The Electricity Journal 31 (2018) 1–8

Contents lists available at ScienceDirect

The Electricity Journal

journal homepage: www.elsevier.com/locate/tej

# An expanding carbon cap-and-trade regime? A decade of experience with RGGI charts a path forward☆

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ARTICLE INFO

*Keyword:*
RGGI
$CO_2$
Cap and Trade

ABSTRACT

On carbon, states have been forced by federal inaction to take matters into their own hands. Over a dozen states are participating in or considering $CO_2$ cap-and-trade regimes. The oldest – the Regional Greenhouse Gas Initiative – has in a decade achieved emission reductions through joint state implementation and efficient market-based carbon pollution control. The initiative also has yielded $5 billion in economic benefits and tens of thousands of jobs. RGGI thus charts a path forward for states seeking a practical approach to carbon reduction in the absence of federal leadership.

## 1. Introduction

The recent retrenchment by the Trump Administration in efforts to reduce greenhouse gas (GHG) emissions from the power and transportation sectors will complicate international efforts to meet the targets of the Paris Accord, and sets the U.S. on a backwards path in addressing the risks of climate change. Moreover, Congress continues to reveal deep divisions on whether it is necessary to establish a national carbon-dioxide ($CO_2$) reduction program and if so, how to do it.

In launching the Regional Greenhouse Gas Initiative (RGGI) almost 10 years ago, and administering the program through many gubernatorial administrations, and major changes in the electric industry, states in the Northeastern and Mid-Atlantic region of the U.S. have gone far beyond the questions of "whether" and "how." Indeed, these states have continued their commitments through two top-to-bottom program reviews with alterations to cap levels and program design. These Northeast states have established and successfully administered cooperative state-driven emission reductions, contributing to continuous declines in power plant $CO_2$ emissions over time.

As other states — such as Virginia and New Jersey — deliberate about whether to adopt and administer similar carbon-control programs (potentially in cooperation with the RGGI states), a great deal can be drawn from studies of RGGI's experience to date.

We have conducted a comprehensive review of the economic impacts of the RGGI program during RGGI's *third* three-year Compliance Period (2015–2017). This study follows our reviews of Compliance Period I (2009–2011) and Compliance Period II (2012–2014). We have also analyzed the impacts of the full nine-year period of RGGI implementation.

Using power-system dispatch and macroeconomic modeling, we sought answers to several key questions: What has happened to the dollars collected in RGGI allowance auctions? How did the states spend them? How did those dollars affect the economies of the RGGI states? How has the program affected consumer expenditures on electricity and other fuels, electricity markets, and the costs and revenues of power suppliers? And what has been learned to date about program design and administration?[1]

Importantly, while we recognize that the RGGI states themselves are

☆ This article is based in part on three reports by Analysis Group, including the most recent report by the authors on RGGI's third Compliance Period (available at www.analysisgroup.com), "The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeast and Mid-Atlantic States," April 17, 2018.

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[1] This article draws on and updates several studies and articles performed with colleagues at Analysis Group over the past seven years related to the implementation of RGGI, including a prior article in *The Electricity Journal* on the first Compliance Period (Paul J. Hibbard and Susan F. Tierney, "Carbon Control and the Economy: Economic Impacts of RGGI's First Three Years," Electricity Journal, Volume 24, November 2011), and our studies of the economic impacts of RGGI during Compliance Period I (Paul J. Hibbard, Susan F. Tierney, Andrea M. Okie, and Pavel G. Darling, "The Regional Greenhouse Gas Initiative: Economic Impacts of the First Three Years," November 2011), Compliance Period II (Paul J. Hibbard, Andrea M. Okie, Susan F. Tierney, and Pavel G. Darling, "The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeast and Mid-Atlantic States," July 14, 2015), and Compliance Period III (Paul J. Hibbard, Susan F. Tierney, Pavel G. Darling, and Sarah Cullinan, "The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeast and Mid-Atlantic States," April 17, 2018). The authors thank Ben Dalzell, Grace Howland, and Jake Silver, who provided analytic assistance for the Compliance Period III study and the compilation of the full nine-year results. Analysis Group's studies of RGGI's administration and economic impacts have been supported in part over the years by a number of foundations; however, the content of this article reflects the views and is the sole responsibility of the authors, and does not necessarily reflect the views of the foundations.

https://doi.org/10.1016/j.tej.2018.05.015

interested in whether the program is effective and cost-effective in reducing $CO_2$ emissions, we did *not* seek to answer the question of *whether* the program is needed to address the socioeconomic and environmental risks of climate change, try to quantify the benefits of doing so, or determine whether the RGGI program is the best way to control $CO_2$ emissions. Significant literature already exists on these questions, including specific analyses focused in part on the environmental benefits of the RGGI program.[2]

Instead, our review focuses on the impact on state economies, and demonstrates key lessons for state policymakers seeking to understand the value of practical approaches to address $CO_2$ emissions from the power sector. Namely, a well-designed, market-based $CO_2$-control regime can generate substantial benefits for local economies. Implementation of that program can be a unique vehicle for advancing important fiscal, social, energy, and environmental policy goals. And a focus on efficient and equitable program design and implementation can help achieve policy objectives while delivering economic benefits.

As a bottom line, since its inception in 2009, RGGI has resulted in economic benefits for the participating states, totaling $4.7 billion (2018$, net present value) in economic value added.[3] We arrived at this number by carefully tracking the uses and effects of the flow of RGGI-related dollars – as they leave the pocket of generators who buy $CO_2$ allowances, show up in electricity prices and customer bills, make their way into state expenditure accounts, and then roll out into the economy in one way or another. Our analysis is unique in that it focuses on the actual impacts of measurable economic activity. We take as inputs known $CO_2$ allowance prices, observable $CO_2$ auction results leading to a distribution of $2.7 billion to the RGGI states, and observable state government determinations as to how to spend the auction proceeds. And we estimate reductions in energy use resulting from energy-efficiency programs funded by RGGI dollars, as well as impacts of such expenditures on prices within the power sector and the value added to the general economy.

## 2. The Regional Greenhouse Gas InitiativeJ

After several years of policy design, in 2009, 10 Northeast and Mid-Atlantic states began to administer RGGI – the country's first market-based program to reduce emissions of carbon dioxide from power plants.[4] The program establishes a cap on $CO_2$ emissions from most fossil-fueled power plants in the RGGI states, and requires each affected facility to turn in a $CO_2$ emission allowance for each ton of $CO_2$ emitted. $CO_2$ allowances are made available primarily through regional auctions, held quarterly, with auction proceeds divided among – and used for a variety of purposes by – the RGGI states.

The RGGI program covers nearly one-fifth of U.S. states, 13% of the U.S. population, 16% of the country's gross economic product, 9% of the nation's electricity consumption, 7% of the nation's power generation, and 7% percent of U.S. power sector $CO_2$ emissions (as of 2016).

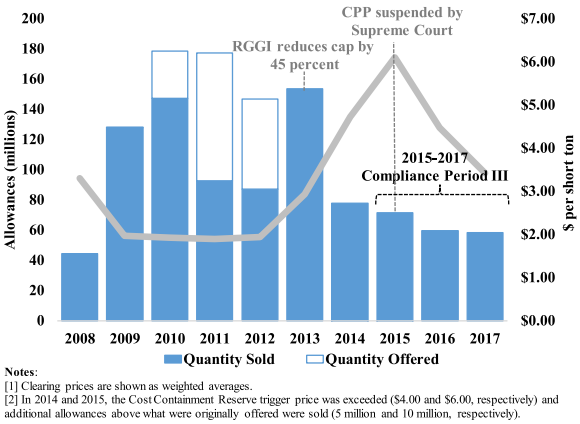



**Fig. 1.** RGGI allowance quantities and prices.

Its performance is important to understand for a number of reasons, including RGGI states' economic clout, their first-mover experience in this area of policy design, and their efforts to launch the policy concurrently in multiple states and in multiple well-functioning competitive electricity markets. Should other states, such as Virginia and New Jersey, become part of the RGGI trading program, it would represent 22% of the U.S. economy, equal to the world's fourth-largest economy (behind only China, the U.S. as a whole, and Japan). Combined with the Western Climate Initiative (WCI), states with caps on power-plant $CO_2$ emissions in the U.S. would represent 36% of the U.S. economy, equivalent to the world's third-largest economy (in terms of gross domestic product).

The RGGI program has now been in operation for nearly a decade. As of December 2017, owners of covered power plants have purchased $CO_2$ allowances in 38 separate auctions, totaling roughly $2.7 billion in allowance auction proceeds. The revenues collected from auction proceeds in each three-year compliance period are approximately equal (within 10%), due to the offsetting effect of decreasing allowance quantities and higher allowance prices. See Fig. 1.

Prices in the regional electricity markets now reflect $CO_2$ emissions costs. Electricity consumers are absorbing these costs as part of their monthly electricity bills. States have received and programmed the $2.7 billion in auction proceeds, and disbursed the money back into the economy in myriad of ways, including spending on energy efficiency measures, investment in community-based renewable power projects, assistance to low-income customers to help pay electricity bills, education and job training programs, and contributions to states' general funds. See Fig. 2.

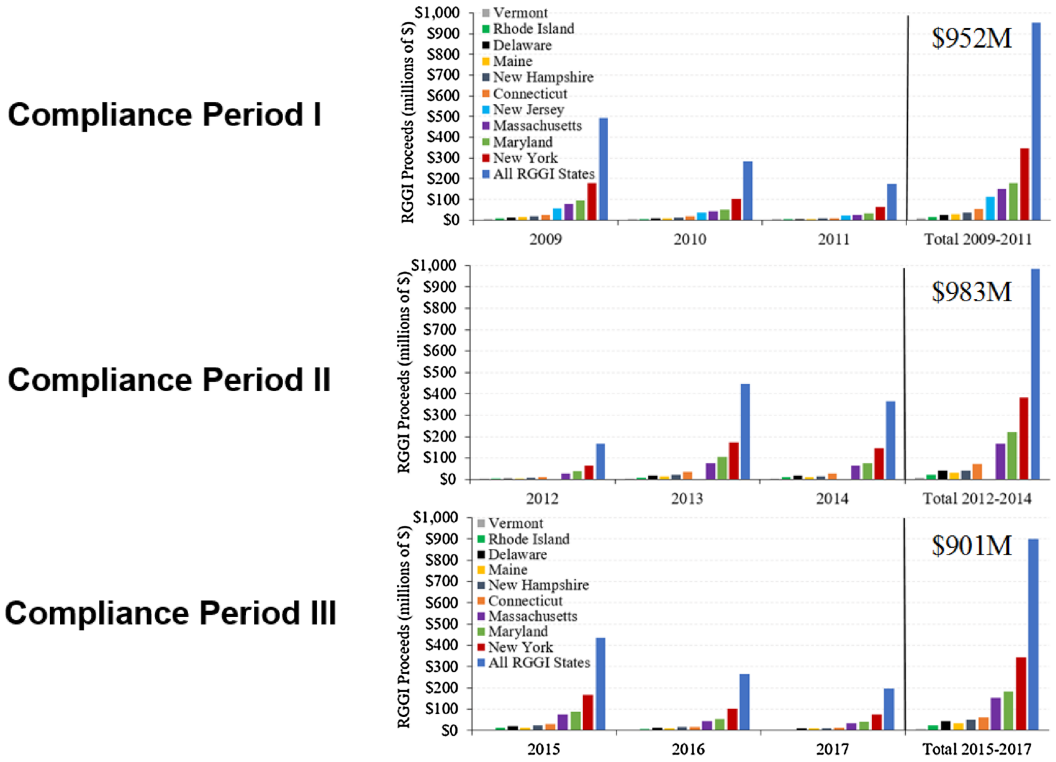
Over this period, $CO_2$ emissions have declined by roughly a half since the start of the program in 2009, with these emissions affected not only by RGGI emission caps but also by other economic factors. The cap is set to continue to decline through 2030 to less than one-third of power plant $CO_2$ emissions in 2000. See Fig. 3.

The first nine years of RGGI program implementation provide a rich body of quantitative information to help with performance assessment. Our own particular focus was intentionally limited to impacts on the region's economy associated with activity in the first three Compliance Periods. We did not try to review how the program might operate in the future – including the level of future $CO_2$ emission caps or allowance prices, or how states might use proceeds from post-2017 auctions. Nor did we attempt to review or discuss broader economic, social or environmental impacts of the RGGI program, such as future economic impacts flowing from reduced $CO_2$ emissions, or fuel diversity, or technological advances aided by RGGI stimulus funding, or other non-

[2] See, e.g., Abt Associates, "Analysis of the Public Health Impacts of the Regional Greenhouse Gas Initiative, 2009-2014", January 2017.

[3] This reflects benefits to the nine states that have participated over the full nine years of program implementation (that is, it does not include the economic benefits that accrued to New Jersey, which exited the program after Compliance Period I). As discussed further below, this $4.7 billion reflects the net present value (NPV) of total benefits as well as the NPV of total costs. Costs arise (1) in the years during which RGGI CO2 allowances are purchased and used for compliance, and during which consumers pay electricity prices affected by those CO2 allowances (2008-2017); as well as across the study period (2009-2028) as a result of reduced revenues to electric generators from the impacts that RGGI-funded EE programs have on electric demand and marginal electricity prices. Benefits arise across the full study period (2009-2028) as RGGI proceeds are expended (2009-2017) and as the impacts of energy efficiency, renewables, and other programs lower the demand for electricity and the prices and total customer payments for electricity. The NPV figures are based on use of a 3% social discount rate.

[4] The 10 states were Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. The development of RGGI began with an agreement in late 2005 among seven of the states to implement the program. RGGI MOU, 12/20/2005. The auctioning of allowances began in late 2008, and compliance requirements started in 2009 when the first three-year compliance period (2009-2011) began. At the end of 2011, then-Governor Chris Christie withdrew New Jersey's participation in RGGI.




Notes: [1] Figures include Auctions 1-38. Auction proceeds from Auctions 1 and 2 (occurring in 2008) are included in 2009. All other values are expressed in nominal dollars in the year the auction proceeds were generated. [2] Figures do not include fixed-price sales proceeds. Source: RGGI, Inc.

**Fig. 2.** RGGI auction proceeds by state and compliance period.

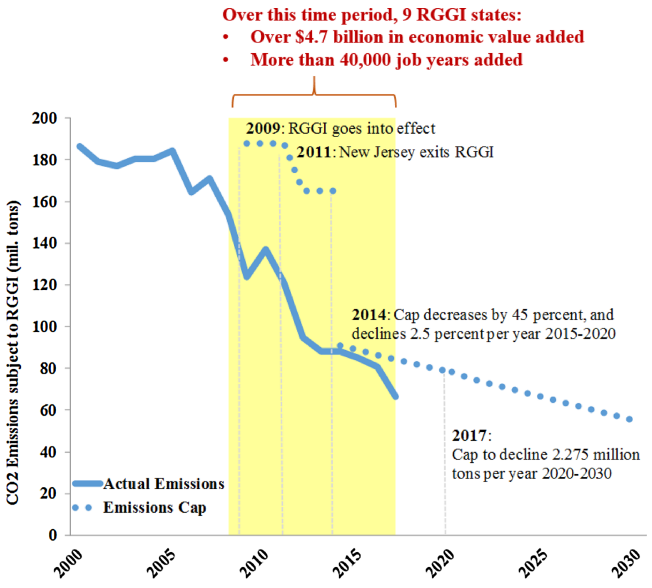
economic impacts of climate change risk mitigation related to human health, environmental sustainability or quality. These potential benefits are important but not the focus of our analysis. That said, we observe consistently positive economic benefits from the program in each Compliance Period since its inception.

## 3. Study method

Our analysis tracks the path of RGGI dollars: from the collection of auction proceeds, to disbursement of proceeds to the states and allocation by the states to different agencies, through to the allocation by agencies to different purposes, programs and/or recipients. We estimate the impact of program expenditures over time (on, for example, the level of reductions in energy consumption achieved through expenditures on energy efficiency measures, or the level of renewable generation developed using RGGI funds).

With these data in hand, we analyzed RGGI dollar impacts in the electric sector and on the overall economies of the states. To do so, we modeled the electric system to compare its actual performance (with RGGI impacts embedded in it) against a "counterfactual" that simulates what the system's outcomes would have been without RGGI in place. We also modeled the flow of RGGI auction proceeds as they make their way through the economies of each state and the RGGI region.

With respect to wholesale power markets, RGGI has two primary effects. First, at times when fossil-fueled power plants are the marginal power producer, spot electricity prices increase to reflect the additional cost to affected generating units of using $CO_2$ allowances. At times, this cost affects the dispatch order of power plants on the margin. Second, where a state uses RGGI auction proceeds to fund the installation of energy efficiency measures, electricity use decreases in some hours, and with it, marginal prices sometimes decrease as fewer plants need to be operated to meet demand. Using the ABB's PROMOD power system dispatch simulation model, we quantify the net impacts on regional and local system loads, power prices, overall use of fossil fuels, and changes




Source: RGGI, Inc. data from RGGI $CO_2$ Allowance Tracking System (COATS), accessed March 2, 2018.

**Fig. 3.** $CO_2$ emissions and caps in RGGI states.

in revenues to various categories of power plant owners. See Fig. 4.

With respect to impacts on the general economy, the use of dollars from RGGI auctions has several effects: First, RGGI auction proceeds recirculate around the economy – states' programming of these dollars leads to purchases of goods and services (such as engineering services for energy audits, rebates for energy efficiency equipment, subsidies for retrofitting windows, labor for installing those measures, dollars for training installers, and so forth). Together, these three types of dollar flows produce first-order changes in the levels of economic activity in

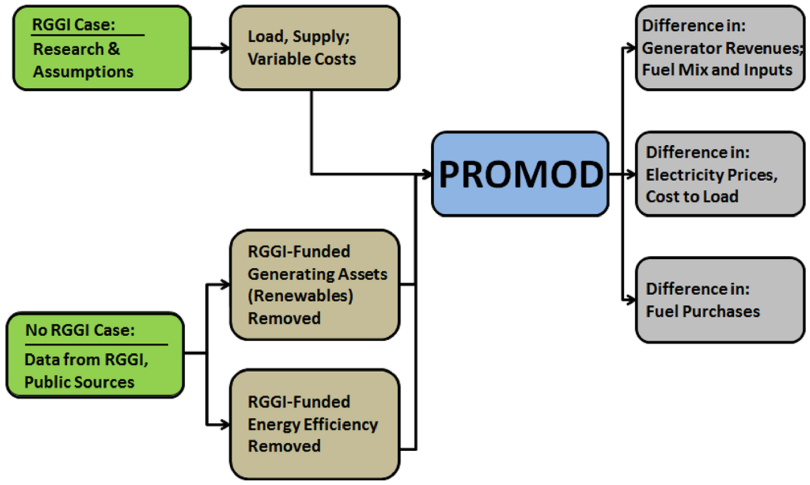



**Fig. 4.** PROMOD inputs and outputs.

various sectors of the economy. Additionally, these direct expenditures have multiplier effects, leading to other indirect and induced changes in economic activity in those same economies. Some of the dollars flow out of the region as well. Additionally, RGGI's impacts on the electric sector lead to effects on the macroeconomy of the region: there are net savings to consumers overall since they spend less on electricity and heating, reflecting the net effect of the electricity price increases from $CO_2$ allowances, the reduction in prices from energy efficiency effects on demand, and their lower consumption of electricity and fuels to meet energy needs. Second, there are changes in net revenues to power generators associated with their purchases of $CO_2$ allowances, their recovery of $CO_2$ allowance costs in market prices, and the overall changes in power plant dispatch.[5]

To model these macroeconomic impacts on the RGGI states' economies, we flow RGGI investments and changes in power system spending through a macroeconomic input-output model, IMPLAN Pro. The general flow of data and modeling outcomes is depicted in Fig. 5.

## 4. Results

### 4.1. Aggregate impact on the RGGI states

All told, implementation of RGGI over the first three Compliance Periods resulted in a net benefit of $4.7 billion to the RGGI states and more than 40,000 job-years. See Figs. 6 and 7, respectively. This large and net positive impact includes the combined impacts that flow from the changes in the electric sector and the direct use of $2.7 billion in RGGI proceeds to buy goods and services.

Energy consumers together experience lower energy bills – in effect, dollars that can be used for savings or expenses elsewhere. Many parts of the economy experience the effects of some part of the spending of the $2.7 billion RGGI proceeds. On the other hand, although power plant owners initially received higher revenues in electricity markets due to $CO_2$-related price increases, these generating companies experience lower overall revenues on a net present value basis as investments in energy efficiency take hold and decrease consumption and power prices.

For residential and business energy consumers, the RGGI program increases opportunities to lower energy consumption and reduce energy-related expenses through participation in energy efficiency programs. While these programs are primarily directed towards the electric sector, there are also RGGI-funded programs focused on efficiency improvements in many non-electric heating and cooking applications. Lower overall electric load levels put downward pressure on prices. Thus, these RGGI-funded programs reduce overall payments by all electricity consumers for energy and capacity in wholesale markets. This benefits electricity consumers across the RGGI region, even those that did not themselves install energy efficiency devices, for a total benefit of approximately $725 million (2018$ NPV). Energy consumers also saved approximately $264 million (2018$ NPV) through RGGI programs focused on reducing consumption of oil and natural gas to cook and heat homes and other buildings.

On the other hand, due to the effects of RGGI on producer and consumer behavior in power markets, power generators experience a net revenue loss of over $1 billion (2018$ NPV) over the entire study period. Of course, within the producer sector, RGGI presents a competitive advantage for power plants with lower or zero $CO_2$ emissions over others. Specifically, non-emitting resources enjoy a net revenue gain of over $1 billion, with fossil fuel generators losing $2.2 billion. (See Fig. 8) Overall, relative to a "no-RGGI" case, producers of power as a group experience net losses, while consumers have reduced total expenditures and are better off.

### 4.2. Design features affecting emission reductions and economic impacts

The ways in which the RGGI states — as a group and individually — have designed and implemented the program have important implications for its contribution to $CO_2$-emissions reductions over time, as well as for the impact the program has had on state economies.

Based on our review of the first decade of RGGI, we highlight two design features in particular, from the point of view of emissions reductions and state prerogatives about how to achieve them.

First, the declining cap on emissions drives both the limit on $CO_2$ emissions on a year-to-year basis as well as the financial incentives for investment in low-carbon electricity generation technologies and strategies over time.

Second, at its core, RGGI is a collection of state programs, with each state retaining full autonomy with respect to a variety of issues. Such issues include: (a) whether to participate voluntarily in the multi-state program; (b) how to distribute the $CO_2$ allowances allocated to each participating state (e.g., through auction to market participants or allocation for free to owners of assets with $CO_2$ emissions (as was done in many states under the acid rain program); and for those states participating in the centralized auctions of $CO_2$ allowances, what to do with the associated auction revenues that accrue to the state.

As with any cap-and-trade program, it is not possible to identify

[5] During the years in which producers include the value of allowances in bids, producer revenues are net positive. However, as energy efficiency measures continue to reduce load – and thus producer revenues – in subsequent years, producer revenues as a whole, and for CO2-emitting resources, are negative on a net present value basis over the study period, while revenues for non-emitting resources (nuclear, hydro, renewable) increase.

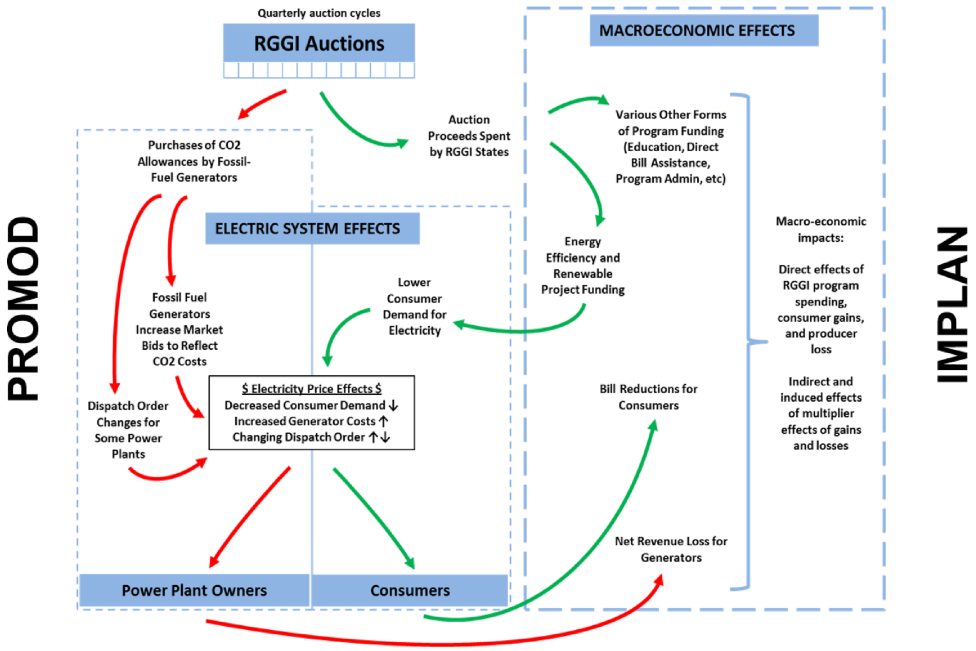



**Fig. 5.** Electric system and macroeconomic effects resulting from modeling.

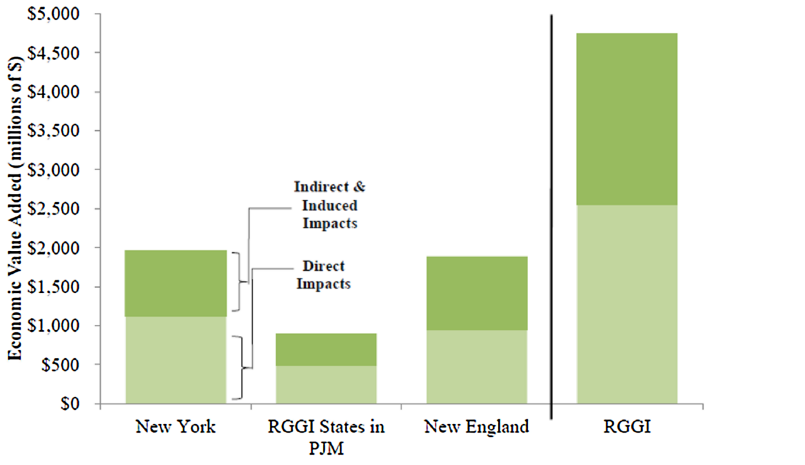



**Fig. 6.** Added economic value.

with certainty the specific quantity of tons of $CO_2$ reduced in the RGGI states due solely to RGGI, as opposed to those reductions that would have otherwise occurred due to other industry factors and circumstances (such as fuel switching due to low natural gas prices, or changes in dispatch order as a result of fuel price changes).

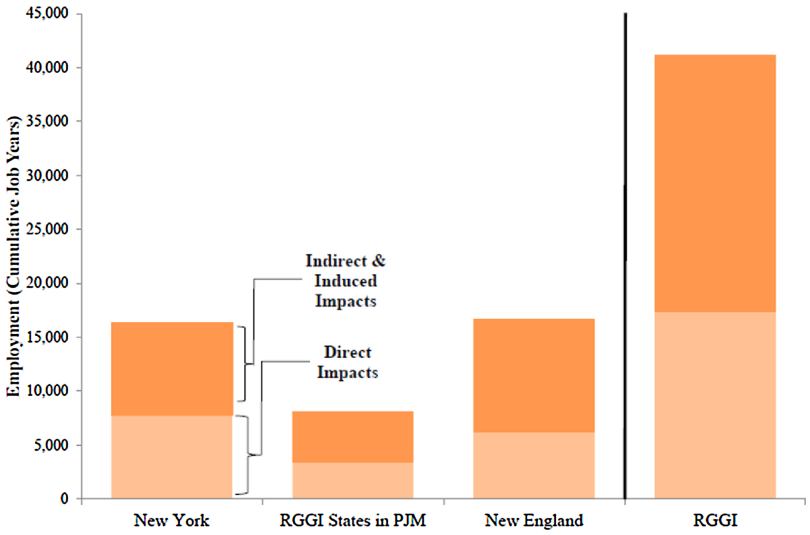
Yet in addition to simply establishing a legal ceiling on aggregate emissions — one that declines over time — there are several ways RGGI has operationally contributed to $CO_2$-emission reductions in recent years.

The first is inherent in how cap-and-trade programs work within a functioning electricity market in the short and long run. In the short run, RGGI has increased the cost of operating more carbon-intensive generating units in New England, New York, and the relevant parts of PJM, by requiring fossil generating units to include a price for carbon in their energy market bids. This has thereby affected the dispatch order of power plants in those regions. As a result, those regions have met electricity demand with lower emissions of $CO_2$ due solely to the fact that carbon-emitting power plants are less competitive than they otherwise would be, compared to low- or zero-carbon electricity generation and compared to a dispatch order in which there was no price on carbon. In the longer run, persistent pricing of $CO_2$ emissions affects power plant investment decisions, providing a financial signal to the investment community to invest in lower-carbon technologies that decrease the system's emissions to at or below the known, and decreasing, cap levels over time.

In the first several years of the RGGI program, there was a significant amount of fuel switching underway from coal and oil to natural gas. This resulted primarily from changing natural gas prices, and this led to some level of $CO_2$ emission reductions from the power sector that would have occurred absent RGGI.

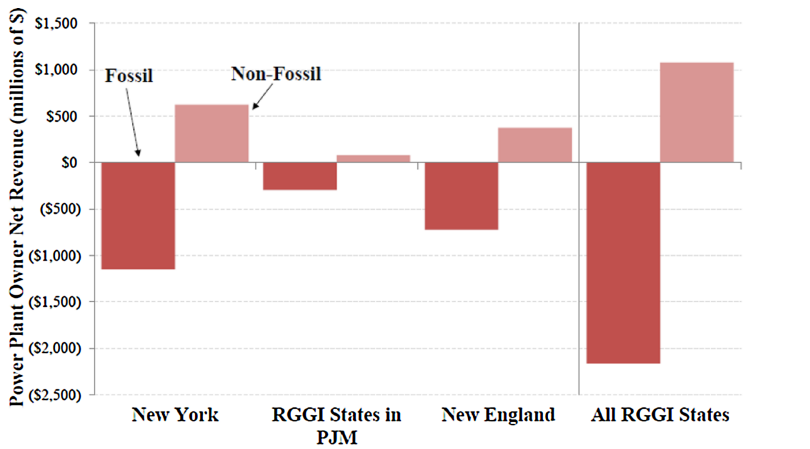
But, the RGGI states have responded accordingly *twice* to reduce the program's $CO_2$ emissions' cap and/or to retire some portion of banked allowances in order to align the RGGI cap with industry circumstances and maintain the program's financial signal for investment in low-carbon power sources.

Going forward these circumstances are likely to change. For




Note: Figures represent employment in terms of cumulative job-years over the study period.

**Fig. 7.** Added employment.




Notes: [1] Figures are reported in 2018 dollars (NPV), using a 3-percent public discount rate. [2] Figures include PROMOD outputs for energy prices and revenues and for capacity-market revenue changes that are calculated separately. [3] "Fossil" includes natural gas, oil, and coal-fired generators. "Non-fossil" includes nuclear, hydro, pumped storage, wind, solar, and biomass.

**Fig. 8.** Power plant owner net revenues.

example, future conditions will be affected by: the degree of generating-unit capacity retirements (including both fossil-units that emit $CO_2$ as well as nuclear units that do not); and the lower utilization of older oil and coal resources in the Northeast over the past decade means "organic" reductions in the power system's carbon intensity through fossil generation fuel switching will be limited on a going-forward basis. Under these circumstances, the RGGI cap might become more binding, strengthening the financial incentive for reductions in emissions due to electricity production from natural gas, and continuous evolution of power systems away from gas and towards greater production from low- and zero-carbon sources.

In addition to such short- and long-run financial signals, RGGI drives lower GHG emissions through the choice by RGGI states to auction nearly all allowances and then to use most of the auction revenues to reduce energy consumption, increase renewable generation, and fund GHG reductions in other sectors of the economy. See Fig. 9. These state expenditures of auction proceeds represent a direct investment of dollars to technologies and programs that reduce greenhouse gases as a direct result of RGGI state spending.

While all states originally committed to using at least 25% of auction proceeds for "public benefit or strategic energy" purposes,[6] in practice, many of the states significantly exceeded 25%, with proceeds for public benefit programs being spent in a wide variety of ways. Indeed, most participating states in the RGGI program have assigned virtually all of these allowances for public benefit purposes. Some states implemented energy efficiency programs, or low-income customer bill assistance, in many cases beyond the programs already in place in those states.[7] Others supported programs to reduce or sequester GHG emissions. Some states used RGGI monies to address general-fund deficits which otherwise could have led to other non-energy-related program

[6] The RGGI Memorandum of Understanding (MOU) among the participating states describes this commitment: "Consumer benefit or strategic energy purposes include the use of the allowances to promote energy efficiency, to directly mitigate electricity ratepayer impacts, to promote renewable or non-carbon-emitting energy technologies, to stimulate or reward investment in the development of innovative carbon emissions abatement technologies with significant carbon reduction potential, and/or to fund administration of this Program" (page 6).

[7] We note that the RGGI states already tended to have strong energy efficiency programs, and in many cases also have programs to assist low-income customers in paying their energy bills. RGGI's expenditures were incremental to these other pre-existing funds.

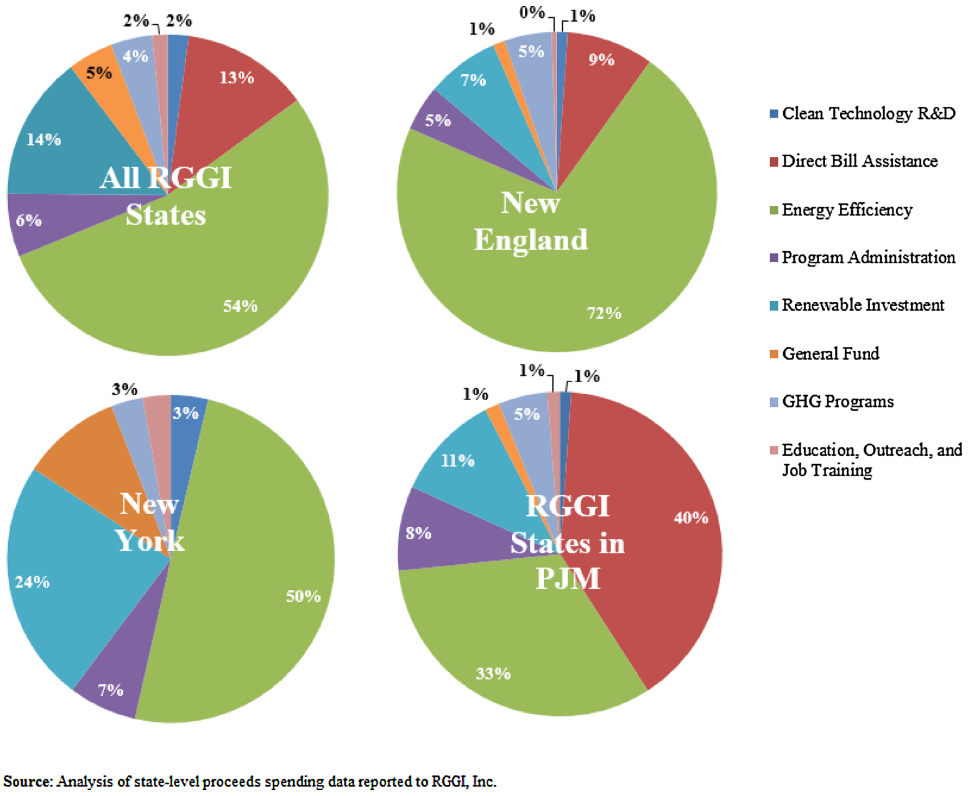



**Fig. 9.** Total RGGI proceed spending by category.

cuts or tax increases.

How states specifically end up using their dollars can have significant implications for economic impacts. As might be expected, the more a state reinvests its RGGI funds back into programs affecting electric energy use, the more the economic benefits remain within the boundaries of the electric sector.

## 5. Insights and observations

Our most recent and prior analyses suggest a number of themes relating to the RGGI experience to date. Some observations are important to provide the participating RGGI states with information about outcomes relative to the states' original goals. Other observations may also be relevant to other states seeking practical ways to implement $CO_2$ emission reductions absent a federal program.

### *5.1. Mandatory, market-based carbon control mechanisms are working and can deliver positive economic benefits*

RGGI's first decade demonstrates that market-based, mandatory $CO_2$-control program can achieve states' $CO_2$ reduction goals while generating positive economic impacts. Competitive auctions have moved $CO_2$ allowances into the markets, with the proceeds plowed back into the local economy. This has occurred seamlessly from an operational point of view. Generators in the RGGI region are now pricing carbon into their market bids in a manner fully consistent with reconciling state carbon reduction policy with competitive wholesale market operations. In addition, consumers are paying electricity prices that reflect a carbon price signal, one that shifts system operations to less carbon-intensive electricity production.

### *5.2. The states have used $CO_2$ allowance proceeds creatively – supporting diverse policy and economic outcomes*

Although the RGGI states collaborated tightly to build a common $CO_2$-control program with a centralized auction and with harmonized market rules, these states have used the $CO_2$ auction proceeds in highly different ways, reflecting their different economic and energy policy goals. Individual states have chosen different paths – in some cases addressing state budget challenges, and in others providing bill-payment assistance to municipalities and ratepayers, investing in programs to support in-state economic development, reducing energy consumption through energy efficiency, and increasing production from renewable energy sources.

### *5.3. The design of the $CO_2$ market in the RGGI states affected the size, character and distribution of public benefits*

The choice by all states to join together to conduct a unified auction of $CO_2$ allowances in effect allowed for the transfer of emissions rights from the public sector to the private sector, in exchange for significant revenues for use by the states. Had states instead decided to grant allowances to generators, they would have given generators a commodity with real value in electricity markets. Auctioning allowances has captured this value fully for the public.

### *5.4. How allowance proceeds are used affects the character and size of economic impacts to the public*

The RGGI MOU fully anticipates that states will place different weights on economic, environmental, social, energy security, and other goals as they implement the program. As noted, states' use of the funds for energy efficiency has ended up offsetting the near-term customer impacts of higher electricity rates with the long-term effects of customers' lowering their usage and reducing the sizes of their overall energy expenditures. Some states have used proceeds to provide rate relief for low-income and other customers. Although doing so tends to have a smaller multiplier effect in the economy than investments in energy efficiency, this use supports an important social policy objective to assist customers that may face higher electricity rates under the RGGI

program.

Other states that used RGGI funds to provide contributions to the general fund were able to avoid raising taxes and/or help preserve critical state programs and services. Many states used RGGI proceeds to seed investments for communities, companies or households to install renewable energy projects. Our studies' focus on economic impacts does not fully capture these macroeconomic impact or other important non-economic policy objectives that are being met by these various funding strategies.

While recognizing the many sound objectives the RGGI states have for investing auction proceeds, we note that the actual policy choices the states make about how to spend RGGI funds does affect how the funds actually end up stimulating local economic activity.

First and foremost, investments in energy efficiency dramatically affect the magnitude of RGGI impacts on electricity consumers. While the additional costs of $CO_2$ compliance provides upward pressure on marginal prices and decreases net revenues to power plant owners, substantial RGGI investment in energy efficiency lowers energy use, power prices, and consumer payments for electricity. These effects indirectly benefit all consumers through downward pressure on wholesale prices, even though they particularly benefit those consumers that actually take advantage of such programs. As RGGI investment in energy efficiency increases, so too will the number of business and residential customers that realize such direct benefits. Reduced energy costs show up as increased consumer disposable income, leading to increased spending or savings. This adds to the induced economic impacts of the direct in-state investment of RGGI dollars in the contractors and, to some extent, materials used in energy efficiency programs. Consequently, there are multiple ways that investments in energy efficiency lead to positive economic impacts.

### *5.5. RGGI reduces the region's payments for fossil fuels sourced outside the states over the study period*

By design, the RGGI program aims to reduce carbon emissions by introducing a cap and requiring purchases of $CO_2$ allowances as a means to regulate the overall level of $CO_2$ emissions in the region. The effect of this program is to decrease generation from emitting sources and increase generation from low- and zero-carbon resources. As a result, the first nine years of RGGI implementation results in large reductions in payments for fossil fuels — dollars that almost entirely flow outside the region.

### *5.6. The first decade of RGGI implementation provides a wealth of information and experience to states seeking practical mechanisms to reduce $CO_2$ emissions*

Over the first decade, the RGGI states have been through major changes to the industry and economic context for power system operations, have seen many changes in state leadership and the political parties in power; and have guided RGGI program implementation through two cycles of top-to-bottom program review, involving extensive stakeholder input and adoption of major program design alterations. Yet the program has operated flawlessly as a multi-state program with joint governance, a common auction platform, and a competitive market for allowance trading. RGGI's open architecture and preservation of states' unique jurisdictional and market circumstances, interests, and authorities leave the door wide open as an option for states seeking a turnkey solution to meeting carbon reduction goals in a manner consistent with economic and environmental principles, while retaining control over most program design features. The RGGI program structure works in the competitive wholesale market context, yet can work just as well in fully integrated, regulated states. In the absence of federal leadership on climate change policy, RGGI stands as a model and opportunity for states pursuing carbon reductions consistent with their unique circumstances and economic and energy policy interests.

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