Policy Evaluation of Regional Greenhouse Gas Initiative (RGGI)

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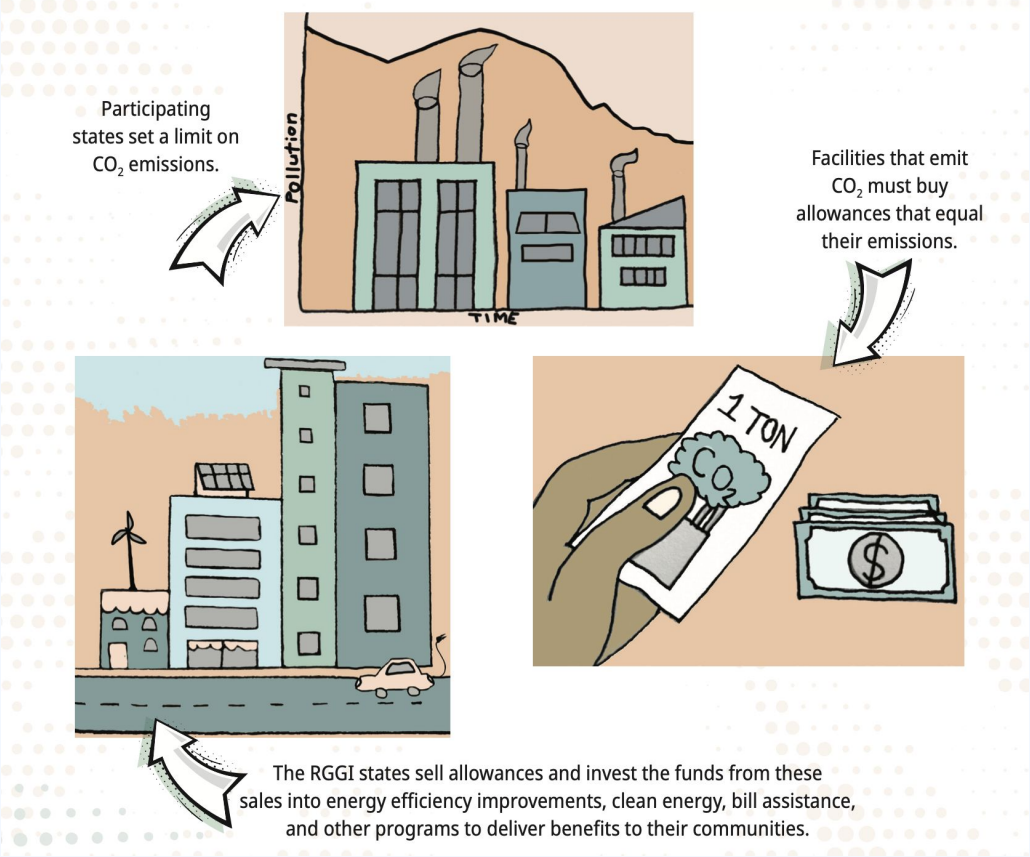
Background Information

What is RGGI?

Regional Greenhouse Gas Initiative

- The **first** mandatory cap-and-trade system in the US where power plants buy or sell emissions allowances to limit CO_2 from the power sector.
- Established in **2005** and administered in **2008.**
- RGGI compliance obligations apply to fossil-fueled power plants 25 megawatts (MW) and larger within the 11-state region.
- Funds raised from auctions are invested in energy efficiency and renewable energy projects.

How does RGGI work?

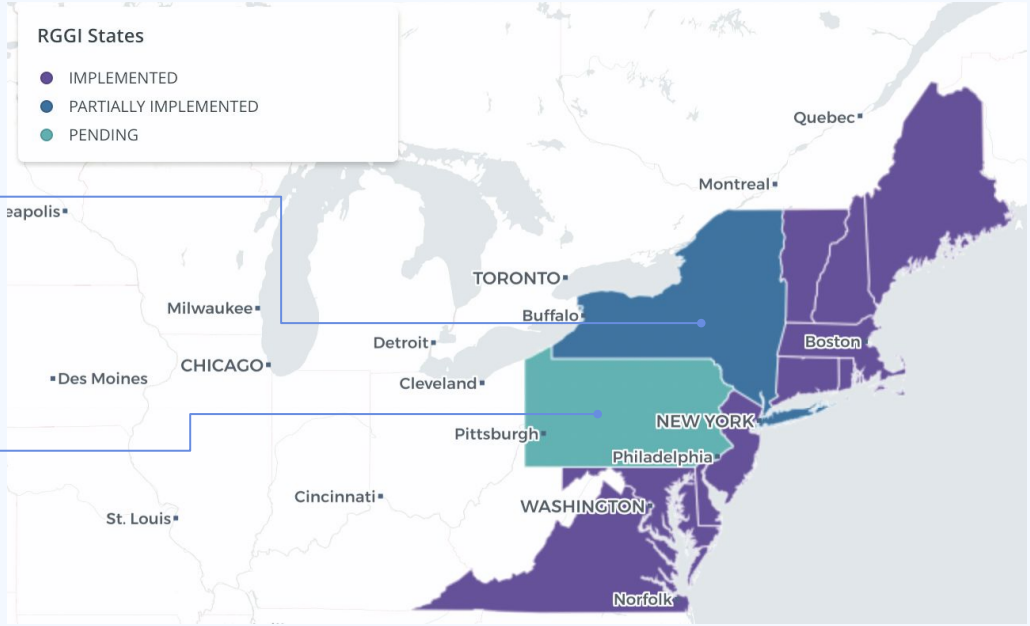


RGGI Map

RGGI States: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia

NY: Partially Implemented
Economy-wide Cap-and-Invest Program: Climate Leadership and Community Protection Act (CLCPA)

PA: Pending
Signed an executive order in 2019
Final regulation was published in April 2022
Opponents caused an injunction
Courts have yet to issue final rulings.

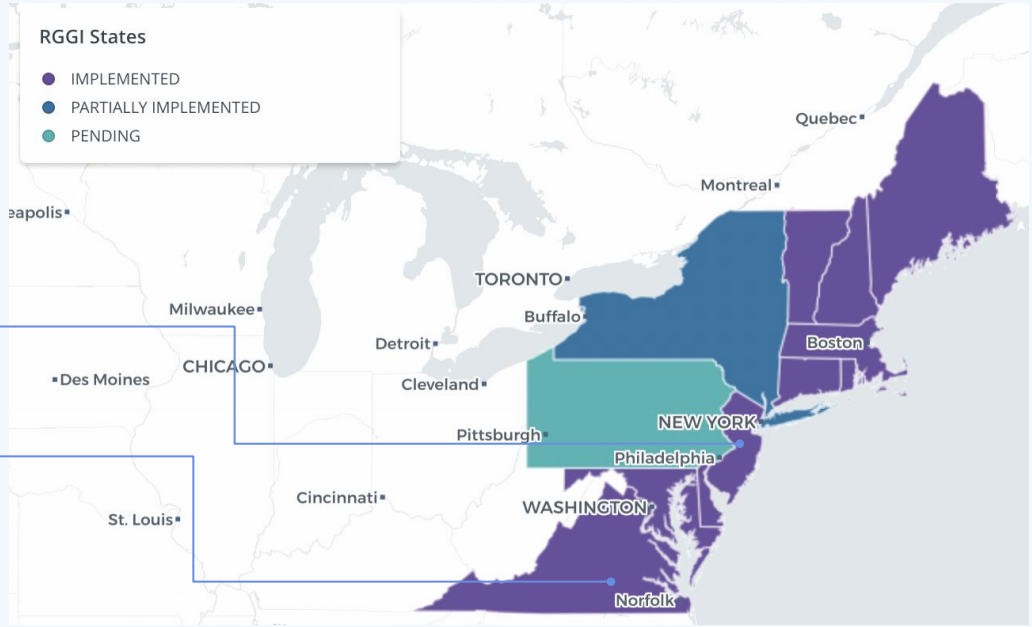


RGGI States

Additionally, some states have not participated consistently during the entire period of implementation.

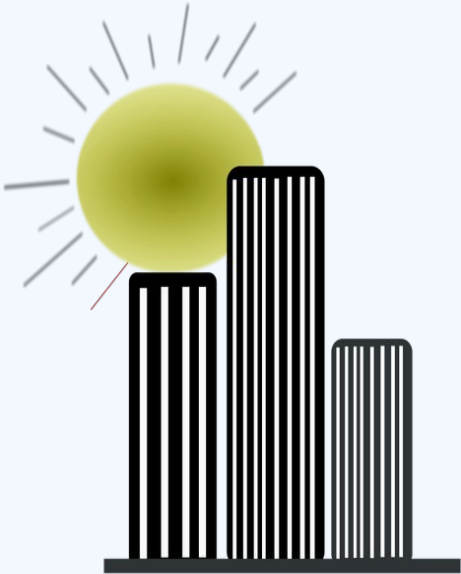
New Jersey: Currently participating.
Joined RGGI initially.
Ended RGGI participation in May 2011.
Rejoined RGGI January 1, 2020.

Virginia: Not currently participating.
Joined RGGI in 2020.
Ended participation in RGGI in late 2023.
State lawmakers are attempting to rejoin RGGI through the state budget, but are met with resistance from the governor.



Benefits of RGGI

- **Improved air quality.** Reducing pollution from emissions leads to a healthier environment for all.
- **Improved public health.** Health benefits include reduced asthma, premature births, and low-birth weights.
- **Investments in communities.** Funds from the sale of CO2 allowances are directly invested in local communities.
- **Direct bill assistance.** A portion of funds from RGGI sales have gone directly to electricity bill assistance for households and businesses.
- **Jobs created.** Investments have created new jobs in clean energy industries.



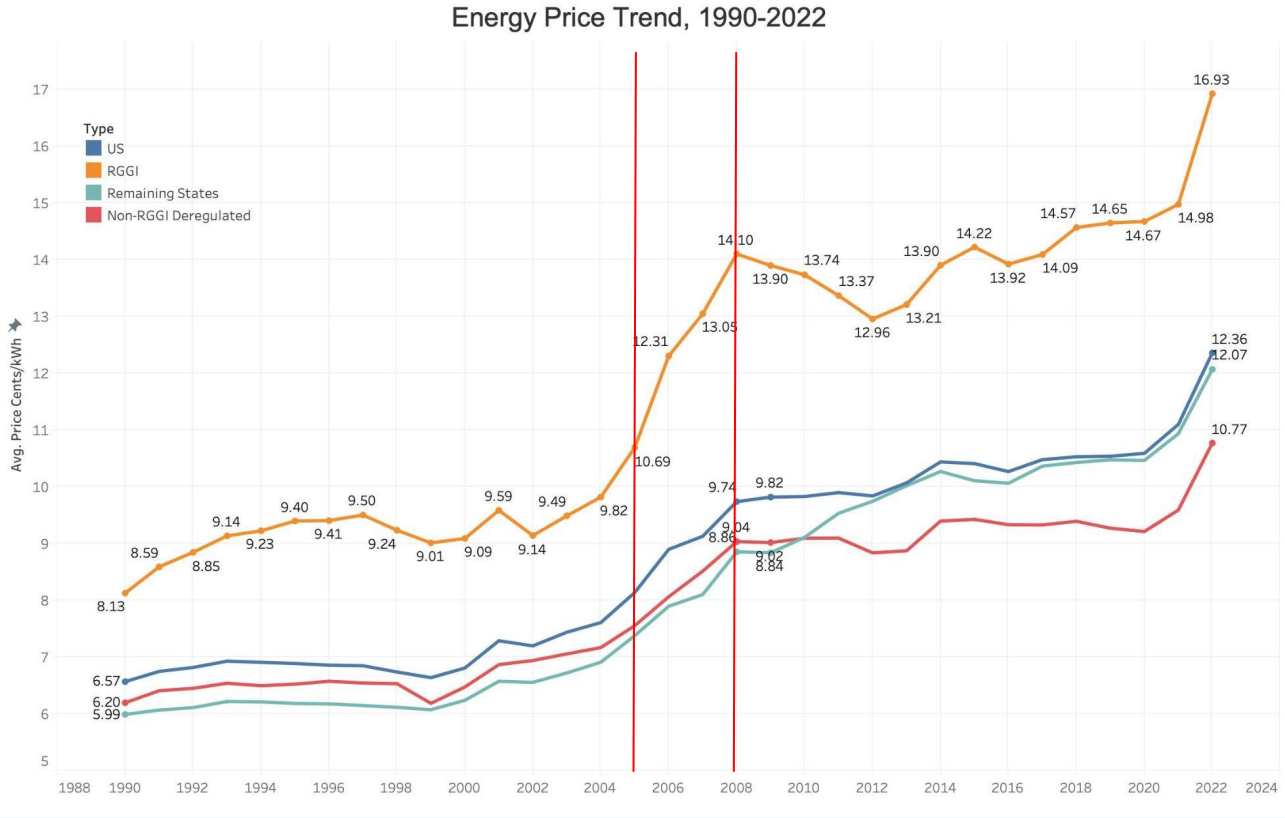
Research Question

1. How have CO_2 emissions trends in the power sector differed between RGGI-participating states and non-participating states?
2. Are there any visible patterns showing an unequal distribution of environmental burdens or benefits from RGGI implementation?
3. Can any observed economic changes in RGGI states be directly attributed to the initiative ?

02

Environmental Effect

Macro Energy Price Trend



Growing Rate (2005-2008)

US: 19.65%

RGGI States: 31.89%

Remaining States: 20.05%

Non-RGGI States: 19.58%

Growing Rate (2008-2022)

US: 26.90%

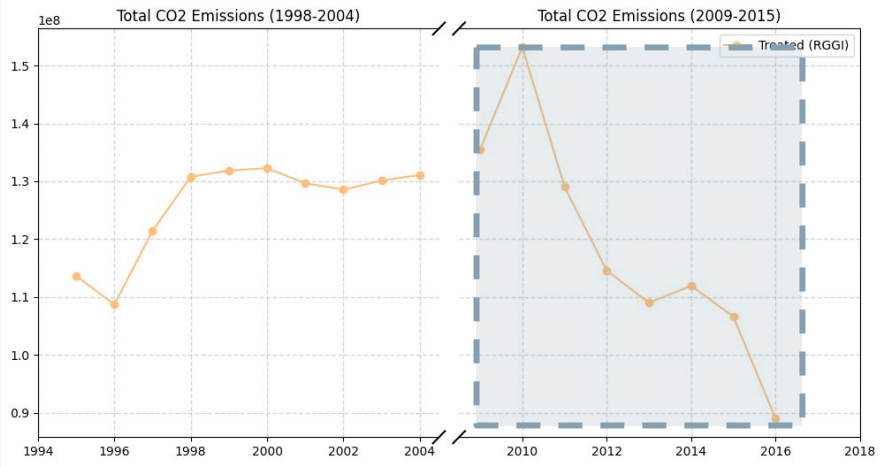
RGGI States: 20.07%

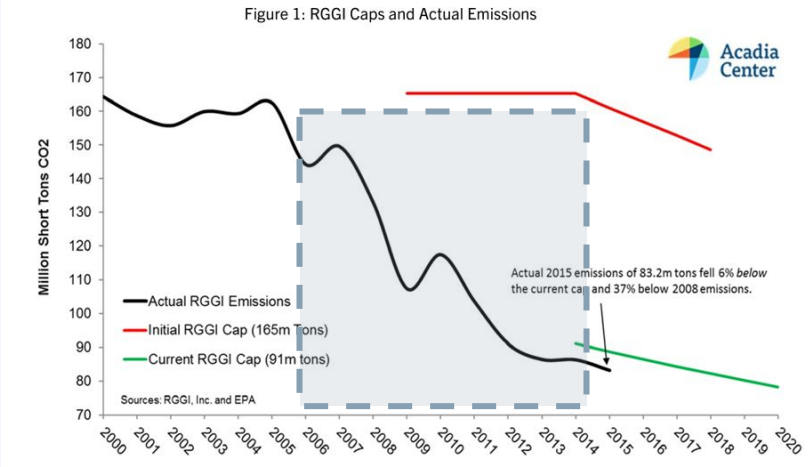
Remaining States: 36.23%

Non-RGGI States: 19.13%

CO2 Emissions Trends

Total CO2 Emissions(tons) in RGGI States





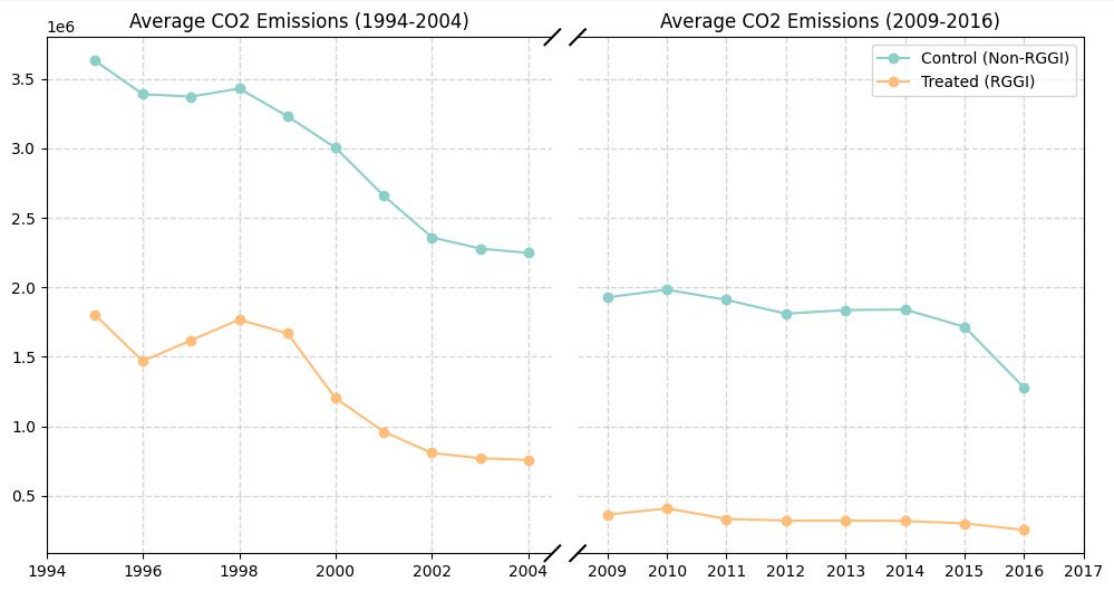
Data limitations

- Longitudinal electric generating units database
  - Lack data of RGGI EGU emissions
- RGGI CO2 Allowance Tracking System
  - The data before 2008 is not complete

Actual 2015 emissions of 106.6m tons fell 21.3% below 2009 emissions of 135.5 m tons

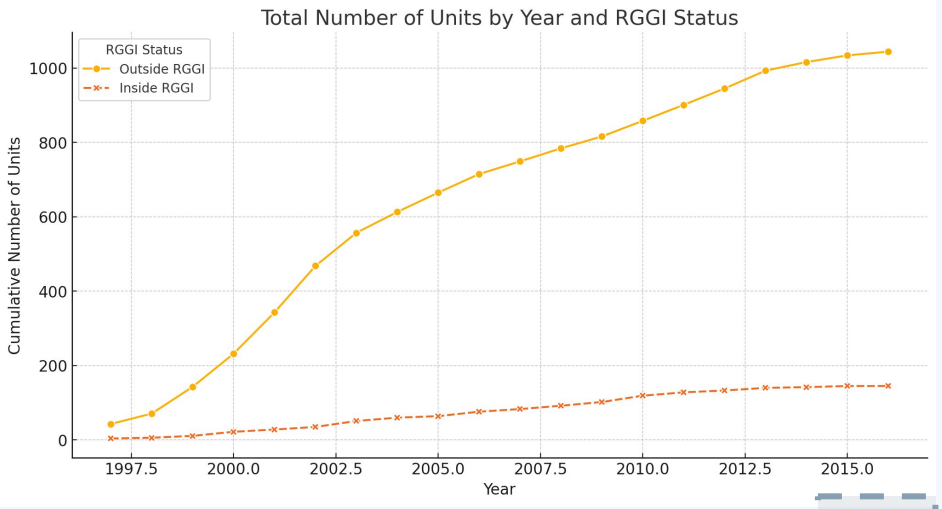
CO2 Emissions Trends

Average CO2 Emissions(tons) per EGU in and out of RGGI States



The average CO2 emissions per EGU in and out of RGGI States decrease before 2005 and after 2008 when the RGGI program established.

CO2 Emissions Trends



Short Term

rggi	2002-2004 Mean Emissions	2009-2011 Mean Emissions	Change	Change%
0	2.294150e+06	1.940403e+06	-353747.454527	15.419541
1	7.779527e+05	3.687194e+05	-409233.372813	52.603886

Long Term

rggi	1998-2004 Mean Emissions	2009-2015 Mean Emissions	Change	Change%
0	2.670291e+06	1.860540e+06	-809751.825050	30.324475
1	1.017030e+06	3.394452e+05	-677584.681039	66.623870

Estimate Change of Total Emission

- For each unit, Percentage Decrease of EGU within RGGI State is higher than that out of RGGI State;
- The percentage increase of total number of units within RGGI State is slower than that that out of RGGI State;
- However, Difference-in-Difference analysis shows that change of emissions due to RGGI Program is not not statistically significant.

	coef	std err	t	P>|t|	[0.025	0.975]
const	2.453e+06	3.66e+04	67.012	0.000	2.38e+06	2.53e+06
rggi	-1.554e+06	9.13e+04	-17.009	0.000	-1.73e+06	-1.37e+06
Post	-5.928e+05	5.52e+04	-10.742	0.000	-7.01e+05	-4.85e+05
post_treatment	3.247e+04	1.2e+05	0.27	0.786	-2.03e+05	2.67e+05

CO2 Emissions Trends

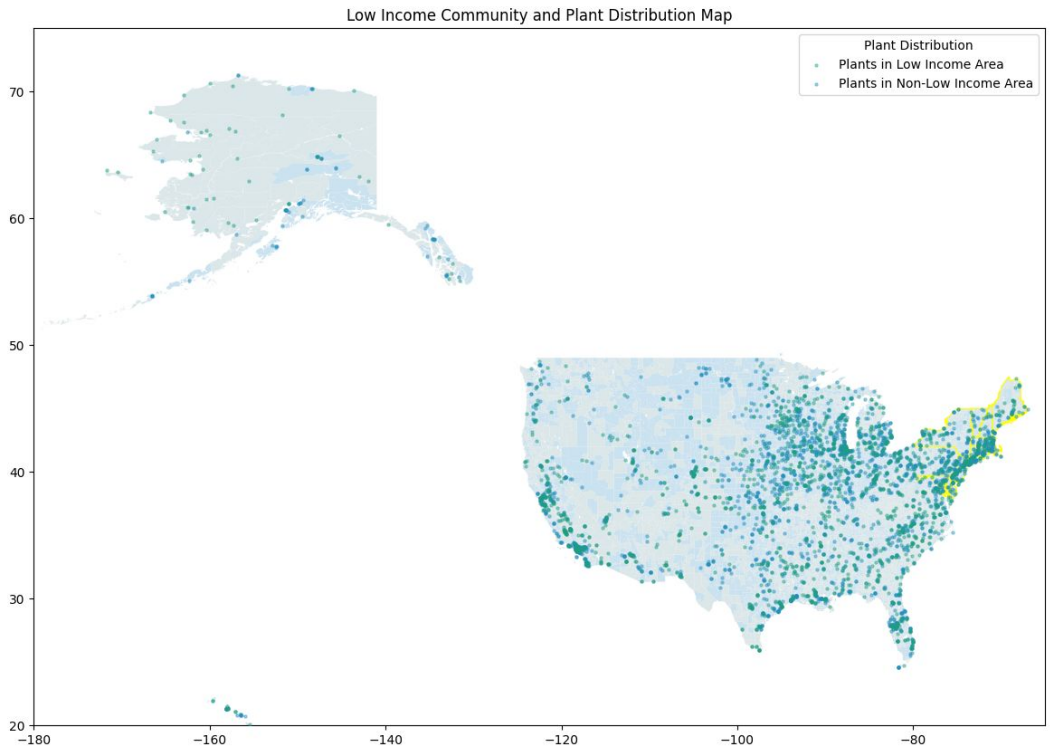
Key takeaway

- Total emissions of EGU in RGGI States fell 21.3% from 2009 to 2015.
- The difference in decrease rate highlights the impact of the RGGI in reducing emissions more effectively.
- RGGI Program did not have a statistically identifiable impact on CO2 emissions. This could mean that the intervention had no additional effect.

03

Environmental Justice

Evaluate Environmental Justice

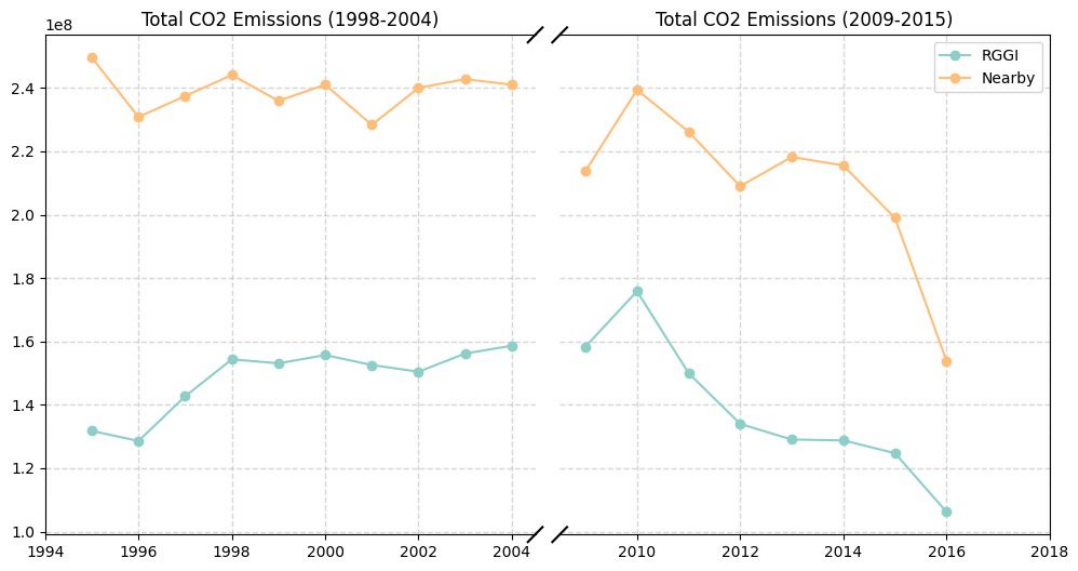


“Environmental justice” means the just treatment and meaningful involvement of all people in agency decision-making and other Federal activities that affect human health and the environment

- State level: Carbon leakage in the state next to RGGI State
- Census tract level: CO2 commissions in low-income communities
- EGU level: Change of Fuel type

State level: Carbon leakage

	RGGI State	Nearby State	Total
Percentage Decrease from 2009-2015	21.34%	6.91%	9.98%



- Three State next to RGGI state:
  - Pennsylvania
  - Virginia
  - West Virginia
- The modest reduction in nearby states raises concerns about carbon leakage

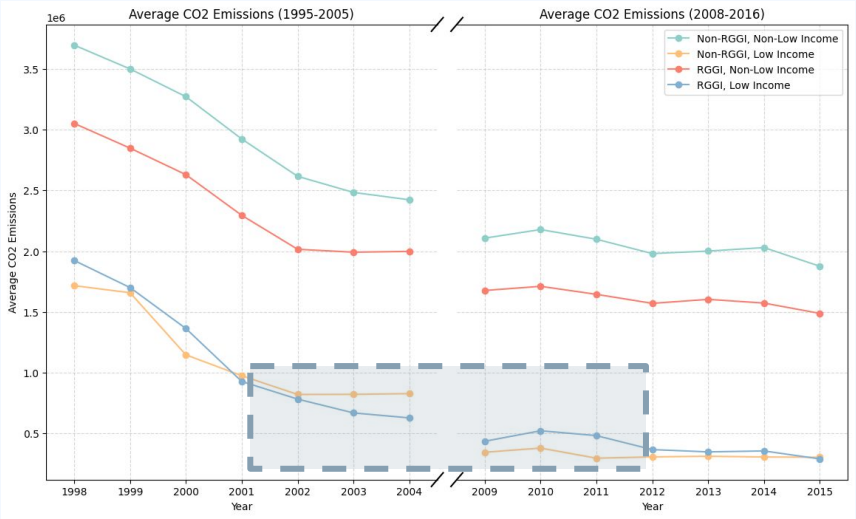
Tract level: Low-income Communities

	RGGI State（10）	non-RGGI State（45）	
Low income community（35162）	2399	19192	21591
Not low income community（49865）	4554	22065	26619
	6953	41257	48210

- If reducing emissions is more expensive in low-income areas compared to other places, businesses will likely cut emissions where it's cheaper.
- This could lead to higher emissions in low-income communities as companies look to save money.
- The term "low-income community" means any population census tract if the median family income for such tract does not exceed 80 percent of statewide median family income – 26 U.S. Code § 45D - New markets tax credit

Tract level: Low-income Communities

rggi	Low_Income	Pre-Treatment Mean Emissions	Post-Treatment Mean Emissions	Change in Emissions	DiD Between Income Groups	Diff DiD RGGI 1 vs RGGI 0
0	0	2.910472e+06	2.038595e+06	-871877.399924	NaN	NaN
	1	2.334942e+06	1.610195e+06	-724747.055469	147130.344455	NaN
1	0	1.050366e+06	3.228510e+05	-727515.501519	NaN	NaN
	1	9.440914e+05	3.969837e+05	-547107.709702	180407.791818	33277.447362

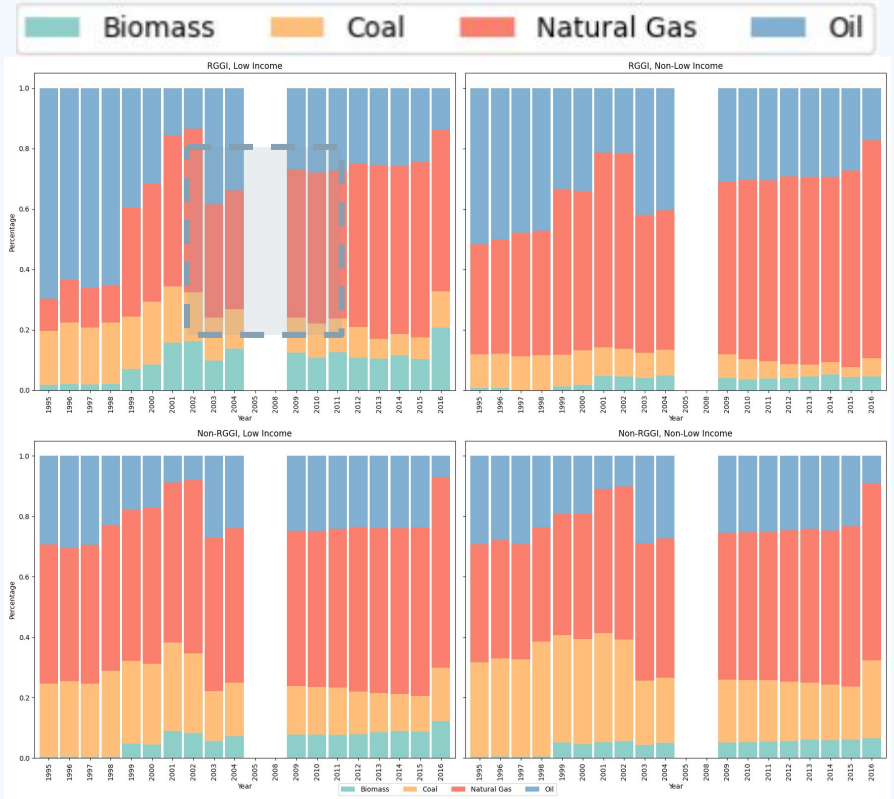


	coef	std err	t	P>|t|	[0.025	0.975]
const	2.673e+06	4.79e+04	55.831	0.000	2.58e+06	2.77e+06
rggi	-1.73e+06	1.13e+05	-15.366	0.000	-1.95e+06	-1.51e+06
Low_Income	-5.257e+05	7.41e+04	-7.095	0.000	-6.71e+05	-3.8e+05
Post	-6.342e+05	7.21e+04	-8.796	0.000	-7.75e+05	-4.93e+05
post_treatment	1.398e+04	1.45e+05	0.096	0.923	-2.71e+05	2.99e+05
rggi_low_income	3.937e+05	1.93e+05	2.043	0.041	1.6e+04	7.71e+05
post_low_income	9.729e+04	1.12e+05	0.871	0.384	-1.22e+05	3.16e+05
post_treatment_low_income	1.088e+05	2.63e+05	0.415	0.678	-4.06e+05	6.23e+05

Environmental injustice appears more pronounced in RGGI states

EGU level: Fuel type Change

rggi	Low_Income	fuel	before	after	change
0	0	Biomass	492	552	60
		Coal	3251	1922	-1329
		Natural Gas	5554	4899	-655
		Oil	3104	2291	-813
	1	Biomass	585	711	126
		Coal	2146	1217	-929
		Natural Gas	5416	4600	-816
		Oil	2540	1977	-563
1	0	Biomass	85	85	0
		Coal	241	104	-137
		Natural Gas	1273	1237	-36
		Oil	954	575	-379
	1	Biomass	135	128	-7
		Coal	196	102	-94
		Natural Gas	482	582	100
		Oil	497	277	-220



Environmental Justice

Key takeaway

- While RGGI states are lowering their emissions, some of their emission sources might be shifting to neighboring states
- Environmental unjustice appears more pronounced in RGGI states, steps are being taken to design and implement policies to address this issue.
- In RGGI State, there is a shift towards more sustainable fuels in low income area.

04

Economic Effects

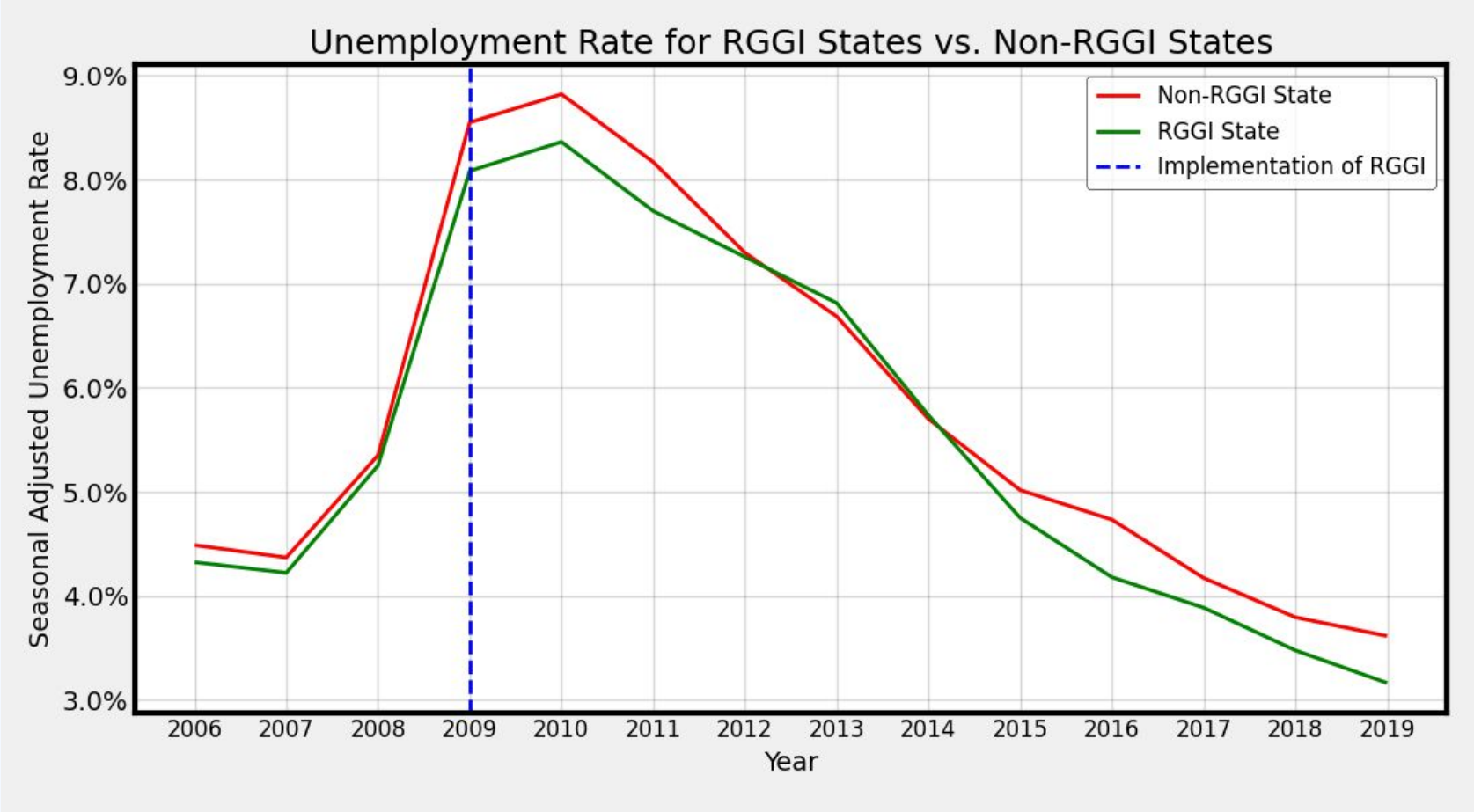
Data Sources and Methods

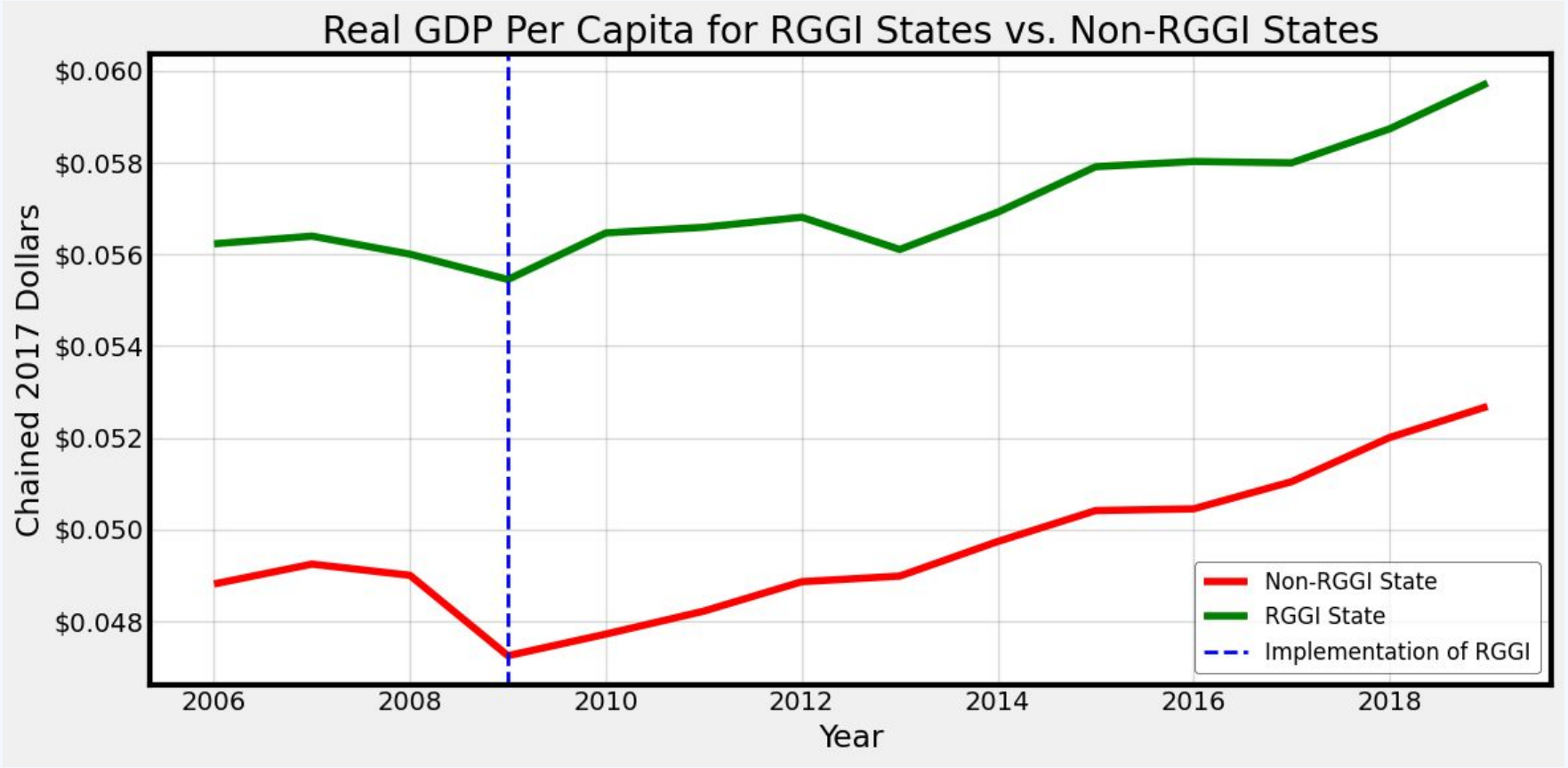
Data Sources

- RGGI COATS Platform
  - Auction Results
  - Investment of Proceeds
- Bureau of Labor Statistics
  - Unemployment Rates
- Bureau of Economic Analysis
  - Gross Domestic Product (GDP)

Methods

- Difference-in-Differences Analysis
- Regression Analysis


Unemployment Rate for RGGI States vs. Non-RGGI States
Seasonal Adjusted Unemployment Rate
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
Year
Non-RGGI State
RGGI State
Implementation of RGGI


Real GDP Per Capita for RGGI States vs. Non-RGGI States
$0.060
$0.058
$0.056
$0.054
$0.052
$0.050
$0.048
Chained 2017 Dollars
2006
2008
2010
2012
2014
2016
2018
Year
Non-RGGI State
RGGI State
Implementation of RGGI

Percent of National GDP

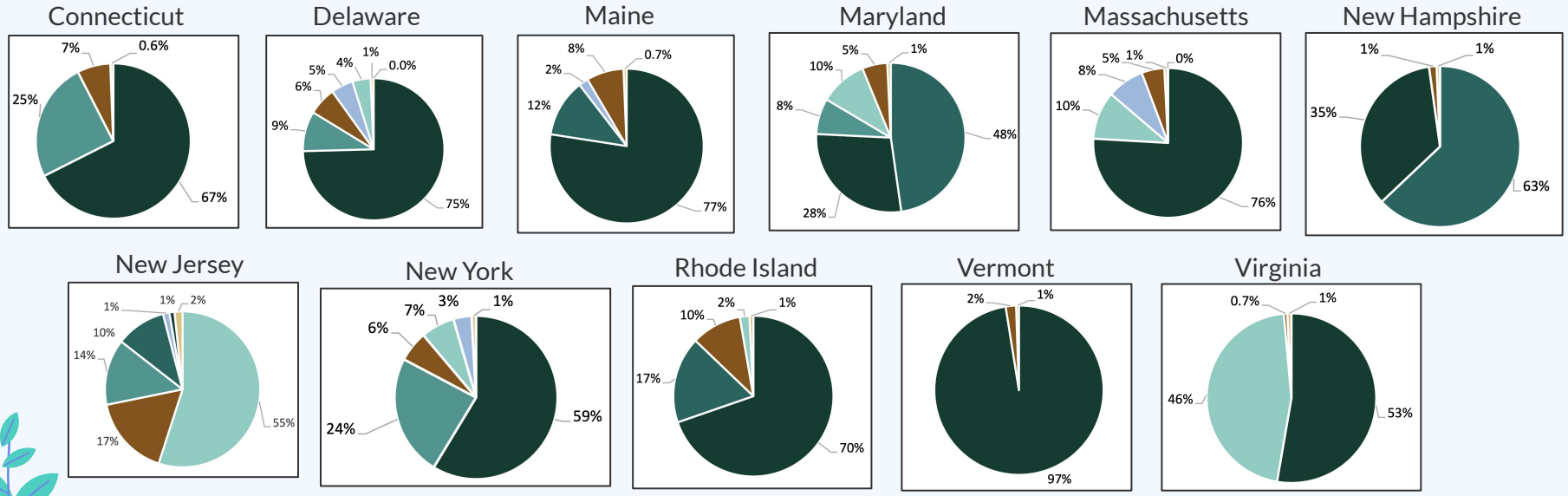
RGGI	2006	2007	2008	2009	2010	2011	2012
0	83.099503	83.168697	83.251389	82.546888	82.415466	82.613677	82.556097
1	15.664276	15.589084	15.456180	16.081410	16.188698	15.970111	16.057262

RGGI	2013	2014	2015	2016	2017	2018
0	82.789571	82.813474	82.719463	82.596397	82.796237	82.810914
1	15.857628	15.857897	15.981206	16.127802	15.960926	15.902764

0: Non-RGGI States
1: RGGI States

Investment of Proceeds

Each state has discretion over how to invest their RGGI proceeds.



Investments Regression Analysis

Effect of Investments on GDP

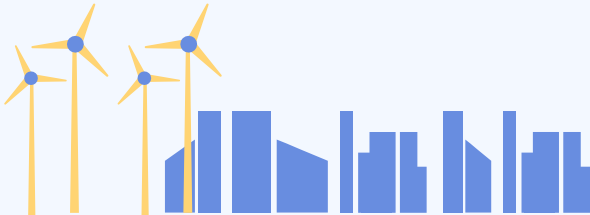
	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	-4.022e+06	1.64e+06	-2.452	0.019	-7.34e+06	-7.04e+05
Greenhouse_Gas_Abatement	6.185e+06	1.79e+06	3.462	0.001	2.57e+06	9.8e+06
Clean_Renewable_Energy	5.124e+06	1.76e+06	2.908	0.006	1.56e+06	8.69e+06
Direct_Bill_Assistance	3.803e+06	1.61e+06	2.360	0.023	5.44e+05	7.06e+06
Energy_Efficiency	3.81e+06	1.65e+06	2.312	0.026	4.77e+05	7.14e+06
Unemployment	1.195e+05	6.62e+04	1.804	0.079	-1.45e+04	2.53e+05

Effect of Investments on Unemployment Rate

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	10.2720	3.564	2.882	0.006	3.068	17.476
Greenhouse_Gas_Abatement	-7.5808	4.095	-1.851	0.072	-15.857	0.695
Clean_Renewable_Energy	-4.9839	4.133	-1.206	0.235	-13.337	3.369
Direct_Bill_Assistance	-7.5312	3.659	-2.058	0.046	-14.926	-0.137
Energy_Efficiency	-6.8803	3.781	-1.820	0.076	-14.522	0.761

05

Conclusion



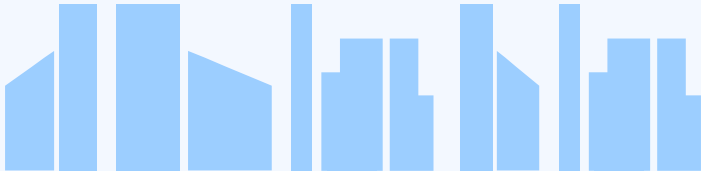
Our Findings

1. The long-term energy price indicates a potential normalization of energy costs in RGGI states despite the regulatory costs initially associated with carbon pricing.

2. The Program is effective in reducing overall emissions but enlarge the gap between states and different income levels within the RGGI States.

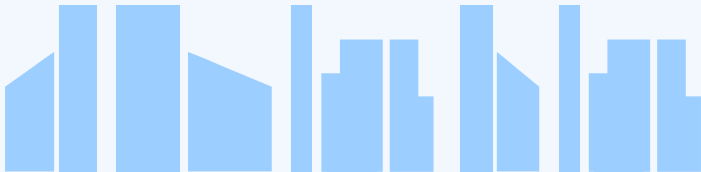
3. RGGI may have reduced the unemployment rate upon implementation, but had little effect on GDP per capita.

4. States that invested more in greenhouse gas abatement demonstrated better outcomes among GDP and unemployment rates.



Limitations

- A further in-depth study examining each state's specific economic policies is needed to fully understand the economic impacts of RGGI
- The 2008 recession and COVID-19 pandemic impacted economic data during our period of analysis
- The statistic result of DID analysis for emissions is not statistically significant, more cleaned data is needed to get a robust result



Thanks!

Do you have any questions?