Regional Greenhouse Gas Initiative

Session 2 Impacts of RGGI and Paths Forward After an 8-year hiatus, New Jersey re-joined the pollution-cutting Regional Greenhouse Gas Initiative (RGGI) market-based program in 2020. After the June 2021 CO2 auction, NJ has been allocated a total of \$139.7 million towards clean energy investment and GHG reduction strategies. This session will discuss the state's plans for development and implementation, as well as the recent developments in RGGI, including the implications of Virginia joining early this year, and Pennsylvania potentially joining in the future. Further, this session will reflect on the path ahead, including impacts on the US economy if the European Union implements its plan on a border carbon adjustment mechanism.

Session 2 Impacts of RGGI and Paths Forward

Moderator: Ben Witherell

Chief Economist

New Jersey Board of Public Utilities



Dr. Ben Witherell serves as the Chief Economist to the New Jersey Board of Public Utilities and is the director of the Office of the Economist. As Chief Economist he advises the President of the Board and other Board Commissioners regarding economic conditions and impacts affecting New Jersey's regulated utilities and clean energy programs. Prior to joining the BPU, Dr. Witherell served as Director of Economic Analysis for the New Jersey Department of Environmental Protection for eight years.

Dr. Witherell also has more than 15 years experience in the private sector as a public policy and environmental consultant and specialized in benefit-cost analysis.

He holds a Ph.D. from right here at Montclair State University as well as a Masters in Engineering from the University of Michigan and a B.S. from Tufts University.

Andrew McKeon

Executive Director

RGGI, Inc.



Andrew McKeon serves as the Executive Director of RGGI, Inc. where he has three broad areas of responsibility: management, execution and engagement. Management responsibilities include overseeing the dayto-day operations of RGGI, Inc. including the supervision of the staff and subcontractors, as well as responsibility for all financial and accounting processes. Execution refers to the guarterly CO2 allowance auctions, and timely reporting on allowance tracking and emissions monitoring, offsets program, and CO2 allowance market monitoring. Engagement relates to outreach to all stakeholders, facilitating meetings with the RGGI, Inc. board and RGGI state staff, and managing RGGI public communications. Before joining RGGI, Inc. Andrew held the role of Director of Operations for the Environmental Registry at IHSMarkit, a global financial information services provider. Prior to Markit, Andrew founded BusinessClimate, a sustainability consulting firm, where he advised major clients on corporate sustainability strategy. For five years he served on the board of TransitCenter, an NGO dedicated to sustainable transportation solutions. Andrew holds an MS in Mechanical Engineering and an MBA from Columbia University.



Regional Greenhouse Gas Initiative (RGGI): Overview and Outlook

Andrew McKeon, Executive Director, RGGI, Inc. September 23, 2021

The RGGI States



RGGI-11

- Eastern US
- 18 percent of US population
- 4th largest economy in the world based on nominal GDP (4.3T)

RGGI Structure

- Eastern states cap-and-invest program
 - Power sector
 - Fossil generators 25+ MW
 - State-issued allowances
 - Auction distribution
 - Fungible, bankable, and tradable
- 2021 cap: 119.8 million tons
- Proceeds reinvested

Track Record: CO₂ Reduction

RGGI: CO₂ Emissions vs. Regional GDP



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Other Impacts

Public health benefits of co-pollutant reductions

Abt Associates, 2017

- Lives saved
- \$5.7 billion health-related costs avoided
- Children's health improved

Economic Benefits

Analysis Group, April 2018

- Job creation
- \$4 billion in net economic benefits

Regional electricity prices

• Modest decline in retail prices & customer bills

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RGGI Reinvestment

2019 Investments: \$217M



Happening Now: RGGI Program Review

Regular, comprehensive program review

- Explore new or revised program design elements
- Evaluate the regional cap
- Open RGGI to public engagement

Improvements announced in 2017 include:

- 30% decline in the RGGI cap through 2030
- Emissions Containment Reserve
- Revision of Cost Containment Reserve
- Third cap adjustment for banked allowances

Happening Now: RGGI Program Review

Public engagement held throughout Program Review

State goals & ambitions informed by the best available science

Technical modeling & analyses to examine electricity market, emissions, economic impacts Updated RGGI Model Rule & accompanying program recommendations

Launch of state rulemaking processes

Looking Ahead

RGGI as a model

- Innovative market mechanisms
- Continuous learning
- Collaborative and open

Geographic expansion

- New Jersey resumed participation (2020)
- Virginia commenced participation (2021)
- Pennsylvania and North Carolina rulemaking in progress



Thank You!

Gary Helm Lead Market Strategist

PJM Interconnection



Mr. Helm evaluates strategic issues for PJM Interconnection, focusing on the impact of environmental legislation/regulation, fuel supply and infrastructure, technology, and broad economic trends on electricity markets and grid operations. Mr. Helm co-authored "Coal Capacity at Risk for Retirement in PJM: Impact of EPA Transport and Hazardous Air Pollutant Rules." Mr. Helm was the PJM project manager for the Eastern Interconnection Planning Collaborative's Gas-Electric System Interface Study. He led the Quadrennial Review of PJM's administrative Variable Resource Requirement curve used to procure capacity resources. His current focus is on the evolution of PJM markets in response to the changing resource mix and public policy objectives.

Mr. Helm has 30 years of industry experience, and prior to joining PJM, managed air quality issues including: policy, strategy, permitting and environmental markets for a merchant generation company.

Mr. Helm earned a Bachelor of Science degree in Horticulture, a Master of Engineering degree, and a Master of Finance degree from The Pennsylvania State University.



RGGI in PJM

M. Gary Helm Lead Market Strategist

PJM Interconnection

Montclair State University

Clean and Sustainable Energy Summit

Sept. 23, 2021



PJM as Part of the Eastern Interconnection





Success of Regional Markets and Planning...



Sustained Reliability at Least Cost



Percentage of Renewable Energy Is Small but Growing









PJM Study on Carbon Price Impacts

Results depend on the generation mix, and emissions intensities, of each sub-region.





RGGI Price Scenarios

Scenarios with RGGI price at \$6.87/short ton and \$14.88/short ton compared to a counterfactual scenario with RGGI price at \$0/short ton ("No RGGI") to quantify differences in:

Generation	Emissions	Prices		
	Case	RGGI Price		
The vear 2023 was simulated for	Case 1-0W	\$0/short ton (i.e., "No RGGI Price")		
the following cases:	Case 6-0W	\$6.87/short ton		
	Case 7-0W	\$14.88/short ton		

Results are broken out by the following regions:				
Carbon-Price Sub-Region – includes DE, MD, NJ, VA and PA	Rest of RTO – all other states in PJM			



2023 Generation Production by Sub-Region



* There may also be shifts in generation within the carbon-price sub-region, as the carbon price is only applied to RGGI generators.



2023 Total CO₂ Emissions

Generation shift from increasing carbon price results in CO_2 :

- **Decrease** in carbonprice sub-region
- Increase in rest of RTO (no carbon price)
- Net decrease across the RTO

 Net RTO
Carbon-Price Sub-Region (DE, MD, NJ, VA, PA)
Rest of RTO



2023 PJM Average Yearly LMPs* by Sub-Region & Carbon Price

LMP (\$/MWh)



Kimberly Scarborough Manager - SGA Operations & Planning

Public Service Enterprise Group



Kimberly has over 23 years of expertise in air environmental management and compliance. Her background includes experience in both industry and the federal government. Provided technical, legal and cost analyses regarding impacts of existing and pending regulations and legislation.

Her specialties involve environmental permitting and auditing, development and implementation of procedures to ensure environmental compliance, and development of an Environmental Information Management System (EMIS).

Currently, she is a member of EPA's Clean Air Act Advisory Committee (CAAAC).

Clean & Sustainable Energy Summit 2021 PSEG We make things work for you.

We have the energy to make things better ... for you, for our investors and for our stakeholders.

PSEG Overview

PSEG is a publicly traded diversified energy company

- 2.3 million PSE&G electric customers
- > 1.9 million PSE&G gas customers

PSEG Power

- Completed long-term coal exit strategy in May 2021
- Announced last month that we entered into an agreement to sell PSEG Power's 6,750 MW non-nuclear portfolio to ArcLight Capital
- > Acquired a 25% interest in the 1,100 MW Ocean Wind project

PSEG has recognized for several decades that climate change is a real phenomenon that impacts our Planet

Climate change has been a key consideration in our long-term strategy since 1990



RGGI is a regional cap-and-trade program addressing carbon dioxide emissions from fossil fuel-fired power plants.

Effective since January 1, 2009

- > Original participating states: CT, DE, ME, MA, NH, NJ, NY, RI and VT
- NJ withdrew from RGGI as of January 1, 2012 and rejoined beginning on January 1, 2020
- > VA joined RGGI starting on January 1, 2021

RGGI conducted program reviews in 2012 and 2016

- New rules effective from 2021-2030 will tighten RGGI's emissions cap as well as implement mechanisms to support pricing
 - Emissions Containment Reserve ("ECR")
 - Draw-down of allowance surplus / bank

PA is expecting to participate in RGGI starting in 2022

- Anticipate litigation
- > PA Legislature may block

New Jersey will experience increased import of electricity as a result of RGGI CO_2 allowance price adders.

Leakage occurs when the cost adder to a unit's bid into PJM's competitive market makes an efficient unit in a RGGI PJM state less competitive than a lesser efficient unit or an equally efficient unit in a non-RGGI PJM state.



The NJ Global Warming Response Act requires that "the board shall adopt... a greenhouse gas emissions portfolio standard to mitigate leakage or another regulatory mechanism to mitigate leakage applicable to all electric power suppliers and basic generation service providers that provide electricity to customers within the State"



Leakage will cause impacts to New Jersey generators and may increase emissions.

- NJ generation will be offset by out-of-state generating units that are not subject to RGGI
- Our internal modeling showed generation shifts from NJ units mostly to PJM (significantly PA), and slightly to NY-ISO
 - Reductions to emissions in NJ are offset by emissions from gas and coal units outside of NJ
- Gabel Associates' modeling on behalf of IEP-NJ shows leakage that will result in an increase in total CO2 emissions
 - A 2 million-ton CO2 reduction in New Jersey is replaced by 3 million tons of CO2 generated elsewhere throughout the Eastern Interconnect
 - By 2030, New Jersey's 9-million-ton reduction is replaced by nearly 13 million tons elsewhere throughout the Eastern Interconnect



RGGI Prices





NJBPU, PJM and RGGI Activities

NJBPU

Kicked off its NJ RGGI Leakage Study in 2019

Modeling was conducted by Montclair State University

PJM

Kicked off its Carbon Pricing Task Force in 2019

- Study the impact of carbon prices and leakage mitigation via border adjustment constraints
- Modeled RGGI price points based on the ECR(\$6.87/ton) and CCR (\$14.88/ton). Also included high carbon price sensitivities (\$25/ton and \$50/ton).

RGGI

- RGGI participating states have initiated the Third Program Review
- Public listening session is scheduled for October 5, 2021



Dileep Birur Associate Director

Clean Energy and Sustainability Analytics Center



Dr. Dileep K. Birur is Associate Director for Clean Energy and Sustainability Analytics Center (CESAC) at Montclair State University. Dr. Birur specializes in partial and general equilibrium economic modeling of energy, environment, climate change, agriculture, international trade, food security, land-use land-cover change, and public policies. Prior to joining the Center, he has worked as Research Economist at Research Triangle Institute, and as a Consultant at McKinsey and Company, performing research for government and private clients.

He holds a PhD in Agricultural Economics from Purdue University, Indiana; MS in Agricultural Economics from University of Idaho; and BS in Agricultural Marketing from University of Agricultural Sciences, Bangalore, India.

Economic Assessment of New Jersey Re-joining RGGI

Presented by: **Dileep K. Birur, PhD**

Associate Director, CESAC, Montclair State University

Based on joint work with:

Pankaj Lal, PhD Bernabas Wolde, PhD Taylor Wieczerak, PhD Nicole Provost Erik Lyttek Archana Prasad



Clean Energy and Sustainability Analytics Center (CESAC) Todd Levin, PhD Zhi Zhou, PhD Prakash Thimmapuram



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Background

- The Regional Greenhouse Gas Initiative (RGGI), established in 2009, is the first mandatory cap-and-trade program in the US to limit CO₂ emissions from electricity sector.
- With the New Jersey's strategic to move towards clean energy future and cut the GHGs emissions by 80% by 2050, the state made a decision to re-join RGGI in 2020.
- Though studies have found RGGI has substantially contributed to reduction in GHGs emissions in the nine states, there is an important issue of "generation shifting" or "leakage":
 - Shift of electricity generation from electric generating units subject to RGGI to those that are not regulated under the initiative'.
 - This may result in less efficient units being dispatched and a risk of increased CO₂ emissions.
- NJBPU commissioned this study to estimate the potential size of the leakage and economic impacts in terms of energy costs, economic growth and employment.

Study Approach

- For this analysis we uniquely combine two models: a bottom-up dispatch model- Aurora & a top-down economy-wide model- NJ-POWER:
 - **Aurora**: Aurora electric modeling forecasting and analysis software: a power system investment and dispatch model.
 - **NJ-POWER**: A global, dynamic, general equilibrium model with explicit New Jersey, other RGGI states, and other PJM regions within the US.



Study Approach...

 Coupling of Power Dispatch Model (Aurora) and Economywide (NJ-POWER) models:



Scenarios:

- 1. Mid CO₂ Allowance Price (Reference) :
 - RPS 50% by 2030
 - Energy efficiency in consumption (-2.15%/year, assumes PJM includes -0.75% EE in forecast)
 - -0.75% EE in Natural Gas consumption.
 - BTM Solar: 400 MW/year
 - New Battery storage: 600 MW by 2021, 1400 MW by 2030.
 - Offshore wind 7500 MW by 2035.
 - RGGI CO₂ Allowance prices Midpoint between ECR & CCR trigger price (\$9.5 in 2021, +7% increase through 2035)
- 2. High Allowance Price: Cost Containment Reserve (CCR) trigger price (\$13/t in 2021, +7% increase through 2035).
- 3. Low Allowance Price: Emission Containment Reserve (ECR) trigger price (\$6/t in 2021, +7% increase through 2035).

Historical & Modelled Future RGGI CO₂ Allowance Prices (\$/t of CO₂)



Scenarios:

3. High Natural Gas Price:

 Henry hub natural gas price projections based on US EIA Low Oil & Gas Supply case from 2020 Annual Energy Outlook.

4. Low Natural Gas Price in New Jersey:

- Natural gas prices in NJ are reduced by 10% for all generation units

Henry Hub Natural Gas Prices (\$/MMBtu)



5. High PJM Demand:

- Average & Peak electricity demand increased by 0.30% starting in 2021, up to 3.0% in 2030.



Results: CO₂ Emissions from Electricity Generation in NJ



- CO₂ emissions sharply decline through 2030 when NJ participates in RGGI.
- These emission reductions mainly stem from reduction in natural gas based generation.

Results: Change in CO₂ Emissions & Energy Generation Mix in Eastern Interconnection when NJ joins RGGI (Reference)



Results: Relative Cumulative Emissions in NJ & EI (2020-2030)



- Overall CO₂ emissions in NJ drop by 80.6 mt during 2020-2030 in the Reference Case.
- El without NJ showed an overall cumulative increase of 17 mt during 2020-2030.
- The increase in EI emissions is much smaller when considered on an annual basis.

Results: Annual Gross State Product (GSP) - Reference Scenario



Results Summary: Economy-wide Impact of NJ joining RGGI (Cumulative change 2020-2030)

	Scenarios	% Change in GSP	Change in GSP \$2019 billion	% Change in Employment	Change in No. of jobs	GSP Multiplier*
1.	Mid CO ₂ Price (Reference)	0.65%	4.20	0.14%	7,612	2.95
2.	High CO ₂ Price	0.82%	5.29	0.13%	7,156	3.05
3.	Low CO ₂ Price	0.56%	3.67	0.14%	7,842	3.76
4.	High NG Price	0.57%	3.71	0.15%	8,389	2.60
5.	Low NJ NG Price	0.76%	4.90	0.14%	7,932	3.44
6.	High PJM Demand	0.62%	3.98	0.12%	6,633	2.79

Note: *GSP multiplier refers to the change in cumulative real GSP with respect to cumulative investment of RGGI proceeds in NJ during 2020-2030.

Key Takeaways ...

- NJ reduces CO₂ emissions significantly and boosts its renewable electricity portfolio considerably in the coming decade, while positively contributing to economic growth.
- The model predicted an overall net reduction in generation within NJ is met by net higher generation in a number of nearby states within EI by 2030.
- The cost of RGGI allowances changes the cost of energy production in NJ marginally and the model results are relatively more sensitive to CO₂ prices than other factors modeled.
- Our analysis included only the RGGI member states as of 2019 and further incorporation other potential RGGI member states can impact model results.
- Further modeling of alternate CO₂ mitigation options such as border cost adjustment measures, carbon tax, increased participation in RGGI, would offer greater insights.

Thank you

https://www.montclair.edu/cesac