
Virginia	810	18.9	24.5

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Highlights of CPP Policy Analysis

➢ Ranking the policy options from lowest to highest costs:

1) Mass-based with regional trading
2) Mass-based with states acting alone
3) Rate-based with regional trading
4) Rate-based with states acting alone

- Under a rate-based approach, there is a large initial drop in coal generation, although coal utilization increases over time
- A mass-based approach helps existing coal and new NGCC at the expense of existing gas
- Under rate-based trading, if states in the Southeast act alone, policy costs are 15-30% higher than if they coordinate
- Costs of a mass-based approach are 40% lower than costs under regional rate-based trading over 2020-2030

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DIEM Model Summary

"Dynamic Integrated Economy/Energy/Emissions Model"

(link to documentation of 2013 version of model)

- Macroeconomic Component – not applied for this analysis
- Electricity Dispatch Component
  - Linear programming model
    - Minimize costs of generation subject to meeting demand and policies
  - U.S. regional markets (10-60 regions, 40 used in this analysis)
  - Historical and forecast data from IPM NEEDS, NREL, EIA's *AEO*
  - Model anticipates future policies, plans ahead to reduce costs
- Model Assumptions Affecting Findings:
  - Annual Energy Outlook 2014 – gas prices, demands, etc.
  - Model sees that CPP starts in 2020 and ends in 2030
    - It begins planning in 2015 to minimize CPP costs including new construction
  - Biomass or gas co-firing is not an option for coal plants
  - In the long term, the model assumes a 2^{nd} 20-year nuclear life extension

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DIEM-Electricity CPP Analysis

- <u>NOT</u> Forcing EPA "Building Blocks" (are choice in model)
- Coal Unit Efficiency Retrofits
  - Scaling of Sargent & Lundy data downward based on current heat rates
  - Implies average efficiency improvement of:
    - 2-3% at $50-$60/kW
  - <u>Allowed</u> in baseline (get 25 GW by 2030, 50 GW by 2050)
- Redispatch of existing NGCC is a choice based on cost
- Renewables can be constructed if cost effective
- New Nuclear is not counted in emissions rate goals
- Energy Efficiency can be selected if cost effective to use
  - Costs and amount available are from EPA's Technical Support Docs on CPP
  - <u>Allowed</u> in baseline (is cost effective with a 50% utility cost share)

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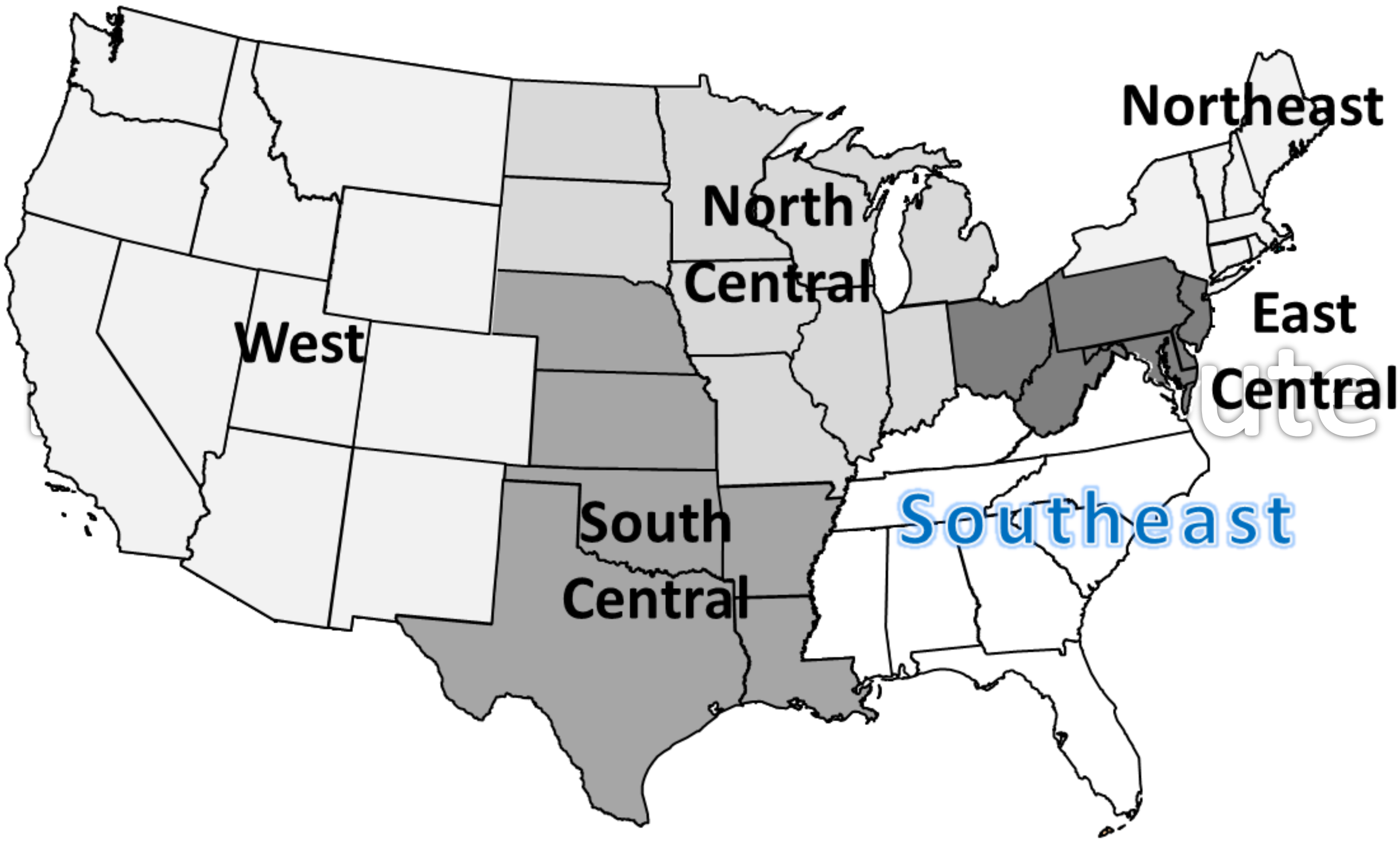
State Groupings for Regional Trading



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Important Policy Considerations

- Rate-based Trading
  - Units below the emissions rate goal are "subsidized" by being able to sell allowances for each hour they generate
  - Units above the emissions rate goal are "taxed" by needing to buy allowances from units generating below the goal
  - It is usually assumed that these interactions occur within the industry
    → no opportunity for states to raise revenue by selling allowances
- Mass-based Trading
  - All units are "taxed" in proportion to their emissions through needing to purchase allowances (unless they are grandfathered to the units)
  - If the state retains ownership of the allowances, they can raise a substantial amount of revenue through sales, but electricity bills may be higher unless revenue is used to lower utility costs or subsidize efficiency
  - A mass-based approach adds flexibility
    → lower costs
    → coal plants are cheaper to operate and will run more

Generation Results: What to Look For

- Rate-based Trading covering Existing Units
  - Coal generation drops quickly, recovers over time
  - Existing gas units maintain/increase output
  - New NGCC is constructed quickly
- Mass-based Trading covering Existing Units
  - Coal generation is significantly higher than under rate-based
  - Existing gas units decrease output a lot
  - New NGCC expands
- Rate and Mass Trading including new NGCC
  - Little difference between the two options (for these assumed targets) as most generation is now covered by the policy
  - The incentives of these approaches tend to shift generation into existing gas, and out of coal and new NGCC

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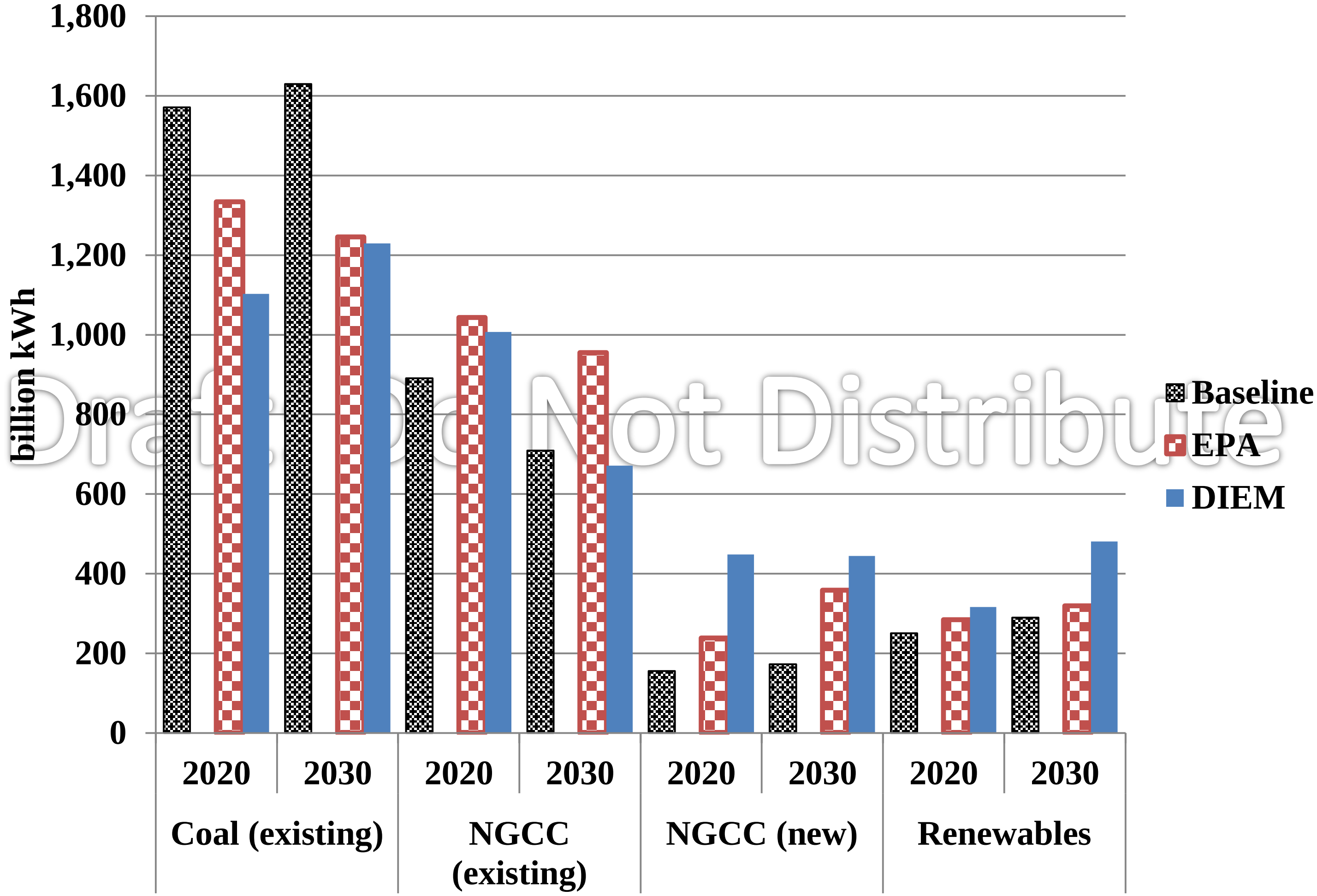
Generation in the United States

Rate-based Trading (Existing) – EPA vs DIEM



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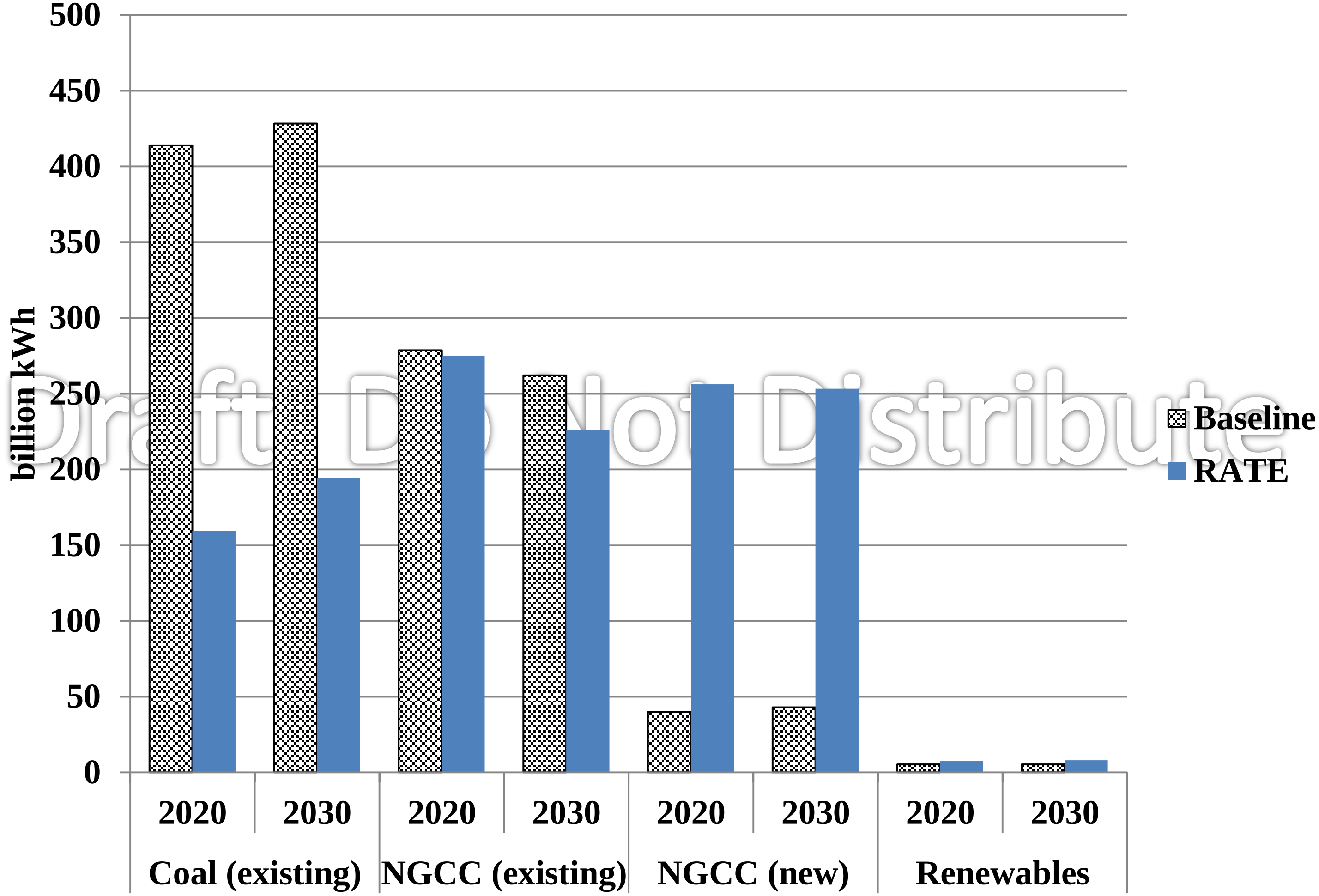
Generation in the Southeast

Rate-based Trading (Existing Units) – DIEM



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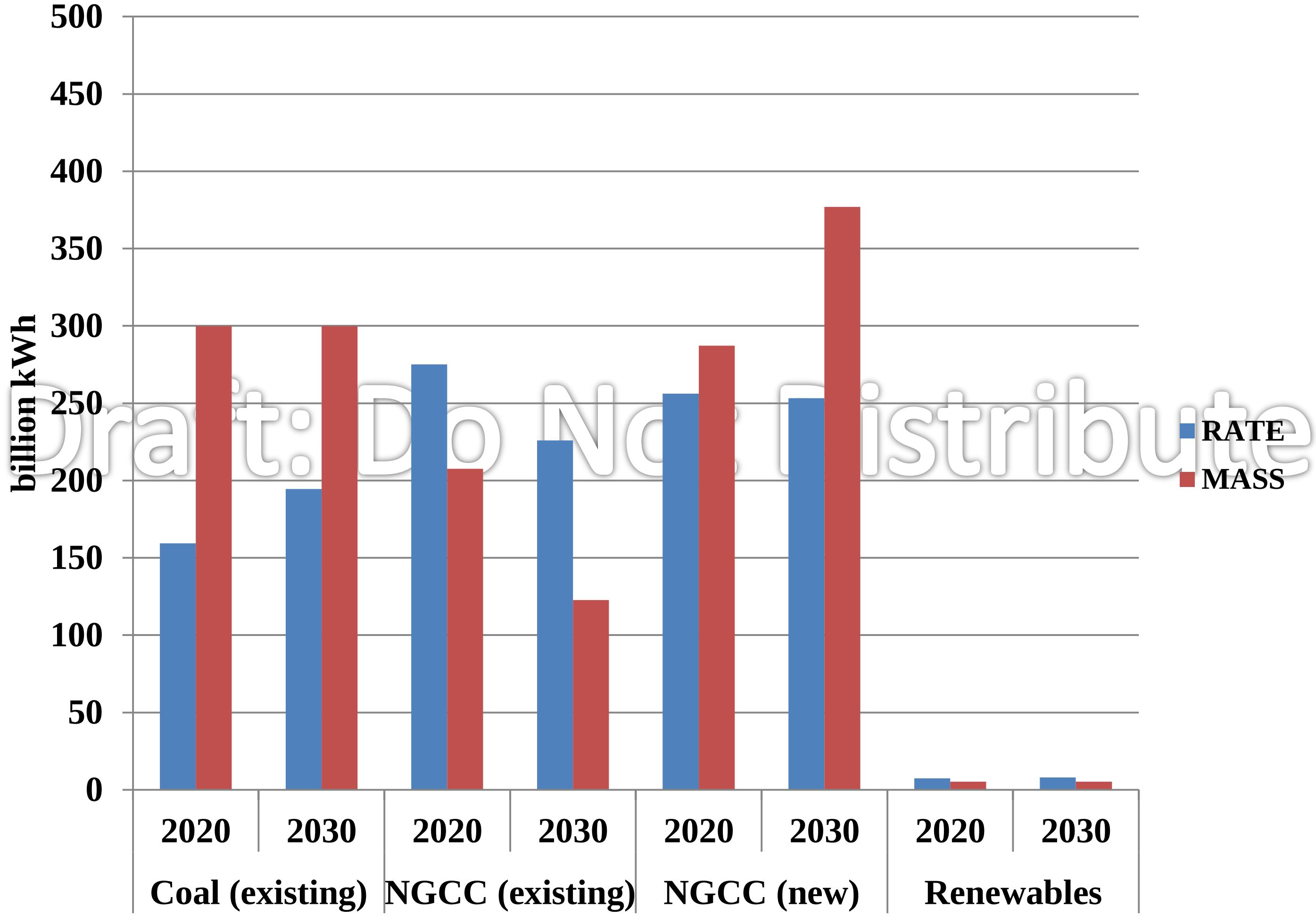
Generation in the Southeast

Rate-based vs Mass-based Trading (Existing)



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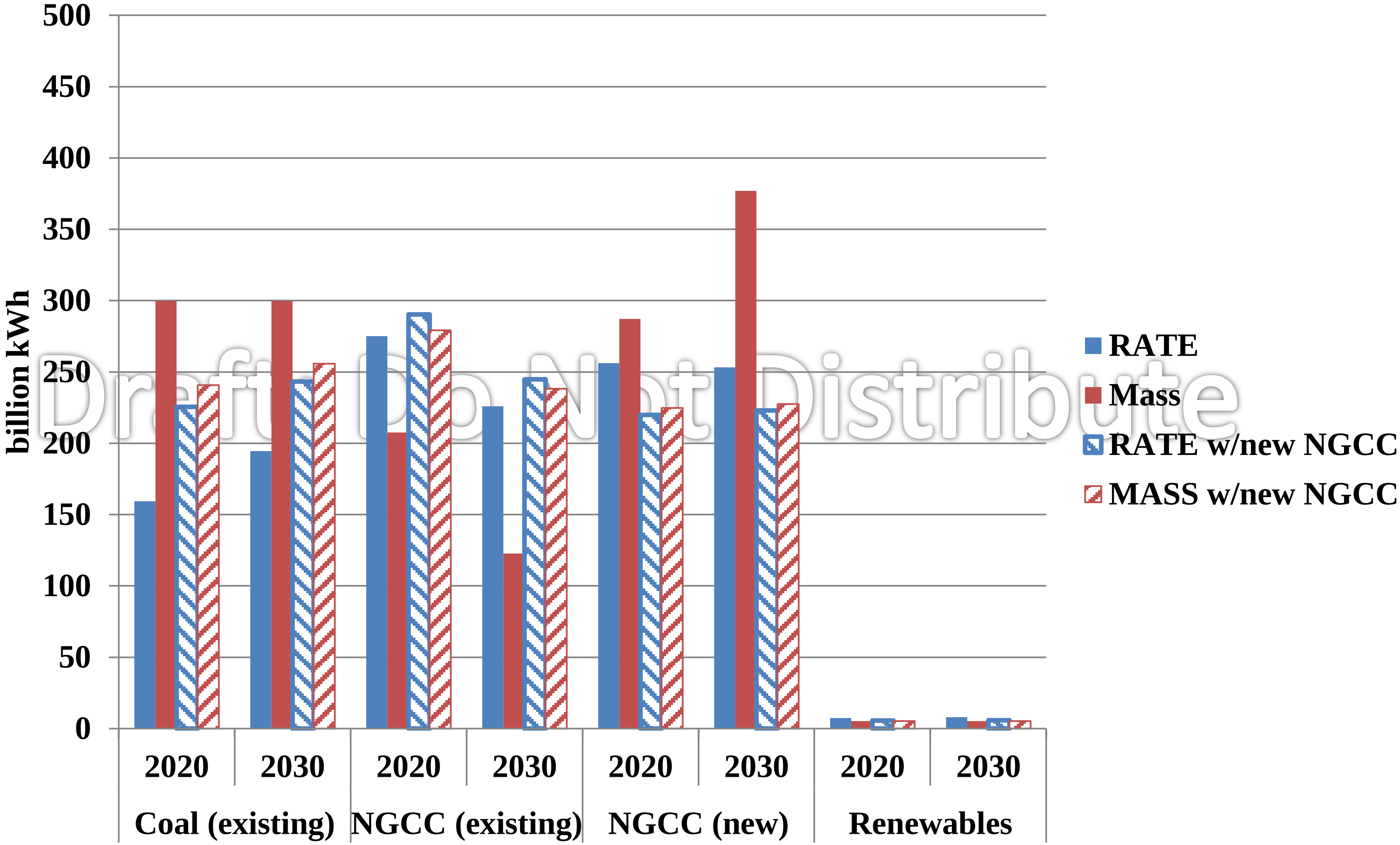
Generation in the Southeast

Rate vs Mass-based – Existing vs new NGCC



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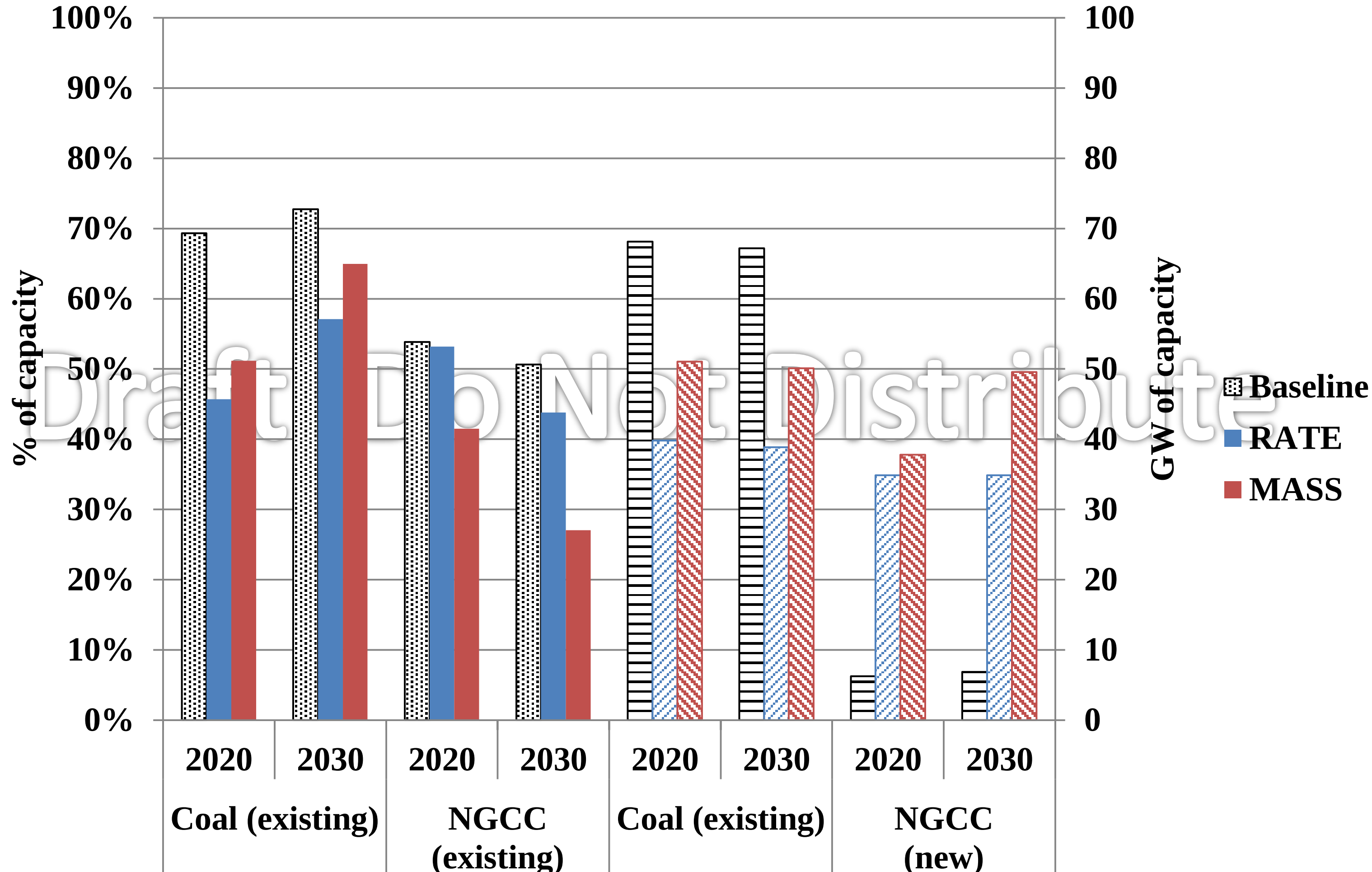
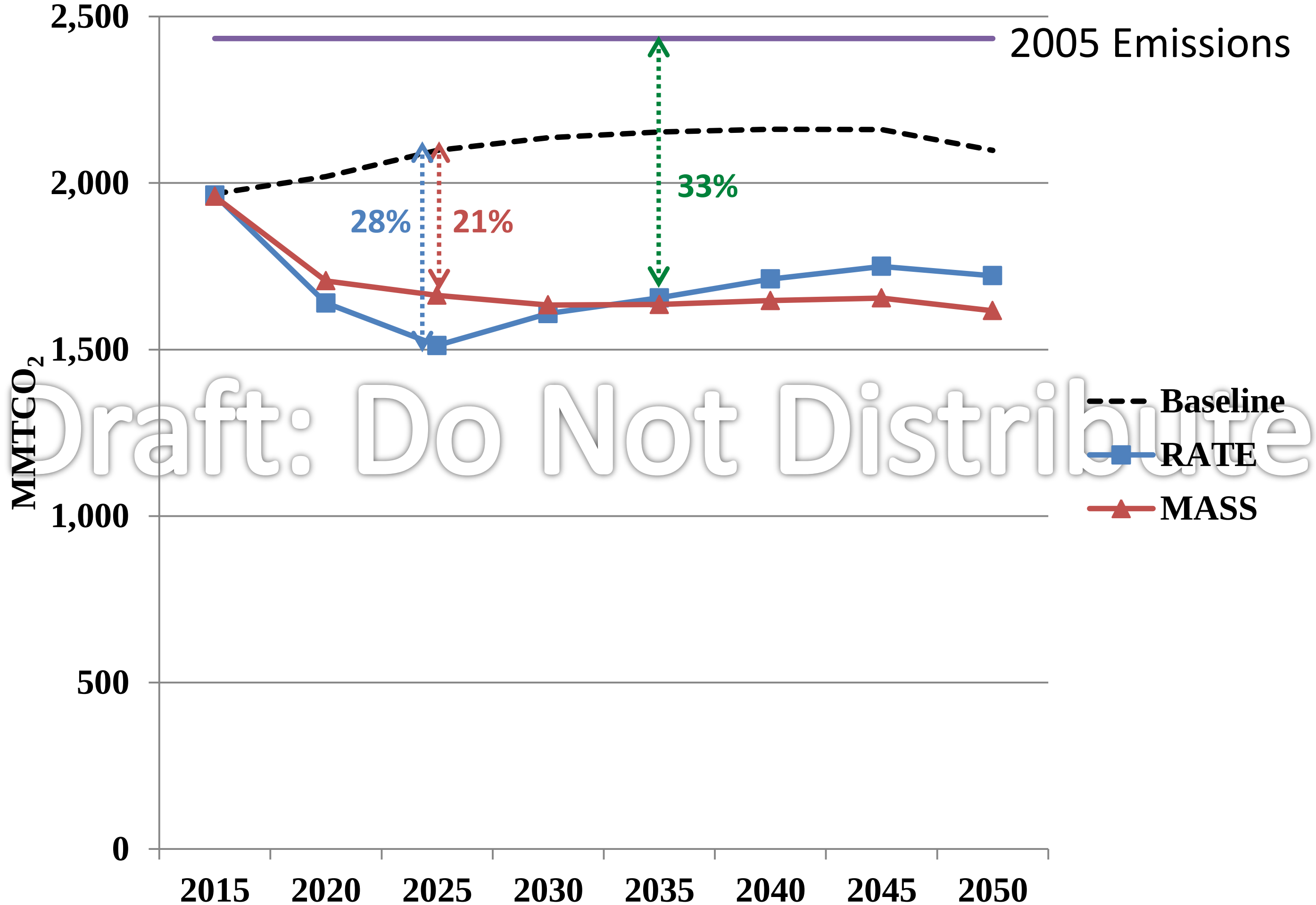
Utilization and Capacity in the Southeast

Rate-based vs Mass-based Trading (Existing)



Emissions in the United States

Rate-based vs Mass-based Trading (Existing)



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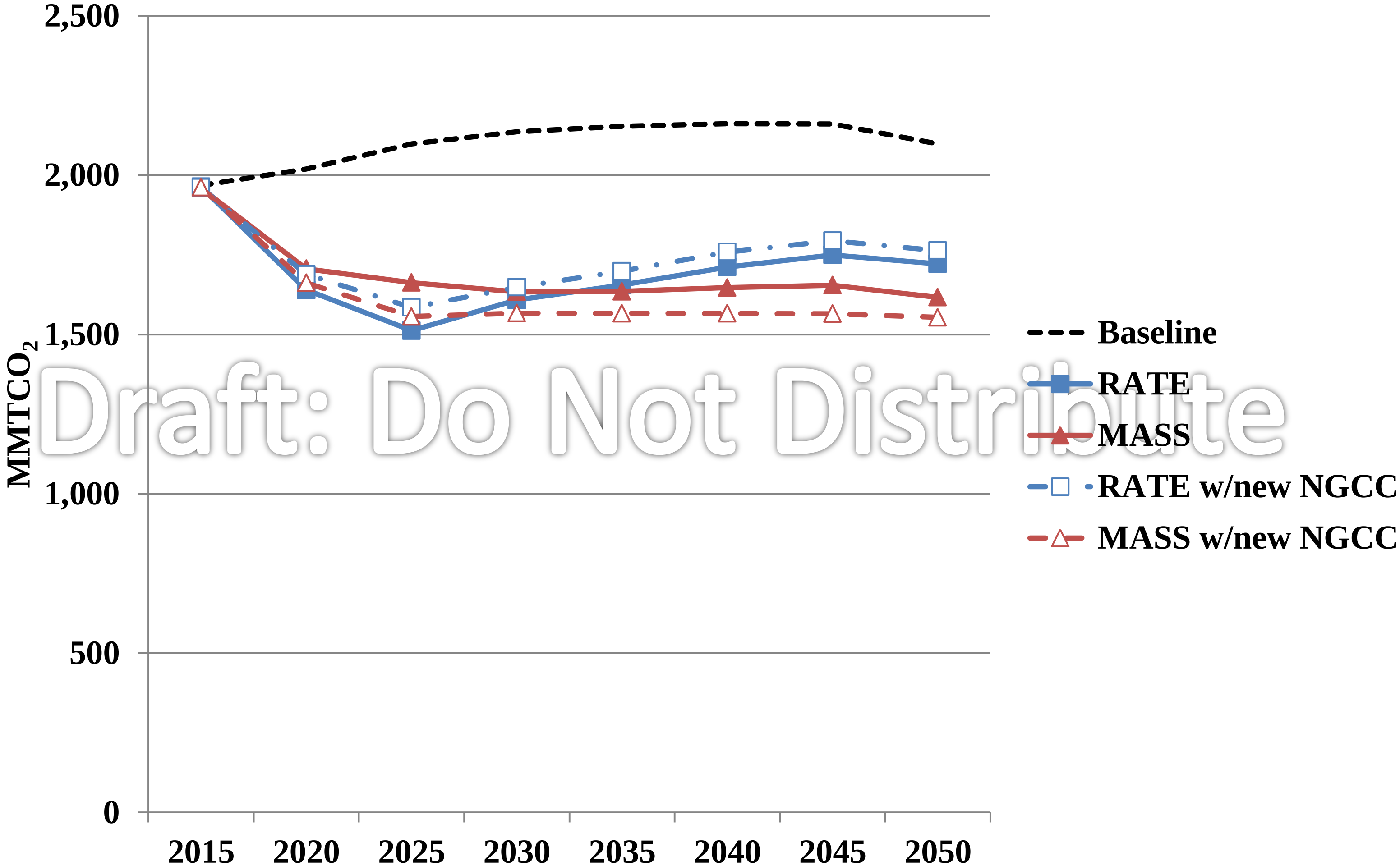
Emissions in the United States

Rate vs Mass – Existing vs new NGCC



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Important Cost Considerations

- Flexibility, in any form, will always lower mitigation costs as people seek out cost-effective responses to policy
- Because of foresight in model, construction decisions will be optimal as people plan ahead for future needs
  (affects costs and pattern of investments over time)
- When interpreting allowance prices (\$/ton CO_2)
  - In rate-based, fossil units pay price if over emissions rate and receive price if under emissions rate
  - In mass-based, affected fossil units pay price for all emissions
- Reported costs for mass-based policies do not include the value of CO_2 allowances as they represent a potential transfer between agents, rather than an economic cost to society as a whole
- Energy efficiency is allowed in the baseline (unlike EPA)
  - Removes its (apparent) cost savings from the policy results
  - Also true of coal efficiency retrofits but they have less impact

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What is the Baseline?

- Baseline – two alternatives to compare with policies
  1) With energy efficiency (EE)
  2) Without energy efficiency (EE)

  ➢ Keep in mind that, according to EPA data, energy efficiency (if cost effective) can lower electricity demand by 3% in 2020, 8% in 2025, and 11% in 2030

- How does EE approach affect estimated policy costs?

  – If the baseline resource costs are $52 billion without EE in 2025, and EE saves $2 billion, the baseline with EE included has a cost of $50 billion

  – Then, if total resource costs for CPP including EE are $53 billion, the change in costs due to CPP is **$1 billion** measured against a baseline that excludes EE ($53 billion - $52 billion)

  – Alternatively, the change in costs from CPP is **$3 billion** if cost savings from EE are already factored into the baseline ($53 billion - $50 billion)

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Policy Cost Results: What to Look For

1) Including energy efficiency (EE) in the baseline means that estimated policy costs will be higher because the EE savings are already factored into the model

2) Rate-based trading across existing units is the most expensive approach, especially in the early years

3) Mass-based trading across existing units is the cheapest option, with some additional savings from a regional approach over a states-go-it-alone approach

4) Policy costs can vary significantly across states for CPP's specified targets, although this variation could be alleviated through trade and policy coordination

5) For the specific assumptions in this analysis, rate-based and mass-based options that cover new NGCC are generally a costly approach

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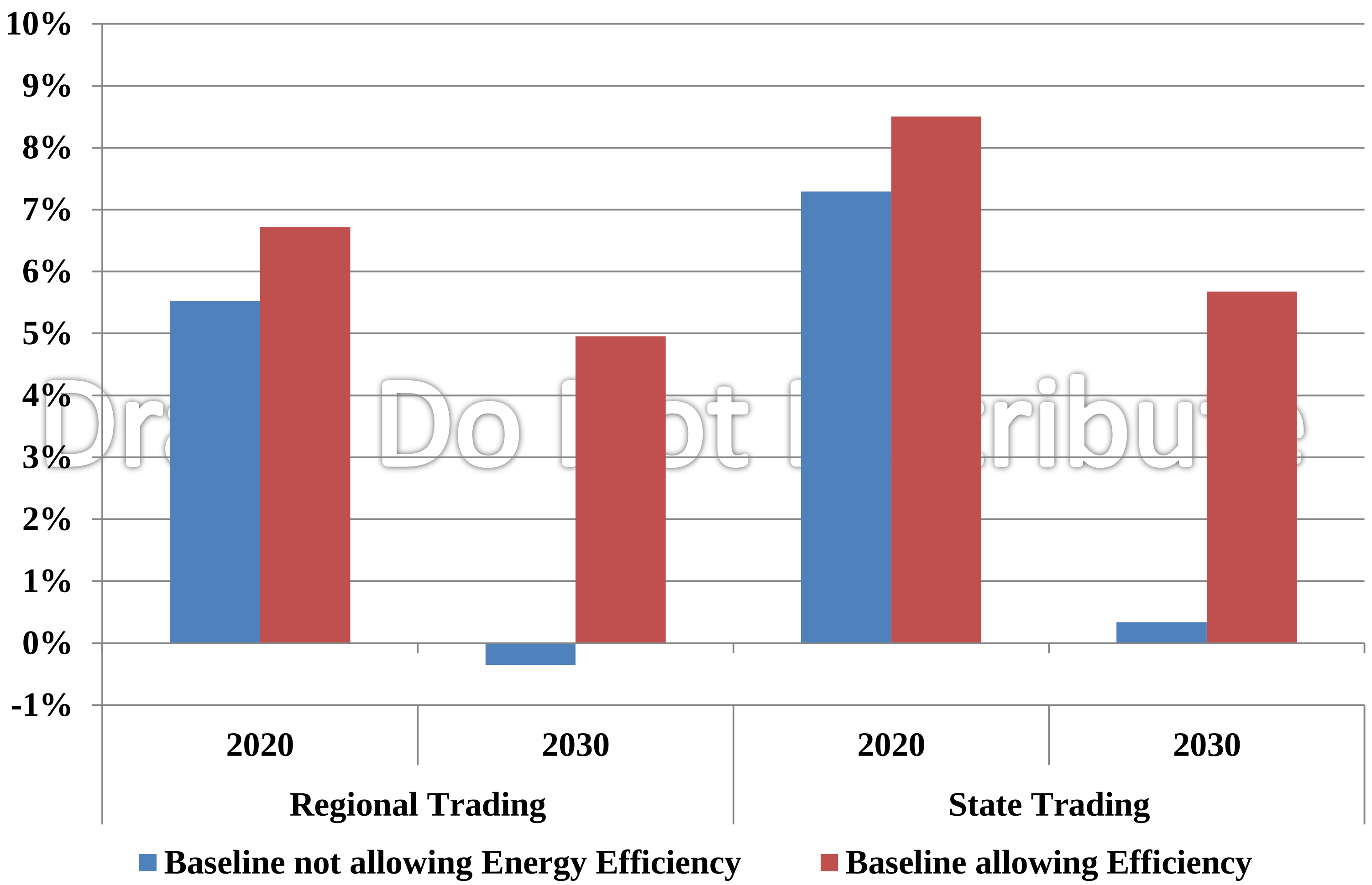
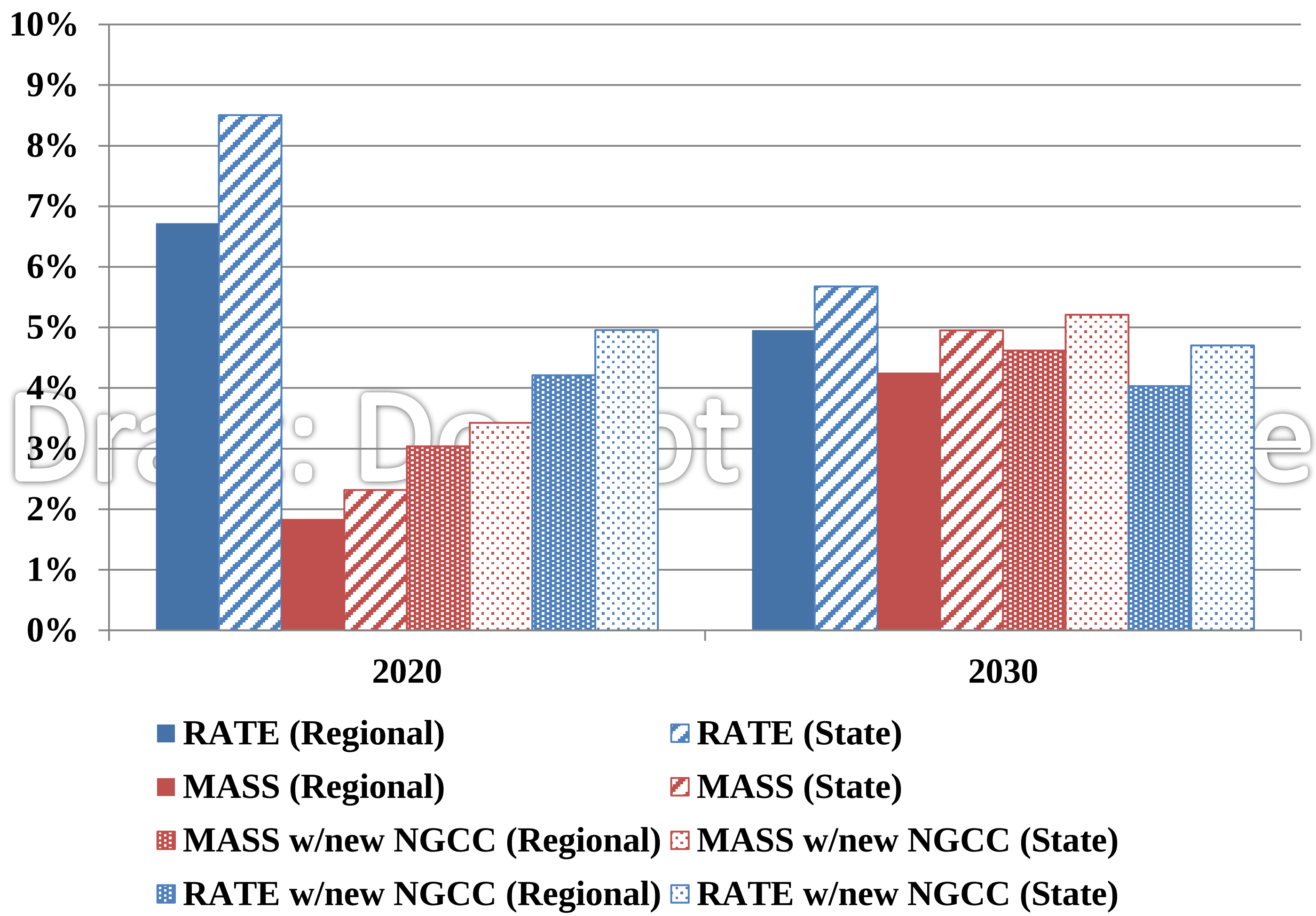
Percent Change in Costs for the Southeast

Rate-based Trading



Percent Change in Costs for the Southeast

All Policy Options



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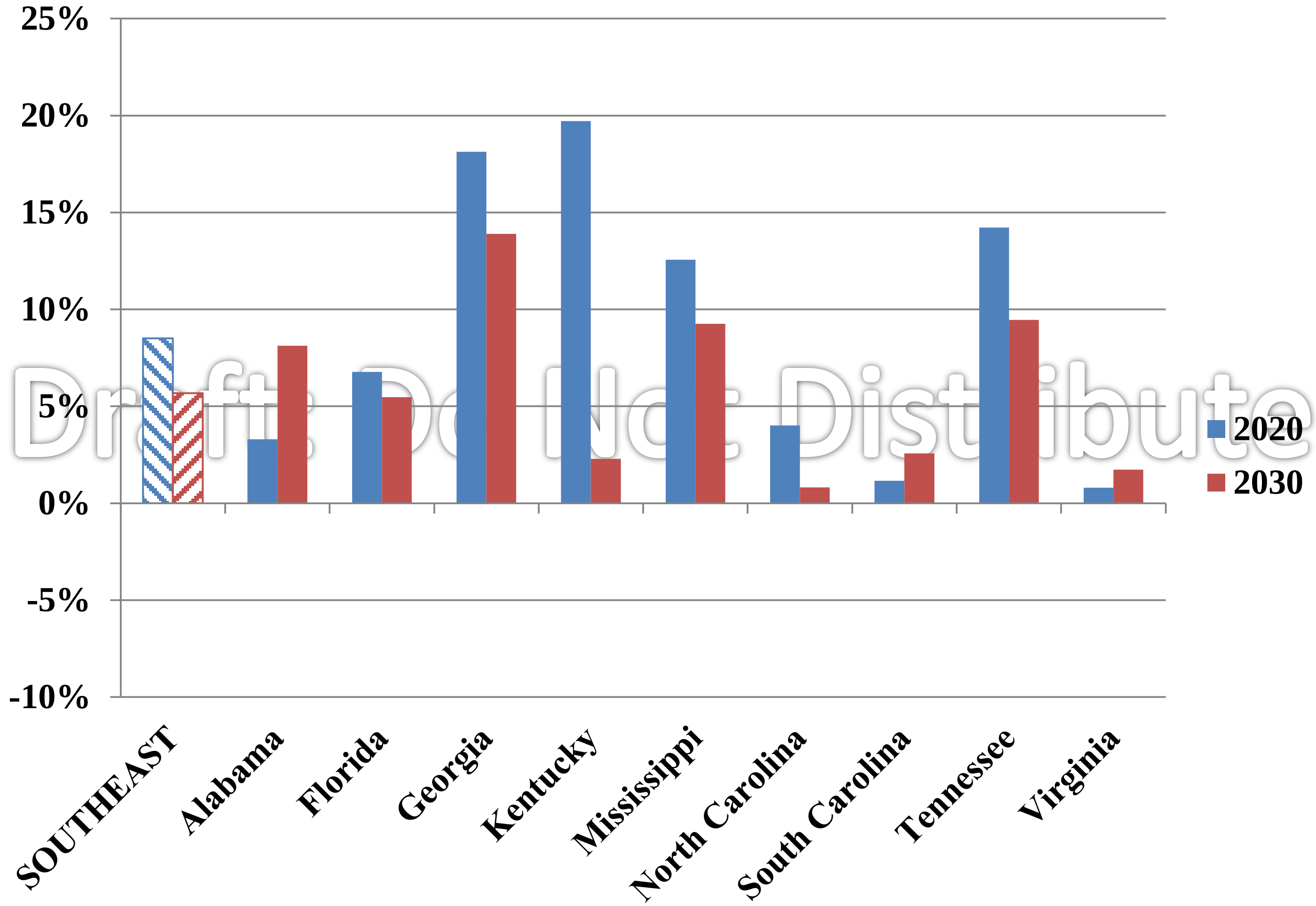
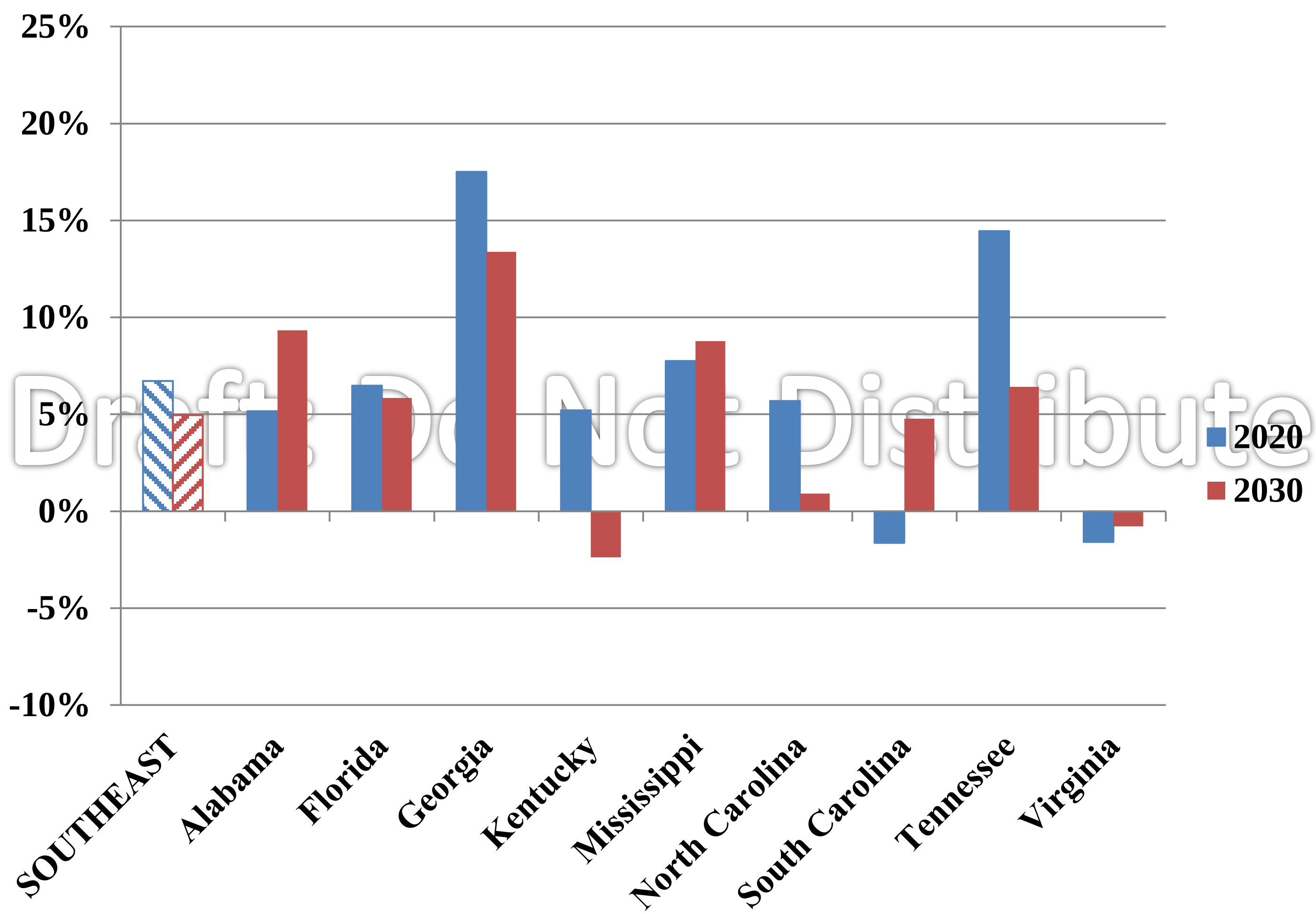
Percent Change in State Costs (Approximation)

Rate-based State Trading (Existing Units)



Percent Change in State Costs (Approximation)

Rate-based Regional Trading (Existing Units)



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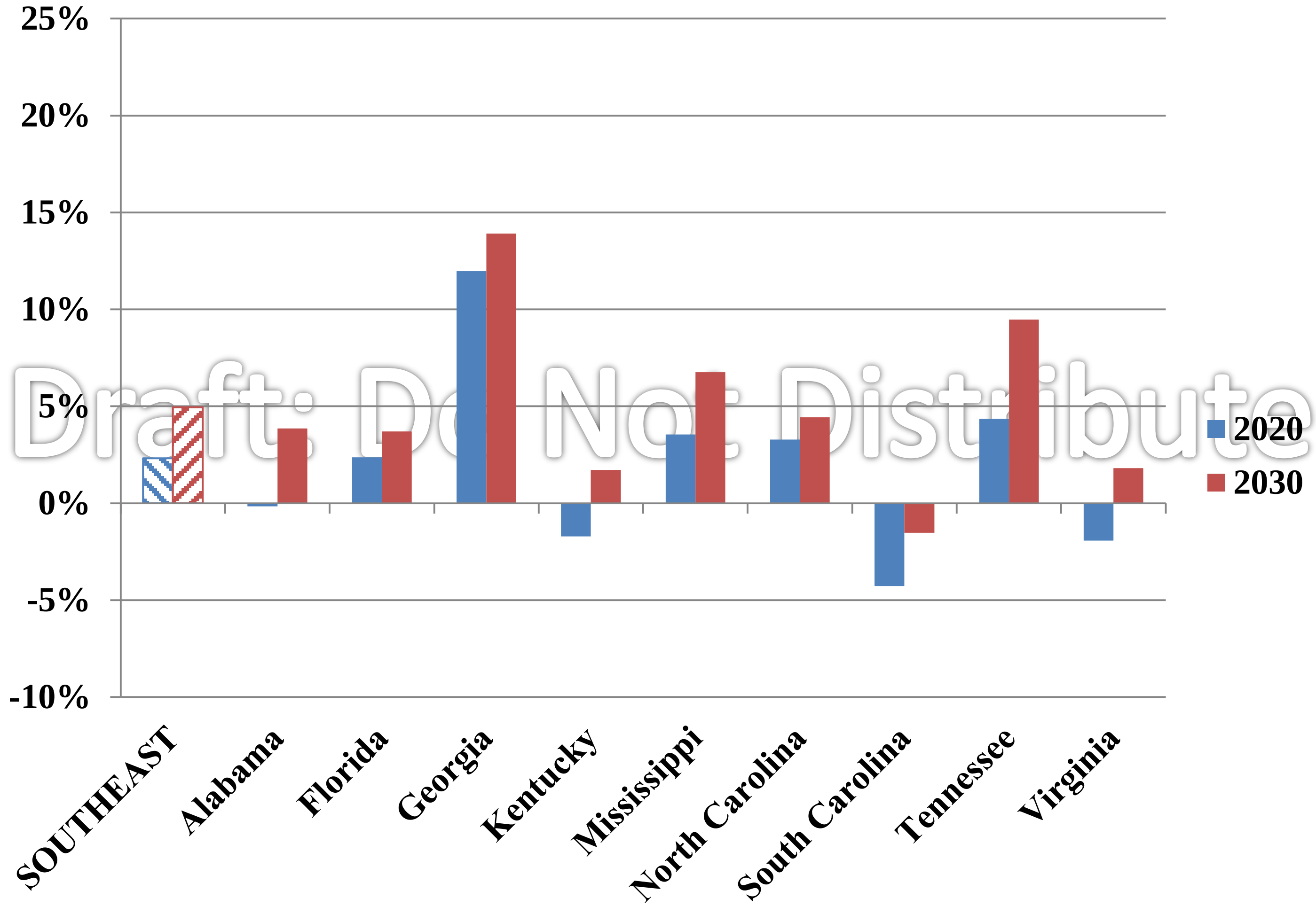
Percent Change in State Costs (Approximation)

Mass-based State Trading (Existing Units)



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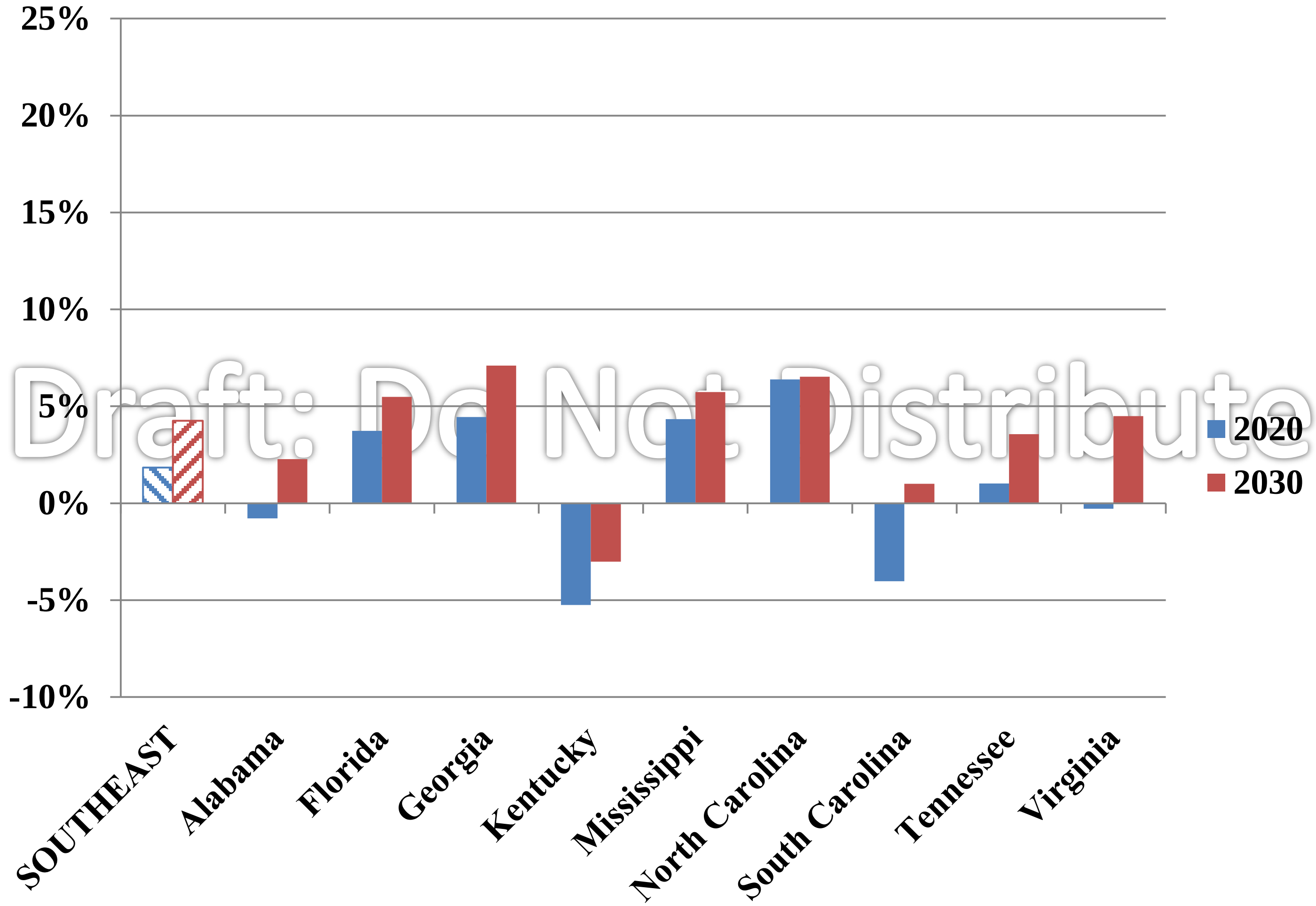
Percent Change in State Costs (Approximation)

Mass-based Regional Trading (Existing Units)



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Allowance Prices: What to Look For

1) Variation in mitigation opportunities across states, shown by differences in allowance prices (policy costs on the margin) or costs per ton of CO2, indicates the potential for gains from coordination
2) Allowance prices under mass-based tend to rise towards 2030 as the added flexibility allows states to shift costs farther out in time
3) Including new NGCC in a rate-based approach lowers allowance prices while raising total costs. It also results in the highest wholesale electricity prices
4) The annual value, or potential revenue, of allowances under a mass-based system range from $300 million to more than $1 billion for states in the Southeast

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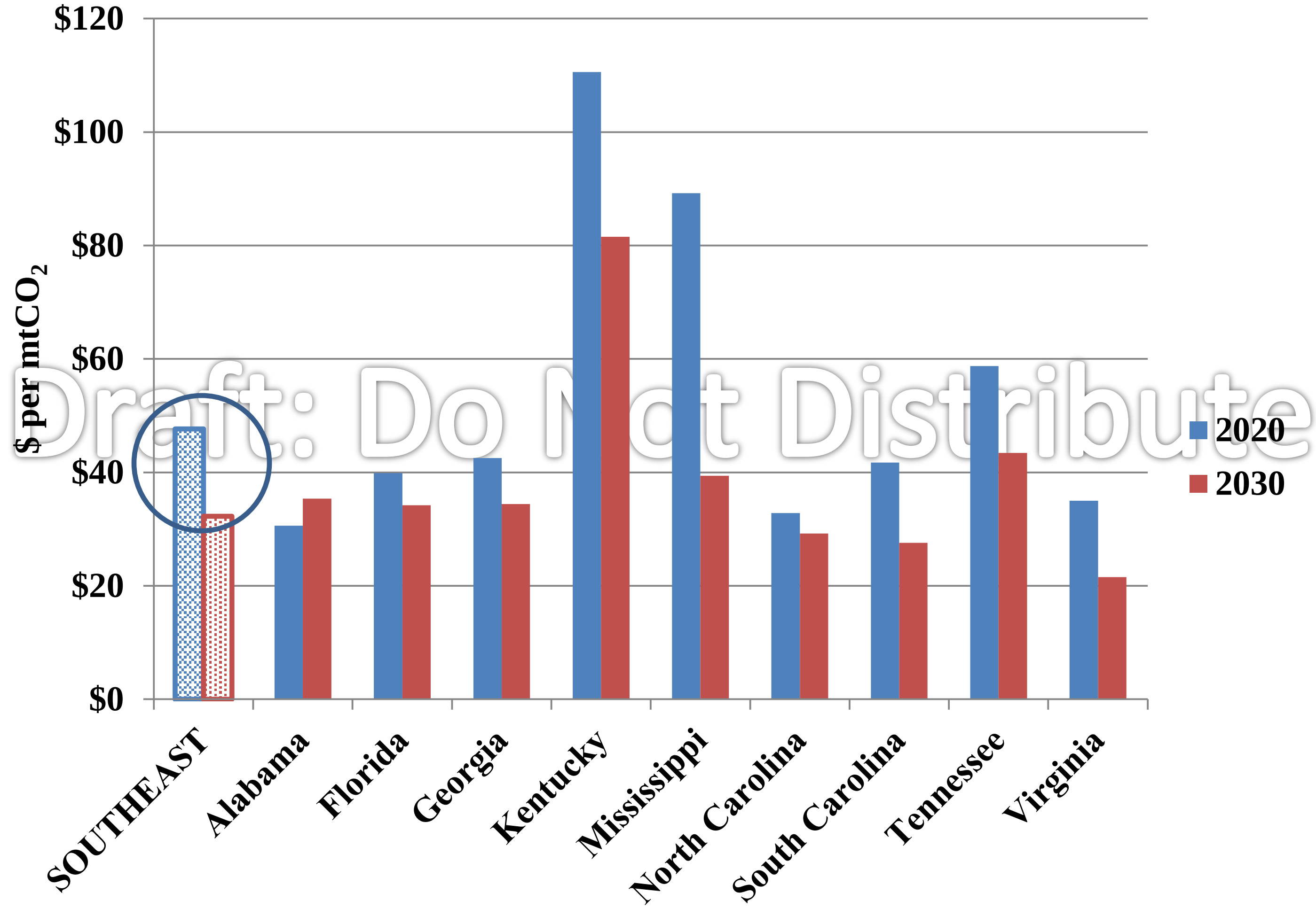
Allowance Prices in the Southeast

Rate-Based Trading - Regional vs State



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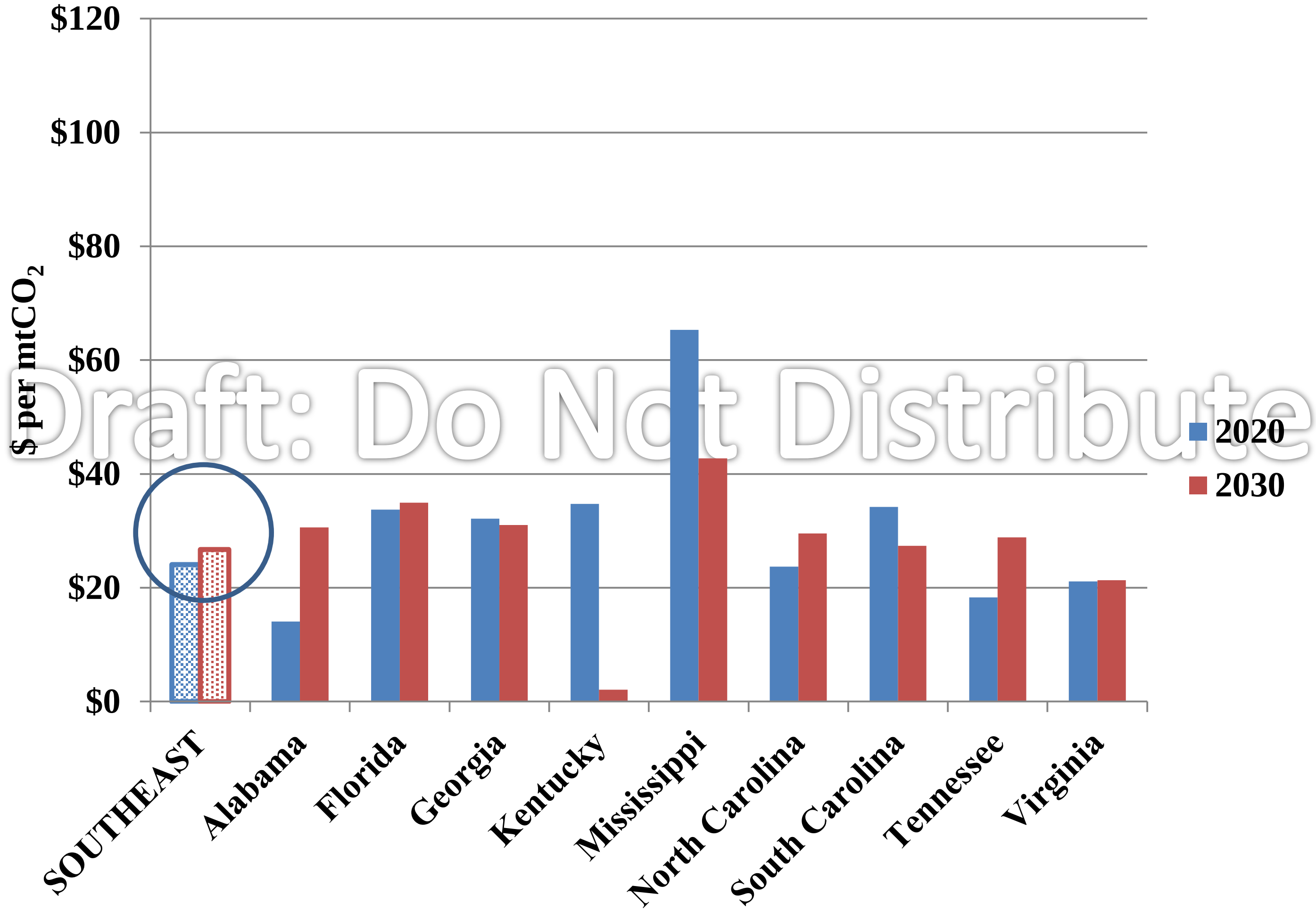
Allowance Prices in the Southeast

Rate-Based Trading with New NGCC



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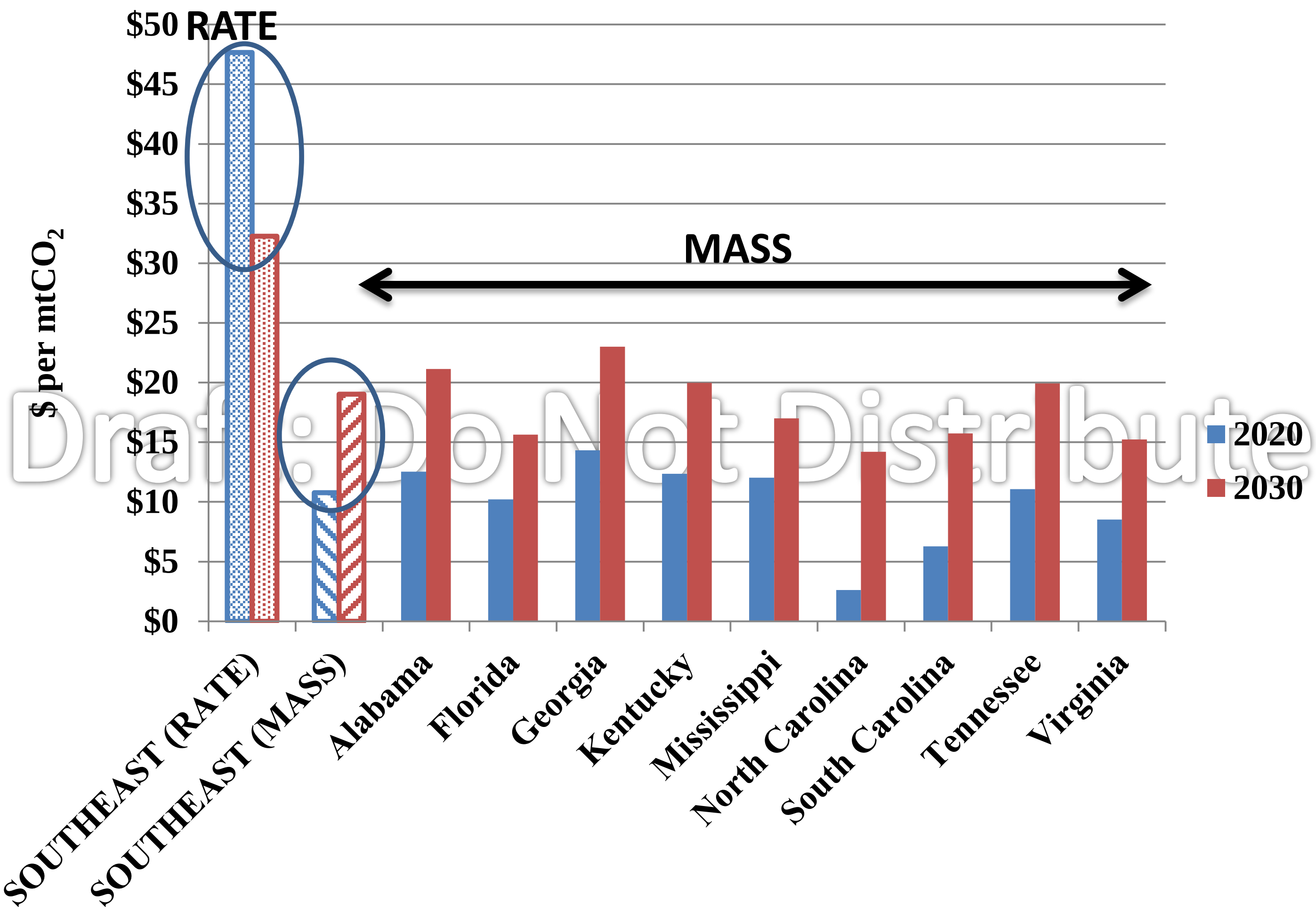
Mass-based & Rate-based Trading

(Allowance Price – Marginal Cost per Ton of CO_2)



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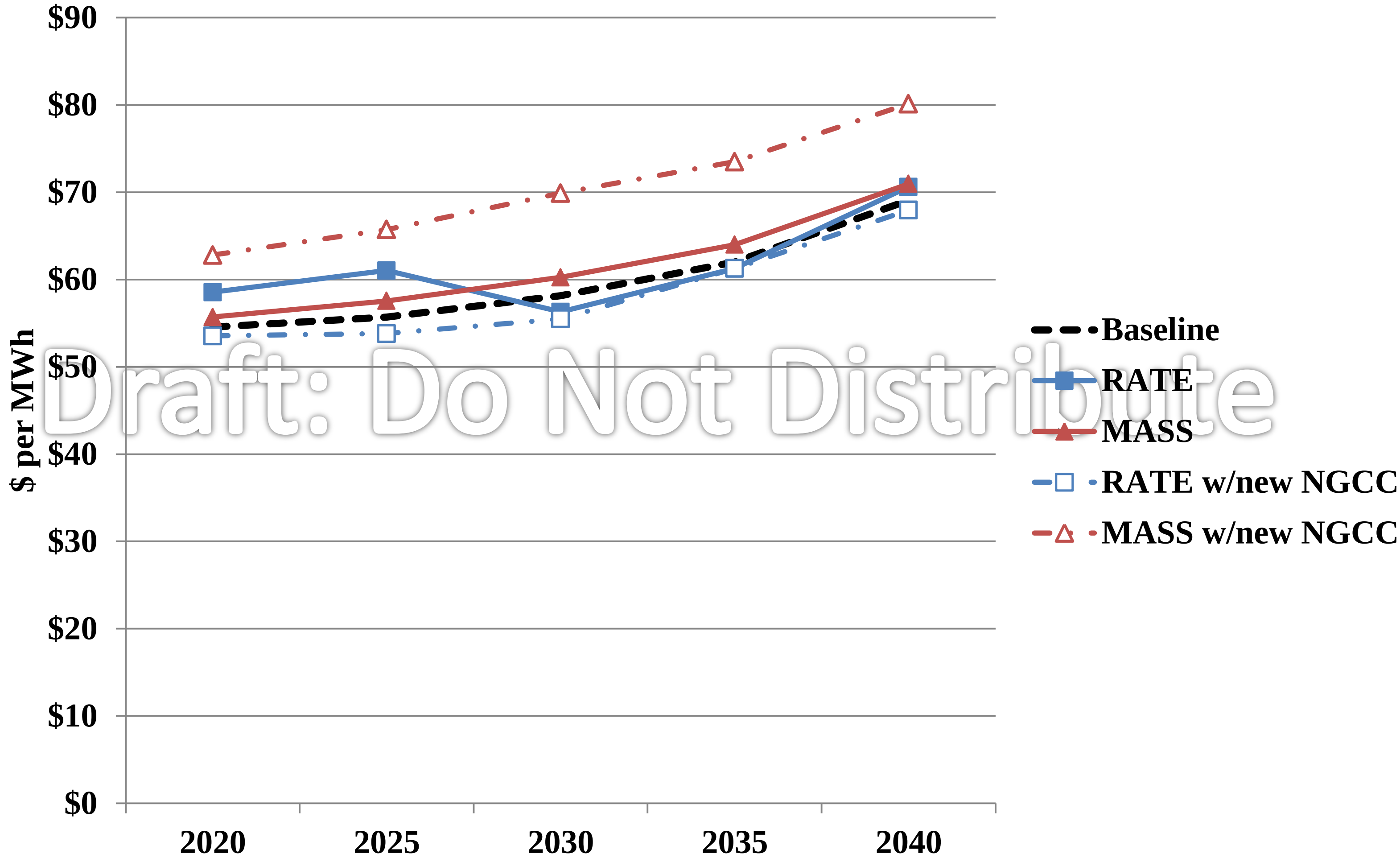
Wholesale Electricity Costs

(Southeast average)



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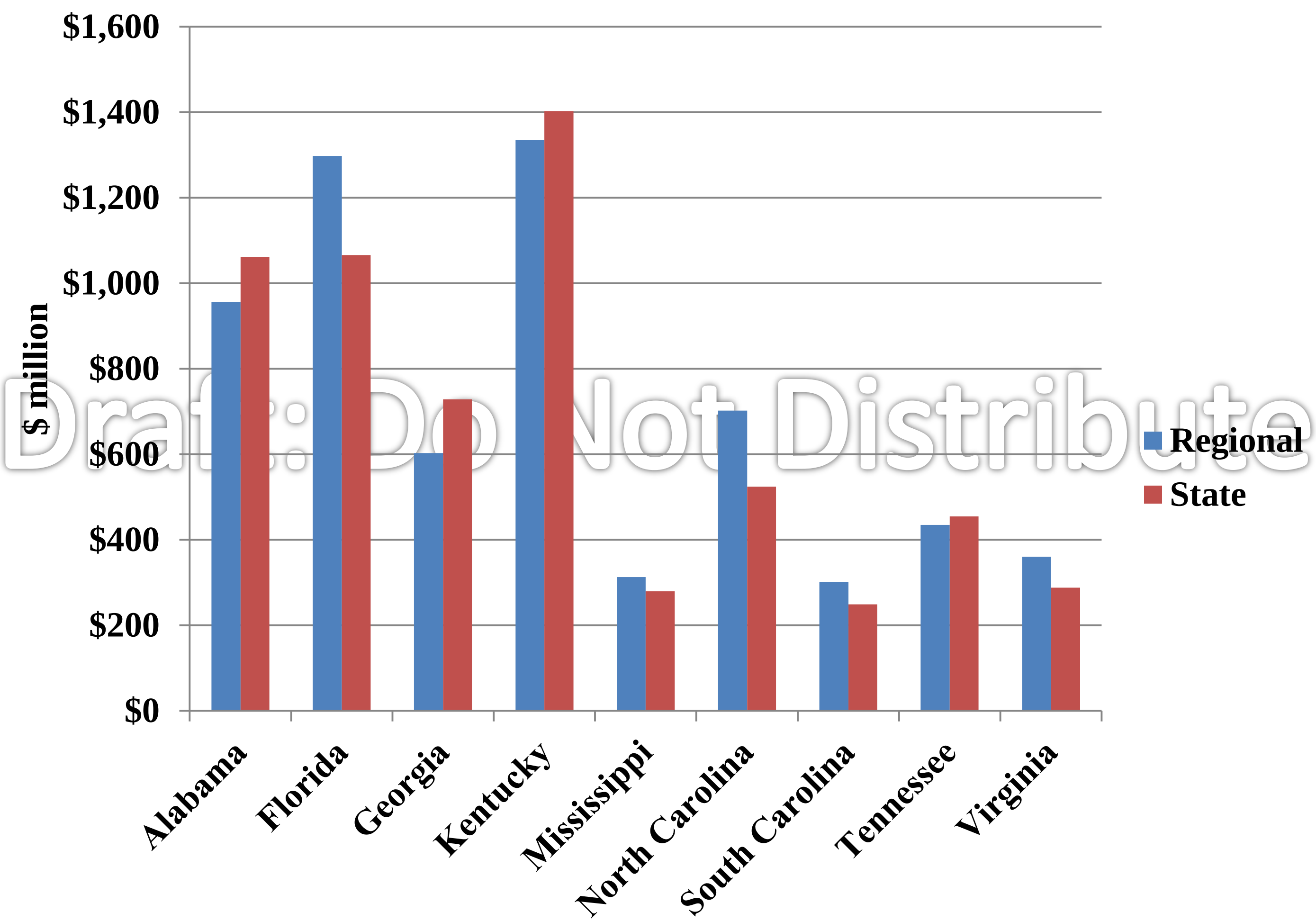
Potential Revenues: Mass-based Approach

Regional vs State Trading (year 2030 – in 2010$)



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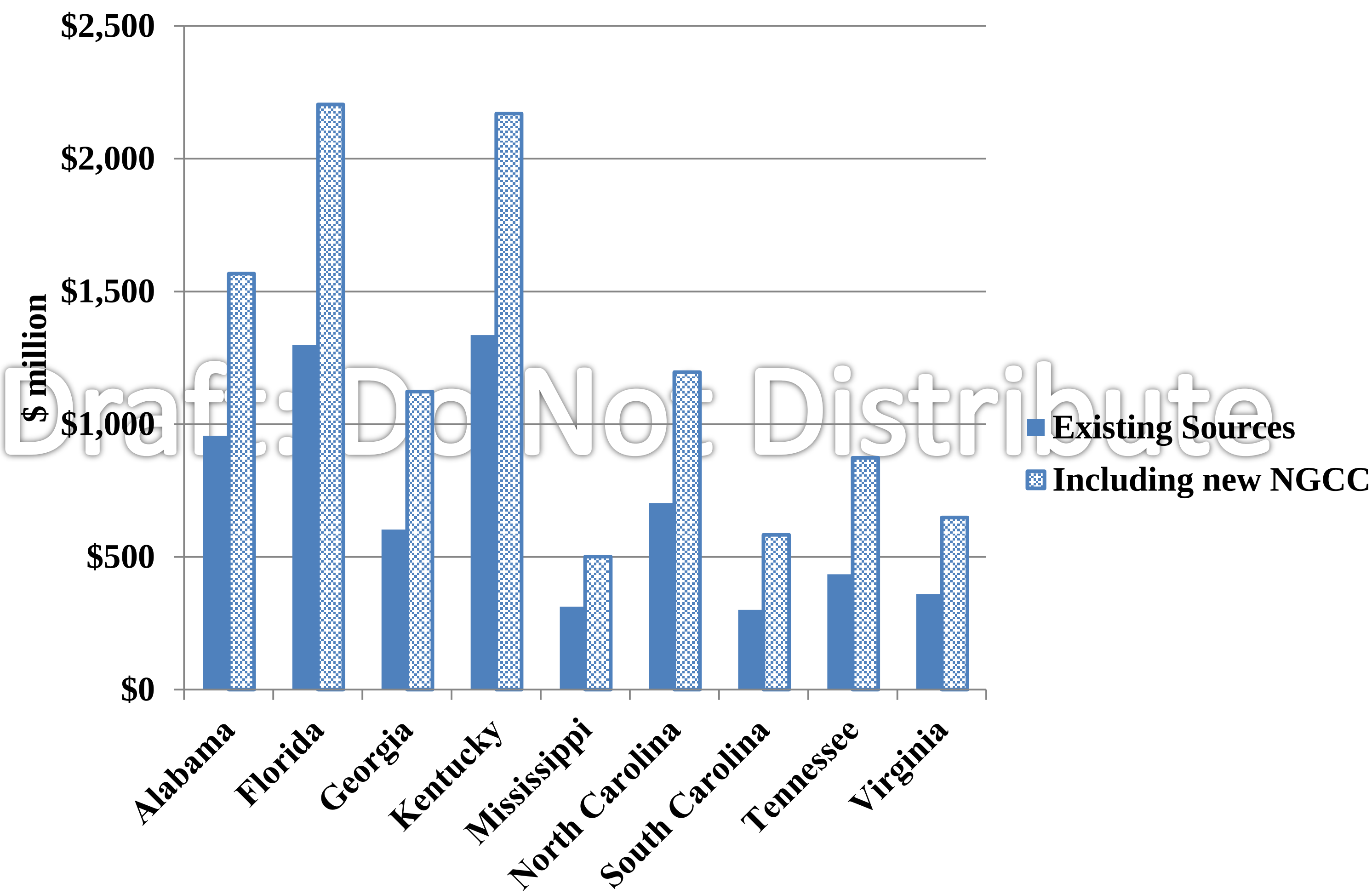
Potential Revenues: Mass-based Approach

Existing vs including new NGCC (year 2030)



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Final Thoughts

- Coal plants have more time to adjust under a mass-based approach, but existing gas plants are affected more quickly
- CPP will leave U.S. emissions around 33% below 2005 levels
- How you account for (and model) efficiency is important
- Ranking the options from lowest to highest costs:
  1) Mass-based with regional trading
  2) Mass-based with states acting alone
  3) Rate-based with regional trading
  4) Rate-based with states acting alone
- There is a significant amount of value tied up in allowances under mass-based approaches

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Future Topics

- Investigate Factors Behind State Cost Variation
- Additional Types of Results of Interest?
- Long-term consequences of CPP
  - What happens if 2030 goals are adjusted in future
  - How will CPP interact with other changes expected in the industry (retirements, etc.)

- Alternative State Plan Design Approaches
- Other groupings of states in trading blocks
- Other Possibilities?
  - Alternative model assumptions?
  - Include new nuclear?
  - Reliability issues?

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Thank You

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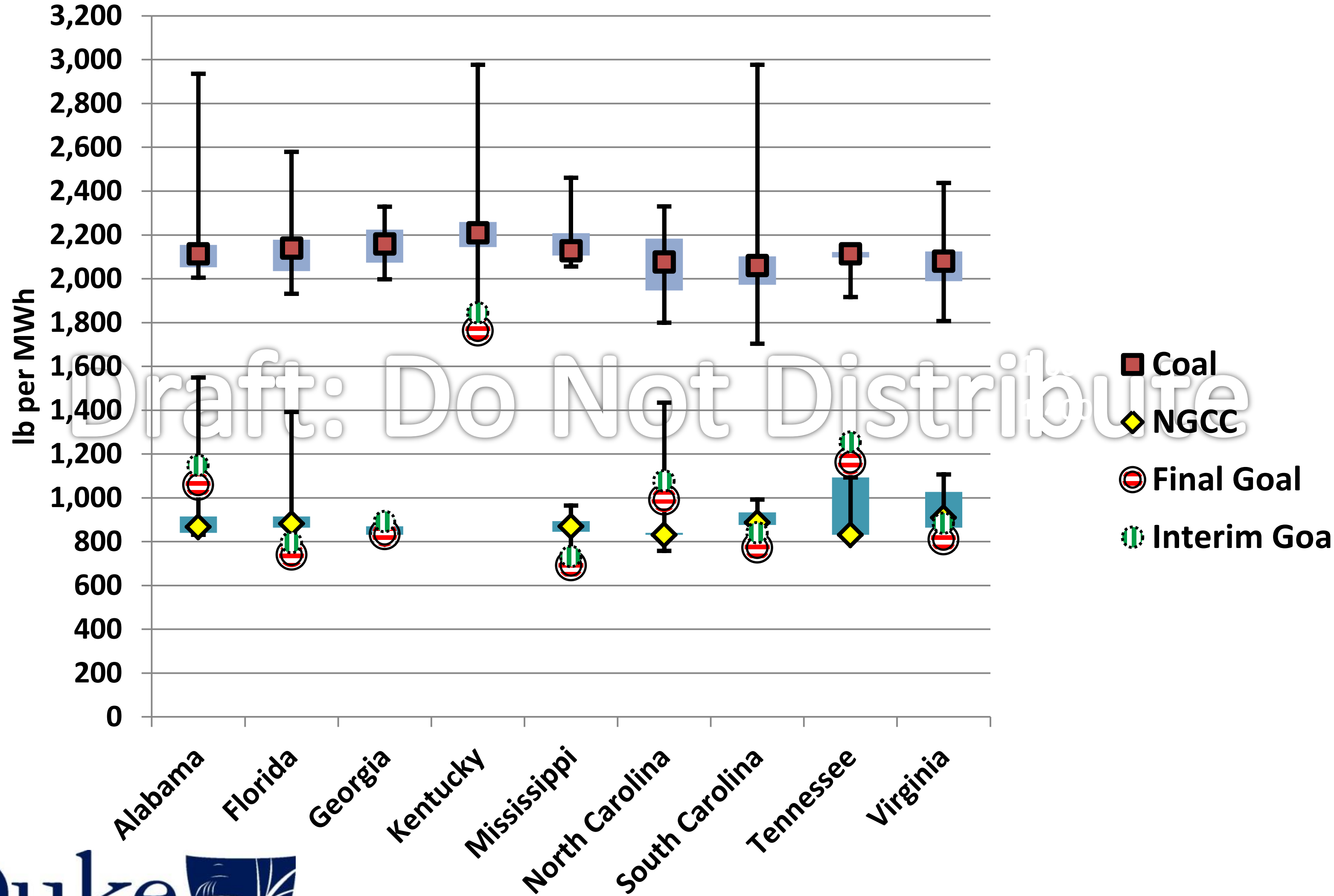
Additional Slides

Emissions Rates in the Southeast



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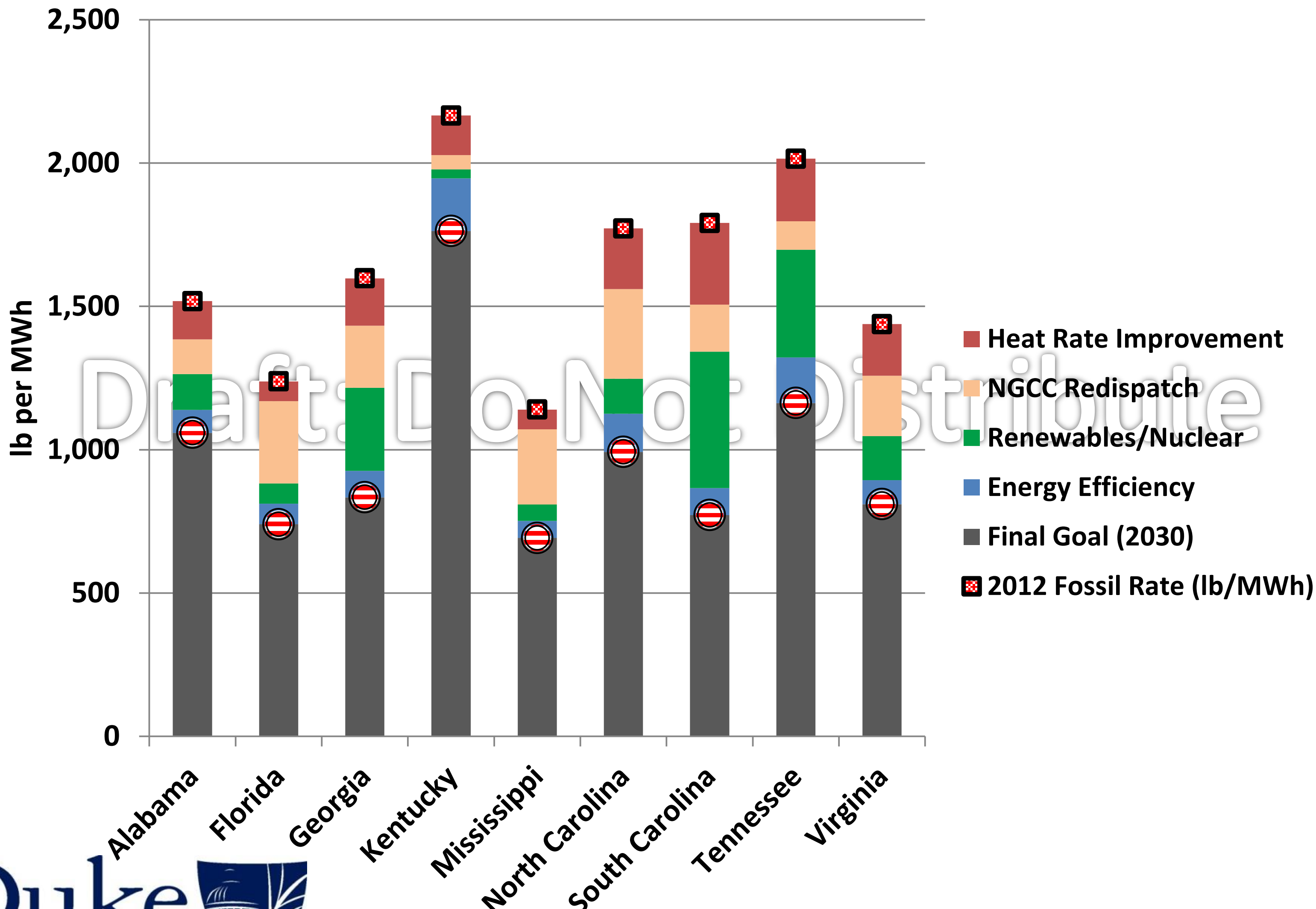
Components of State Goals in the Southeast



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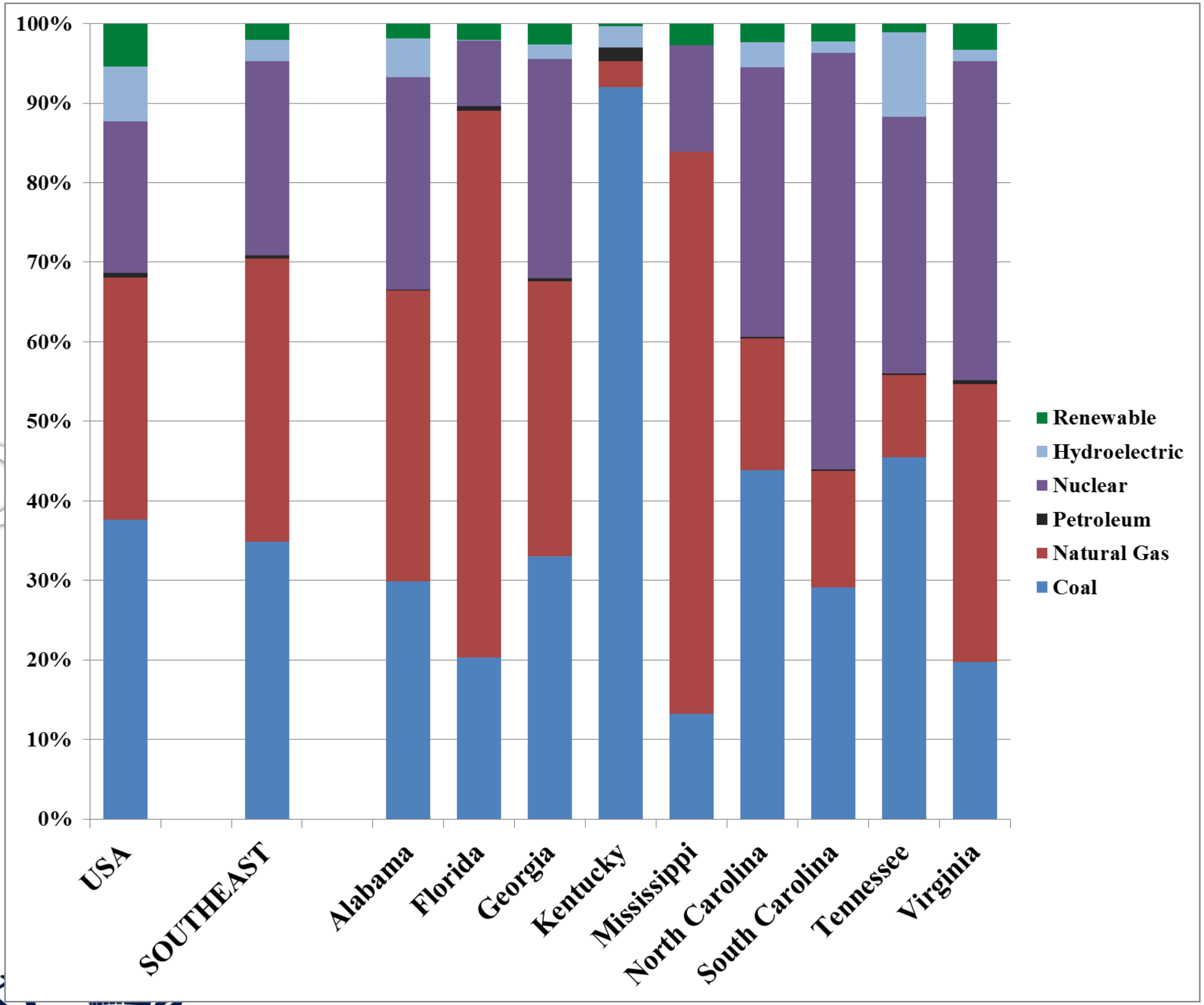
Generation Characteristics (2012)



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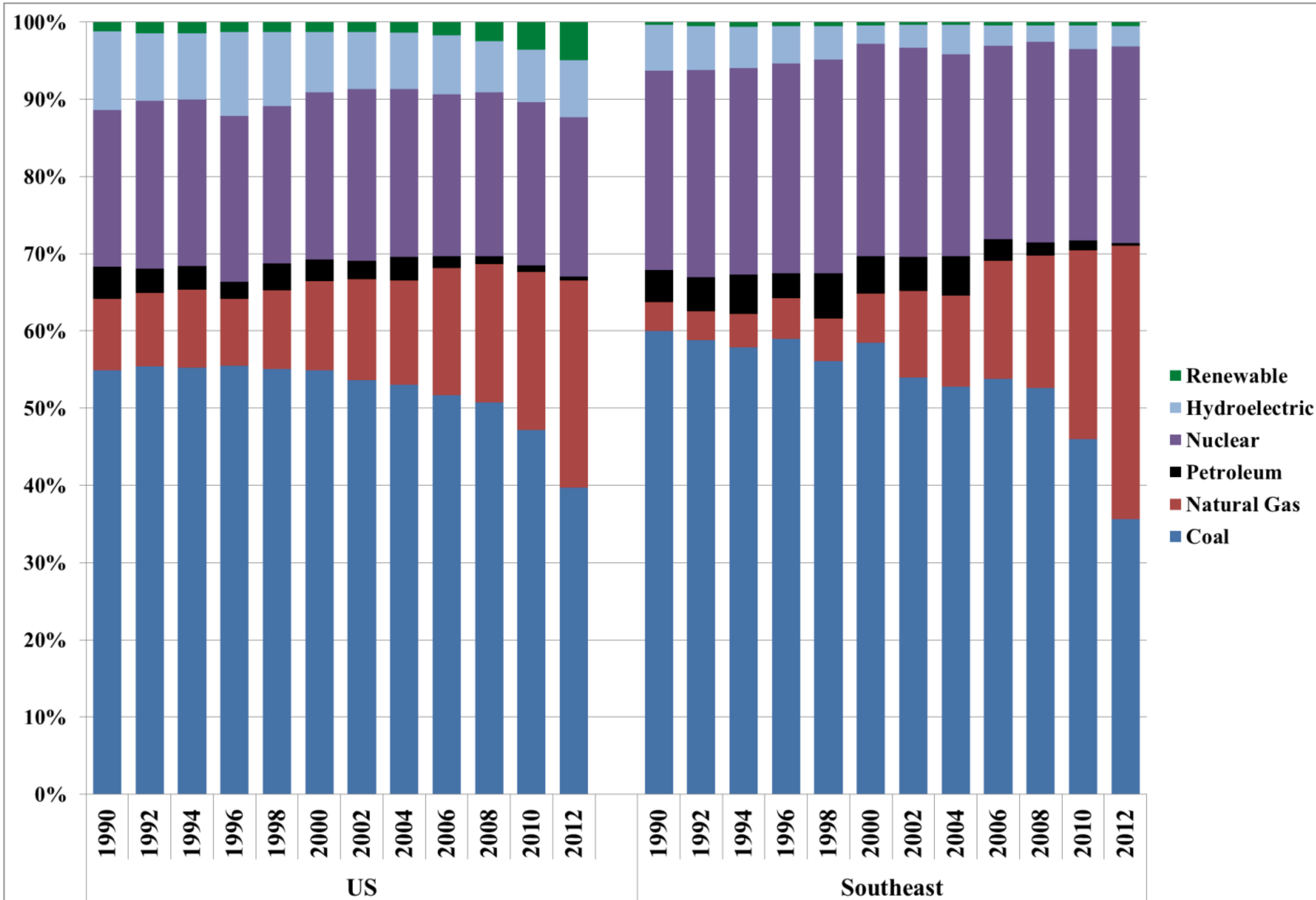
Generation Characteristics in the Southeast



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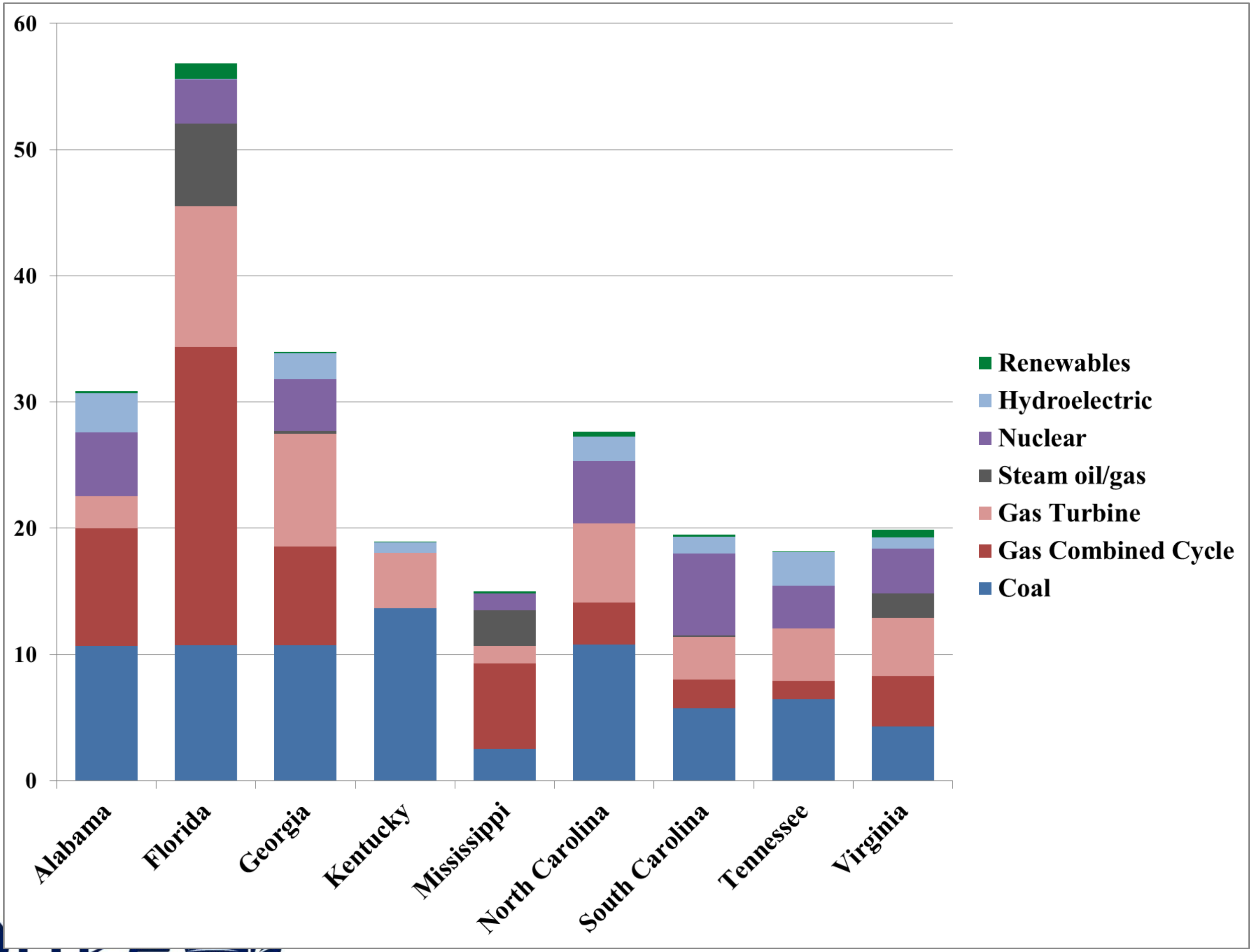
Existing Capacity in the Southeast



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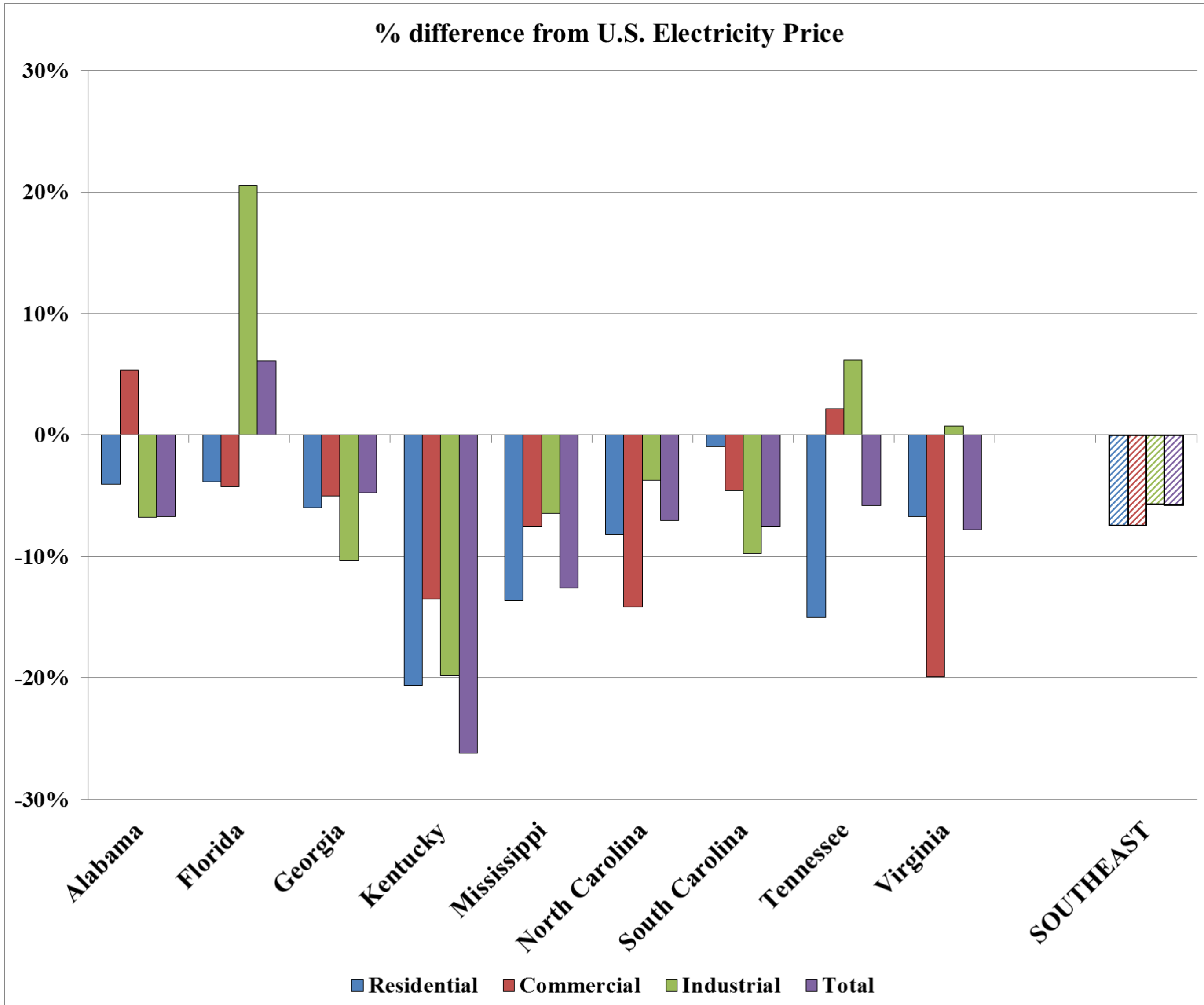
Electricity Prices in the Southeast (2012)



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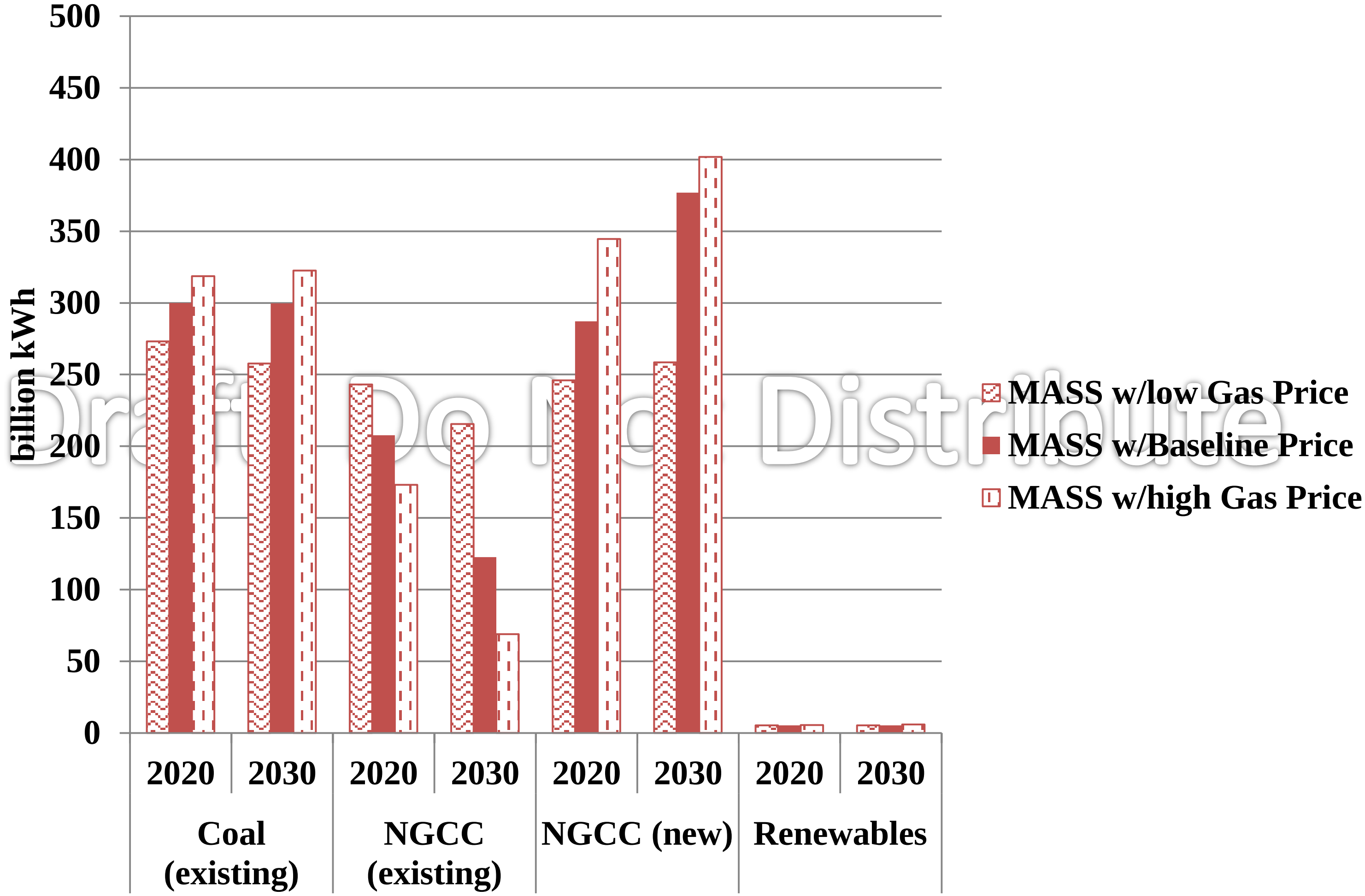
Sensitivity Analysis Results

- **Natural Gas Prices** (plus/minus 25-30%)
  1) High gas prices strongly disadvantage existing gas units and benefit new, more efficient gas units
  2) Total gas use is relatively insensitive to gas prices
  3) Mass-based approach provides some insulation from policy costs increases associated with high gas prices

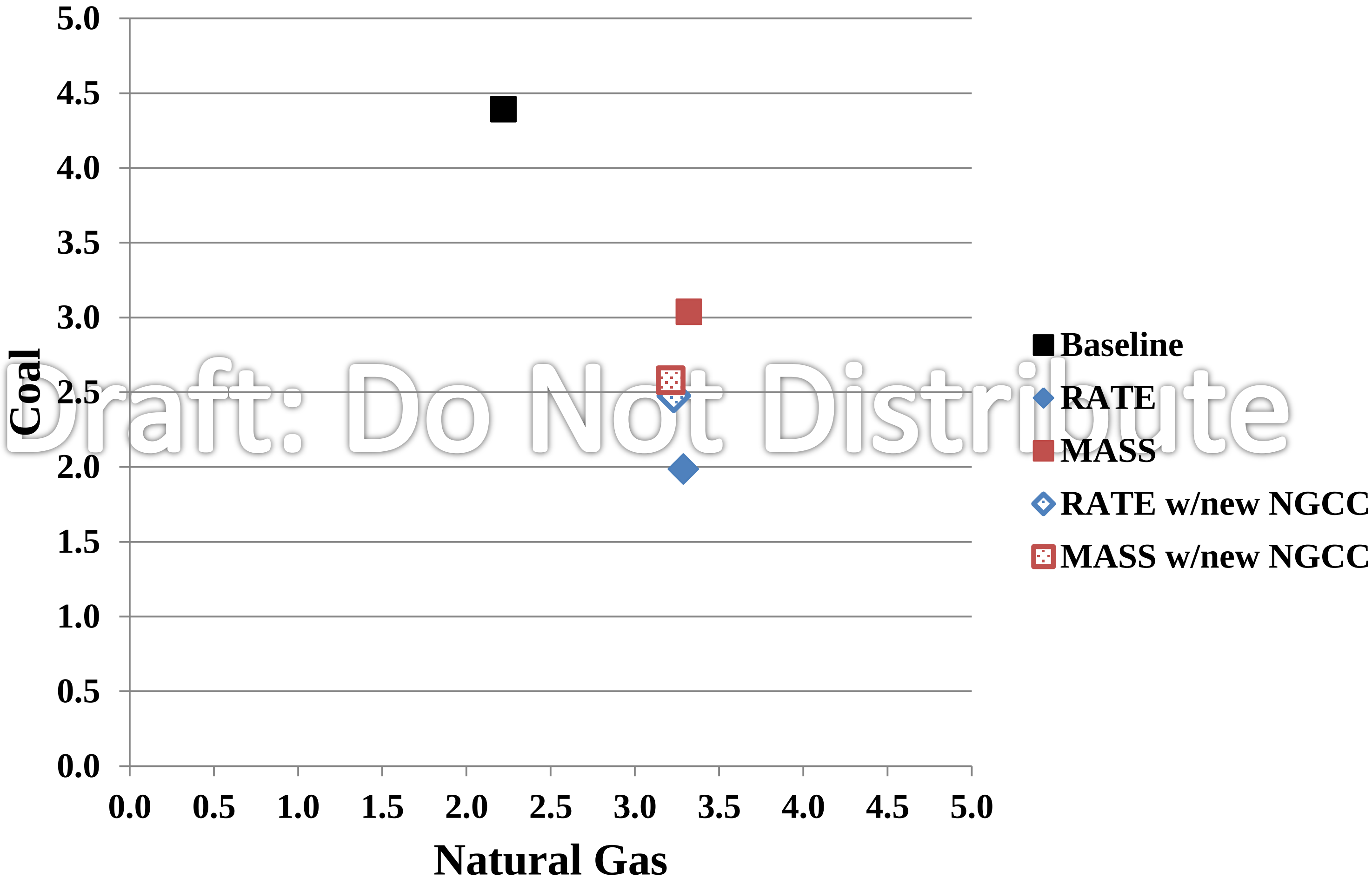
- **Amount of Energy Efficiency** (plus/minus 50%)
  1) Reductions in energy efficiency results in more construction of new gas
  2) Generation by existing coal and gas is relatively unaffected
  3) Under a rate-based approach that incentivizes efficiency, high levels of available efficiency can significantly reduce policy costs
  4) Under a mass-based approach, policy costs are insensitive to the amount of efficiency available

Generation in the Southeast

Alternative Gas Prices (Mass-based)



Fuel Use in the Southeast
(quadrillion Btu in 2030)



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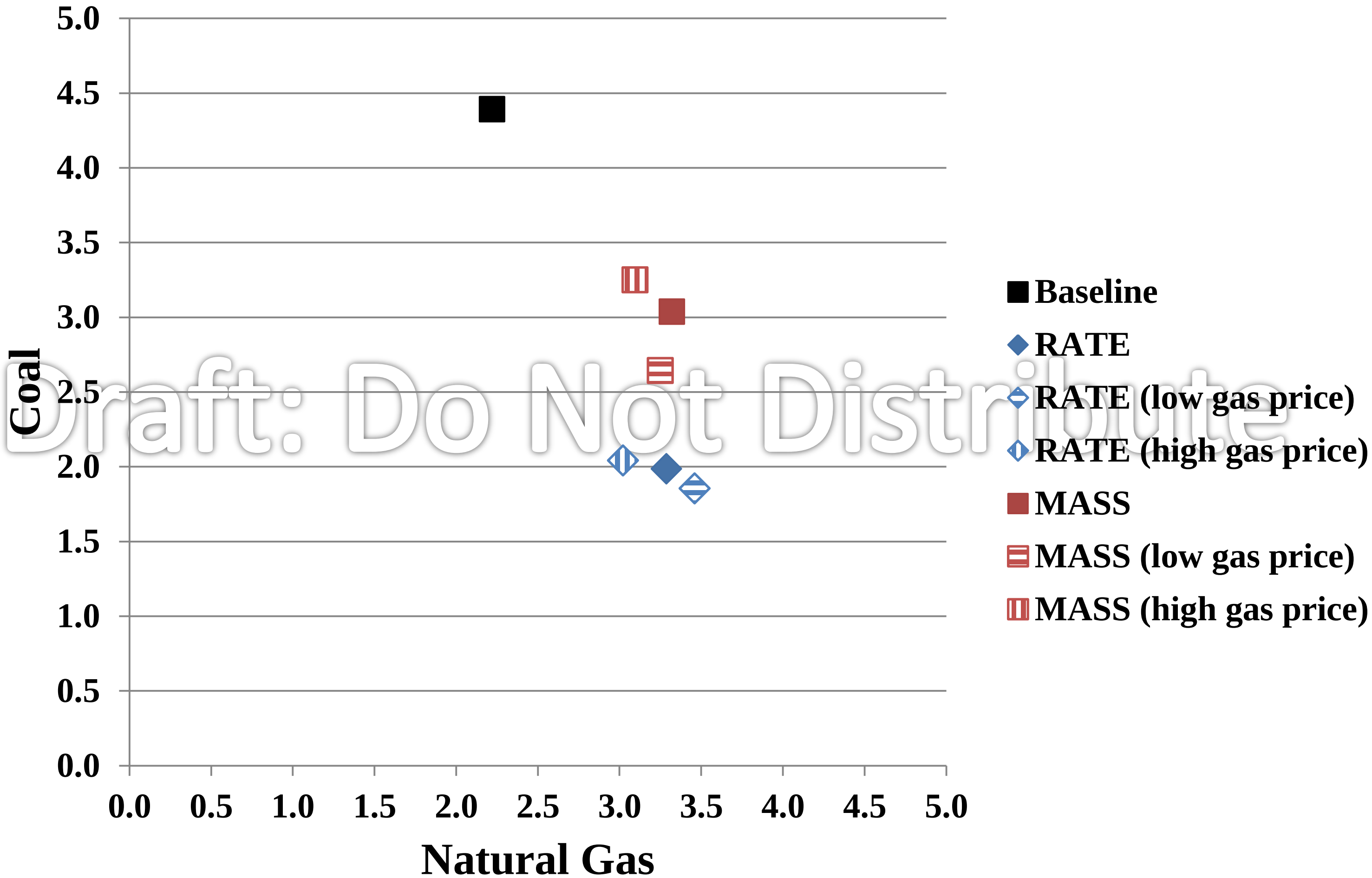
Fuel Use: Low vs High Gas Prices
(quadrillion Btu)



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Percent Change in Costs for the Southeast

Alternative Gas Prices

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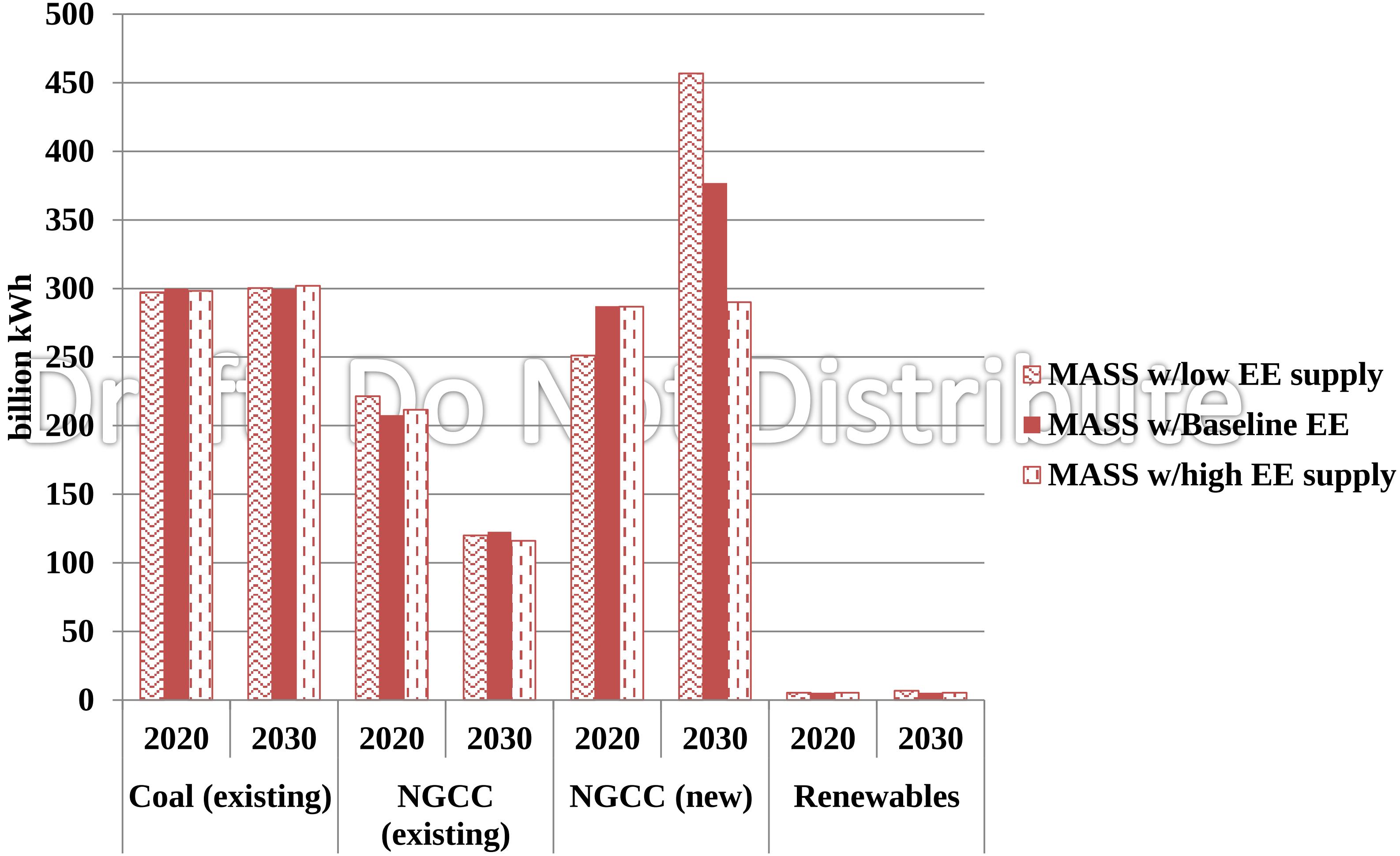
Generation in the Southeast

Alt. Energy Efficiency Levels (Mass-based)



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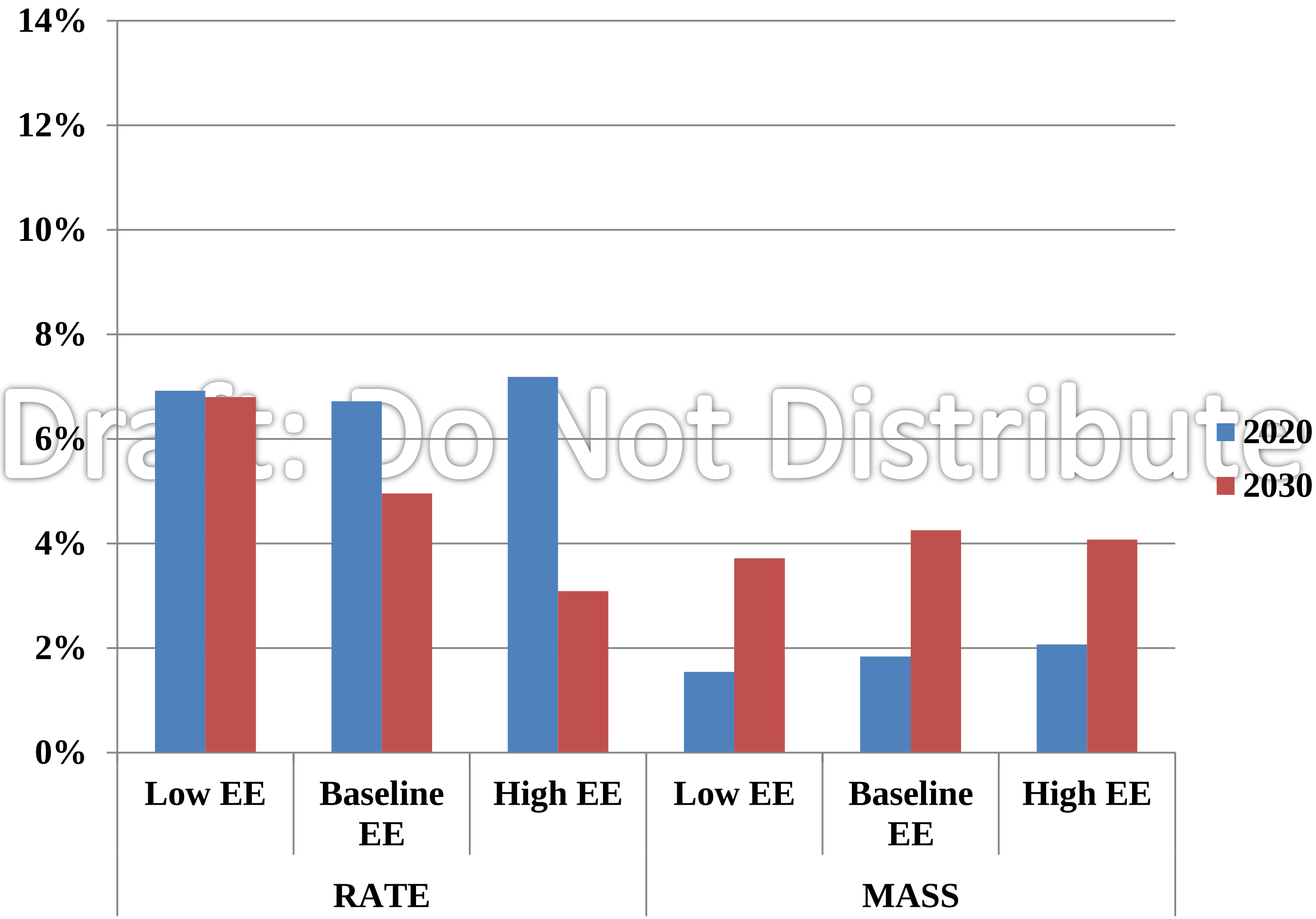
Percent Change in Costs for the Southeast

Alternative Energy Efficiency Levels



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