Ongoing Evolution of the Electricity Industry:

Effects of Market Conditions and the Clean Power Plan on States

Martin T. Ross*

Power Sector Trends in the Eastern Interconnect
Atlanta, Georgia
September 13, 2016

* Excerpts from July 2016 paper by Martin Ross, David Hoppock, and Brian Murray

Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

- Current Paper: https://nicholasinstitute.duke.edu/climate/publications/ongoing-evolution-electricity-industry-effects-market-conditions-and-clean-power-plan

- Two Papers on the Original CPP Proposal: https://nicholasinstitute.duke.edu/climate/publications/clean-power-plan-implications-three-compliance-decisions-us-states; https://nicholasinstitute.duke.edu/climate/publications/assessing-impacts-clean-power-plan-southeast-states

- *Energy Policy* Paper: http://www.sciencedirect.com/science/article/pii/S0301421515001421

Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

Working Paper
NI WP 16-07

July 2016

www.nicholasinstitute.duke.edu

Ongoing Evolution of the Electricity Industry: Effects of Market Conditions and the Clean Power Plan on States

Martin T. Ross, David Hoppock, and Brian C. Murray

CONTENTS

Author Affiliation
Nicholas Institute for Environmental Policy Solutions, Duke University

Citation
Ross, Martin T., David Hoppock, and Brian Murray. 2016. "Ongoing Evolution of the Electricity Industry: Effects of Market Conditions and the Clean Power Plan on States." NI WP 16-07. Durham, NC: Duke University. http://nicholasinstitute.duke.edu/publications.

SUMMARY

The electricity industry is evolving as changes in natural gas and coal prices, along with environmental regulations, shift the generation mix. Future trends in gas prices and renewables costs are likely to continue moving the industry away from coal-fired generation and into lower-emitting sources such as natural gas and renewables. The U.S. Environmental Protection Agency's Clean Power Plan (CPP) is likely to amplify these trends. The CPP rule regulates emissions from existing fossil generators and allows states to choose among an array of rate-based and mass-based goals.

This analysis uses the electricity-dispatch component of the Nicholas Institute for Environmental Policy Solutions' Dynamic Integrated Economy/Energy/Emissions Model to evaluate electricity industry trends and CPP impacts on the U.S. generation mix, emissions, and industry costs. Several coordinated CPP approaches are considered, along with a range of uncoordinated "patchwork" choices by states.

Modeling indicates future industry trends are likely to make CPP compliance relatively inexpensive, with cost increases of 0.1% to 1.0%. Some external market conditions such as high gas prices could increase these costs, whereas low gas or renewables prices could achieve many CPP goals without additional adjustments by the industry. However, policy costs can vary greatly across states, and may lead some of them to adopt a patchwork of policies that, although in their own best interests, could impose additional costs on neighboring states.

DIEM Model Summary

"Dynamic Integrated Economy/Energy/Emissions Model"

- Electricity Dispatch Model – linear program minimizing costs
  - Gas prices similar to AEO 2016, EPA renewables costs and EE
  - CPP policies: Dual Rate, Mass Cap over Existing, Mass with NSC
  - Sensitivities on gas prices, renewable costs, elec growth and EE
- Interpretation of State-Level Policy Impacts
  - USE CAUTION…
  - Changes in overall industry costs are measured as capital, O&M, and fuel
  - To estimate policy costs at the state level, the model:
    - has the capability to reflect data on existing and new units within a state
    - assigns new generating units to a specific state, rather than broader utility region
    - forecasts electricity demand at the state level
    - estimates electricity flows between states and values it at wholesale prices
    - assigns ERCs to the state in which the ERC generating unit operates
  - Costs/benefits across neighboring states may be shared out differently by utilities
  - Note: dispatch models are trying to minimize overall costs over a long time horizon, not those to any specific state for a limited number of years

Duke NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS

Broad Highlights of the Analysis

- Gas prices are very important for baseline emissions and for CPP policy costs and emissions
  - Renewables costs and energy efficiency availability are also important
- Costs of CPP are relatively low, nationally (0.1%-1.0% on average)
  - Mass Cap over Existing Units is the cheapest option
  - Mass with New Source Complement and Dual Rate have similar costs
- Mass-based options have a narrower range of cost outcomes
  - Happens across states and also alternative assumptions about the future
- Emissions "leakage" to new sources or across states is important
- There may not be a single best answer for many states
  - Some states are clearly better off under one approach over others
  - Some states can even be better off than they were without the CPP (largely through exporting ERCs, mass allowances, or electricity)
  - For most states, answers are less clear and can depend future conditions
  - What your neighbors do will matter a lot…

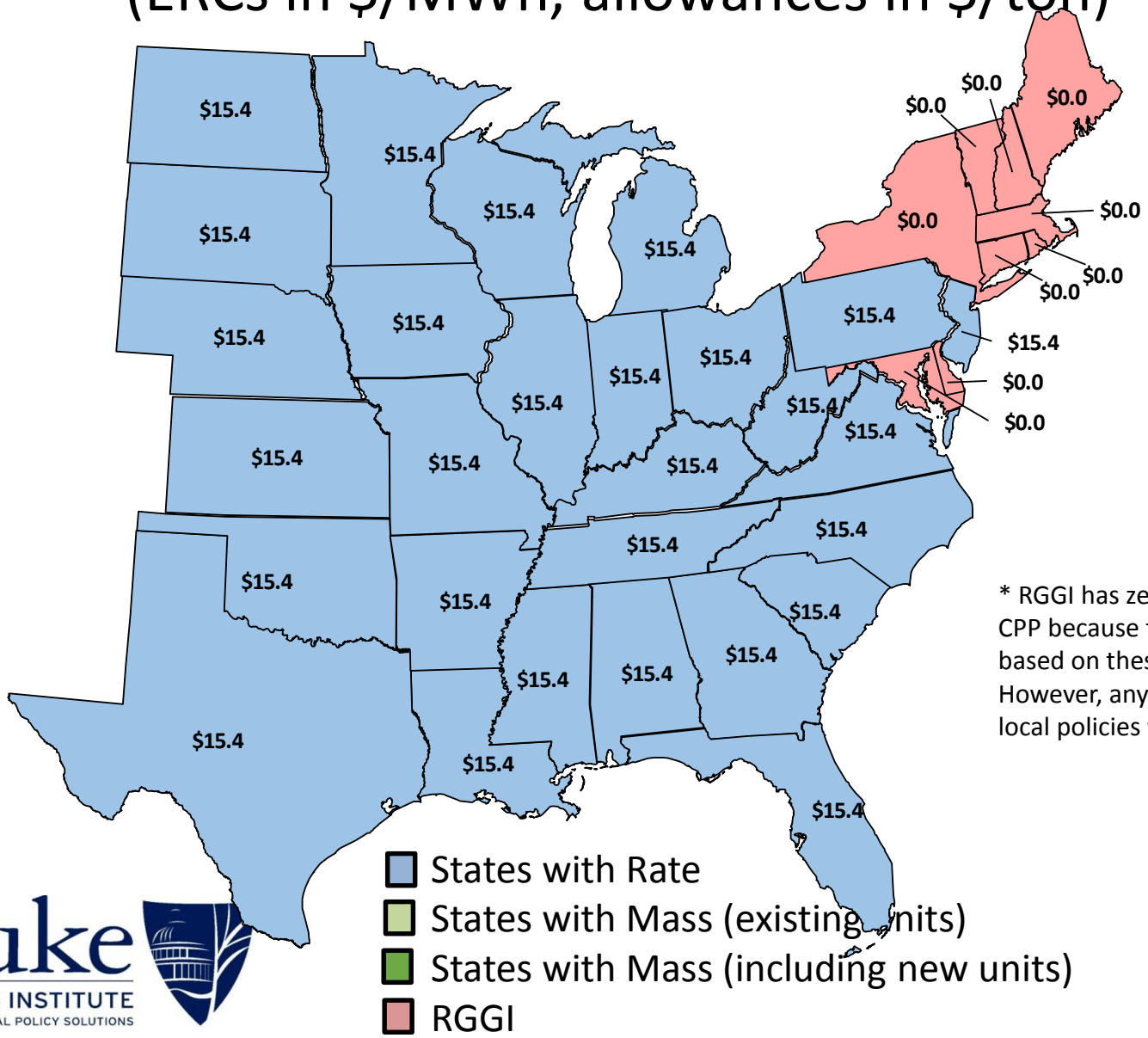
Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

Highlights of State-Level Policy Choices

- Patchwork options – who may go Rate?
  - Who has excess ERCs or relatively cheap methods of generating them?
  - Who has lower policy costs under rate-based trading?
- Under uncoordinated "patchwork" outcomes, actions of neighboring states can have large impacts on a state
- Patchwork outcomes depend on size of ERC/allowance markets
  - States experiencing difficulties meeting their emissions goals will benefit from trading markets that allow them to purchase ERCs/allowances
  - States in position to sell ERCs or allowances will have to evaluate market prices
- The ability to sell, or need to purchase, ERCs and allowances is a good proxy for a state's benefits (costs) from the policy
- ERC and mass allowance prices
  - Prices are generally low (zero in some years), but depend on scope of expected markets
  - However, low ERC prices may encourage additional states to go with Dual Rate
  - Low ERC prices provide little incentive to renewables, mass options also have few incentives
  - Low allowance prices limit the effectiveness of leakage provisions in mass over existing units

ERC and Mass Allowance Prices (2030)

(ERCs in $/MWh, allowances in $/ton)

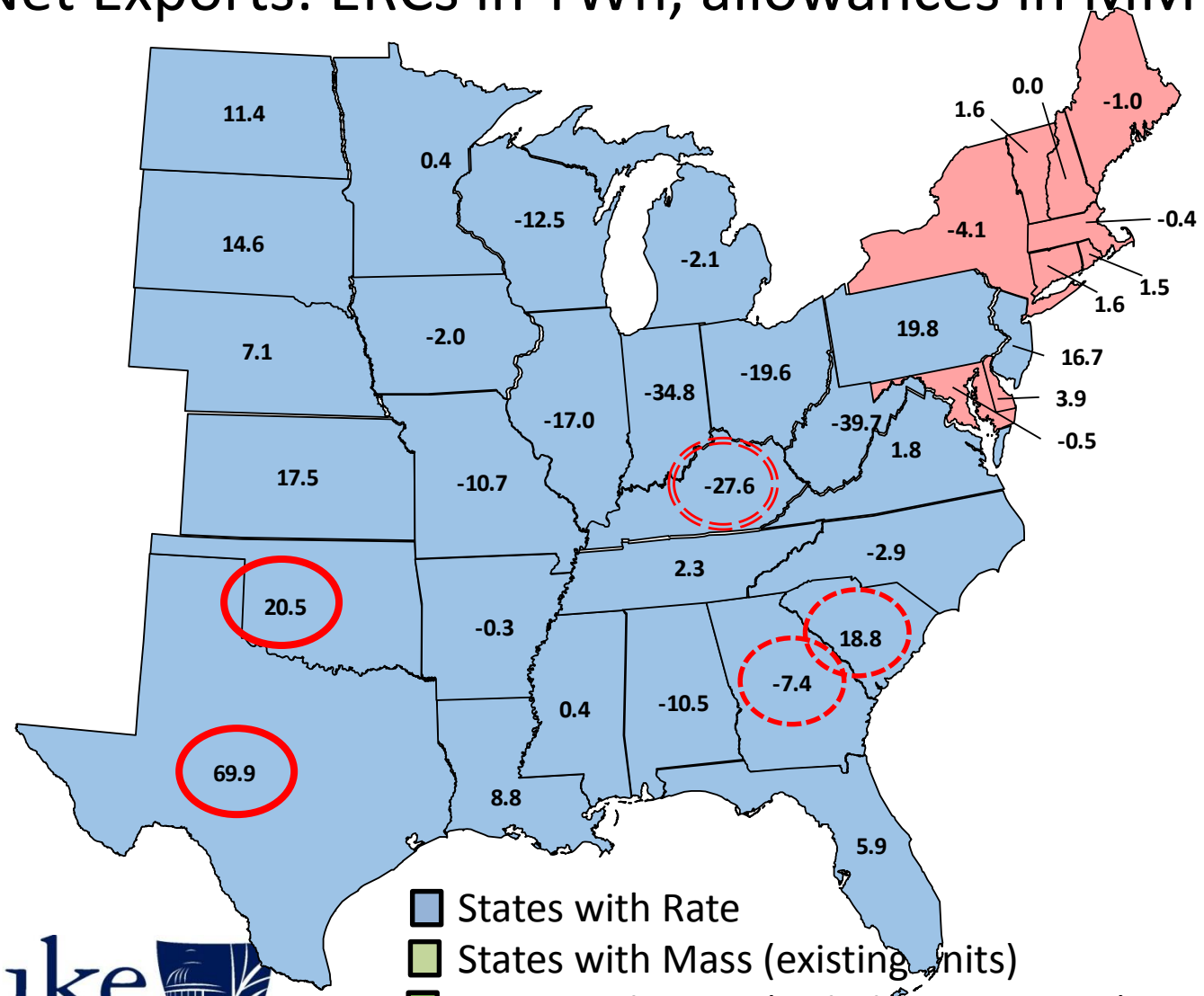


* RGGI has zero allowance prices for CPP because the cap is non-binding, based on these market assumptions. However, any CO_2 price floors from local policies would still apply.

Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

ERC and Mass Allowance Trade (2030)

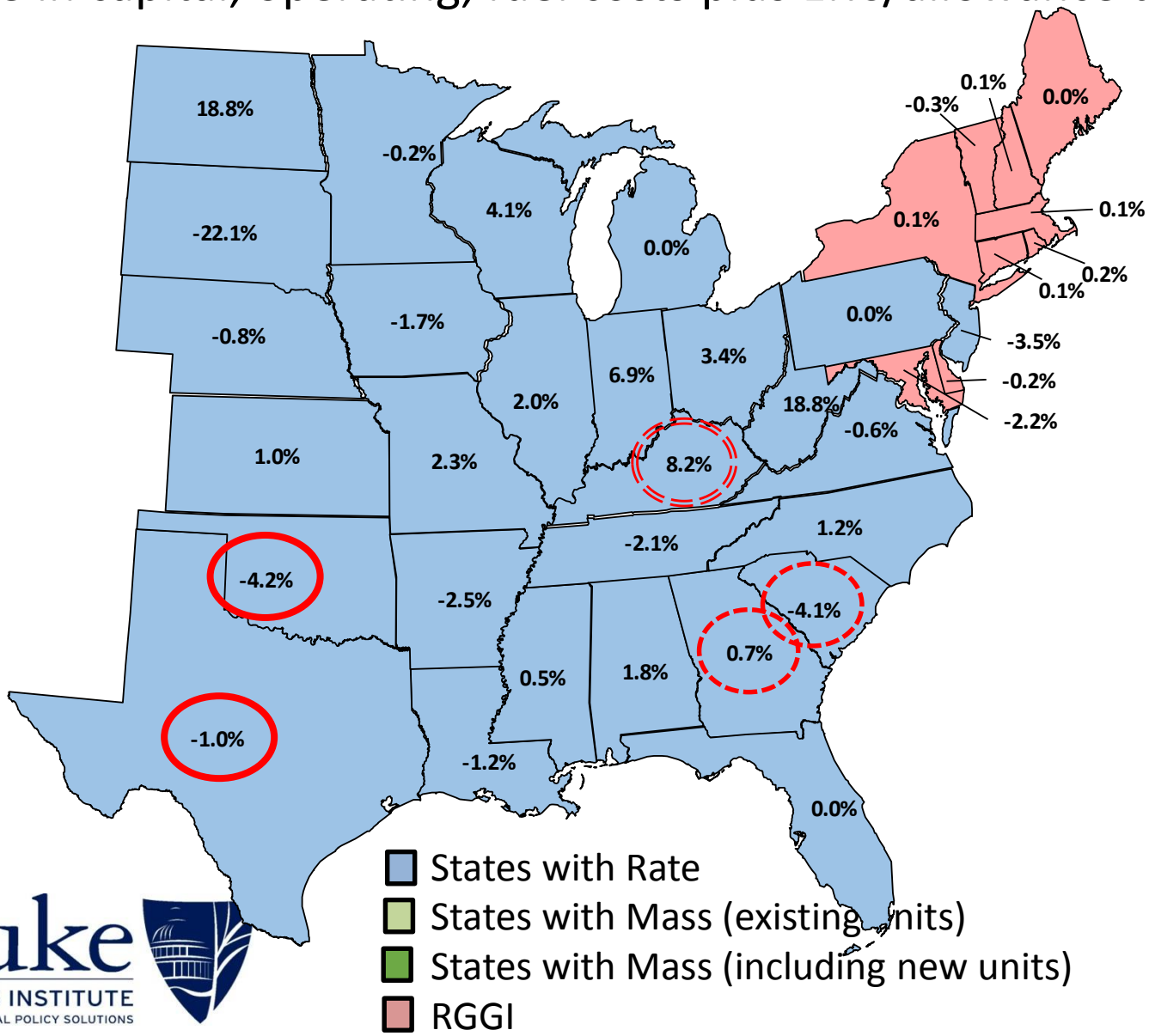
Net Exports: ERCs in TWh, allowances in $MMTCO_2$



Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

Policy Costs – Dual Rate (ΔPV to 2040)

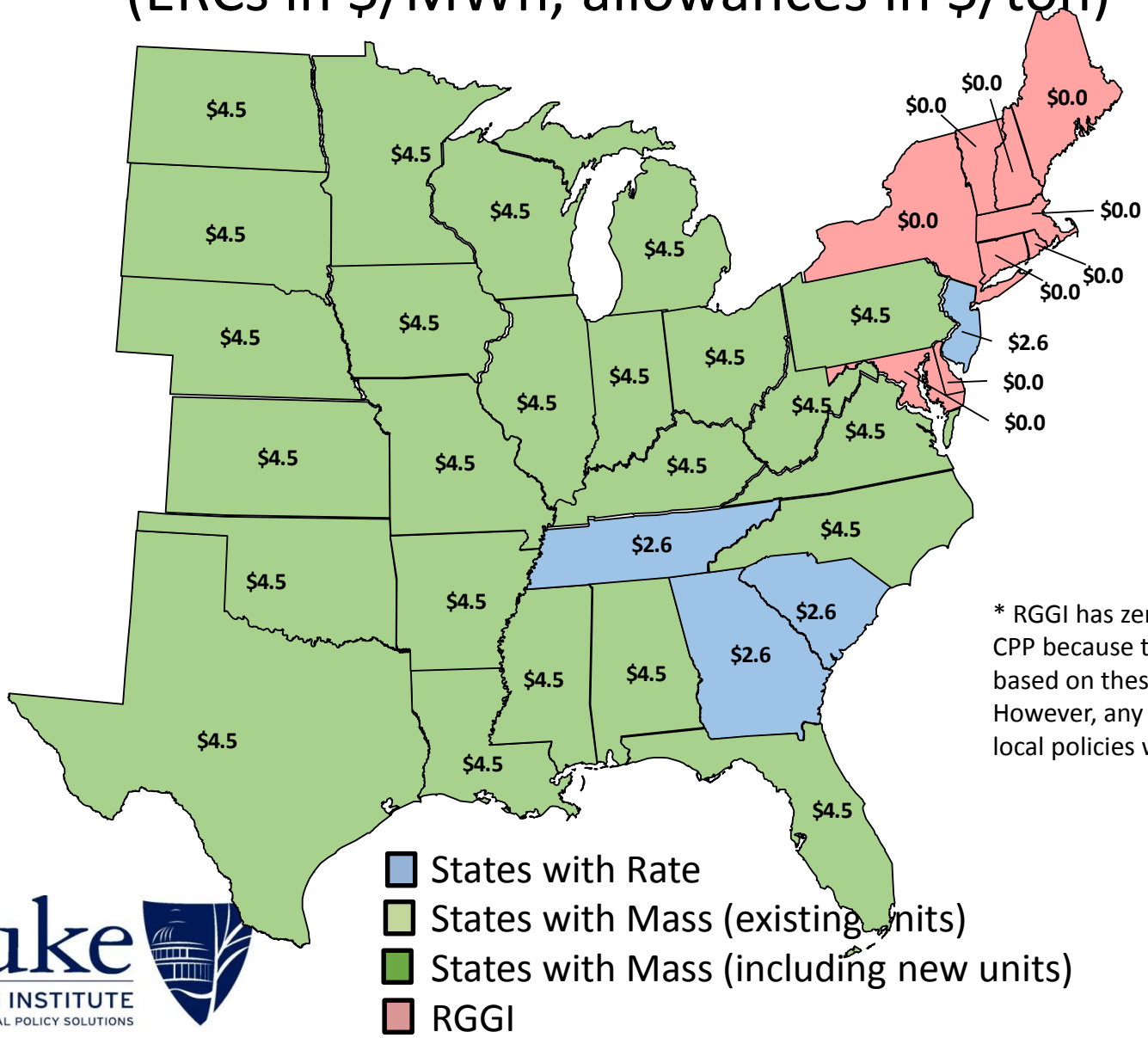
(Change in capital, operating, fuel costs plus ERC/allowance trade value)



Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

ERC and Mass Allowance Prices (2030)

(ERCs in $/MWh, allowances in $/ton)

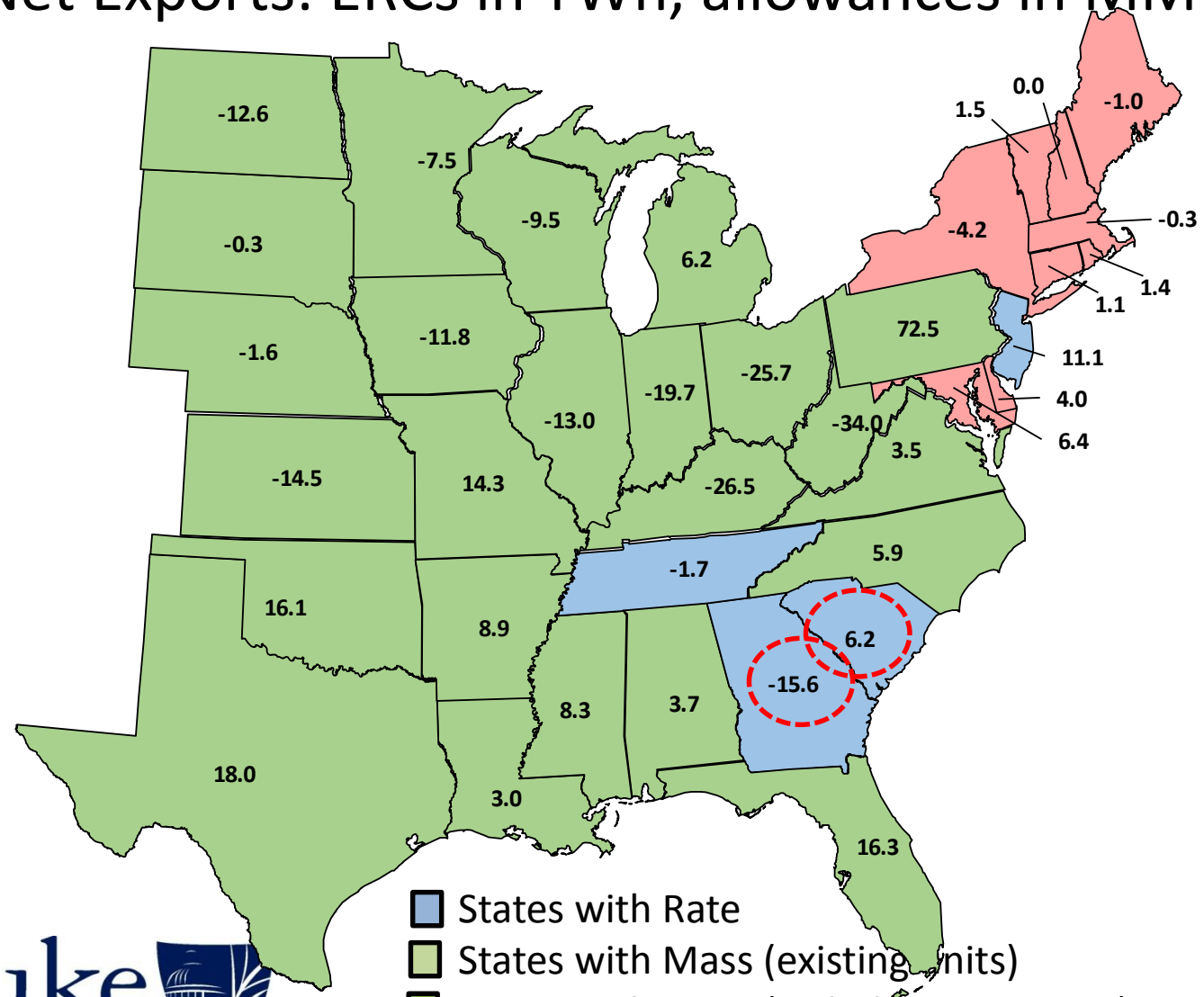


* RGGI has zero allowance prices for CPP because the cap is non-binding, based on these market assumptions. However, any CO_2 price floors from local policies would still apply.

Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

ERC and Mass Allowance Trade (2030)

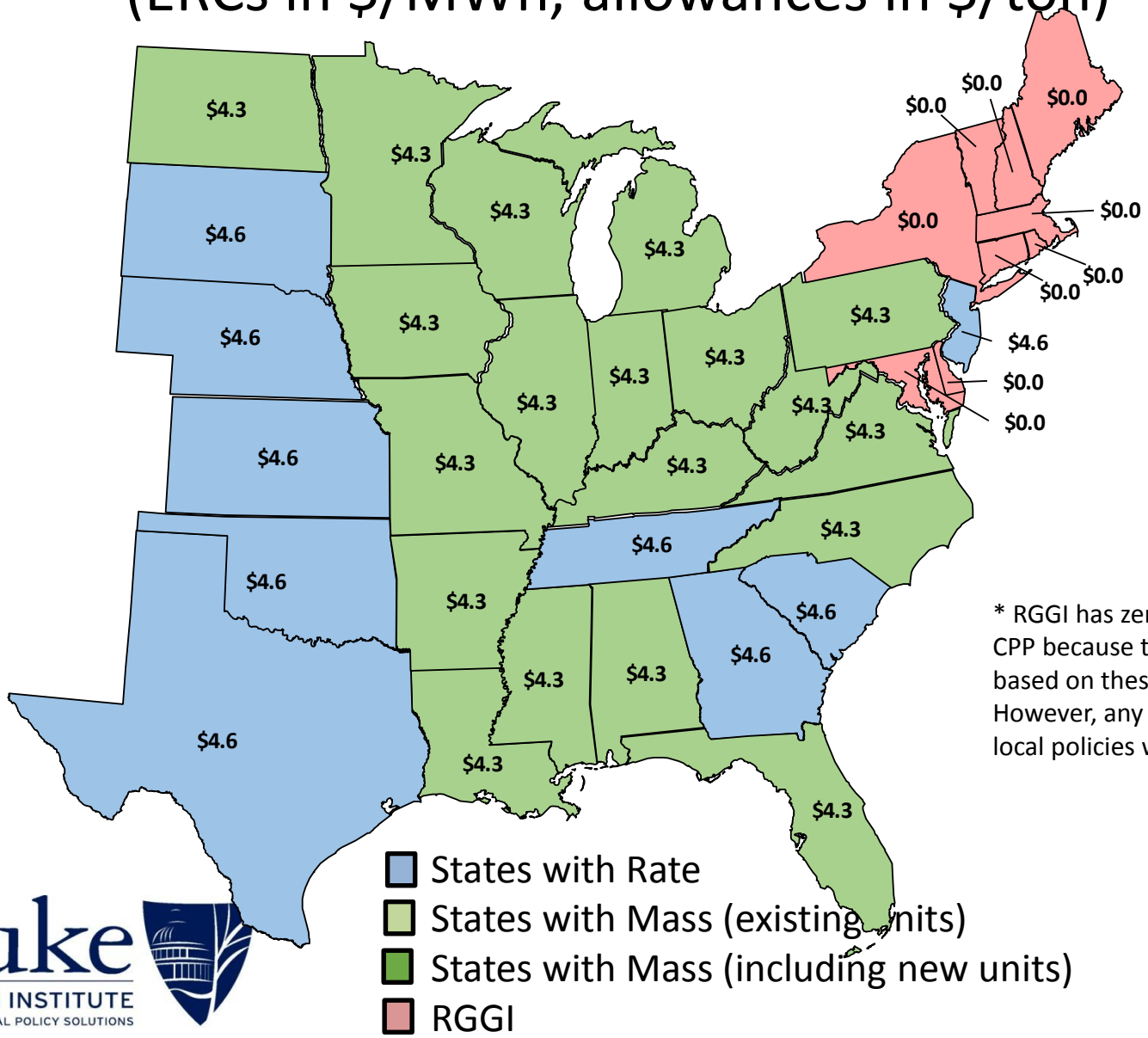
Net Exports: ERCs in TWh, allowances in $MMTCO_2$



Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

ERC and Mass Allowance Prices (2030)

(ERCs in $/MWh, allowances in $/ton)

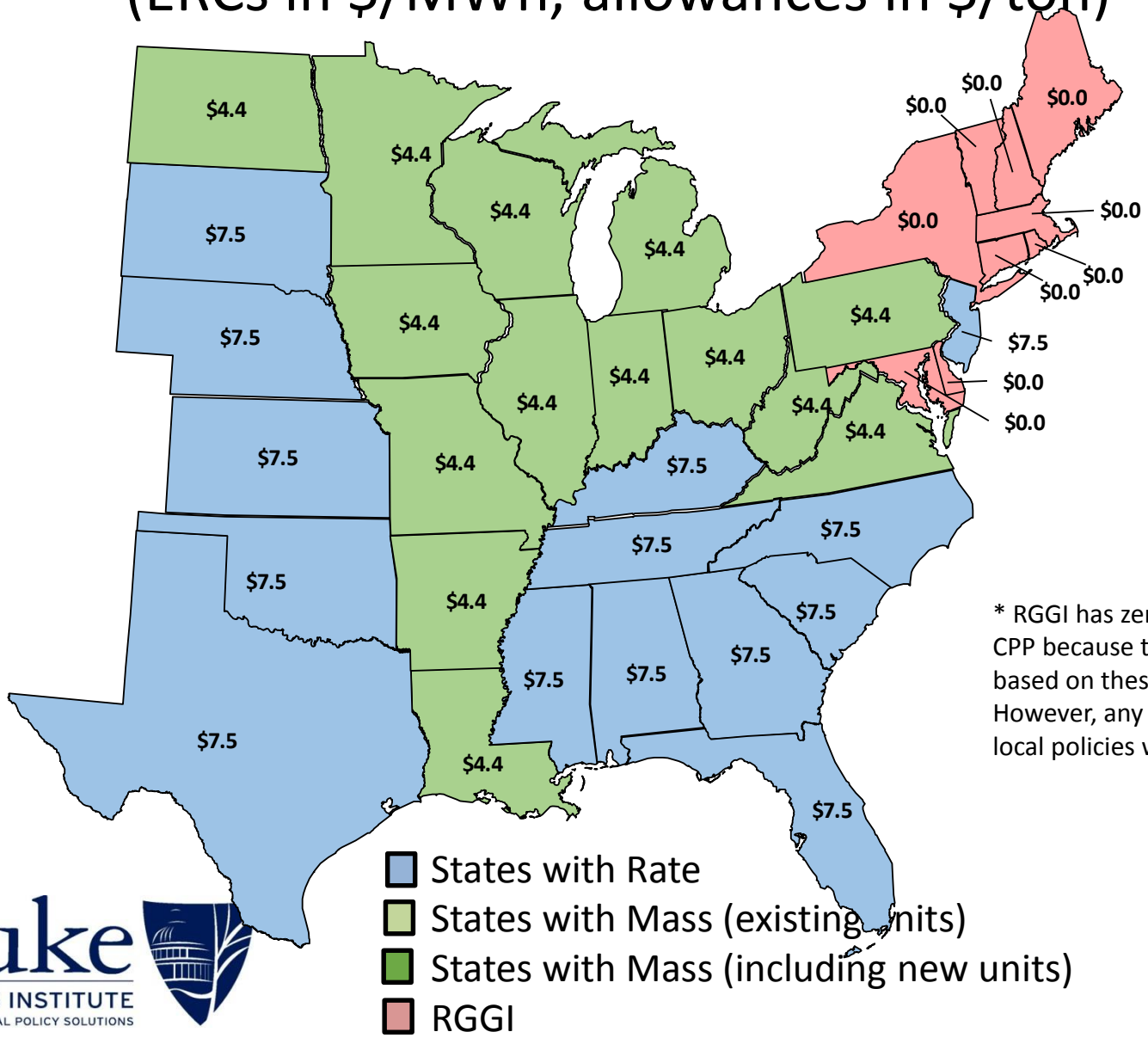


* RGGI has zero allowance prices for CPP because the cap is non-binding, based on these market assumptions. However, any CO_2 price floors from local policies would still apply.

Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

ERC and Mass Allowance Prices (2030)

(ERCs in $/MWh, allowances in $/ton)



* RGGI has zero allowance prices for CPP because the cap is non-binding, based on these market assumptions. However, any CO_2 price floors from local policies would still apply.

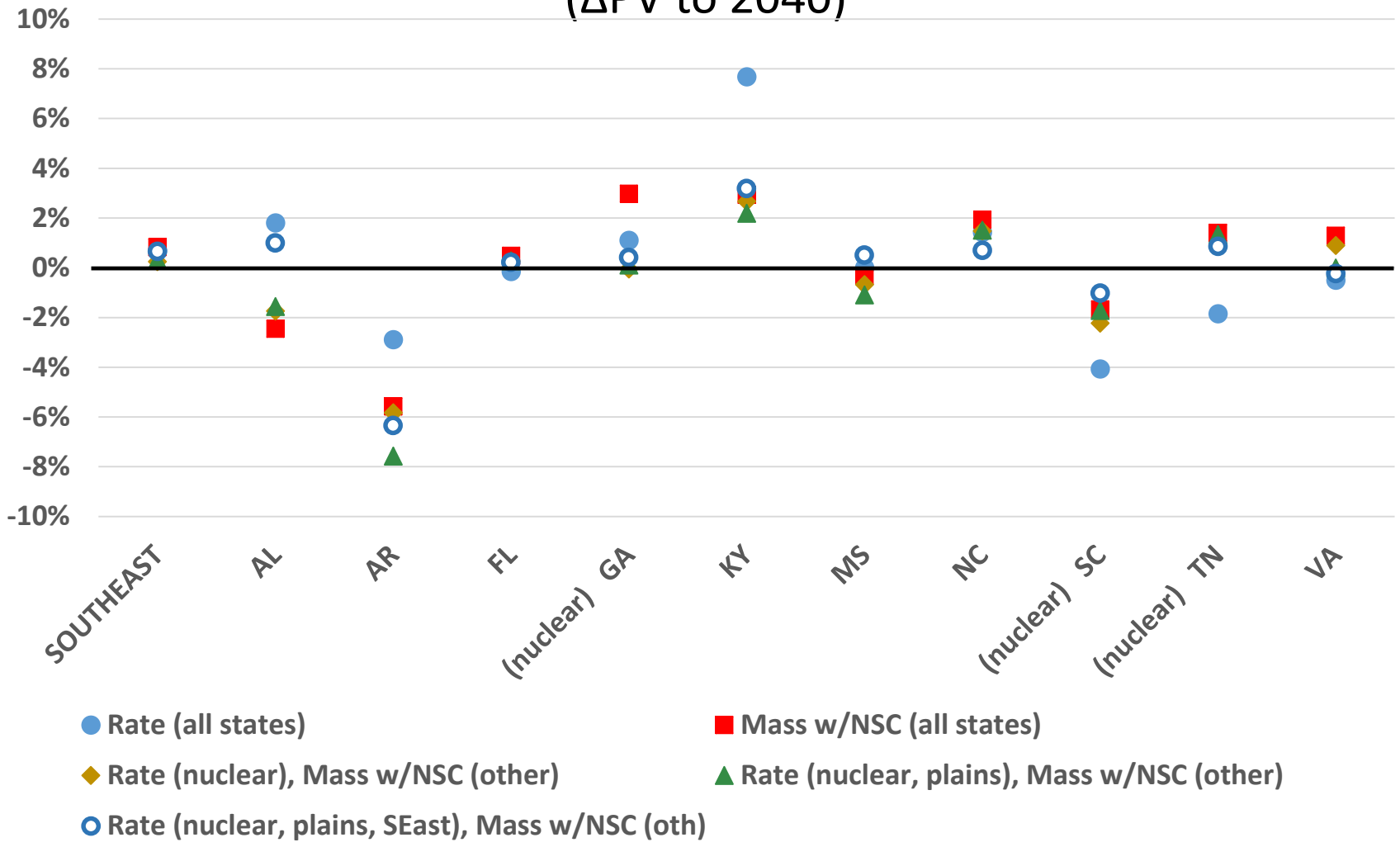
Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS

Outcomes of State Patchwork Choices and Sensitivities on Future Market Conditions

- Policy Costs (assuming patchwork approach)
  - Even if policy costs for a region are close to zero, individual states may be sensitive to variations in gas & renewables costs, or electricity demand
  - Things will not always move in the direction you expect, depending on what happens with your neighbors (costs will be shifted across states)
- Natural gas
  - High gas prices have the largest CPP costs, while low prices eliminate most costs
  - Low prices encourage gas at the expense of coal, and also replaces renewables
  - Reduced demand from energy efficiency comes out of gas generation, not coal
- Electricity demand
  - High demand makes Mass with NSC more expensive and Dual Rate cheaper
  - Higher than expected electricity demand growth is supplied by gas
- Renewables and energy efficiency
  - Low renewable costs make Dual Rate cheaper but lead to higher emissions
  - Limited EE makes Dual Rate (and other policy options) more expensive

Policy Costs – Dual Rate vs Mass with NSC

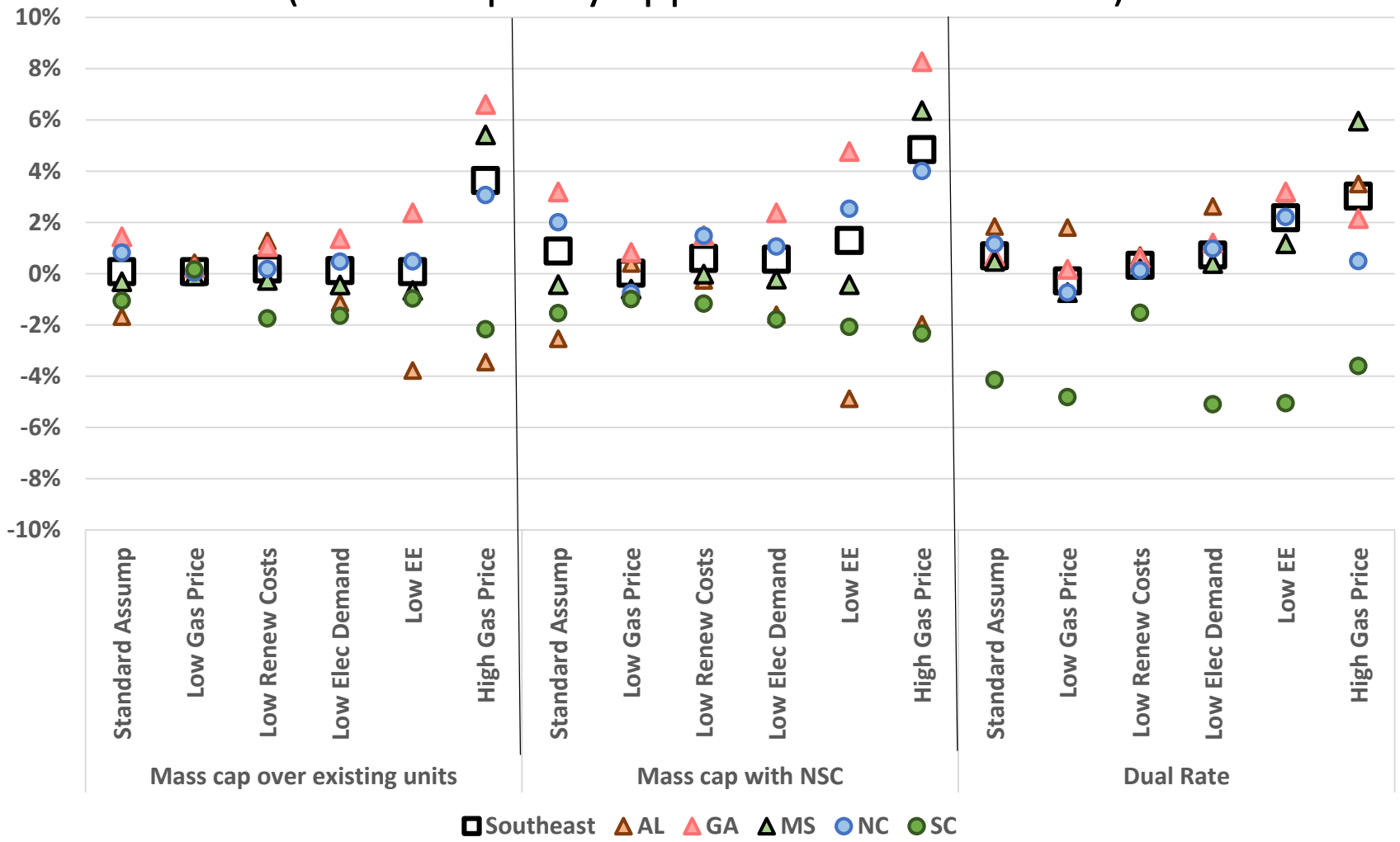
(ΔPV to 2040)



Duke NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS

Policy Costs – Sensitivities across futures

(National policy approach – ΔPV to 2040)



Standard Assumptions: electricity growth of 1.0%/yr in Southeast, gas price average of $4.57/MMBtu (2016-2037), EPA assumptions on renewables costs and EPA EE prices and quantities (1.0%/year off of demand)
Low Gas Price: gas price average of $3.76/MMBtu
Low Renewable Cost: NREL Annual Technology Baseline (low case)
Low EE: 0.5%/year off of demand
High Gas Price: gas price average of $5.38/MMBtu

Duke NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS

Thank You

Duke
NICHOLAS INSTITUTE
FOR ENVIRONMENTAL POLICY SOLUTIONS