Economic and Environmental Interactions between Alternative Carbon Pricing Policies in New York

Gökçe Akın-Olçum

Andrew Schreiber, Christoph Böhringer, Thomas Rutherford

2019 REMI AMHERST ECONOMIC ANALYSIS CONFERENCE

Amherst, MA

June 27th - 28th, 2019

EDF ENVIRONMENTAL DEFENSE FUND®

Finding the ways that work

Outline

- NY’s climate change policies
- NYISO’s “carbon adder” proposal
- UWiNDC-blueNOTE (National Open Source Tools for General Equilibrium Modeling)
- GE analysis of various policy simulations

New York's State Energy Plan

- NY's State Energy Plan (SEP) calls for:
  - Reducing state economy-wide GHG emissions 40% by 2030 and 80% by 2050, relative to 1990 levels.
  - Generating 70% of electricity from ren
  - Increasing energy efficiency from 201

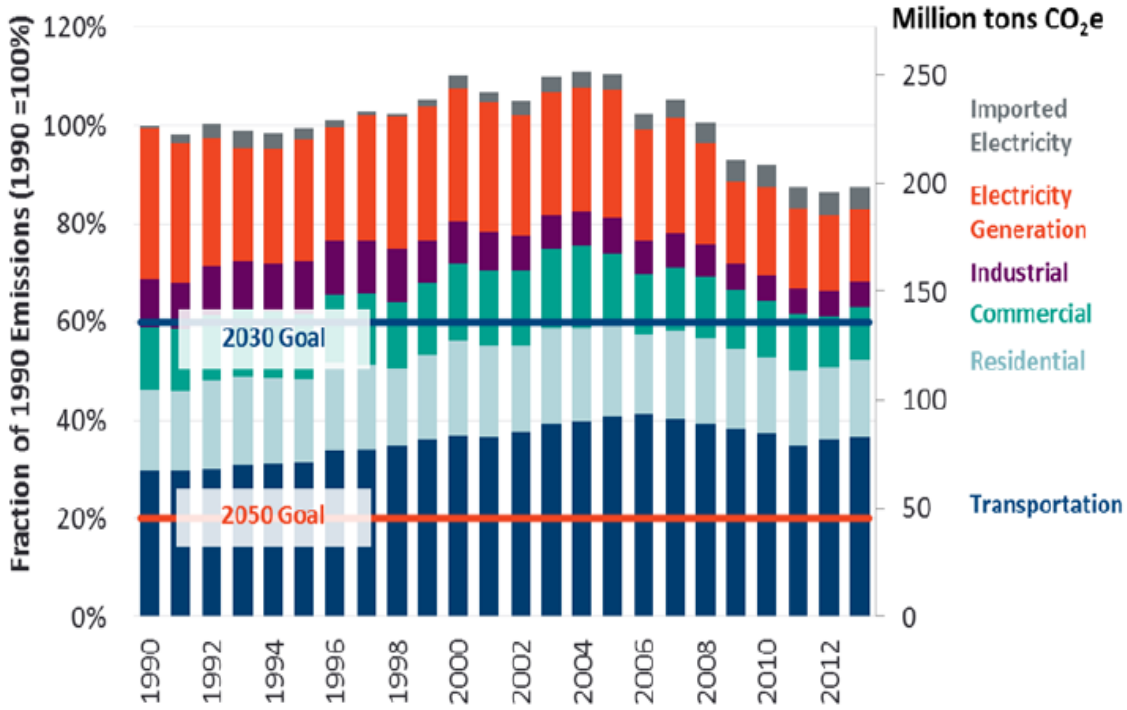


Figure 1: New York CO2e Emissions by Sector, 1990-2013 (The Brattle Group, 2017)

The New York State Climate Leadership and Community Protection Act

- Current bill status: passed senate and assembly
- Goals of the state of New York
  - Reducing GHG emissions from all anthropogenic sources 100% over 1990 levels by the year 2050,
  - With an incremental target of at least a 40% reduction in climate pollution by the year 2030,
  - Ensuring that this transition creates good jobs and protects workers and communities that might get negatively affected

New York's Power Sector

- Policy instruments to date:
  - The Clean Energy Standard (CES)
    - "Renewable Energy Credits (RECs)" to attract investment in new renewable generation
    - "Zero-Emissions Credits (ZECs)" to retain existing nuclear generation
  - The Regional Greenhouse Gas Initiative (RGGI)
  - Energy efficiency programs

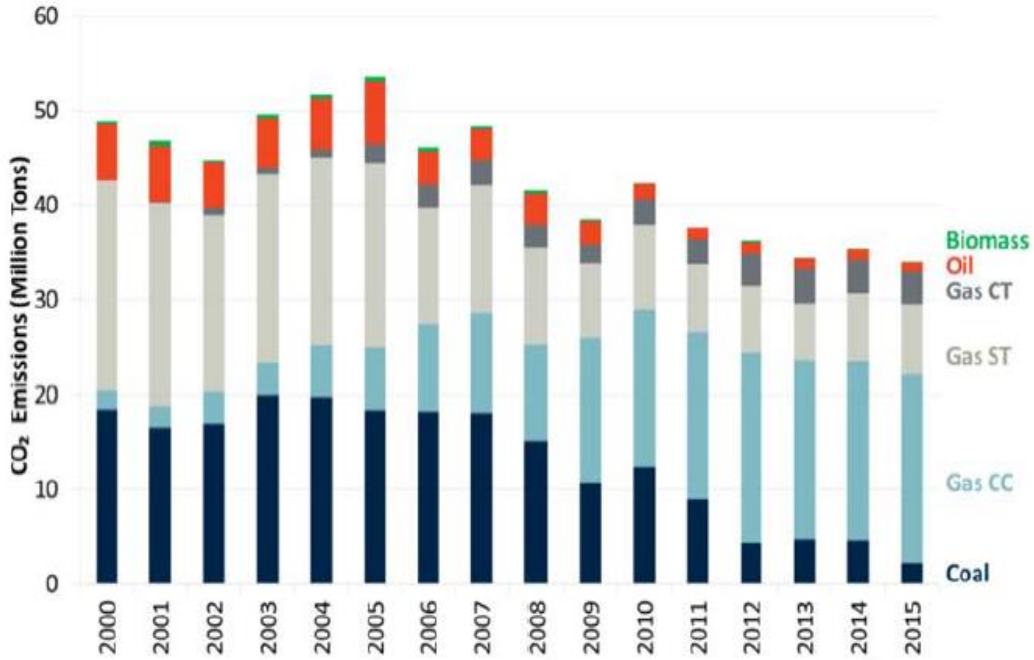


Figure 2: Historical NYISO Fossil CO2 Emissions by Generator Type (The Brattle Group, 2017)

Problem Statement

- Currently, the wholesale electricity markets operated by NYISO are not aligned with NY's SEP.
  - Designed mainly for providing electricity reliably and cost effectively.
  - The true environmental costs are not fully internalized.
    - The cost of CO_2 emissions is conveyed only through the RGGI price.

- How to harmonize the wholesale electricity markets operated by NYISO to align with New York's CO_2 reduction targets from the SEP?

The Gross Social Cost of Carbon

- The New York Public Service Commission adopts the Social Cost of Carbon (SCC) as estimated by the US Interagency Group on the Social Cost of Carbon.

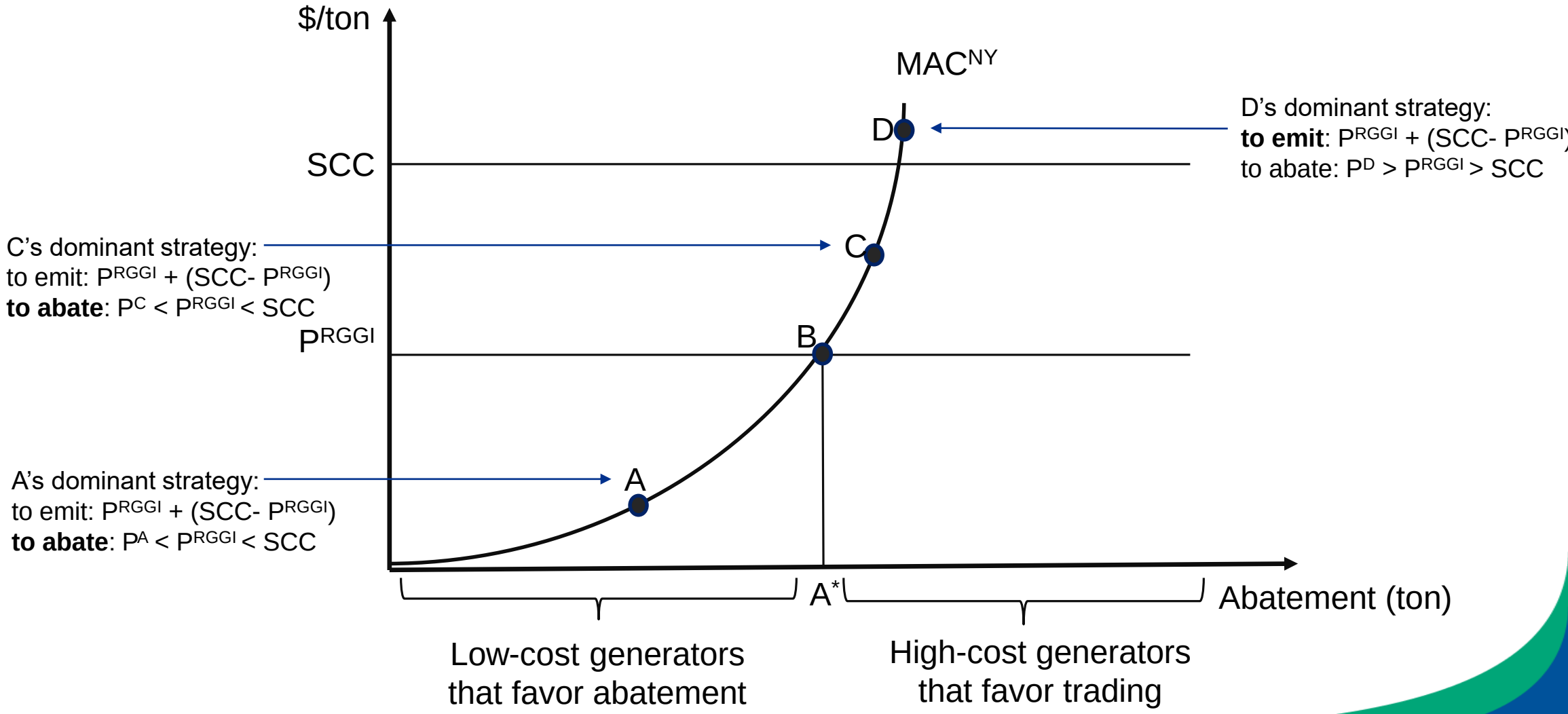
	Gross SCC	RGGI, Inc.	Net SCC
	$nominal/US-ton	$nominal/US-ton	$nominal/US-ton
2020	47.30	6.56	40.74
2021	48.30	6.98	41.32
2022	50.48	7.39	43.09
2023	52.74	7.81	44.93
2024	55.07	8.45	46.62
2025	57.48	9.09	48.39
2026	59.96	9.73	50.23
2027	62.52	10.35	52.18
2028	65.17	10.96	54.20
2029	66.54	11.58	54.96
2030	69.32	12.55	56.77

Figure 3: Gross and Net Social Cost of Carbon (NYISO, 2018)

An Alternative Policy

- What is the alternative to the existing policies?
  - Carbon Adder
    - Mechanism which helps NYISO to incorporate a higher carbon price into its energy market by adding a charge to resources' costs based on their emissions rate and a price-per-ton established by the NYPSC.
    - Targets the environmental externality, i.e. carbon charge level should be set such that the carbon charge plus the RGGI allowance price sums to the desired price level.
  - What is the desired price level?
    - The social cost of carbon (SCC)

Carbon adder mechanism



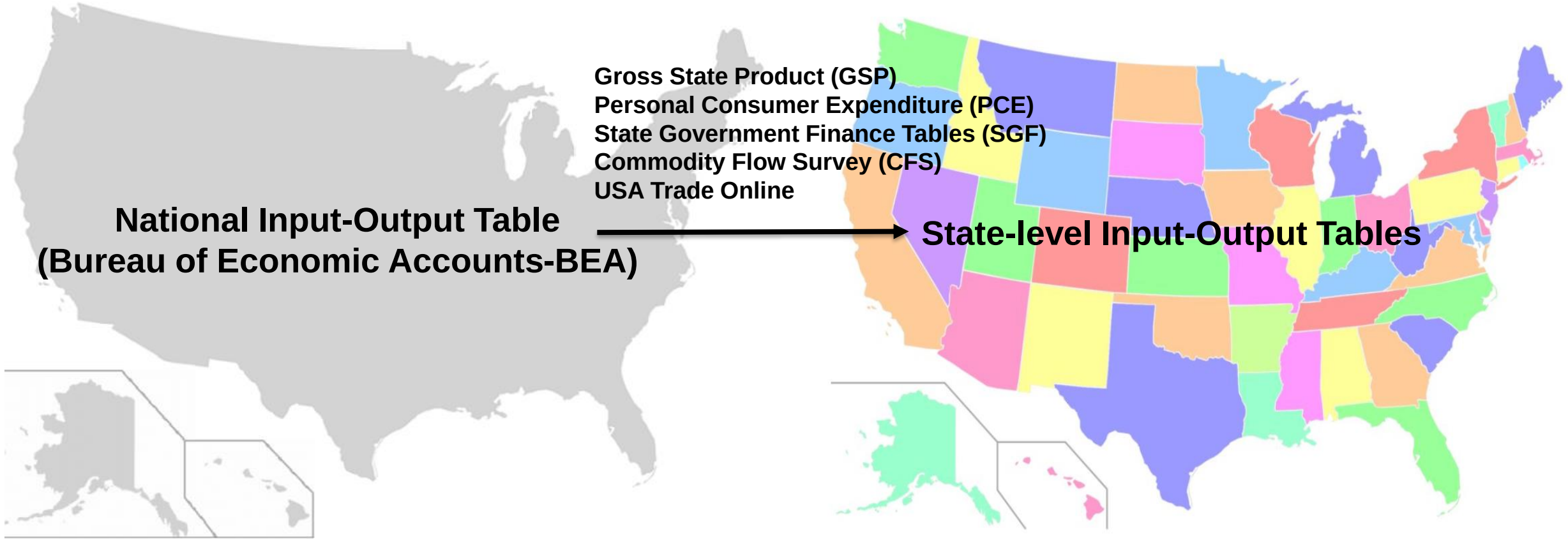
Question and Method

- Question:
  - What are the effects of imposing a carbon adder on top of RGGI pricing?
    - Technology mixes
    - Carbon emissions and electricity pricing
    - Cost of compliance
  - Can we think of alternative policies in order to meet NY's environmental targets?
    - Tightened RGGI targets
    - NY-wide cap and trade program
  - Method:
    - Applied general equilibrium analysis

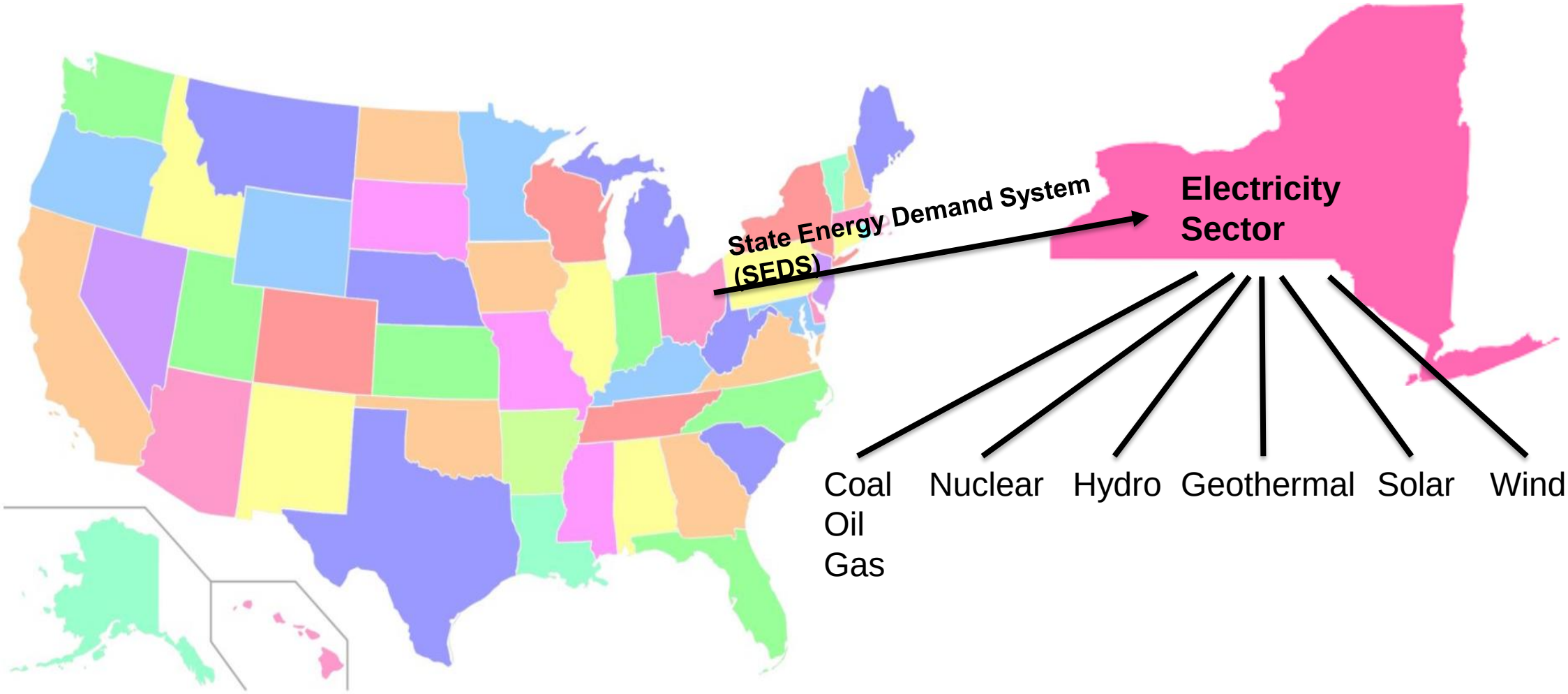
U.S. Environmental Policy Analysis Model

- **blueNOTE** "**N**ational **O**pen source **T**ools for general **E**quilibrium modeling"
  - Micro-consistent sub-national SAMs
    - Consistent national income/product tables from Bureau of Economic Analysis
    - State-level tables relying on sharing data parameters
      - Gross State Product (GSP)
      - Personal Consumer Expenditures (PCE)
      - State Government Finance Tables (SGF)
      - Commodity Flow Survey (CFS)
  - Matrix balancing routines for recalibration using additional satellite data
  - State Energy Data System (SEDS) used to impose energy demands and emissions
    - Separate energy technologies: coal, natural gas, oil, nuclear, hydro, wind, solar, geothermal
    - Trade margins are adjusted in the electricity sector so that the difference between wholesale and retail prices are captured.

BlueNOTE build stream



BlueNOTE build stream



U.S. state-level economy model

- Multi-state, multi-sector CGE model of the U.S. economy calibrated to 2016 data
- A small open economy model, all U.S. economic sectors are price-takers in the international markets

Regions	Sectors	Electricity generation technologies
New York	Crude oil extraction	Coal
RGGI states (excld. NY)	Natural gas extraction	Oil
PJM states (excld. DE and MD)	Coal mining	Natural Gas
Rest of the U.S. (RUS)	Petroleum refineries	Nuclear
	Electricity	Hydroelectric
	Energy-/Emission-intensive sectors	Geothermal
	Other manufacturing	Solar
	Transportation	Wind
	Other services	
	Rest of the economy	

U.S. state-level economy model

- Static equilibrium with no market imperfections (technology spillover, market power, etc.)
- Representative regional HHs and governments
  - Demand their final consumption and public goods
- Structural unemployment captured through an empirical relationship, known as wage curve (Blanchflower and Oswald, 1994)
  - The elasticity of the real wage with respect to the unemployment rate is -1.
- Production is allocated to either the national, regional or foreign markets.
  - For non-electricity goods, national market is assumed to be pooled.

Statistics on the regional economies

- Regional statistics on
  - Total gross domestic product
  - Share of value added attributed to electricity production
  - Reliance on electricity trade
  - Total CO_2 emissions and CO_2 intensity

Table 2: Aggregate regional economic data

	Total GDP (Bill. $)	Elec VA (% of GDP)	Elec Demand national/state (%)	Total CO_2 (Mt)	CO_2 intensity
NY	1472.4	0.5	18.0	167.9	0.11
RGGI	1534.5	0.5	29.8	224.1	0.15
PJM	5343.3	0.9	20.5	1678.5	0.31
RUS	10350.0	0.9	18.0	3423.0	0.33

Statistics on the regional economies

- Regional statistics on
  - Percentage shares of total electricity production attributed to generation technologies
  - Total CO_2 emissions from each generation technology type

Table 3: State-level electricity generation

		Generating Technologies							
		Coal	*Oil*	*Gas*	*Nuclear*	*Hydro*	*Geo*	*Solar*	*Wind*
NY	% Generation	1.3		45.5	30.6	19.7			2.9
	CO_2 (Mt)	1.5		25.8					
RGGI	% Generation	14.3	0.7	45.9	32.0	4.7		0.4	1.9
	CO_2 (Mt)	17.5	0.4	26.6					
PJM	% Generation	41.9	0.2	26.7	27.6	1.2		0.2	2.1
	CO_2 (Mt)	518.8	2.0	130.0					
RUS	% Generation	30.2	0.8	39.7	13.1	7.4	0.7	1.2	7.0
	CO2 (Mt)	701.2	11.1	365.4					

What does “state-level CGE model” deliver?

- Objective
  - Determine market clearing prices and quantities for economic sectors (through endogenous demand and supply)
- Output
  - GDP and consumption trajectories;
  - Sectoral outputs and price of sectoral outputs, i.e. energy, manufacturing, services;
  - Sectoral/state-level emission trajectories;
  - Structural unemployment
- Policy Analysis
  - Macroeconomic impacts of policy interventions such as energy tax/subsidies, emission quotas/pricing
    - Scale, composition, and technique effects
  - Bilateral electricity trade and leakage potential
  - Competitiveness between sectors/states
  - Incidence analysis

Relevant Policy Scenarios

Scenario	The RGGI market	CO_2 price control	Other CO_2 pricing	Sector coverage
Business-as-usual (BAU)	Active ($5/ton)	Price Floor	No	Power sector
Reference (REF)	Active	Price Floor	NY's Carbon Adder ($10-20-30/ton)	Power sector
RGGIplus	Active	Price Floor	No	Power sector
NYSA	Active	Price Floor	NY's economy-wide Cap-and-Trade Market	Power sector + All sectors for NY

Impacts under “NY’s Carbon Adder”

- Downward pressure on the RGGI price
  - Decrease in aggregate demand for RGGI allowances
- Conventional power generation increases in the RGGI states
  - Highest increase is observed in coal-based generation, followed by gas-based generation
- Change in power generation in PJM and RUS stays modest
- Necessity for “Emissions Containment Reserve”
  - Introduced with 2017 Model Rule, and scheduled to begin in 2021
  - States implementing ECR can withhold allowances from circulation if prices fall below established trigger prices.

Emission Containment Reserve

- ECR trigger price is the price below which CO2 allowances will be withheld from sale by the regulatory agency or its agent at an auction.

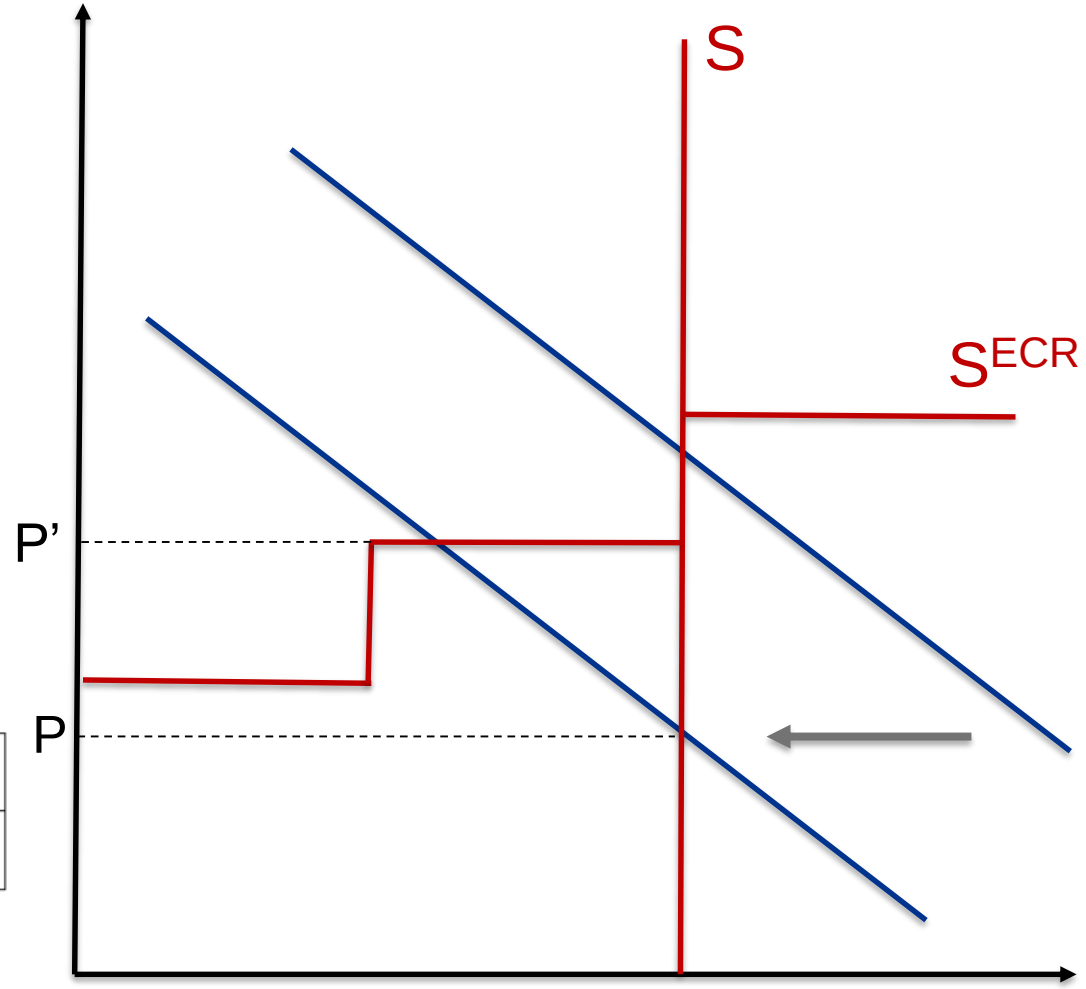


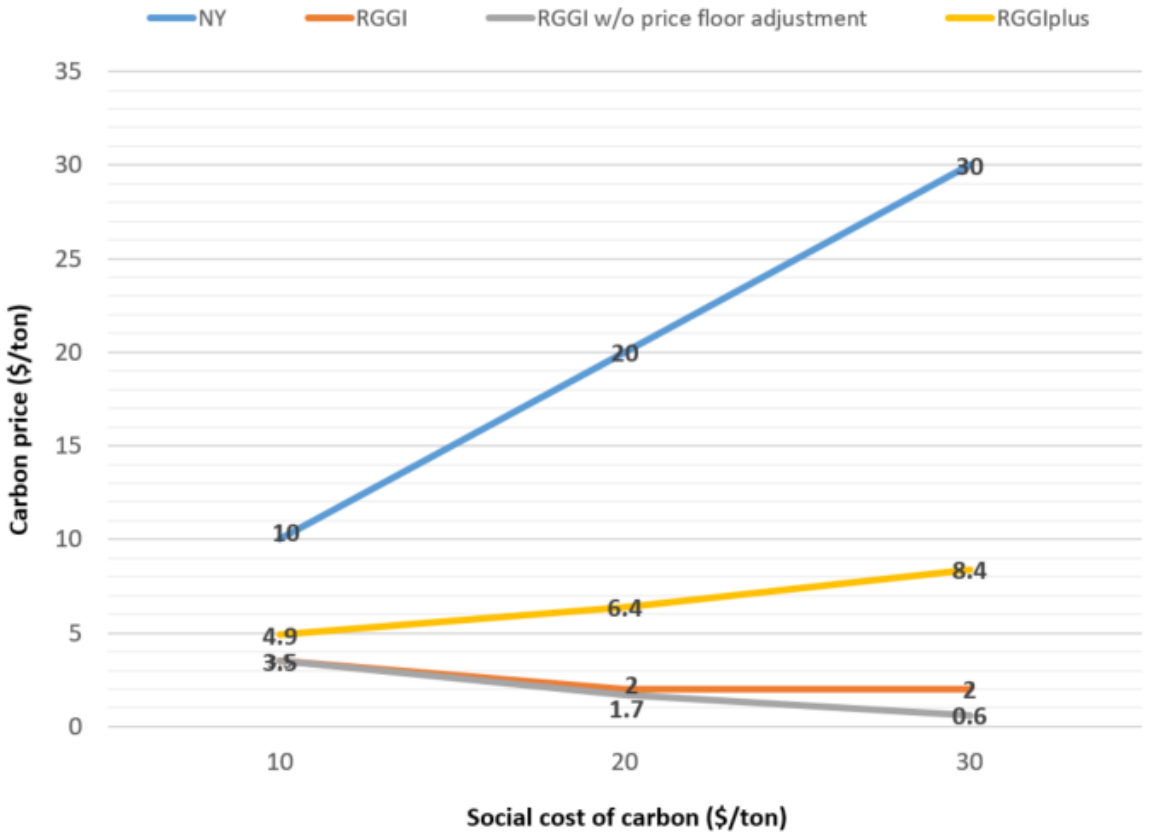
Table 2. CO_2 ECR Trigger Price

2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
$ 6.00	$ 6.42	$ 6.87	$ 7.35	$ 7.86	$ 8.41	$ 9.00	$ 9.63	$10.30	$11.02

Figure : CO2 ECR Trigger Price
Source: Principles to Accompany Model Rule Amendments, rggi.org, 2019

Alternative scenarios to “Carbon Adder Policy”
RGGIplus scenario

Upward pressure on the RGGI price

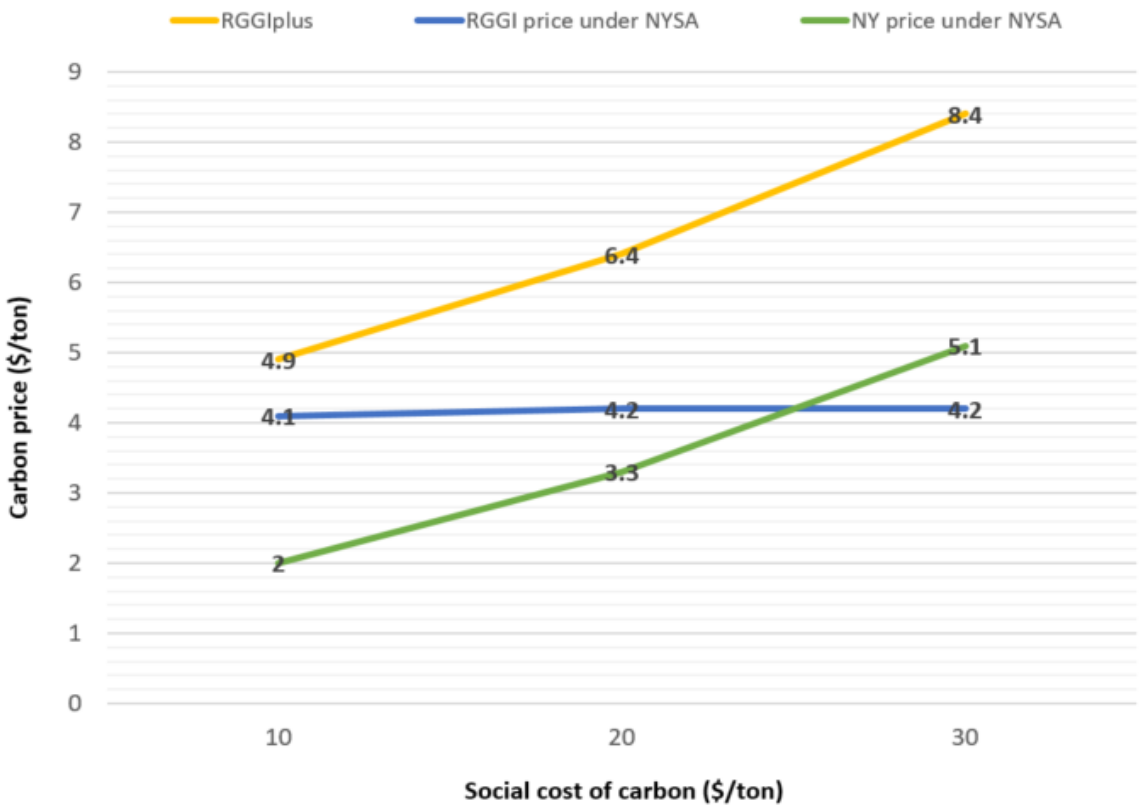


In comparison to the “Carbon Adder” scenario

- Stronger RGGI price signal
- NY’s green power transformation stays limited
- Increase in welfare/output for NY
- No significant change in welfare/output for RGGI

Alternative scenarios to “Carbon Adder Policy”
NYSA scenario

Decreased CO_2 price in NY



In comparison to other scenarios

- Low-cost abatement opportunity in other sectors of the NY economy
  - Transportation
  - Energy intensive
  - Natural gas
- Lower CO2 prices both in the RGGI market as well as NY market
- Increase in welfare/output for NY
- No significant change in welfare/output for RGGI

Conclusions

- "Carbon adder" on top of "RGGI pricing" results:
  - Downward pressure on the RGGI price
  - No effects on total emissions under binding CO_2 constraint
    - ECR mechanism might lead to further improvements
  - Reallocation of emissions and market shares
    - More of high emission-intensive industry (i.e. coal power) in the RGGI states
    - Less of low emission-intensive industry (i.e. gas power) in the RGGI states
    - Potential local/regional pollution outside NY, i.e. the RGGI states
  - Higher compliance and welfare costs

Conclusions

- “RGGIplus” and “NYSA” results in comparison to the “REF” case:
  - Upward pressure in the RGGI price
  - Market shares of energy generation technologies
    - More of clean power, less of dirty power in the RGGI states
    - Reduced/increased incentives for the use of clean/dirty power in NY
  - Lower compliance and welfare costs

Thank you!

gakin@edf.org

EDF
ENVIRONMENTAL
DEFENSE FUND®
Finding the ways that work