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The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States

Review of the Use of RGGI Auction Proceeds from the First Three-Year Compliance Period

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Analysis Group provides economic, financial, and business strategy consulting to leading law firms, corporations, and government agencies. The firm has more than 500 professionals, with offices in Boston, Chicago, Dallas, Denver, Los Angeles, Menlo Park, New York, San Francisco, Washington, D.C., and Montreal.

Analysis Group's energy and environment practice area is distinguished by expertise in economics, finance, market analysis, regulatory issues, and public policy, as well as significant experience in environmental economics and energy infrastructure development. The practice has worked for a wide variety of clients including energy producers, suppliers and consumers; utilities; regulatory commissions and other public agencies; tribal governments; power system operators; foundations; financial institutions; and start-up companies, among others.

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1. EXECUTIVE SUMMARY

Overview and Results

In 2009, ten Northeastern and Mid-Atlantic states began the Regional Greenhouse Gas Initiative (known as RGGI), the country's first market-based program to reduce emissions of carbon dioxide (CO_2) from power plants. Understanding the program's performance and outcomes is important given that RGGI states account for one-sixth of the population in the US and one-fifth of the nation's gross domestic product. Through the development of the RGGI program, these states have gained first-mover policy experience and have collaborated to merge a common policy into well-functioning electricity markets. Insights and observations gleaned from an analysis of the program's performance will be valuable in evaluating past policy decisions and future policy recommendations.

RGGI has now been operating for nearly three years. The rights to emit CO_2 have been auctioned off. Power plant owners have spent roughly $912 million to buy CO_2 allowances. Consumers now pay regional electricity rates that reflect a price on CO_2 emissions. These emissions have gone down, affected by both RGGI and larger economic conditions.[1] States have received, programmed, and disbursed virtually all the $912 million in allowance proceeds[2] back into the economy in myriad ways – on energy efficiency measures, community-based renewable power projects, assistance to low-income customers to help pay their electricity bills, education and job training programs, and even contributions to a state's general fund. Figure ES1 shows RGGI proceeds by state and region.

Looking back, how has the RGGI program affected electricity markets, power producers' costs, electricity prices, and consumers' electricity bills? What happened to the $912 million in proceeds from the sale of CO_2 allowances? Has the program produced net economic benefits to these states in its first three years, or otherwise helped them pursue their goals for "continued overall economic growth" and reliable electric supply, while also reducing CO_2 emissions? What has been learned to date? These are the principal questions this study set out to address.

At the request of four foundations,[3] Analysis Group has measured the economic impacts of RGGI's first three years. Our analysis tracks the path of RGGI-related dollars as they leave the pockets 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 this way – it focuses on the actual impacts of economic activity: known CO_2 allowance prices; observable CO_2 auction results; dollars distributed to the RGGI states; actual state-government decisions about how to spend the allowance proceeds; measurable reductions in energy

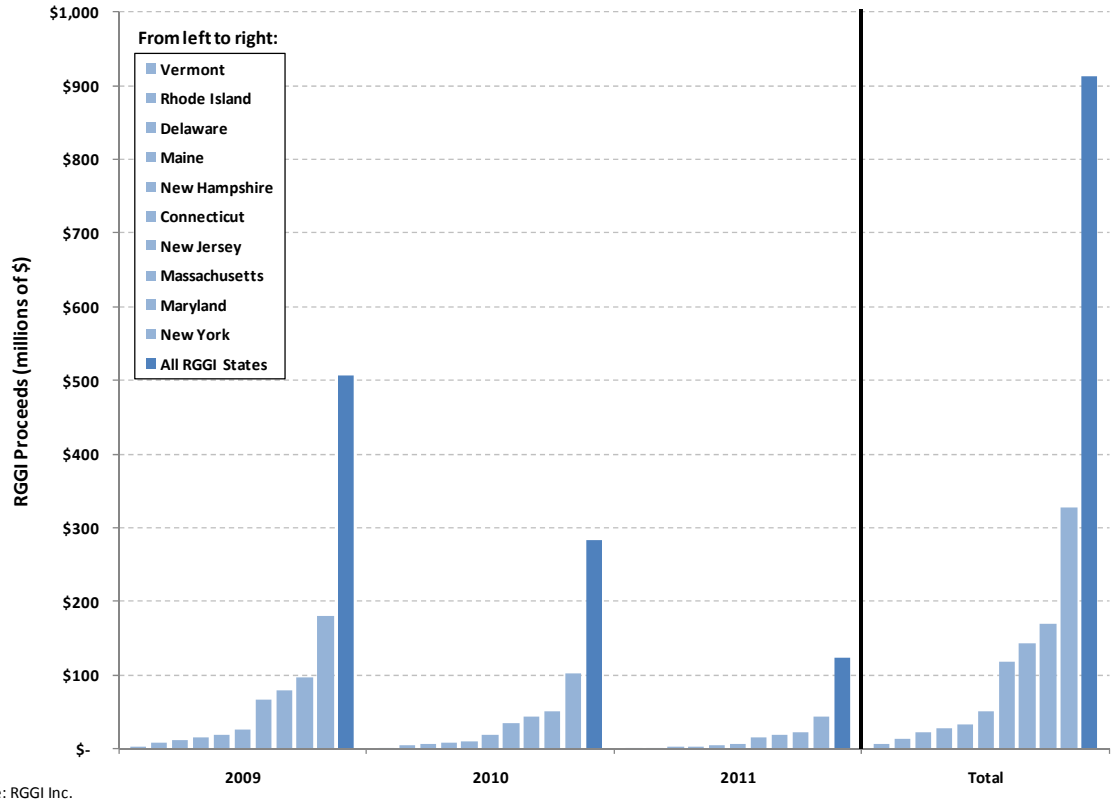
[1] RGGI, Inc. has reported that between 2008 and 2009, electric generation from RGGI-affected electric generation sources decreased by 17.9 million MWh, or 9.1 percent. During that same time period CO_2 emissions from RGGI electric generation sources decreased by 27.6 million short tons, or 18.4 percent. "CO_2 Emissions from Electricity Generation and Imports in the 10-State Regional Greenhouse Gas Initiative: 2009 Monitoring Report," RGGI, Inc., September 14, 2011.

[2] Of the $912 million paid for CO_2 allowances (through 13 auctions from Q3 2008 through Q3 2011 and through a small amount of direct sales to qualifying emitters), 0.7 percent was used for administering the RGGI program; the remaining proceeds were disbursed to the RGGI states.

[3] The foundations are the Merck Family Fund, the Barr Foundation, the Chorus Foundation, and the Henry P. Kendall Foundation.

use from energy efficiency programs funded by RGGI dollars; traceable impacts of such expenditures on prices within the power sector; and concrete value added to the economy. By carefully examining the states' implementation of RGGI to date, based on real data, we hope to provide a solid foundation for observations that can be used by others in future program design and to inform deliberations about RGGI going forward.

Figure ES1
RGGI Allowance Proceeds by State



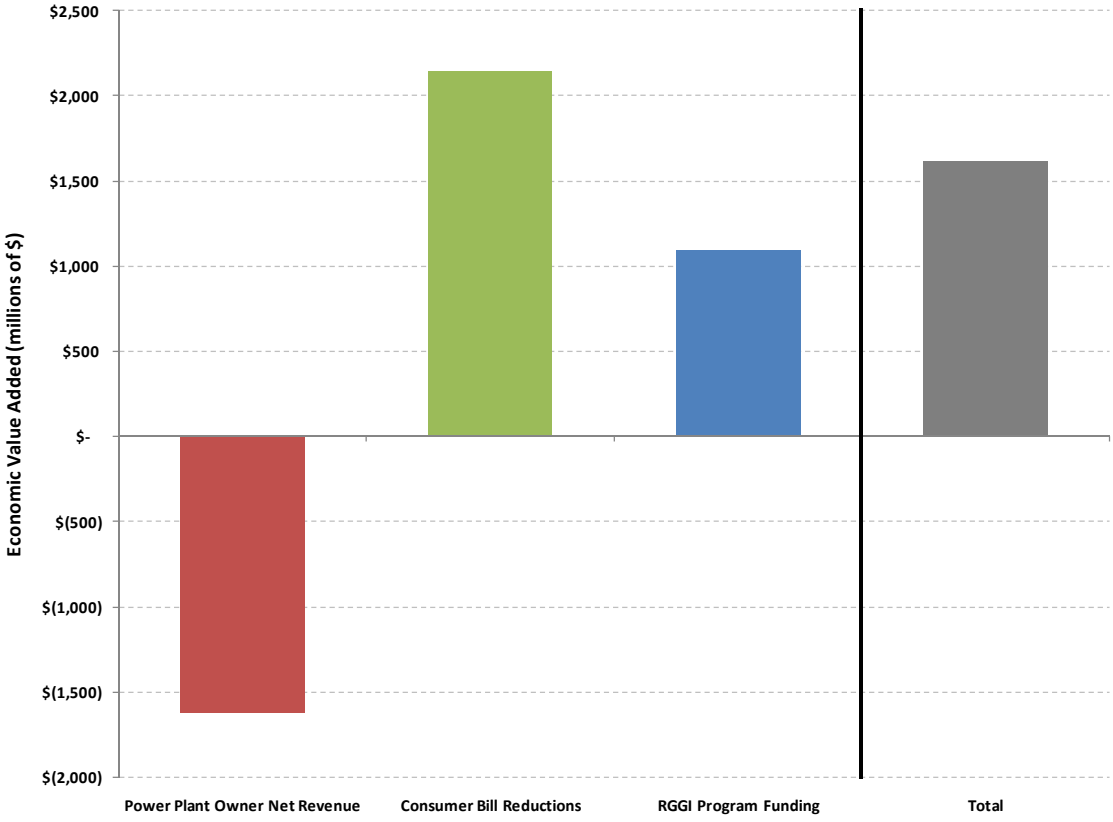
Source: RGGI Inc.
Notes: Figures include Auctions 1-13 and direct sales proceeds for New Jersey (2009) and Connecticut (2009/2010).
Auction proceeds from Auctions 1 and 2 are reflected in the 2009 values.

What happened to the dollars? First, RGGI produced $1.6 billion in net present value (NPV) economic value added to the ten-state region.[4] The region's economy – and each state's as well – benefits from the RGGI program expenditures. When spread across the region's population, these economic impacts amount to nearly $33 per capita in the region.[5] Figure ES2 shows the net economic

[4] This reflects a 3 percent social discount rate to put benefits and costs occurring in different time frames into a common reference point, which is 2011. We present results using the public rate in the body of this report, while noting the private rate results and providing further details in the Appendix. All figures show 2011 dollars discounted using a 3 percent social discount rate, unless otherwise noted.
[5] Using a 7 percent private discount rate, RGGI produced $1.0 billion in net economic value, amounting to nearly $21 per capita in the region.

value broken out by the macroeconomic effects of the impacts of RGGI on consumers and power plant owners, as well as effects that flow from direct spending of RGGI allowance revenues.

Figure ES2
Net Economic Impact to States in the RGGI Region (2011$)



Notes: Figures represent dollars discounted to 2011 using a 3% public discount rate.

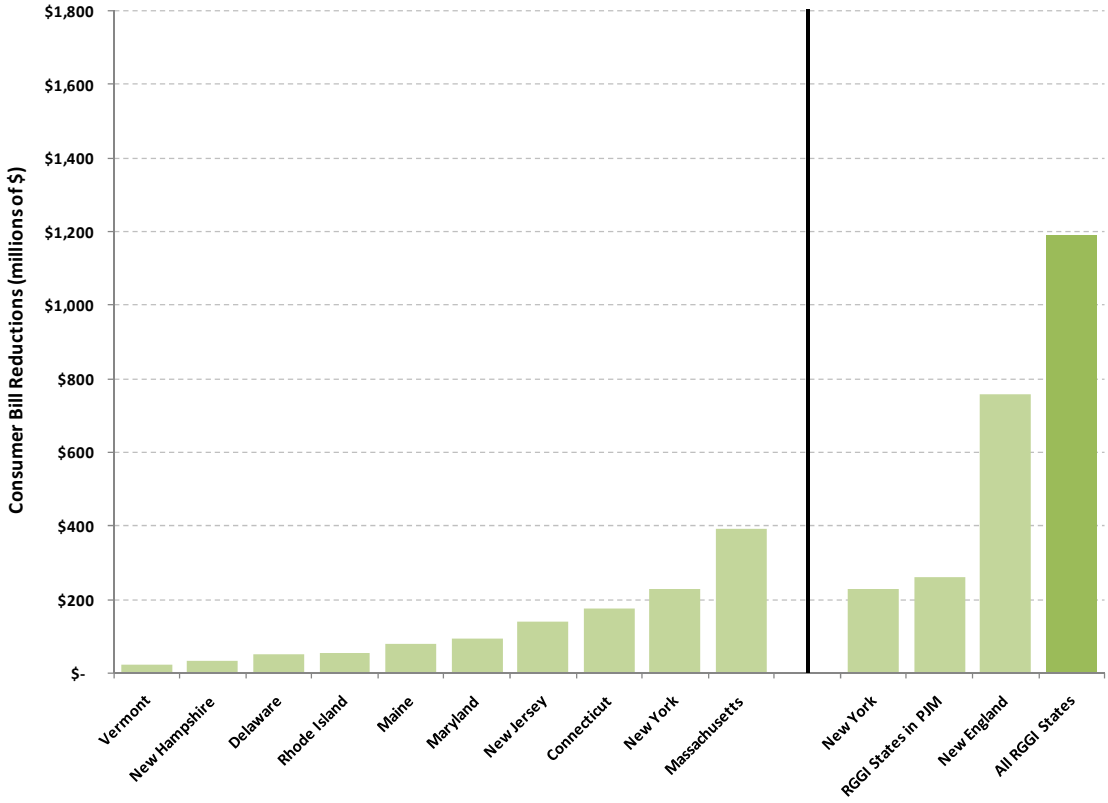
This economic benefit reflects the complex ways that RGGI dollars interact with local economies: the states' use of RGGI auction proceeds on programs leads to more purchases of goods and services in the economy (e.g., engineering services for energy audits, more sales of energy efficiency equipment, labor for installing solar panels, dollars spent to train those installers and educators, and so forth). Together, these dollar flows have direct and indirect multiplier effects locally and regionally.

RGGI has also produced changes in consumers' overall expenditures on electricity. Although CO_2 allowances tend to increase electricity prices in the near term, there is also a lowering of prices over time because the states invested a substantial amount of the allowance proceeds on energy efficiency programs that reduce electricity consumption.[6] After the early impacts of small electricity price

[6] During the 2009–2011 period, we estimate that RGGI increased consumers' overall payments for electricity by 0.7 percent; over the long run, however, this investment, which states used to support a variety of economic activity (of which approximately 48 percent went to

increases, consumers gain because their overall electricity bills go down as a result of this investment in energy efficiency. All told, electricity consumers overall – households, businesses, government users, and others – enjoy a net gain of nearly $1.1 billion, as their overall electric bills drop over time.[7] This reflects average savings of $25 for residential consumers, $181 for commercial consumers, and $2,493 for industrial consumers over the study period. Consumers of natural gas and heating oil saved another $174 million. Figure ES3 shows the net bill reductions to consumers.

Figure ES3
Net Bill Reductions to Consumers (2011$)



Notes: Figures include GE MAPS outputs, non-electric benefit calculations, and capacity market gain calculations.
Figures represent dollars discounted to 2011 using a 3% public discount rate.

Although power plant owners have to purchase CO_2 allowances, they recover all of their early expenditures through the increase in electricity prices during the 2009–2011 period; in the long run, however, RGGI-driven energy efficiency leads to lower sales of electricity, which ends up eroding power plant owners' electric market revenues. On an NPV basis, RGGI means that, in total, the power generation sector will experience a decrease in revenues of $1.6 billion.[8] Figure ES4 shows the

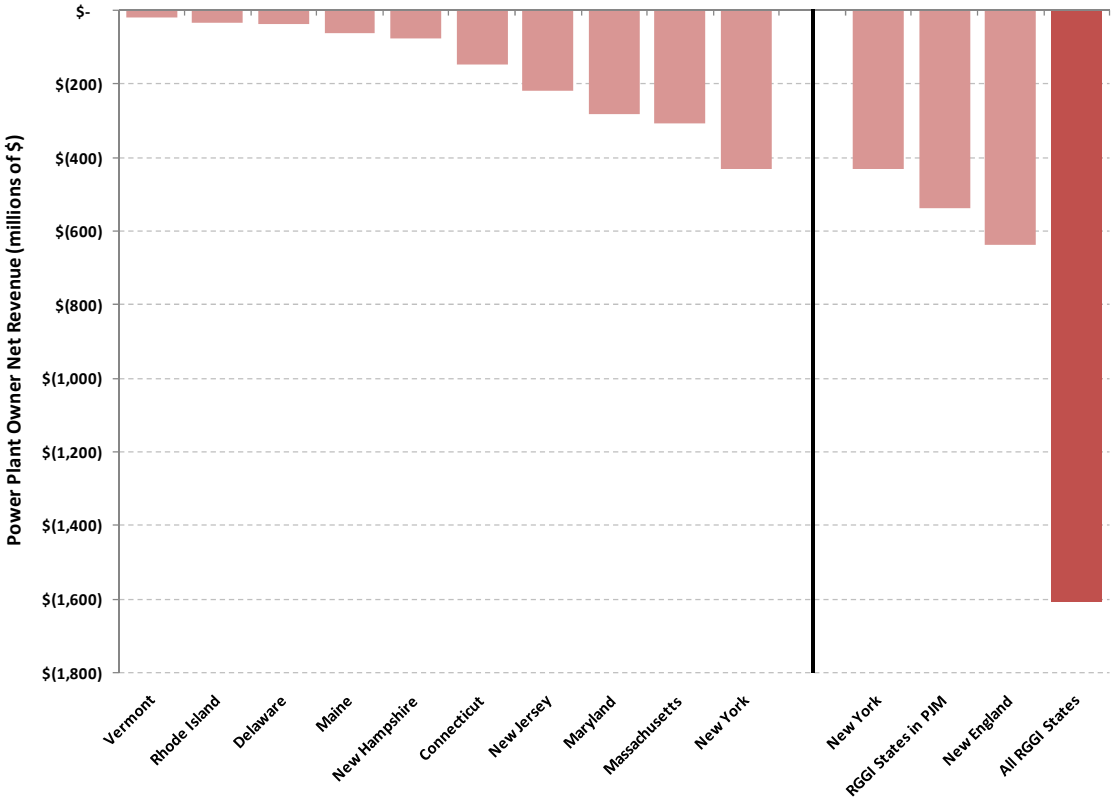
support energy efficiency programs) led to net savings in electricity bills to all consumers in all states, relative to an electric system that did not include RGGI for the 2009–2011 period.

[7] Using a 7 percent private discount rate, RGGI produced an overall net bill reduction of nearly $600 billion to consumers.

[8] Using a 7 percent private discount rate, the decrease in net revenues to power plant owners is $1.3 billion.

net revenue impact on power plant owners. Among the power plant owners, RGGI afforded a competitive advantage to power plants with lower CO_2 emissions.

Figure ES4
Net Revenue Change for Power Plant Owners (2011$)



Notes: Figures include GE MAPS outputs, allowance true-up calculations, and capacity market loss calculations.
Figures represent dollars discounted to 2011 using a 3% public discount rate.

Second, the scope of RGGI's positive economic benefits varies by state and region, in large part because the states spent the RGGI allowance proceeds differently.[9] Different expenditures have different multiplier effects in their economies and different impacts on their electric systems. For example, a state's use of RGGI dollars to reduce energy use in the electric sector lightened the early-years' cost impact for electricity consumers by turning the RGGI program into a down payment on lower overall bills for electricity in the longer-term. The New England states, for example, spent much of their RGGI dollars on energy efficiency programs, and so New England's electric system realizes overall benefits from RGGI, even before looking at the macroeconomic impacts. In the other regions, use of RGGI dollars to pay for general-taxpayer-funded programs ends up transferring

[9] Overall, the distribution of spending across the states was as follows: 48 percent on energy efficiency and other utility programs; 20 percent on general fund and other government support; 14 percent on bill-payment assistance to energy consumers; 9 percent on other greenhouse gas programs and program administration; 7 percent on renewable energy projects; and 2 percent on education, outreach, and job training. Individual state's expenditures ranged significantly across these categories.

dollars from the electric system to the other sectors of the economy. The gains in the larger economy (from re-circulating RGGI auction proceeds broadly) offset the negative impacts in the electric sector in these other RGGI states (New York, New Jersey, Delaware, and Maryland (in PJM)).

Also, the ten RGGI states reside in one of three "electrical regions," each with a different generating mix. The extent of a state/region's reliance on natural gas and other forms of low-carbon electric generation (such as nuclear and renewables) lessens the impact of CO_2 allowance purchases on prices. Practically speaking, this means that New York and the New England states experience lower price impacts than Maryland, New Jersey, and Delaware.

Insights and Observations

These patterns, and the others described in more detail in our report, suggest a number of themes emerging from the RGGI experience to date. Some are important for providing the RGGI states with information about how the policy is performing relative to some (but not all) of its original goals. The observations are also relevant to other states and national policy makers if and when they decide to adopt a CO_2 control program.

Mandatory, Market-Based Carbon Control Mechanisms Are Functioning Properly and Can Deliver Positive Economic Benefits

Based on the initial three years of experience from the nation's first mandatory carbon control program, market-based programs are providing positive economic impacts while meeting emission objectives. The pricing of carbon in Northeast and Mid-Atlantic electricity markets has been seamless from an operational point of view and successful from an economic perspective.

The States Have Used CO_2 Allowance Proceeds Creatively – Supporting Diverse Policy and Economic Outcomes

The states' use of allowance proceeds not only provides economic benefits, but also has helped them meet a wide variety of social, fiscal, and environmental policy goals, such as addressing state and municipal budget challenges, assisting low-income customers, achieving advanced energy policy goals, and restoring wetlands, among other things.

RGGI Has Reduced the Region's Payments for Out-Of-State Fossil Fuels

RGGI helped lower the total dollars these states sent outside their region in the form of payments for fuel by over $765 million. Most of the RGGI states' electricity comes from fossil fuels, even though these states produce virtually no coal, natural gas, or oil locally. Since RGGI helped the states lower total fossil-fired power production and lower use of natural gas and oil for heating, RGGI reduced the total dollars sent out of state for energy resources.

The Design of the CO_2 Market in the RGGI States Affects the Size, Character, and Distribution of Public Benefits

The joint decision by the RGGI states to make their CO_2 allowances available to the market through a unified auction ended up generating substantial revenues for public use. This approach transferred emissions rights from the public sector to the private sector at a monetary cost (rather than transferring them for free). Had these allowances been given away for free, the states would not have had the benefit of the auction proceeds, and instead would have transferred that economic value to owners of power plants (which in the RGGI region are merchant generators, not owned by electric distribution utilities). In the end, the combination of the cap level, the design of the auction mechanism, and the depressed economy, reduced the challenge of meeting the RGGI cap, and CO_2 allowance prices decreased over time. Decreasing allowance prices also made it harder for power plant owners to recoup early purchase of higher-priced allowances, and reduced the funding available for public investment.

How Allowance Proceeds Are Used Affects Their Economic Impacts

The RGGI Memorandum of Understanding (MOU) fully anticipates – if not encourages – states to place different weights on economic, environmental, social, energy security, and other goals as they implement the program. But from a strictly economic perspective, some uses of proceeds clearly deliver economic returns more readily and substantially than others. For example, RGGI investment in energy efficiency depresses regional electrical demand, power prices, and consumer payments for electricity. This benefits all consumers through downward pressure on wholesale prices, yet it particularly benefits those consumers who actually take advantage of such programs, implement energy efficiency measures, and lower both their overall energy use and monthly energy bills. These savings stay in the pocket of electricity users. But positive macroeconomic impacts exist as well: the lower energy costs flow through the economy as collateral reductions in natural gas and oil consumption in buildings and increased consumer disposable income (from fewer dollars spent on energy bills), lower payments to out-of-state energy suppliers, and increased local spending or savings. Consequently, there are multiple ways that investments in energy efficiency lead to positive economic impacts; this reinvestment thus stands out as the most economically beneficial use of RGGI dollars. Other uses also provide macroeconomic benefits, even if they do not show up in the consumers' pocket in the form of lower energy bills.

RGGI Produced New Jobs

Taking into account consumer gains, lower producer revenues, and net positive macroeconomic impacts, RGGI led to overall job increases amounting to thousands of new jobs over time. RGGI job impacts may in some cases be permanent; others may be part-time or temporary. But according to our analysis, the net effect is that the first three years of RGGI led to over 16,000 new "job years,"[10] with

[10] In the context of the entire workforce in the ten-state RGGI region, 16,000 new job-years is small (about 1/10th of one percent of the total employment in September 2011). But considering the fact that the ten states' civilian labor force dropped by 73,400 from September 2010

each of the ten states showing net job additions. Jobs related to RGGI activities are located around the economy, with examples including engineers who perform efficiency audits; workers who install energy efficiency measures in commercial buildings; staff performing teacher training on energy issues; or the workers in state-funded programs that might have been cut had a state not used RGGI funds to close budget gaps.

Timing Differences in Program Costs versus Benefits Affects Results

Lags between CO_2 allowance auctions and the expenditure of allowance proceeds back into the economy can significantly delay the realization of benefits. The delay stems from the time it takes RGGI, Inc. to administer allowance auctions and transfer proceeds to states, for the states to distribute funds to the program agencies and make grants to recipients, and then for the grant recipients to put those funds to productive use in the economy. Inevitably, the various steps in this programmatic chain follow after the time period in which the purchases of allowances end up in electricity prices. Because the first step of transferring auction proceeds to the states occurs quite quickly, deliberate efforts by states to re-circulate the funds back into the economy as quickly as possible could reduce the lag and increase the economic returns of the RGGI program.

A Region's Pre-Existing Generating Mix Affects Economic Impacts

Since power generation resources have different CO_2 emission impacts – with coal-fired generation having higher combustion-related CO_2 emissions than other electricity generating resources – the amount of coal in a particular state's generating mix affects the costs of the RGGI program. Even so, every state experiences net positive benefits from RGGI, including in the more coal-heavy region (i.e., in the PJM states, New Jersey, Delaware and Maryland).

RGGI's First Three Years of Program Investments Point to Some Best Practices

Based on our review of state program investments, it is clear that some states' practices can serve as best practices for others. First, speeding up the timing of when RGGI auction proceeds are used reduces the lag between CO_2 costs showing up in electricity prices and the time when benefits begin to flow to the region. Second, re-circulating RGGI auction proceeds back into the economy in the form of energy efficiency programs can dramatically increase the value of the RGGI program for electricity consumers and for the larger economy. Finally, standardizing the collection, measurement and verification of data on RGGI dollar flows could significantly improve the ability to quickly translate program lessons into improved program design. Our economic impact analysis involved significant effort to collect, organize, and process the data on how states disburse and spend RGGI allowance revenues and on the character of program impacts on various recipients in the larger economy. Greater consistency in data collection and reporting would add more transparency and accountability for these expenditures.

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to September 2011 (from 25,165,100 to 25,091,700), the number of RGGI-related jobs (or, conversely, the potential loss of thousands of additional jobs absent RGGI) is significant. Source: Bureau of Labor Statistics, http://www.bls.gov/news.release/pdf/laus.pdf.

2. THE REGIONAL GREENHOUSE GAS INITIATIVE

Overview and Purpose

Starting with the first auction of CO_2 allowances in 2008, ten states in the Northeast and Mid-Atlantic regions initiated RGGI, a multi-state market-based program to reduce emissions of CO_2.[11] The program created the country's first mandatory program to cap emissions of CO_2 from power generation sources, with the cap set initially at 188 million short tons of CO_2 annually across the ten-state RGGI region. The regional cap is apportioned to states in a manner based generally on emissions from the affected sources (fossil fuel power plants that are 25 megawatts or over in size), and in accordance with specific state allowance budgets agreed upon by the states. As originally designed, the cap would decline by 2.5 percent per year beginning in 2015, to reach an overall reduction of 10 percent of CO_2 emissions by 2018.[12] Although they had the option to distribute allowances for free, the states decided to distribute the vast majority of CO_2 emission allowances into the market through a centralized auction, administered by RGGI, Inc., the non-profit organization they set up to run the program.

The states developed the RGGI program over several years, starting in late 2003, in order to begin to address the risks associated with climate change. The specific goal of RGGI is to seek stabilization and reduction of CO_2 emissions within the signatory states, based on the conclusion among state signatories that: (1) climate change is occurring; (2) it poses serious potential risks to human health and the environment; (3) delay in addressing CO_2 emissions will make later investments in mitigation and adaptation more difficult and costly; and (4) a market-based carbon allowance trading program will create strong incentives for the development of lower-emitting energy sources and energy efficiency, and reduce dependence on imported fossil fuels.[13]

Market-Based Mechanism

RGGI is a market-driven emissions control program. Similar to that of other market-based programs administered for control of nitrogen oxides (NO_x) and sulfur dioxide (SO_2), the foundation of the RGGI program is an annual cap on emissions of CO_2 in aggregate for all affected sources. Affected or "regulated" sources in a given state generally include all fossil-fueled electric power generators with a capacity of equal to or greater than 25 megawatts. Program compliance is relatively straightforward: shortly after the end of each 3-year compliance period (with the first being 2009–2011), every affected source must retire a number of allowances equal to the total tons of CO_2 emissions from the source over the three-year period (one allowance equals one ton of emissions).

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[11] The ten states are Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. On May 26, 2011 New Jersey announced its intention to withdraw from the RGGI program, at the end of 2011. Baxter, Christopher, "Gov. Christie Announces N.J. Pulling Out of Regional Environmental Initiative," May 26, 2011, http://www.nj.com/politics/index.ssf/2011/05/gov_christie_to_announce_nj_pu.html.

[12] Information on RGGI is drawn from various fact sheets on the website of RGGI, Inc., the non-profit organization established by the states to administer the RGGI program. http://www.rggi.org/design/fact_sheets.

[13] Regional Greenhouse Gas Initiative Memorandum of Understanding, December 20, 2005, pages 1-2.

The states' selection of a market-based control program for CO_2 emissions from the power sector reflects the history and success within this region of market-based programs established under the federal Clean Air Act for control of SO_2 and NO_x emissions. It is also a natural fit for the electric industry given the ease with which allowance costs can be rolled into competitive wholesale electricity market price signals. This mechanism allows prices to reflect CO_2 emissions, leading over time to industry operational decisions (relating to power plant dispatch) and investment decisions that reflect the most efficient long-run compliance path for the industry. In this context, the use of a market-based control program for CO_2 encourages efficiency in power dispatch decisions and long-run efficiency for achieving compliance with the market-based cap on emissions.[14]

The CO_2 emissions cap is administered through limiting the quantity of allowances issued for a given year. For example, 188 million allowances were available for the year 2009. The owners of affected power plants generally obtain CO_2 allowances by purchasing them through the initial auctions (held quarterly), or by purchasing/transferring them in a secondary market.[15]

RGGI allows for flexible compliance in a number of ways. First, recognizing the long-lived nature of CO_2 in the atmosphere, compliance is required not annually, but on a three-year basis. That is, sources can purchase, bank, and use allowances bought at any auction for a given compliance period within the three-year compliance period, and need only demonstrate compliance (through retiring allowances in amounts equal to emissions) shortly after the end of that same period. Second, sources can meet up to 3.3 percent of their CO_2 compliance obligation through the purchase of offsets – greenhouse gas (GHG) reduction projects outside the power sector.

Allowance Disbursement to the RGGI States

Allowances are made available primarily through central auctions that are conducted quarterly by RGGI, Inc. on behalf of the RGGI states. An independent market monitor assesses the auctions to ensure that they are administered according to auction rules, and that there is no anti-competitive behavior in the market. Approximately 99 percent of allowances are initially distributed via RGGI auctions, with the remainder sold directly by selected states (Connecticut and New Jersey) to qualifying affected sources. Participation in the auctions is open to any company or person meeting qualification requirements (e.g., financial security requirements), with a ceiling of 25 percent placed on purchases by a single buyer or group of affiliated buyers in each auction. Proceeds from the quarterly auctions – which are determined by quantities sold and auction clearing price (subject to a reserve (floor) price that is currently $1.89 per allowance) – are distributed to states, and states determine how to use the funds.

[14] In all three of the power regions where RGGI states are located, the wholesale power market has evolved over time into a comprehensive electricity market construct (including energy, capacity, and ancillary services) that shapes the dispatch of power plants in an efficient and reliable way in real time as well as affecting the near-term and long-term price signals for the addition of new generating capacity. These regions are centrally administered wholesale markets operated by three entities: ISO-New England (for the six New England states); the New York Independent System Operator (NYISO) (which is a single-state market); and PJM (for New Jersey, Delaware and Maryland, along with 10 other states and the District of Columbia outside of the RGGI MOU).

[15] In addition, Connecticut and New Jersey disburse a small amount of allowances through direct sales to qualifying emitters.

The initial auction occurred in September 2008, before the commencement of the compliance period in 2009; all 12.56 million allowances offered for sale were sold at a single clearing price of $3.07 per allowance.[16] The most recent auction as of this writing occurred in September 2011, with approximately 18 percent of the 42.19 million allowances offered for sale selling for $1.89 per allowance.[17] Thus during the first compliance period, allowance auction prices trended downward and ultimately reached the reserve price level, due primarily to the decrease in emissions associated with diminished economic output and lower-than expected power sector demand.

Use of Auction Proceeds and Other Allowance Revenues

The use of auction proceeds varies by state, consistent with enabling state legislation, regulation, and policy. Examples of how the states used their funds include investment in energy efficiency programs, investment in community-based or private-sector installation of renewable or advanced power generation systems, direct reductions in electricity bills, funding of state government operations through allocation to state general funds, education and job training programs, and administration of the RGGI program or other greenhouse gas reduction initiatives. How states have used the auction proceeds during the time period reviewed in this study (that is, the first compliance period, 2009–2011) is discussed in detail below.

RGGI Program Review

The RGGI program was designed with a number of specific elements of review and evaluation. In particular, the RGGI agreement provided for a comprehensive program review in 2012, which is currently underway. The comprehensive program was designed to review, at a minimum, program success and impacts, imports and emissions leakage, the integrity of the offset program, and whether additional reductions beyond 2018 should be implemented.

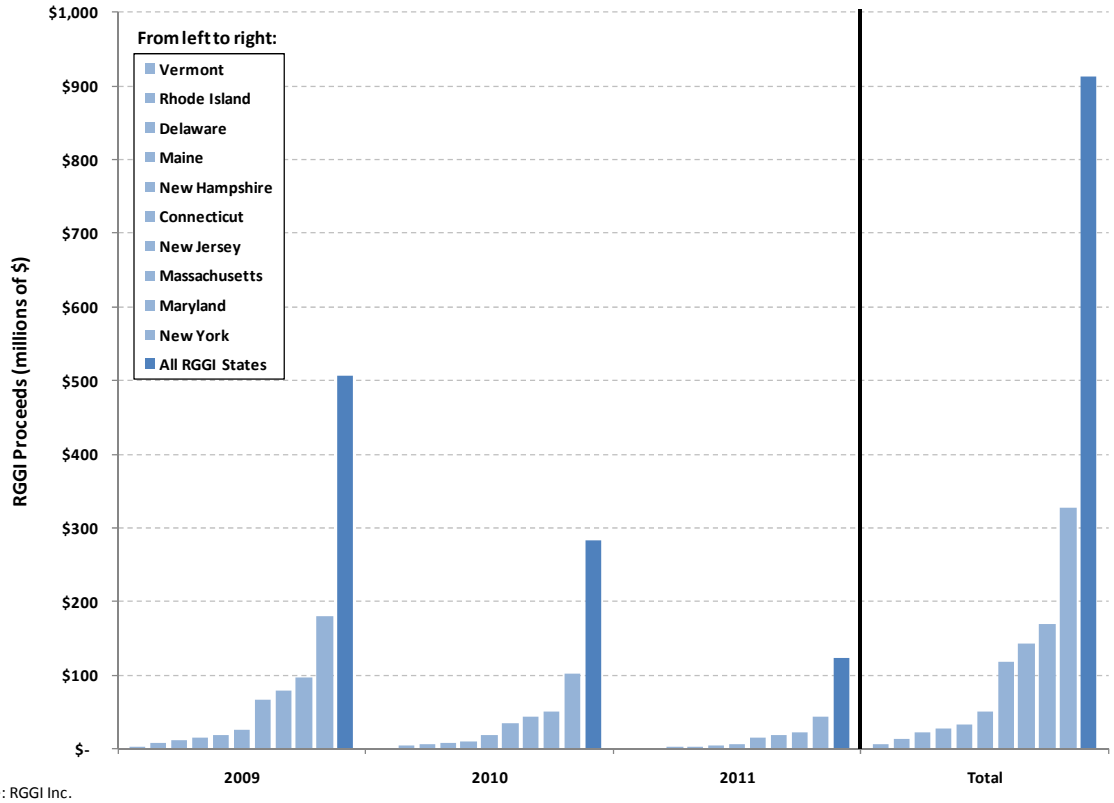
[16] http://www.rggi.org/docs/rggi_press_9_29_2008.pdf.
[17] http://www.rggi.org/docs/Auction_13_Release_Report.pdf.

3. STUDY METHOD OF ECONOMIC IMPACTS OF RGGI PROGRAM TO DATE

Overview

From Q3 2008 through the present, the auction or direct sale of RGGI CO_2 emission allowances has resulted in the collection and disbursement to states of nearly $1 billion. See Figure 1.

Figure 1
RGGI Allowance Proceeds by State



Source: RGGI Inc.
Notes: Figures include Auctions 1-13 and direct sales proceeds for New Jersey (2009) and Connecticut (2009/2010). Auction proceeds from Auctions 1 and 2 are reflected in the 2009 values.

The purpose of our analysis is to follow this money and identify the economic impacts of its use. Namely, we track the path of RGGI-related dollars as they leave the pockets of power plant owners 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. This analysis is unique in this way: it focuses on the actual impacts of economic activity; known CO_2 allowance prices; observable CO_2 allowance proceeds ($912 million); dollars distributed to the RGGI states; actual state-government decisions about how to spend the allowance proceeds; measurable reductions in energy use from energy efficiency programs funded by RGGI dollars; traceable impacts of such

expenditures on prices within the power sector; and concrete value added to the economy. By carefully examining the states' implementation of RGGI to date, based on real data about both the expenditures inside and outside of the electric sector, and value added from RGGI program implementation, we track the extent to which RGGI program implementation represents a positive or negative impact on the economies of the RGGI states.

There were five major elements of our review, each of which is discussed in more detail in the sections that follow:

1. We first established the **scope and overall framework of the analysis**, to create as much as was possible an integrated analytic framework that separates and highlights RGGI-state impacts based on known historical program implementation data (i.e., during the first compliance period), from other factors and impacts outside the region or associated with forecasts or projections. This scope of analysis thus included modeling of actual funds received and spent by the states, and actual impacts on electricity markets, as well as an assessment of the impacts of RGGI program expenditures on the larger economy. The analysis aimed at providing a better understanding of uses of funds by developing a number of illustrative case studies to provide some indication of the wide variety of programs that have been funded in the first compliance period.
2. Next we conducted a thorough review of **data and information on use of revenues collected from the sale of RGGI allowances**. These data were gathered from public sources: RGGI, Inc. reports, RGGI state agency documentation, and other industry documents and studies of the RGGI program. We used these data to develop a comprehensive catalogue of how each state used its RGGI allowance proceeds, and supplemented this effort through comprehensive interviews with and collection of data from representatives of implementing agencies in the RGGI states. The purpose of this step was to track with as much accuracy as possible exactly how RGGI revenues have been allocated and disbursed over the first compliance period, how disbursed funds were used, and what the impacts were of associated program implementation. Part of this analysis resulted in information about the use of allowance proceeds that affected activity in the electric sector (e.g., how expenditures on energy efficiency programs affected the level of energy use in various portions of the day and in different seasons of the year) and in other parts of the economy (e.g., how those same energy efficiency programs affected buildings' use of oil or natural gas for heating purposes; how different program expenditures provided job training, purchases of equipment, and so forth, as described further below).[18]
3. Third, we modeled **electric sector outcomes** from both the incurrence of increased costs associated with affected facilities' compliance obligations (namely, the purchase of allowances and pricing of power consistent with those CO_2 allowance costs), and the effect of changes in electric generation and demand associated with the use of funds to spur

[18] These various uses of allowance proceeds are described in the Appendix.

investment in energy efficiency and advanced energy technologies. Our electric sector analysis was conducted using the GE Multi-Area Production Simulation (MAPS) model.[19]

4. Fourth, we modeled **macroeconomic outcomes**, combining electric sector outcomes – positive and negative – with expenditures in all sectors of the economy associated with the use of RGGI funds in the ten states. This produced an overall picture of how RGGI program implementation has affected the economy, including multiplier effects associated with the impacts on consumer electricity payments, power plant owners' costs and revenues, and the flow of RGGI-related dollars through other sectors of the economy. Our macroeconomic analysis was conducted using the IMPLAN model.[20]
5. Finally, we identified and collected information on specific examples of how RGGI funds were spent, and produced 11 **case studies** designed to provide an illustrative cross-section of how programs resulted in actual impacts on households, community, companies, and others in the RGGI region. These cases reveal only a small sampling of how the states used RGGI proceeds, the larger effects of which are tracked in the macroeconomic analysis.[21]

It is clear from our program research and results that different investment vehicles have vastly different impacts from both economic and non-economic perspectives. Because our analysis focuses only on economic impacts, it does not shed light on all of the objectives and outcomes of the RGGI program (e.g., addressing climate change risk, etc.).

Scope of Analysis

Overview

In order to carry out our analysis of economic impacts of RGGI, we ran power system dispatch and macroeconomic models under two scenarios: the "RGGI case," which is effectively the world as it actually evolved; and the counterfactual "no-RGGI case," which involves changes to model inputs and assumptions to create conditions as if the RGGI program never happened. The difference in economic impacts between the two cases reflects the incremental impacts of the RGGI program to date.

In constructing the scope of our analysis, we were guided by three key objectives: First, we wanted to focus on impacts only within the RGGI states (the geographic perspective). Second, we wanted to identify near-term and longer-term impacts associated with RGGI's implementation during the first compliance period only (2009–2011) (the temporal perspective). Third, we wanted results that were grounded as much as feasible in actual, known expenditures, programs, and impacts (the empirical perspective).

[19] The MAPS model and our analysis of electric sector impacts are described in detail in the Appendix.
[20] The IMPLAN model and our analysis of macroeconomic impacts are described in detail in the Appendix.
[21] The case studies, along with the full list of all RGGI program grants we considered, are in the Appendix.

From a geographic perspective, we focused our analyses on the activities and impacts exclusively within the RGGI states. While some money from RGGI spending that flows outside of the RGGI states affects the economies of states outside the RGGI region (for example, for the manufacture of light bulbs or insulation used in energy efficiency programs, or flows of dollars to the federal government associated with changes in income), we did not try to capture or report those impacts in our analysis. Similarly, in the power system modeling, our evaluation of impacts on power plant owners (also referred to as producers or generators here) and energy consumers was limited to those located within RGGI states.

From a temporal perspective, we focused our analysis on the first RGGI compliance period. We tracked the impacts of RGGI-related dollars associated with the first three years of implementation. This means that we included in power pricing the cost to power producers of obtaining RGGI allowances in the first three years, and we included in power and economic sectoral investments only RGGI revenues that were collected during the first three years of the program.

Focusing on these initial three years of RGGI dollars required incorporating nuanced timing adjustments. We tracked actual dollars collected from power producers during the 13 auctions that have occurred to date: these 13 auctions took place from Q3 2008 through Q3 2011. The funds from these auctions flowed to the states immediately, with states spending them (or programming them for expenditures) during the 2009–2012 time period. Within the electric system, the impacts of these initial auctions show up during the 2009–2011 period, as power plant owners priced the value of CO_2 allowances into prices they bid in regional wholesale markets. The macroeconomic impacts occur over the time period that allowance proceeds are spent (2009–2012), but there are tail-end effects associated with the imprint of energy efficiency expenditures made during that period on energy use for the following decade (through 2021). We thus track these direct effects of RGGI to date in the near term (i.e., the first compliance period), and in the long term track indirect impacts from expenditure of RGGI dollars by the states (for energy efficiency expenditures from 2009–2012, and from the implications of those energy efficiency measures on electricity use from 2009–2021).

Consequently, from the perspective of modeling data and assumptions, we focus our analysis on known quantities associated with actual results from the first three years. That is, we do not forecast allowance prices; we use actual allowance prices as they revealed themselves through the auctions. We do not estimate future program revenues, since we were focused on actual RGGI auction proceeds to date. We do not project how future revenues will be spent by states, since we rely entirely upon how the states have actually decided to spend allowance proceeds received to date. We make no assumptions about states' participation in RGGI going forward. Nor do we project impacts associated with programs funded through RGGI dollars collected in future years.

The goal of our analysis is thus to identify economic impacts associated with historical implementation: known allowance prices and revenues; known distribution of revenues to states; actual or committed expenditures associated with state proceeds; and observable impacts associated with past or current RGGI-funded program implementation. In this sense, our analysis should be viewed as a snapshot of impacts associated with a finite period – the initial compliance period – of RGGI program administration, and not a projection or forecast of how RGGI may, could, or should evolve. To accomplish our goal, however, we did have to establish what these programs meant from

an economic perspective, in order to create the "no-RGGI" counterfactual case, against which to compare the actual economy that included RGGI during the 2009–2011 time period.

Data Collection and Processing

Overview

Our analysis began with the collection and processing of data related to RGGI program implementation in each of the ten states. Identifying and tracking the use of RGGI proceeds is fundamental to our analysis, yet it was somewhat challenging due to the newness of the RGGI program, as well as to the complexity of tracing dollars through each state's different administrative channels. This process also involved the translating of expenditures for energy efficiency measures into impacts on power system energy consumption and electricity peak loads in various seasons and days of the year.

In each state in the past three years, RGGI funds sometimes supported new programs in many functional areas of state government. In most cases, even the underlying state laws and regulations governing administration of the RGGI program were new, and the states needed to set up new programs with new state employees in new divisions. Reporting procedures and records had to be established and put into effect. All of that has affected the availability and form of program-specific information from the states.

In the end, we were able to obtain most of the necessary information from the states. Where information was missing or incomplete, we took successively deeper steps (including follow-up interviews with agency staff and reviews of enabling legislation and regulations) to fill in data holes, sort out inconsistencies, and arrive at a workably complete data set for use in the study.

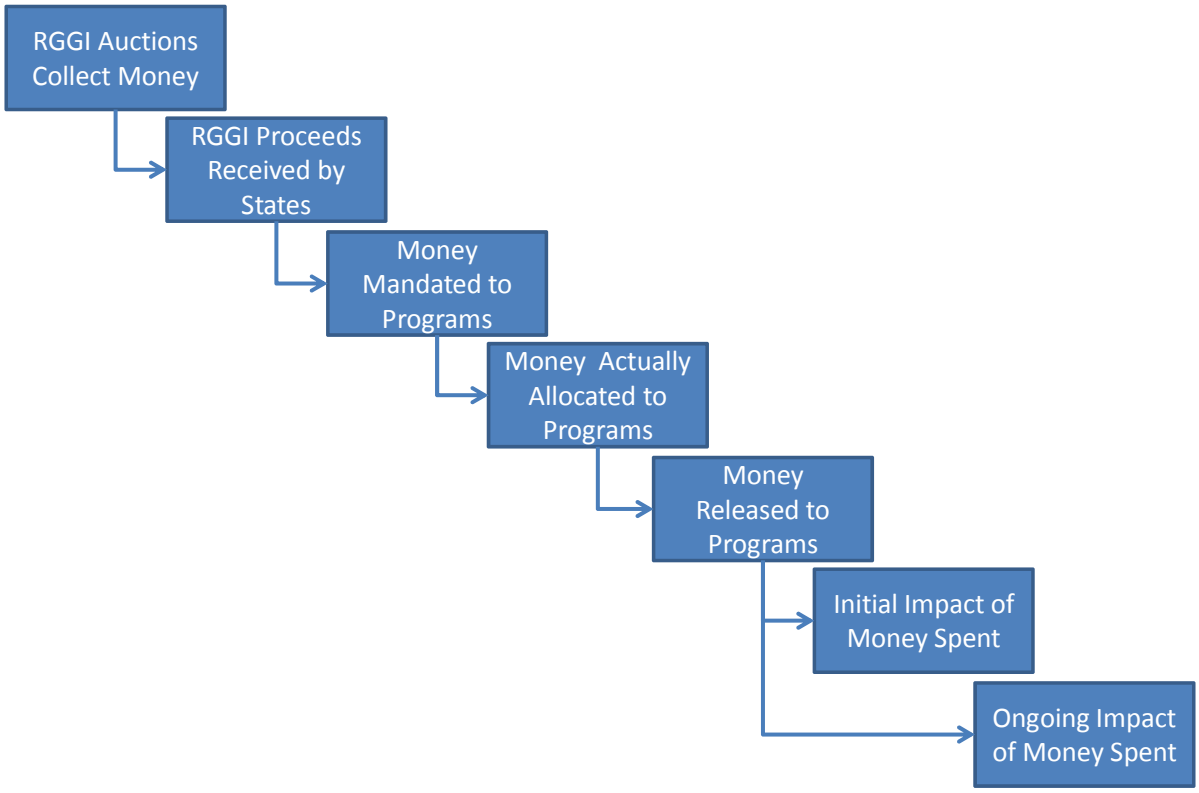
Data Gathering

Our data gathering and processing effort focused on identifying the use of RGGI allowance proceeds in as complete and accurate a manner as possible, to ensure a good match between revenues collected and expenditures tracked. We gathered, processed, and audited the data using a methodological approach that "follows the money" through the sequence of steps that begin with the creation of a pot of auction proceeds that then goes to the states for programming and expenditure through grants of one form or another (see Figure 2). Once we were able to track monies into different expenditure pots, we then processed the result for input into the MAPS and IMPLAN models.

Approach

The first anchor point for our data analysis is the level of revenues collected through the quarterly auctions of allowances ($900.6 million), and through the direct sale of allowances ($11.8 million). This was the target amount of revenues that, in the end, we needed to match up with state program expenditures. Our first point of data collection and verification with states was with the collection of revenue information related to sales of allowances into the market, and then allocation of those revenues to states. Total revenue allocations to states are shown in Figure 1.

Figure 2
Representation of Dollar Flows from RGGI Auctions through State Spending Impacts



Much of the challenge in data collection and verification involved tracking the flow of money once received by the states through various programs, channels, and agencies. Once we knew the amounts allocated and released by states to programs, we then tracked dollar flows to determine whether and how the dollars were actually disbursed. We traced and categorized in some detail the actual use of program dollars for funding to various types of recipients, activities, measures, or completed installations (e.g., numbers of energy efficiency measures by type of measure and by type of customer).

Finally, we identify the effects of the funded activities, programs, and investments. By "effects," we mean the tangible results of the expenditures that are significant or important from the standpoint of measuring economic impact through the MAPS and IMPLAN modeling effort. For example, what are the annual household electricity savings, on- and off-peak, associated with an appliance rebate program to replace old air conditioners with new, efficient ones? How many MWh of generation will flow annually from a solar photovoltaic system installed on a capped municipal landfill using RGGI dollars? Identifying such effects involved (1) collecting data and estimates by states on such effects, (2) reviewing and processing these estimates for consistency of assumptions and calculations across

states for similar programs, and (3) applying "best-practice" estimation methods where data across states were missing, incomplete, or inconsistent.

Process

Our process for cataloguing the collection, allocation, disbursement, and use of RGGI allowance revenues involved three basic steps:

- We first collected and reviewed all data on RGGI program expenditures and on estimated effects of RGGI-funded programs from all public sources. The public sources of information were RGGI, Inc., the state agencies, and various publicly available reports on the RGGI program.
- We organized and recorded the data in a manner designed to achieve consistency in data documentation across the states. Based on this step, we developed a survey to support the gathering of data from states to fill in where there were holes in reported data gathered from public sources.
- Using the existing public data and survey information collected through interviews with state officials, we obtained all of the remaining data available, and organized it for consistency. Since the information came from many sources, the data reflected varying levels of detail, requiring us to process the data to place expenditures into consistent spending categories across the RGGI states, and to format the data for input into the MAPS and IMPLAN models.

Based on our review of the data, the similarities in spending vehicles across RGGI states, and the levels of disaggregation needed for model inputs, we divided program spending into six categories. These categories are described below, and expenditures by category for each electric market region (New England, New York, and PJM RGGI states[22]), as well as for the entire RGGI footprint, are presented in Figures 3 through 6.

1) *General Fund/State Government Funding* – includes money used to fund state agencies, programs, and other expenses not necessarily tied to RGGI program activities, through use of RGGI allowance revenues as a contribution to meeting overall state budget requirements.
2) *Energy Efficiency and Other Utility Programs* – described further below.
3) *Renewable Investment* – includes grants to programs and investments focused on the development, distribution, and installation of renewable or advanced energy technologies (e.g., a program to support installation of rooftop photovoltaic systems).
4) *Education, Outreach, and Job Training* – includes monies used for programs (i) to educate business and residential consumers about energy consumption and the

[22] As described in further detail below, the ten RGGI states are located in three electrical regions: the six New England states are together part of the unified electric grid/market administered by the ISO-New England; New York has a single-state wholesale market/grid; and Delaware, Maryland and New Jersey are part of a larger electrical market administered by PJM.

availability of programs to reduce consumption, and (ii) train workers with new skills and knowledge in industries and activities that contribute to lowering energy use (e.g., energy efficiency measure installation) or the production and distribution of renewable or other advanced energy technologies.

5) *Direct Energy Bill Assistance* – includes use of RGGI funds to reduce bills paid by consumers for electricity and heating/cooling. Most significantly, investments in this category were targeted to low-income households.

6) *Other GHG Reduction Programs and Program Administration* – The GHG reduction programs include a variety of expenditures aimed at reducing GHG emissions [such as research and development grants for carbon emission abatement technologies, direct investment in "green" start-up companies, direct GHG emissions reduction measures (e.g., efforts to reduce vehicle miles traveled and programs to increase carbon sequestration), climate change adaption measures and investments in existing fossil-fuel fired power plants to make them cleaner and/or more efficient (e.g., installing pollution controls and installing technologies to increase plant efficiency)]. RGGI Program Administration refers to RGGI auction proceeds used by each RGGI state to cover costs associated with the administration of the state's CO_2 Budget Trading Program and/or related consumer benefit programs.

Because so much of the RGGI funds were spent on energy efficiency ("EE") measures, and because different measures lead to different impacts on consumers' demand for electricity, we grouped information on energy efficiency programs into several expenditure categories. This enabled us to use the data at a more granular level in the MAPS and IMPLAN models. EE categories include the following:

- Audits and Benchmarking – Expenditures associated with the energy auditing function (initial visits to homes or businesses to provide some initial EE measures and to refer the owner to additional EE programs and/or to estimate self-funding measures) and the measurement and verification of energy use and program impacts to guide future program design.
- Installations and Retrofits – The vast majority of EE funds involved direct expenditures for installations and retrofits. Within this category, we collected data by program type (e.g., residential retrofit, residential new construction, appliances, commercial retrofit, commercial new construction). Disaggregation of information at this level was needed to be able to assign "load profiles" to the various types of EE programs for modeling program load reductions in the MAPS model.
- Demand Response and Management of Consumption – Expenditures on demand response measures, smart meters, and the use of other technologies designed to manage customer consumption of electricity in response to various supply conditions. This includes programs where there is a dispatch signal provided to a consumer of electricity to modify consumption under certain conditions, technologies that inform consumers about electric price signals (which may lead to modified behavior), and other programs that can shift or curtail loads.

Figure 3
Summary of RGGI Proceed Spending
All RGGI States

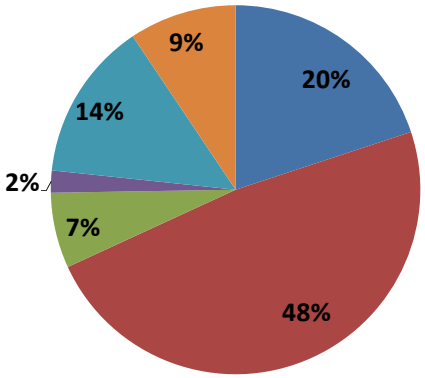


Figure 4
Summary of RGGI Proceed Spending
New England

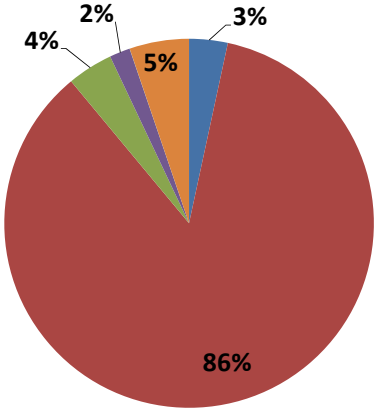


Figure 5
Summary of RGGI Proceed Spending
New York

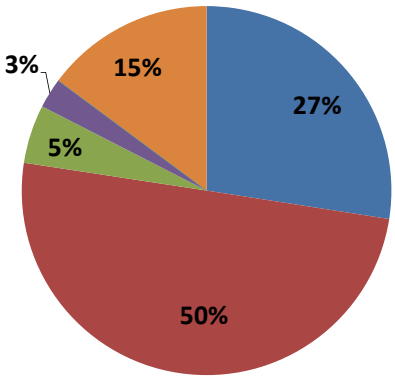
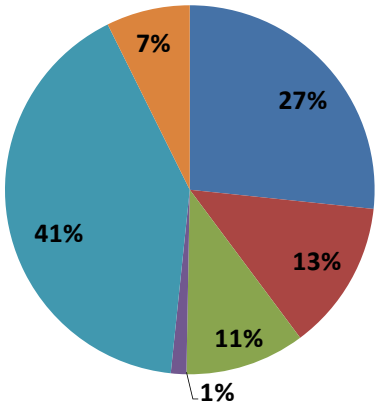
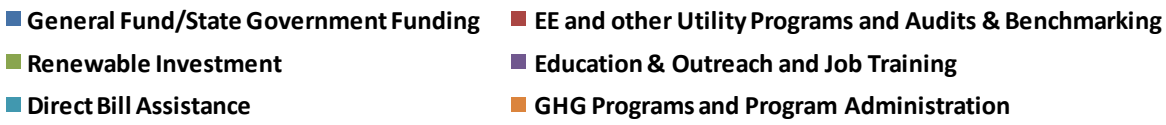


Figure 6
Summary of RGGI Proceed Spending
RGGI States in PJM





Source: Individual state reports and interviews.
Note: Certain grant programs may include multiple components, and are categorized in the figure above based on the largest share of spending.

The amounts of funds spend by program category by region (and in the ten RGGI states as a whole) are show in Table 1, below.

Table 1
Spending of RGGI Proceeds by State and Category

	General Fund/State Government Funding	EE and other Utility Programs and Audits & Benchmarking	Renewable Investment	Education & Outreach and Job Training	Direct Bill Assistance	GHG Programs and Program Administration	Total
Connecticut	$ -	$ 37,667,961	$ 10,705,482	$ 337,290	$ -	$ 3,020,516	$ 51,731,248
Maine	-	22,831,749	-	-	-	4,398,768	27,230,517
Massachusetts	-	133,960,304	325,324	3,108,774	17,083	5,093,587	142,505,072
New Hampshire	9,272,116	21,483,151	-	1,181,506	-	998,939	32,935,712
Rhode Island	-	13,210,854	-	314,528	-	744,155	14,269,538
Vermont	-	6,496,814	-	-	-	102,630	6,599,444
New England Subtotal	**$ 9,272,116**	**$ 235,650,833**	**$ 11,030,806**	**$ 4,942,097**	**$ 17,083**	**$ 14,358,596**	**$ 275,271,531**
New York	$ 90,000,000	$ 163,660,609	$ 16,800,000	$ 8,600,000	$ -	$ 48,588,106	$ 327,648,716
New York Subtotal	**$ 90,000,000**	**$ 163,660,609**	**$ 16,800,000**	**$ 8,600,000**	**$ -**	**$ 48,588,106**	**$ 327,648,716**
Delaware	$ -	$ 13,977,755	$ -	$ -	$ 1,663,210	$ 6,809,816	$ 22,450,780
Maryland	7,770,000	26,840,847	5,471,340	4,181,160	115,465,494	9,871,582	169,600,424
New Jersey	74,950,622	-	27,089,246	-	10,185,525	6,069,154	118,294,547
RGGI States in PJM Subtotal	**$ 82,720,622**	**$ 40,818,602**	**$ 32,560,586**	**$ 4,181,160**	**$ 127,314,229**	**$ 22,750,552**	**$ 310,345,751**
All RGGI States	**$ 181,992,738**	**$ 440,130,044**	**$ 60,391,392**	**$ 17,723,257**	**$ 127,331,312**	**$ 85,697,254**	**$ 913,265,997**

Source: Individual state reports and interviews.
Note: NY dollars include interest earned in addition to proceeds from the RGGI auctions.

Modeling Approach

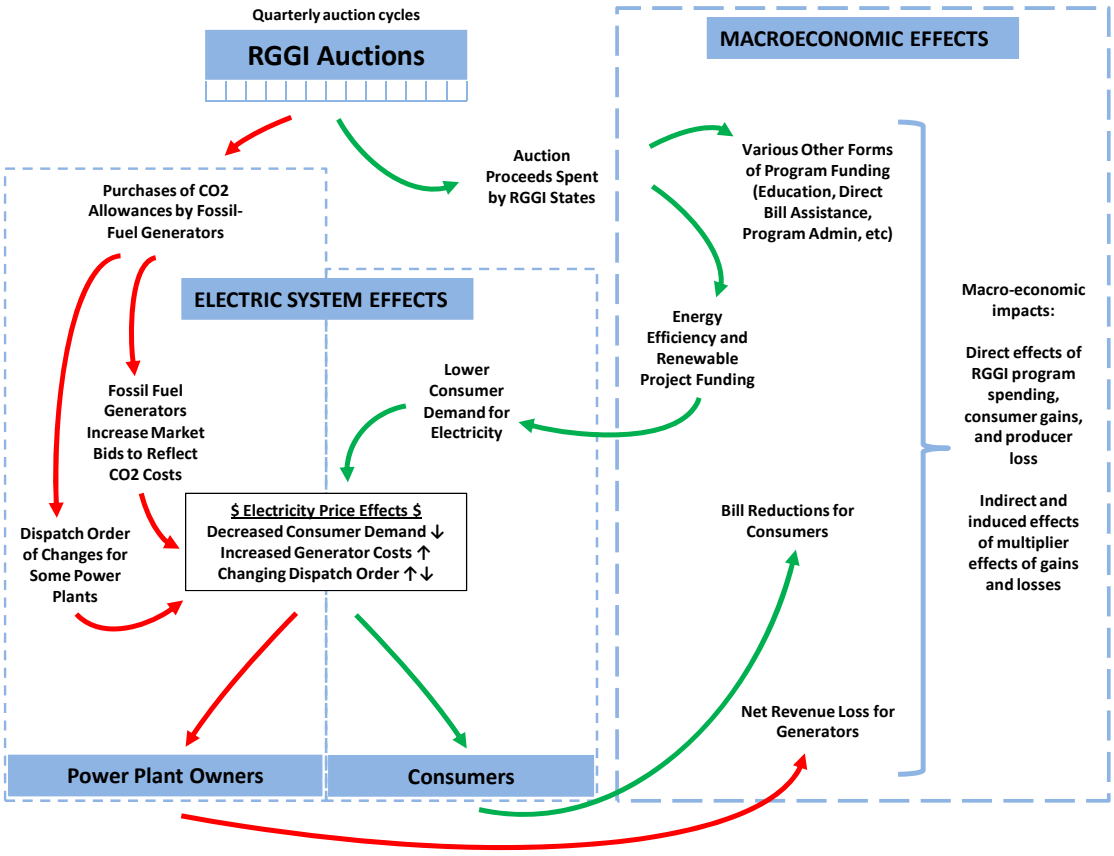
Overview

Given that our goal was to track the impact on the economy of the states' use of RGGI allowance proceeds, we needed to construct a counterfactual electric system that did not reflect RGGI funding and develop an analysis that followed the RGGI funds through the economy. We provide the details of our assessment tools in the Appendix, which describes the IMPLAN and MAPS models in greater detail.

With respect to impacts on the general economy, RGGI allowance proceeds have two effects. First, when the states use RGGI proceeds to fund an activity (such as energy efficiency), those monies have a direct impact in the form of purchases of goods and services in the economy. Second, the compliance obligation and the use of RGGI proceeds create changes in the power sector, in the form of changes in power plant owners' costs, prices bid into wholesale electricity markets, and consumer spending for power. In aggregate, these changes in spending lead to revenue gains and losses (to power plant owners) and gains and losses (to consumers), which, in turn, affect economic flows in the macroeconomy.

To estimate these impacts on the economies of RGGI states, we model changes to the electric system and macroeconomic outcomes. The general flow of data and modeling outcomes is depicted in Figure 7.

Figure 7
Flow of Data and Modeling Outcomes



Our modeling approach combines analysis of power sector affects (through modeling using MAPS), and analysis of macroeconomic effects (through use of IMPLAN). The foundation of our modeling analysis is, in effect, a comparison between two scenarios run through the models. In the IMPLAN analysis, we start with economic relationships that exist among providers and users of goods and services in the ten RGGI states, and then we introduce the direct expenditures (RGGI proceeds) and the revenue gains and losses to electricity consumers and power producers. In the MAPS model, we run a dispatch of the ten-states' power systems "with" and "without" RGGI, and include in each run the same core conditions: power system infrastructure both in place and as it evolves over the modeling period (that is, transmission configurations and power plant additions and retirements); local and regional forecasts of electric energy and peak load by service territory over the modeling period; projections of fuel prices and allowance prices for NO_x and SO_2; etc.

The two cases in MAPS can be described as follows:

- RGGI Scenario – In the RGGI scenario, the power system is modeled as is. That is, the RGGI case represents the world as it has evolved with RGGI in place and operating. It includes all of the programs, measures, investments, and funding that are associated with the first three years of RGGI program implementation, and all of the impacts on the power system and economy associated with the use of RGGI funds.
- No-RGGI Scenario – In order to create the counterfactual against which we compare and contrast the RGGI case, we create a scenario configured to represent the power system and economy as it would have progressed absent expenditure of RGGI-related dollars. In order to do this, we relied on all of the data and representations of RGGI investments and associated effects described in the previous section, and removed those investments and effects from the RGGI scenario.

We then traced the dollar differences in these two MAPS runs (with and without RGGI) through the macroeconomic IMPLAN model to capture the impacts of these electric sector outcomes; we also injected funds related to the states' direct expenditures of RGGI program dollars in IMPLAN.

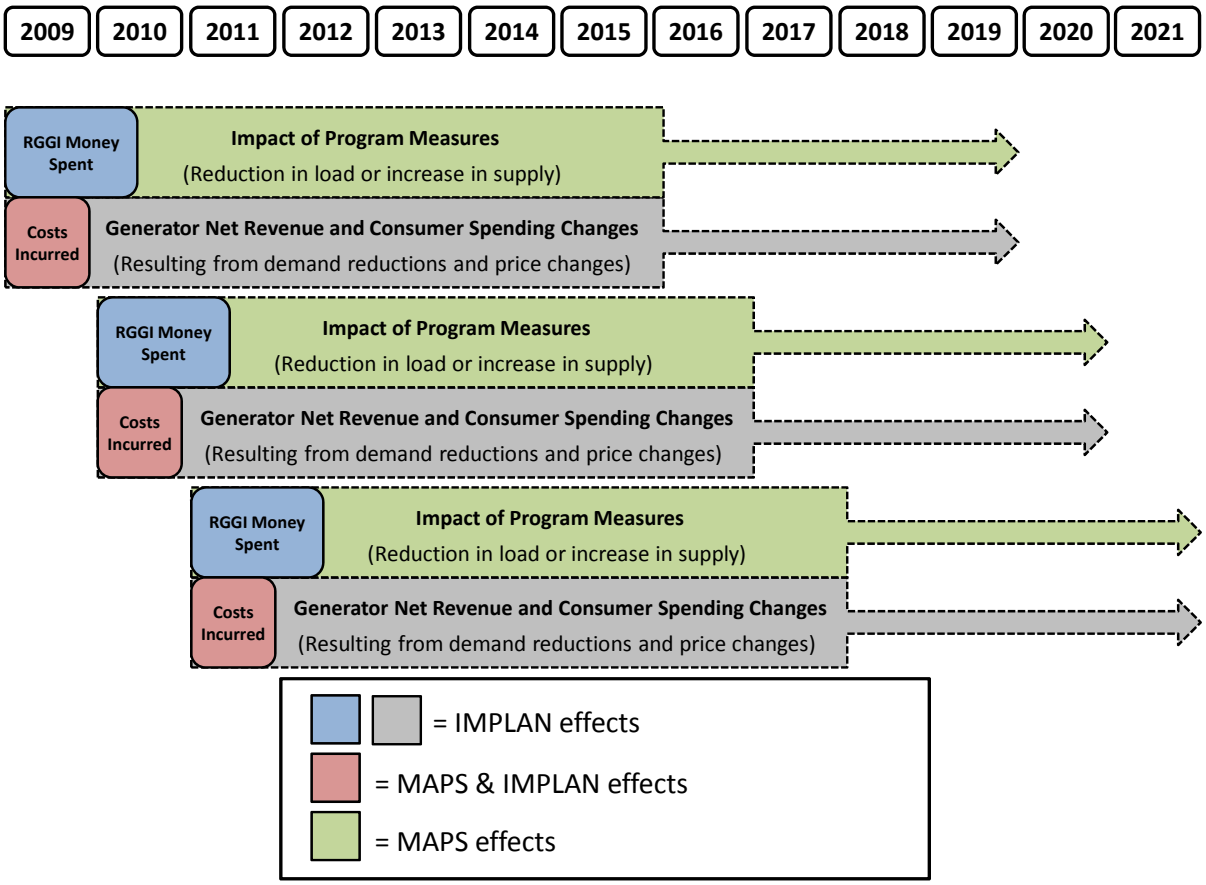
Modeling Timeframe

Figure 8 captures in schematic form how RGGI program costs and effects are represented in the MAPS and IMPLAN modeling. More detail on how the modeling is carried out is presented in the Appendix, but in summary the items to note in this figure are the following:

1. The 13 auctions (Q3 2008 through Q3 2011) provide CO_2 allowances into the markets, which are then used by affected power plant owners during the first compliance period from 2009–2011. During this period, CO_2 allowances affected the prices at which fossil-fueled power plant owners offered to supply their power into regional electric energy markets, with offer prices also tied to their fuel cost (e.g., natural gas or coal or oil), variable operations and maintenance expense, and generating efficiency (heat rate). At times (when the affected producers are on the margin) the cost of CO_2 allowances increases the wholesale price for power – and thus electricity costs – to all customers. These effects are represented as red blocks in Figure 8. This incremental impact of CO_2 prices in electricity markets stops after this first three-year period; that is, our analysis does not make any assumption about the RGGI program going forward, which is important for isolating the effects of the first three years of the program.
2. The money collected from CO_2 allowance sales (from Q3 2008 through Q3 2011) are spent on various programs. These expenditures are represented as blue blocks in Figure 8. (Note that the lag between revenue collection from auctions in the first three years and program expenditures by the states means that some portion of revenues collected during that period is actually spent in the economy in 2012, with programming of the monies by the states reflecting decisions made in 2011. Consequently, the blue blocks extend into 2012.) These expenditures are one-time events in those years – program administration, rate relief to electric utility ratepayers, construction, maintenance or purchases, energy efficiency program implementation, energy audits or measurement, verification and benchmarking, education

investments, etc. These all represent single purchases or expenses that *directly* affect economic activity only in the year in which they occur.

Figure 8
Representation of RGGI Program Costs and Impacts through MAPS and IMPLAN Modeling



3. Some of these one-time expenditures (e.g., on CO_2 allowances, on purchases of electricity, on expenditures of RGGI-funded activities) lead to impacts (e.g., energy use, energy costs, energy savings) beyond the year of incurrence. This results fundamentally from the use of RGGI funds on energy efficiency and new renewable generating capacity. Once made, such investments continue to produce reductions in load or shifting of generation for many years beyond the investment. This in turn affects how RGGI expenditures to date affect (a) current-period and later-term revenues to owners of power plants (which, over the long term, realize negative impacts in the form of decreased revenues due to producing less power because demand is lower compared to the "no RGGI" case) and (b) current-period and later-term expenditures on electricity (and natural gas and oil for heating purposes) by consumers (who realize lower wholesale electricity prices and lower energy bills in the "with RGGI" case).

These long-term impacts of one-time expenditures are reflected both in changes to power system dispatch over the period of study and changes in economic activity over the same time period.

By constructing the analysis in this way, we were able to isolate our measurement of impacts to "known" outcomes, with the assessment grounded in known information from the first compliance period, and with impacts limited to those occurring in the RGGI states.

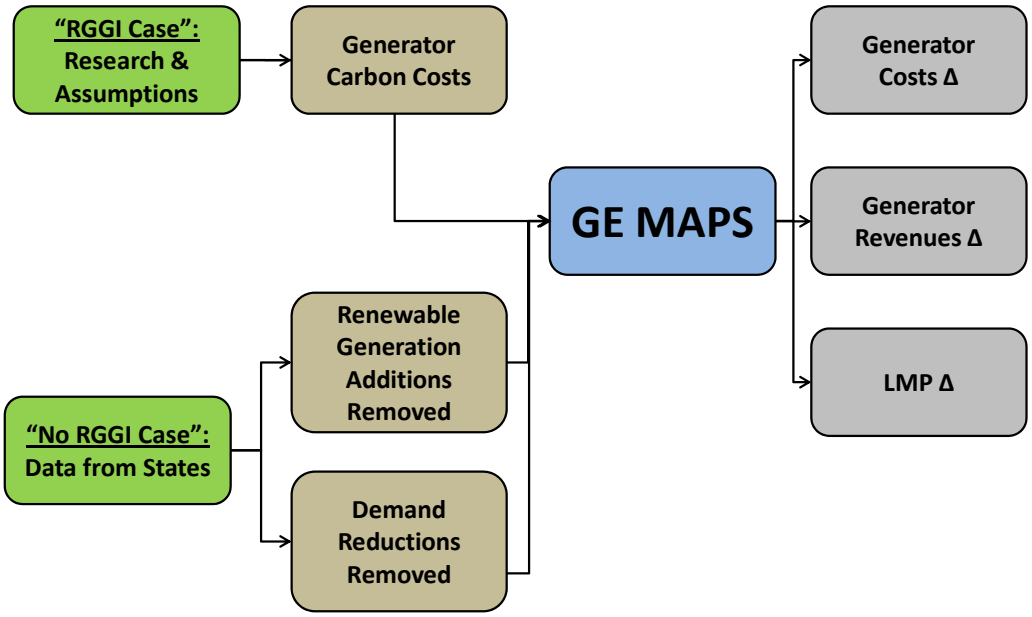
In the following sections, we summarize the power system and macroeconomic models, and highlight a few key factors of the modeling approach that help to interpret the results.

Power Sector Analysis

RGGI has two primary effects in wholesale power markets. First, marginal power prices are at times increased by the additional CO_2 allowance cost to affected (fossil-fired) power generating facilities. Second, load, demand, and marginal prices are at times decreased by energy efficiency measures installed with the use of RGGI allowance proceeds.

Using the MAPS power system dispatch simulation model, we quantified these net impacts on regional and local system loads, power prices, and revenues to power producers associated with implementation of the RGGI program. (See the Appendix for a detailed description of the MAPS modeling platform, whose core logic is explained briefly below.) These relationships are summarized in Figure 9. Using MAPS, we created the "with RGGI" case (benchmarking the modeling results to the actual electric output) and then constructed a counterfactual "no-RGGI" case. Comparing the results of the two cases provided information about the incremental effect of RGGI on power system users and producers.

Figure 9
Diagram of MAPS Modeling Inputs and Outputs



Traditional cost-minimizing strategies in the dispatch of power systems involve use of production-cost information to determine which power plants operate at different times of the day to meet changing load conditions. In competitive wholesale electric market regions like the Northeast and Mid-Atlantic regions, decisions on which power plants to turn on and off are made based primarily on bids submitted by power plant owners indicating the price at which they are willing to supply power into the markets. Provided the market is sufficiently competitive, price bids should approximate marginal production costs of the facilities in the system. Generally, prices in wholesale markets are set hourly based on the last generating unit dispatched – that is, the most expensive unit that was needed to meet hourly load.

The GE MAPS power system model is configured to comprehensively simulate the dispatch of the power system on an hourly basis based on power plant marginal costs, subject to various operational and transmission system constraints that can alter dispatch order (and thus prices) in real time. The MAPS model simulates system dispatch based on, and reflecting: (1) the operational characteristics and marginal production costs of every generating facility in the power region being studied (in this case, New England, New York, and PJM); (2) the configuration of, and limits on transfers of power across, the transmission system, comprising every transmission line and other system components in place; and (3) algorithms designed to reflect the operational constraints of power plants, such as the time it takes to start units and to ramp them up to various power levels, the minimum time they must be on, and the minimum time they must be off. Given the level of detail in how MAPS represents the power system – that is, down to very small power plants and specific transmission system components and limits – it is able to model and represent power prices, unit output, emissions, consumer costs, producer revenues and other factors on an hour-by-hour basis, and with a high degree of geographic resolution (that is, down to a utility's service territory, or a specific substation).

Given this level of detail, we are able to model investments in energy efficiency and the development of new generation using RGGI funds at a detailed state- and utility-specific level. This allowed us to capture the impact of such investments on the prices that consumers pay – and that power producers are paid – on hourly and locational bases. As shown in Figure 9 above, we simulated the dispatch of the three regional power systems that contain the RGGI states for each hour of the modeling period (January 2009 through December 2021) for both the "with RGGI" and "no-RGGI" cases. Based on the output of those two cases, we calculate changes in (1) unit dispatch, (2) wholesale electric prices, (3) payments to power producers, and (4) payments by consumers.

We used the MAPS output and associated calculations of changes in generator and consumer prices, revenues, and payments in two ways. First, the data are used to describe the impacts on generators and consumers from the perspective of the electric system only – that is, how much more or less do power plant owners get paid as a result of RGGI program investment effects? How much more or less do consumers pay for electricity as a result of RGGI program investment effects? How does that differ by state and region? How do these electric system impacts change with time? The impact on power plant owners and consumers associated with the RGGI program – which is focused on the electric sector only – is an important consideration in program design and effectiveness.

Additionally, we used the output data from MAPS as inputs to the IMPLAN model. From a macroeconomic perspective, the end result of changes in power system costs, revenues, and payments are (a) changes in economic conditions for power plant owners (affecting their ability to spend and

save in the general economy), and (b) changes in the level of disposable income enjoyed by consumers as a result of RGGI (e.g., relating to their having higher or lower electric bills), which affects their spending and saving in the general economy. Consequently, changes in these two factors serve as inputs to the general economic model (described below), along with other categories of RGGI program investment.

Macroeconomic Model

As previously noted, changes in power producer revenues and consumer incomes associated with electric system impacts lead to these larger direct and indirect impacts in the economy as a whole. Other economic impacts also need to be taken into account: those related to the actual direct spending of RGGI auction proceeds by government agencies (and in turn, indirectly by the recipients of the RGGI-funded grants). Additionally, these other impacts result from the multiplier effects of these changes in consumer income and producer revenues and from the purchases of goods and services in the economy by those who receive RGGI-related grants from the states.

Consequently, in order to model macroeconomic impacts, we combine the changed revenues and spending that come from the MAPS model with all categories of the direct investment of RGGI allowance revenues in the macroeconomic model, IMPLAN. The relationship between MAPS and IMPLAN, and the source of additional inputs to IMPLAN, are shown in Figure 7 (and explained in more detail in the Appendix).

IMPLAN is a social accounting/input-output model that attempts to replicate the structure and functioning of a specific economy, and is widely used in public and private sector economic impact analyses. It estimates the effects on a regional economy of a change in economic activity by using baseline information capturing the relationships among businesses and consumers in the economy based on historical economic survey data that track flows of money through the economy. IMPLAN tracks dollars spent in a region, including dollars that circulate within it (e.g., transfers of dollars from consumers to producers), dollars that flow into it (e.g., purchases of goods and services from outside the local economy), and dollars that flow outside of it (e.g., payments to the federal government). The model thus examines inflows, outflows, and interactions within the economy under study.

The IMPLAN model allows one to investigate interactions in the RGGI region and the individual states within it, and to calculate various economic impacts in that economy when a new activity (such as investments in energy efficiency, use of funds for government programs supported by the general fund, assistance in helping customers pay their energy bills, or lost revenues for owners of power plants) involves money flows around the economy. Specifically, the model captures various impacts, including:

- *Employment impacts* (the total number of jobs created or lost);
- *Income impacts* (the total change in income to employees that results from the economic activity); and
- *"Value-added" impacts* (the total economic value added to the economy, which reflects the gross economic output of the area less the cost of the inputs).

In our analysis, we report employment impacts but focus primarily on the "value-added" impacts produced by the model, reflecting the combination of the following economic effects of the change in money flow associated with RGGI:

- *Direct effects:* the initial set of inputs that are being introduced into the economy. In our study, this included the direct effects of RGGI on owners of power plants as a whole, on energy "consumers" (end users of electricity, natural gas and heating oil), and use of RGGI proceeds to buy goods and services in the economy (e.g., investment in energy efficiency, work training programs, contributions to the general fund, bill payment assistance for low-income consumers).
- *Indirect effects:* the new demand for local goods, services and jobs as a result of the new activity, such as the purchase of labor to retrofit buildings with energy efficient measures, or to train workers in these skills. Some RGGI auction proceeds lead to payments for things outside the local region (e.g., the purchase of efficient lighting equipment or solar panels manufactured outside of the RGGI region), and thus represents a way that such funds do not stay within the local economy after having been generated by power plant owners' purchases of CO_2 allowances.
- *Induced effects:* the increased spending of workers resulting from income earned from direct and indirect economic activity.

Modeling Factors

To calculate the impacts of RGGI, we needed to make a number of simplifying assumptions about the systems and economies that we are studying. These assumptions relate to: (1) the relevant (geographic, temporal) boundaries around the analysis, (2) the methods for putting dollar flows occurring during different time periods into a common economic framework; (3) key modeling parameters in the power system; and so forth. We highlight a few of these below.

Focus on the First Compliance Period

First, the analysis assumes neither pricing for carbon nor any additional RGGI-funded investments in energy efficiency or generation beyond the program's first compliance period. For modeling purposes alone, and in order to isolate the incremental effects of the first three years of RGGI, we made no assumptions about RGGI continuing beyond 2011. Further, we do not assume that there is a price on carbon through other regional, state, or federal legislation at any point during the modeling period (through 2021). Neither assumption should be interpreted as a judgment or expectation about the likelihood one way or the other of continued RGGI program implementation, or the emergence of a national carbon pricing regime. Constructing the analysis in this way limits the impact on power plant owner revenues and consumer savings associated with continued increases in energy efficiency and new carbon-free generation investments relative to what will actually result over time, should RGGI continue forward in some form in the region.

Discount Rate

Our analysis involves the assessment of costs (e.g., expenditures and investments, decreases in revenues) and benefits (e.g., lower electricity bills for consumers, added value in the economy) that

occur in different periods of time. We examine the flow of dollars associated with the purchase of CO_2 emissions allowances in 13 RGGI auctions that took place in Q3 2008 through Q3 2011, the impact of these allowances in electricity prices in 2009–2011, and the impact of RGGI-funded programs on electric system outcomes and the macroeconomy from 2009–2021. Thus, the study period, in one way or another, spans from 2008–2021.

To compare these benefits and costs properly, we discount all dollar flows into net present values as of 2011. We calculate the net present value by applying an appropriate discount rate to dollar flows in different years, and then subtracting the sum total of discounted costs from the sum total of discounted benefits.

Our analysis requires choosing an appropriate discount rate, one that must reflect the preferences for money today versus in the future for various constituencies – power producers, who are largely private enterprises, consumers (e.g., households, businesses, government energy users), and others. RGGI-funded activities add value to the macroeconomy of a wide range of actors in the Northeast and Mid-Atlantic region. Choice of appropriate discount rate needs to properly reflect the opportunity costs of these various private and public entities in society.

We have chosen to use two discount rates, as recommended in situations where an analysis involves money flows to various entities in society over different periods of time, especially when "there is a significant difference in the timing of costs and benefits, such as with policies that require large initial outlays or that have long delays before benefits are realized."[23] First, we calculate net present values using a "social" or public discount rate of 3 percent. Second, we also calculate net present values using the opportunity cost of capital to private entities (at 7 percent).[24] These choices are described in more detail in the Appendix.

In our results, we do not choose one or the other discount rate as being the one appropriate for review and interpretation of RGGI's economic impacts. Since the use of RGGI allowance proceeds has some characteristics that would suggest use of the public rate, yet others that would suggest use of the private rate, we present results using the public rate in the body of this report, while noting the private rate results and providing further details in the Appendix. Importantly, while the use of different rates affects the magnitude of impacts we found, in no case does the use of one rate over the other qualitatively change our findings.

Timing of Economic Impacts that Affect the Power Sector

The focus on actual expenditures and impacts in only the first three years of program implementation, in combination with the application of a social and private discount rate, ends up highlighting the fact that RGGI benefits lag behind RGGI costs. The costs show up in electric system impacts to consumers in the first three years of the program, with benefits flowing to them over the entire study period

[23] "Guidelines for Preparing Economic Analyses," U.S. Environmental Protection Agency, EPA 240-R-10-001, December 2010, page 6-5 (hereafter, "EPA Guidelines").
[24] EPA Guidelines, page 6-23.

(through 2021). Conversely, the benefits flow to owners of power plants early on, with outer-year effects diminishing those net positive revenues received in the first compliance period.

Indeed, there is a significant lag between the incurrence of costs in the "with RGGI" case and the timeframe in which installation of energy efficiency measures funded through RGGI allowance revenues begin to affect demand, supply, and prices in the outer years.

Representation of Energy Efficiency Programs

A significant percentage of RGGI allowance proceeds went to funding investments in energy efficiency programs across the RGGI states. Programs included auditing and benchmarking efforts, investments in retrofit measures for existing homes (e.g., window and door treatments, insulation); residential lighting and appliance change-out (replacing refrigerators, washers, dryers or air conditioners with more efficient ones); commercial building shell, lighting, and equipment replacement; and new building measures (e.g., funding for more efficient materials and appliances at the time of new construction).

Given these various uses of RGGI funds for EE, there are two major analytic challenges in the MAPS modeling effort: First, we needed to determine an assumed duration or lifetime for savings from particular measures (for example, for how long does installation of insulation continue to produce savings?). Second, we needed to develop a way to map annual energy and peak load savings onto estimates of impacts on load in every hour of the year.

In all of the RGGI states where EE programs are in place, there is substantial documentation of estimates of annual energy savings and, in some cases, contributions to reductions in peak loads. There is a long history of EE implementation and measurement and verification efforts to support engineering and statistical estimates of how the installation of a given EE measure actually translates into annual savings, distribution of savings across the hours of the year, and measure lifetimes. We relied on this literature to calculate the lifetime and load-impact characteristics of the various EE programs funded by RGGI dollars.

Where available, we reviewed on a program-by-program, measure-by-measure basis, the estimates of measure lives developed by states and utilities and currently used in programs, based on the past few decades' of experience in administering EE programs. We calculated weighted average measure life assumed by states and utilities across the range of measures, and found that virtually all programs have measure lives in excess of ten years; on average, measure lives were 12–13 years. In our modeling, we conservatively truncated measure savings at ten years.

In some areas of the RGGI region, states have estimated how EE-related savings break down on a seasonal basis (summer or winter) and on a daily basis (on- or off-peak). Based upon a review of these estimates where available, we developed representative distributions of savings across seasonal and daily categories, and assigned annual energy savings to a given distribution on a company-by-company and program-by-program (and in some cases, measure-by-measure) basis.

Using these characterizations of EE program impacts, we calculated hourly adjustments to load for each EE program, and in aggregate for all programs used these to adjust hourly load in the MAPS model.

4. RESULTS

Overview

Although the RGGI program was developed in response to concerns over the socioeconomic and environmental risks associated with climate change, our analysis focused exclusively on economic impacts of the program as a result of its first three years of operation. Thus, it sheds light only on economic issues, and does not address the many other objectives that underpinned the RGGI states' adoption of the program.[25]

By contrast with the approach used in many other allowance trading programs (such as ones developed under the Clean Air Act for SO_2 and NO_x emissions), the RGGI states decided to distribute virtually all of the CO_2 allowances through quarterly auctions, with auction revenues distributed to states in accordance with the RGGI state budget allocation.[26] Auctioning allowances and distributing allowance proceeds to states in this way had an important impact on program outcomes since it meant, in effect, that the public benefitted by transferring the value of allowances to market at market prices (rather than for free, as was done in the SO_2 and NO_x allowance programs). The decisions to distribute allowances in this manner reflected complex decisions by each state which allowed for the use of auction proceeds to pursue specific energy- and non-energy-related public policies there was an opportunity to both address some of the potential cost impacts of RGGI program implementation, and to pursue other key public policy objectives.

The first 13 RGGI auctions produced $912 million dollars. This sum includes just over $900 million from the auctioning of allowances, and just under $12 million from the direct sale of allowances to affected sources.[27] These allowances revenues were distributed to (or held by) states in the following amounts:

[25] The RGGI States' Memorandum of Understanding ("MOU") has a preamble that recognizes the common objectives of the states' own policies "to conserve, improve, and protect their natural resources and environment in order to enhance the health, safety, and welfare of their residents consistent with continued overall economic growth and to maintain a safe and reliable electric power supply system." Additionally, the MOU declares as common goal of the states of "reducing our dependence on imported fossil fuels will enhance the region's economy by augmenting the region's energy security and by retaining energy spending and investments in the region…" Additionally, the original RGGI MOU starts with the states' premises that: (1) climate change is occurring; (2) it poses serious potential risks to human health and the environment (including severe droughts and floods, changes in forests and fisheries, sea level rise); (3) delay in addressing greenhouse gas emissions will make later investments in mitigation and adaptation more difficult and costly; and (4) a market-based carbon allowance trading program will create strong incentives for the development of lower-emitting energy sources and energy efficiency, and reduce dependence on imported fossil fuels. RGGI States' Memorandum of Understanding, December 20, 2005, pp. 1-2.

[26] Where allowances were not distributed via auction, they were sold directly to affected sources, again retaining the value of the allowances sold for public purpose.

[27] This includes all revenues collected from allowance auctions and direct sales through the first 13 auctions. The fourteenth and final auction in the first compliance period is scheduled to happen on December 7, 2011, and so could not be accounted for in our analysis.

- $52 million for Connecticut
- $22 million for Delaware
- $27 million for Maine
- $170 million for Maryland
- $143 million for Massachusetts
- $33 million for New Hampshire
- $118 million for New Jersey
- $327 million for New York
- $14 million for Rhode Island
- $7 million for Vermont

See Figure 1 for proceeds received in each year by the ten states.

These dollars ended up having three types of economic impacts:

1. *Impact on the general economy.* This is the "bottom line" result of our analysis. These impacts include effects on overall economic value in the RGGI states from the following economic losses and gains:
    - the direct investment of RGGI allowance proceeds in various economic sectors (such as spending in government agencies, payments to individuals for training and educational initiatives, and direct payments to consumers of electricity, direct payments to builders and contractors installing energy efficiency measures or renewable systems); and
    - the *net* impact on power plant owner revenues and electricity consumer payments tied specifically to changes in the price of power and the quantity of power generated/consumed as a result of reinvesting dollars to reduce energy consumption or increase non-emitting generation.

    These economic "value added" impacts flow from both the direct effect of injecting RGGI dollars into various economic sectors, and the additional effects that flow from additional – or secondary – economic activity "induced" by the effects of direct injection of RGGI dollars.
2. *Impact on the electric sector.* These are observable impacts, which are part of the large impacts on the general economy noted above. Electric sector impacts include overall changes to power plant owner revenue streams (from increased costs for obtaining and using CO_2 allowances and changes in the price and quantity of power sales); and overall changes to payments by consumers for the purchase of electricity (from decreased consumption and changes in market prices).
3. *Other effects.* These include changes in employment and payments for fuel that flow from the impacts of the use of RGGI allowance revenues in the electric system and general economy.

Impacts

Our high-level results for each of the ten states, and for the RGGI region as a whole, are summarized in Table 2. This summary points out the bottom line: RGGI has produced positive economic outcomes for each state and for the region as a whole.

Table 2
Summary of Economic Impacts, by RGGI State and Region
Discounting Dollars Using a Social Discount Rate

	Value Added[1] (millions of $)	Employment[2]
Connecticut	$ 189	1,309
Maine	92	918
Massachusetts	498	3,791
New Hampshire	17	458
Rhode Island	69	567
Vermont	22	195
New England Subtotal	**$ 888**	**7,237**
New York	$ 326	4,620
New York Subtotal	**$ 326**	**4,620**
Delaware	$ 63	535
Maryland	127	1,370
New Jersey	151	1,772
RGGI States in PJM Subtotal	**$ 341**	**3,676**
Regional Impact[3]	$ 57	601
Grand Total	**$ 1,612**	**16,135**

Notes:
[1] Value Added reflects the actual economic value added to the state and regional economies, and therefore does not include the costs of goods purchased from or manufactured outside of the state or region.
[2] Employment represents job-years as outputted from IMPLAN.
[3] Regional Impact reflects the indirect and induced impacts resulting within the RGGI region as a result of state dollar impacts.
[4] Results are discounted to 2011 dollars using a 3% social discount rate.

The RGGI States Together

Impact on the General Economy

Overall, RGGI's first compliance period produced a net present value economic benefit of $1.6 billion, using a public discount rate.[28]

Generally speaking, this positive impact results from: the positive direct and induced impacts associated with the injection of RGGI dollars into economic goods and services; the net positive impacts associated with consumer savings on electric and non-electric energy supply expenditures; and the net negative impacts associated with a loss of power plant owner net revenues from allowance purchases and power

[28] Using a 7 percent private discount rate, the NPV benefit is $1.0 billion.

system dispatch and price effects (see below). The first two more than offset the latter, resulting in a net positive economic benefit.

Impact on the Electric Sector

From a consumer perspective, RGGI program impacts are net positive over the study period. Although CO_2 allowances tend to raise electricity prices in the near term,[29] there is also a lowering of prices over time because the states invested so much of the allowance proceeds on energy efficiency programs. RGGI expenditures on energy efficiency programs increase the opportunities for consumers to reduce their energy use and their energy bills. This occurs primarily for electricity, but also for fuel consumed for heating. Lower overall electric load levels resulting from RGGI-funded energy efficiency places downward pressure on electricity prices and energy payments for all electricity consumers, relative to a no-RGGI case. After the early impacts of small electricity price increases, consumers gain because their overall electricity bills go down as a result of this investment in energy efficiency. All told, electricity consumers overall – households, businesses, government users, and others – enjoy a net gain of nearly $1.1 billion, as their overall electric bills drop over time.[30]

This reflects average savings of approximately $25 for residential consumers, $181 for commercial consumers, and $2,493 for industrial consumers over the study period. Consumers who participate in an energy efficiency program funded by RGGI proceeds actually experience a level of savings much higher than the average savings for all consumers.

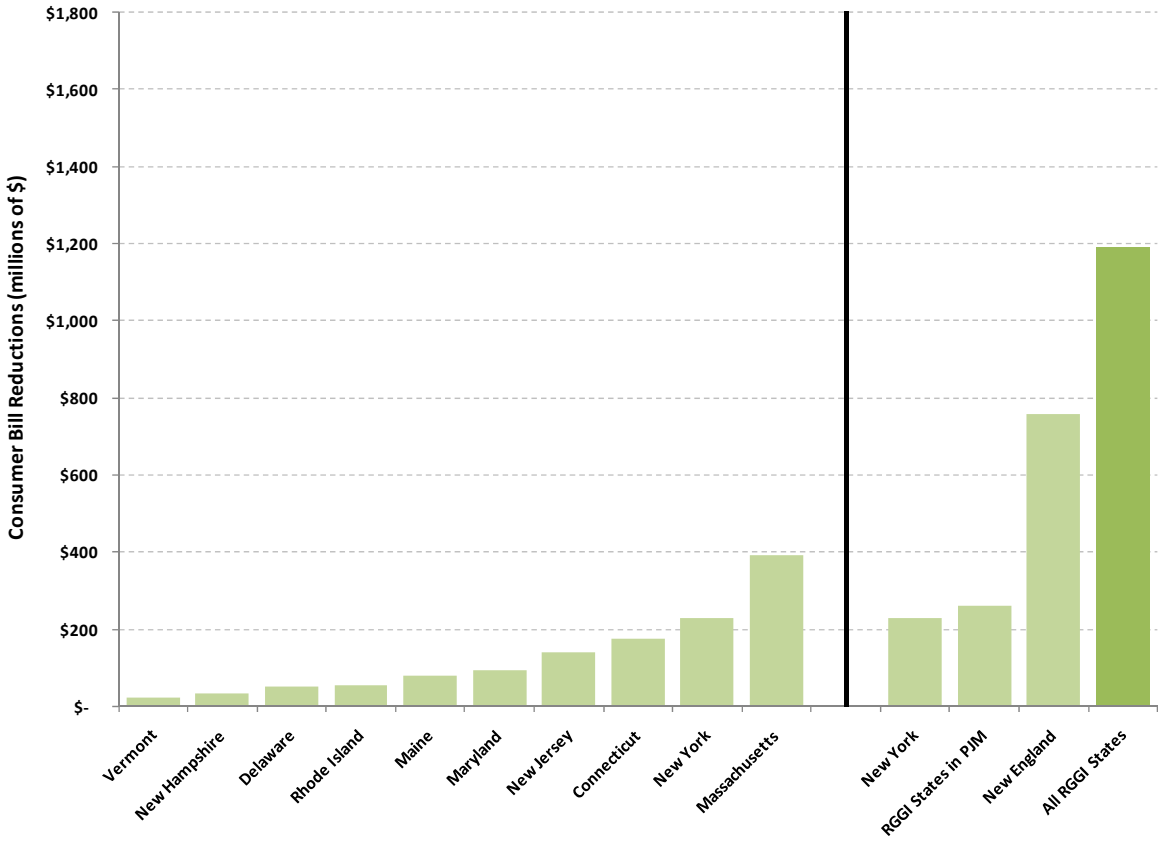
Note, that due to the energy efficiency programs supported by RGGI funds, energy consumers also save nearly $174 million through RGGI programs focused on reducing consumption of oil and natural gas heat homes; these savings are above and beyond those experienced in the electric system.

Figure 10 summarizes the overall gains to consumers by state and region, including bill savings in electricity, gas, and oil markets.

[29] During the 2009–2011 period, we estimate that RGGI increased consumers' overall payments for electricity by 0.7 percent; over the long run, however, investment of RGGI proceeds, which states used to support a variety of economic activity (of which approximately 48 percent went to support energy efficiency programs) lead to net savings in electricity bills to all consumers in all states, relative to an electric system that did not include RGGI for the 2009–2011 period.

[30] Under a 7 percent private discount rate, gains to electricity consumers overall are nearly $600 million.

Figure 10
Consumer Bill Reductions by State and Region (2011$)



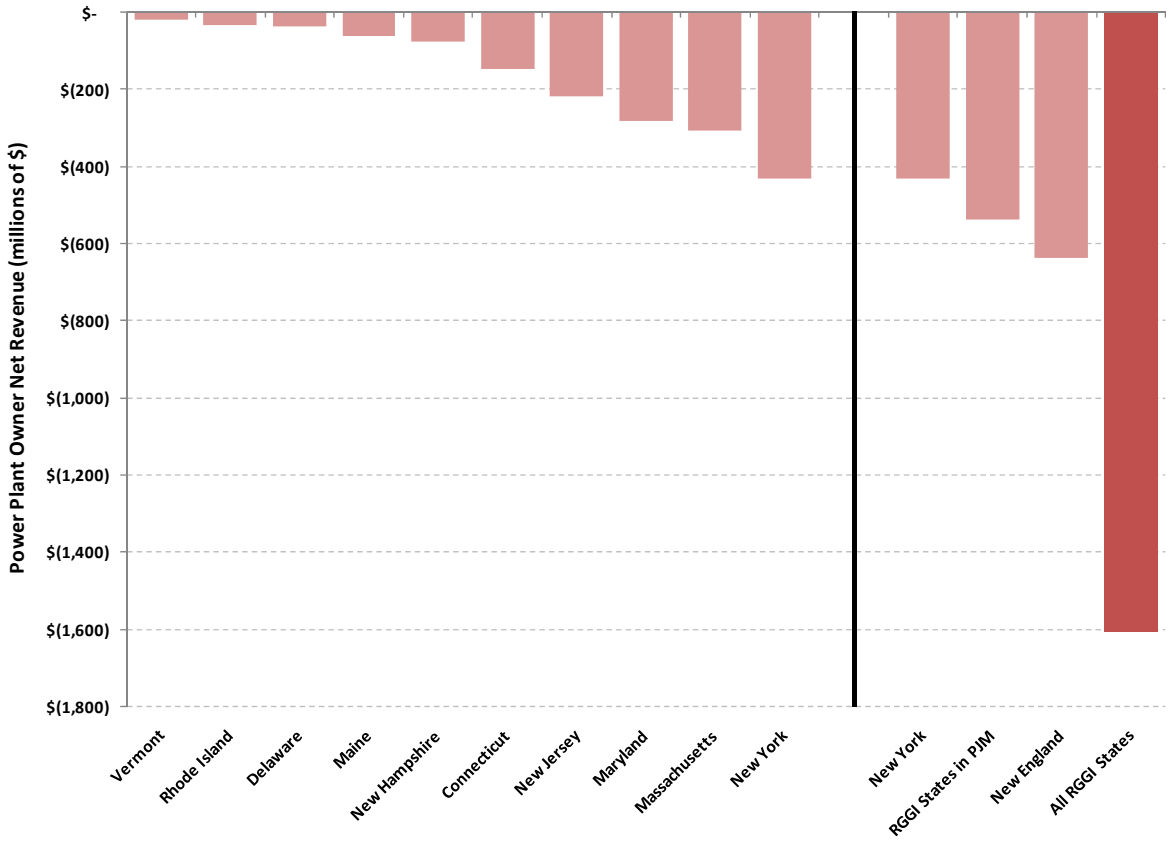
Notes: Figures include GE MAPS outputs, non-electric benefit calculations, and capacity market gain calculations.
Figures represent dollars discounted to 2011 using a 3% public discount rate.

From the perspective of the power generation sector, the RGGI program leads to an overall drop (on an NPV basis) in electric market revenues, amounting to approximately $1.6 billion.[31] Although power plant owners have to purchase CO_2 allowances, they recover all of their early expenditures during the 2009–2011 period; in the long run, however, RGGI-driven energy efficiency leads to lower sales of electricity which ends up eroding power plant owners' electric market revenues. The net impact to electric power plant owners is summarized by state and region in Figure 11. However, these impacts are not distributed equally across power plant owners; RGGI affords a competitive advantage to power plants with lower CO_2 emissions.

Combining the power plant owner and consumer changes, net electric market impacts are negative for the RGGI region as a whole, amounting to a net loss of slightly over $500 million.[32]

[31] Under a 7 percent private discount rate, the net decrease in revenues for power plant owners is $1.3 billion.
[32] Under a 7 percent private discount rate, net electric market impacts are a net loss of just under $720 billion.

Figure 11
Net Revenue Change for Power Plant Owners (2011$)



Notes: Figures include GE MAPS outputs, allowance true-up calculations, and capacity market loss calculations.
Figures represent dollars discounted to 2011 using a 3% public discount rate.

Non-Dollar Impacts

In addition to an economic benefit, the use of RGGI proceeds results in a positive employment impact through an increase of approximately 16,000 new job-years, and reduced payments to out-of-region providers of fossil fuels by just over $765 million.[33]

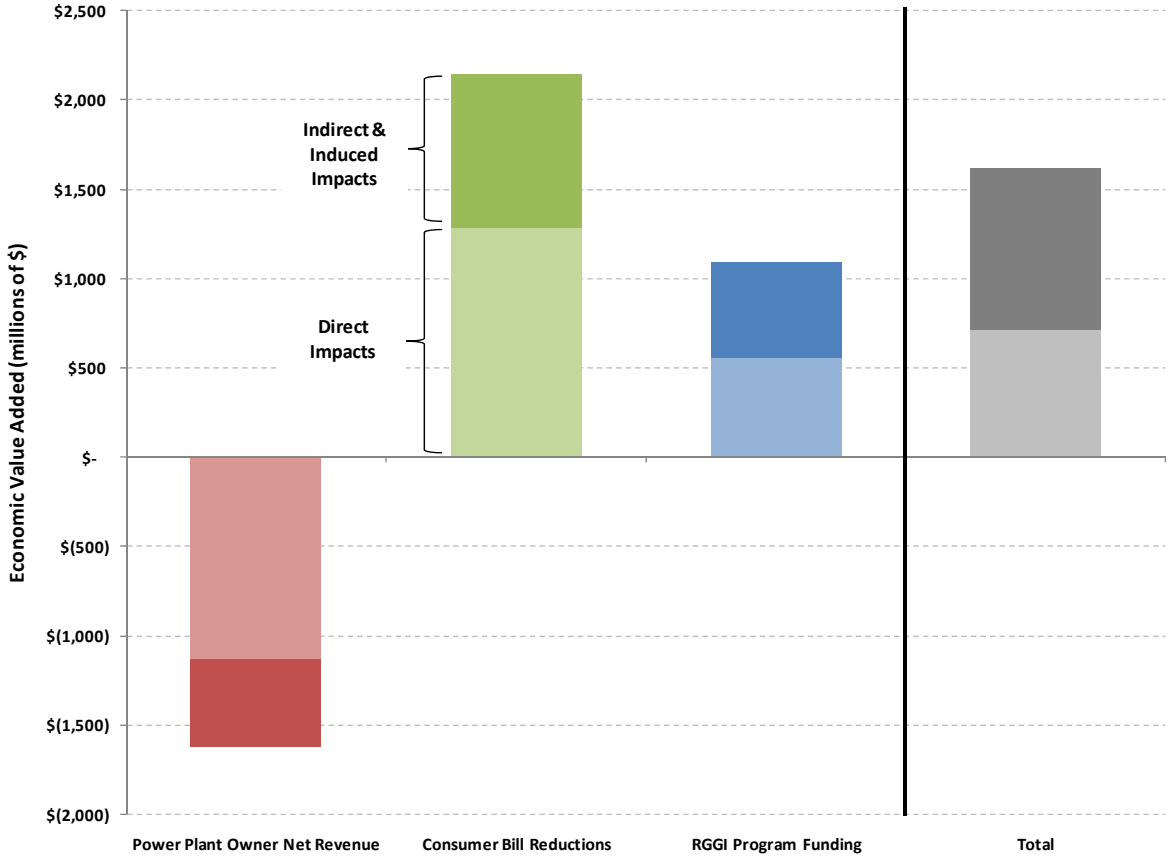
Overall Impact

Overall, RGGI's first compliance period produced a net present value economic benefit of $1.6 billion, using a public discount rate.[34] As previously mentioned, this includes electric sector impacts to consumers and power plant owners, in addition to the non-electric benefits and program spending that result from state spending of RGGI proceeds. As these individual impacts ripple through the economy,

[33] Under a 7 percent private discount rate, fossil fuel payments to out-of-region providers decreased by slightly over $755 million.
[34] Using a 7 percent private discount rate, the NPV benefit is $1.0 billion.

they have the net effect of producing positive economic value. This can be seen in Figure 12, which shows the direct, indirect, and induced economic impacts to the ten-state region from the individual components described above.

Figure 12
Net Economic Impacts for the Ten State RGGI Region

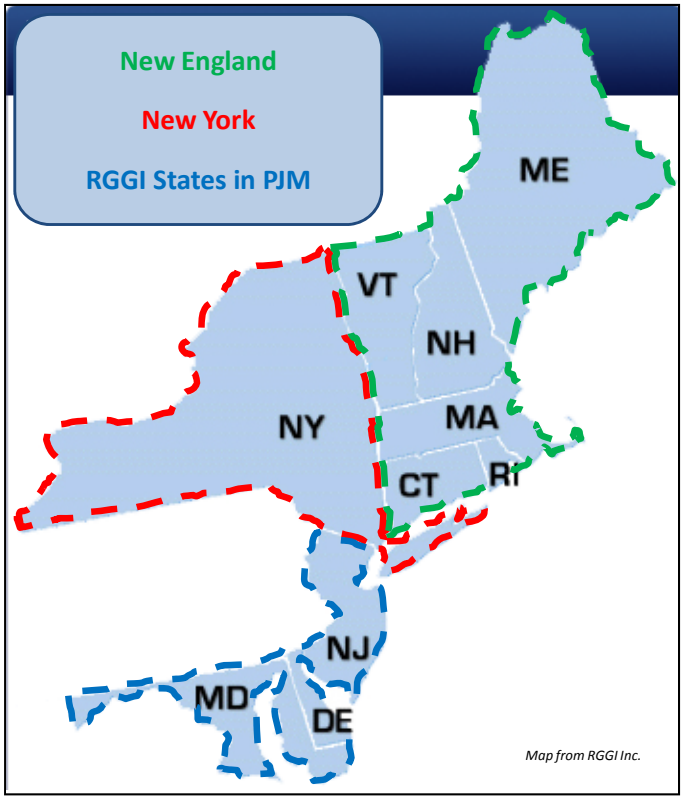


Notes: Figures represent dollars discounted to 2011 using a 3% public discount rate.

Regional Differences

Because the ten RGGI states fall into three electrical regions, each with a common electric market, we also analyzed the impacts of RGGI on a regional basis. The three electric regions are: the New England states (with a market operated by ISO-NE); New York (with a market administered by NYISO); and Delaware, Maryland, and New Jersey (all part of the larger regional market administered by PJM). Figure 13 highlights the RGGI states included in each region.

Figure 13
RGGI States by Region



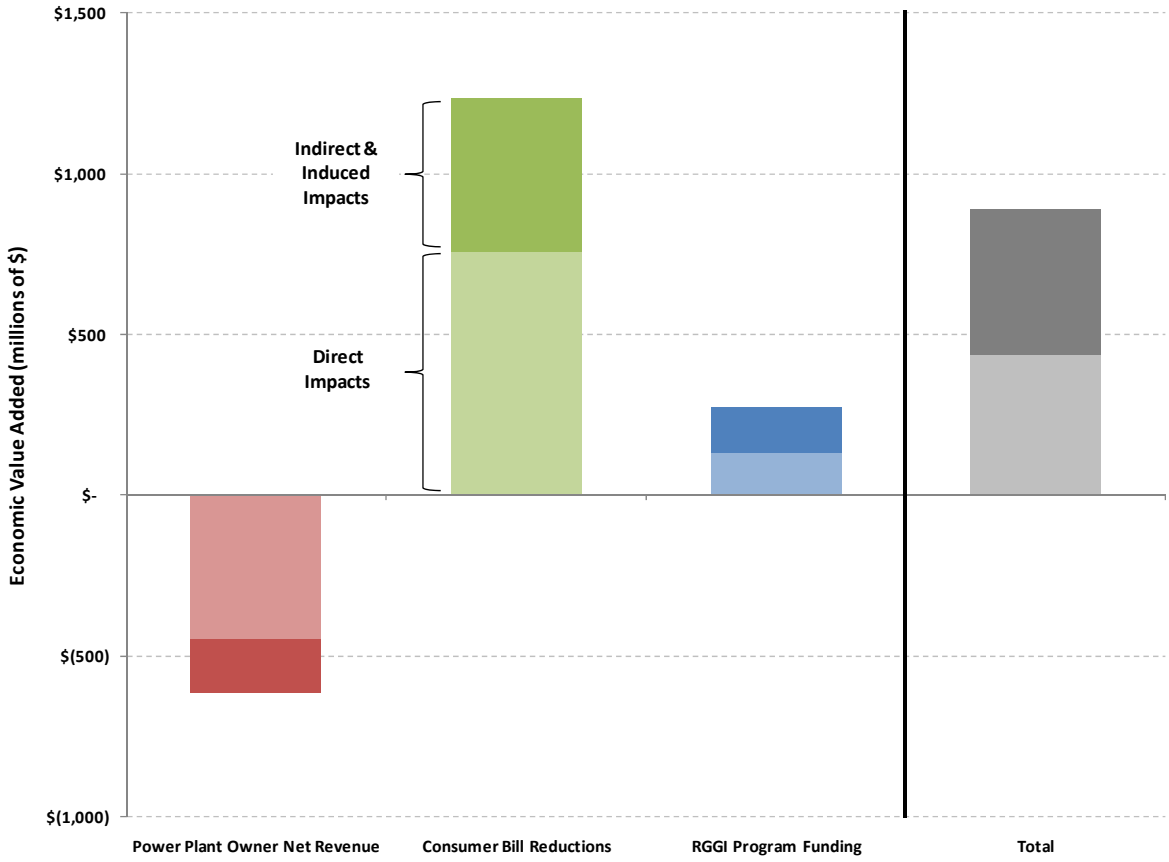
Every region experienced net positive macroeconomic effects. Even so, there are significant variations in both the overall level of impact and the magnitude of impact within each category, in each region.

Of the three regions, only in New England do the savings to electricity consumers outweigh the reduction in revenues by power generators. This is due to a combination of factors – most notably the much-higher level of investment in energy efficiency with RGGI allowance proceeds than the other regions. On the other hand, the higher level of direct spending on government funding and direct bill assistance in the New York and PJM RGGI states leads to relatively higher levels of economic return in the form of direct, indirect and induced macroeconomic impacts.

New England

In New England, the overall macroeconomic impacts are large: almost $900 million to the six-state region.[35] These effects include net positive electric sector impacts (see above) and the net positive impacts of direct spending on programs, rebates, administrative obligations, and government programs. See Figure 14.

Figure 14
Net Economic Impacts for the States in New England (2011$)



Notes: Figures represent dollars discounted to 2011 using a 3% public discount rate.

As shown, net negative impacts to power producers[36] are offset by net positive impacts on consumer spending for electric and non-electric energy services.[37] Although the net electricity price increases to

[35] Under a 7 percent private discount rate, net economic impacts in New England are just over $675 million.

[36] From the perspective of New England's power generation sector, RGGI program compliance during the first compliance period decreased supplier revenues on a net present value basis by approximately $640 million. These reductions come in the form of costs incurred to purchase allowance that exceeded the recovery of such costs in wholesale markets, an overall reduced level of revenue due to the combination of lower overall load levels (due to energy efficiency investments) and lower prices for power sold, and reduced capacity market revenues.

New England consumers from 2009–2011 were relatively small (0.6 percent), the long-term gains more than offset these initial increases in electricity bills and also offset the net revenue losses to power producers. These combine with the direct and induced impacts associated with the injection of RGGI dollars into the purchase of economic goods and services with positive multiplier effects on the New England economy.

Additionally, RGGI proceeds end up producing positive employment impacts, amounting to an increase of approximately 7,200 new job-years in New England, and reduced payments to out-of-region providers of fossil fuels of approximately $210 million.[38]

New York

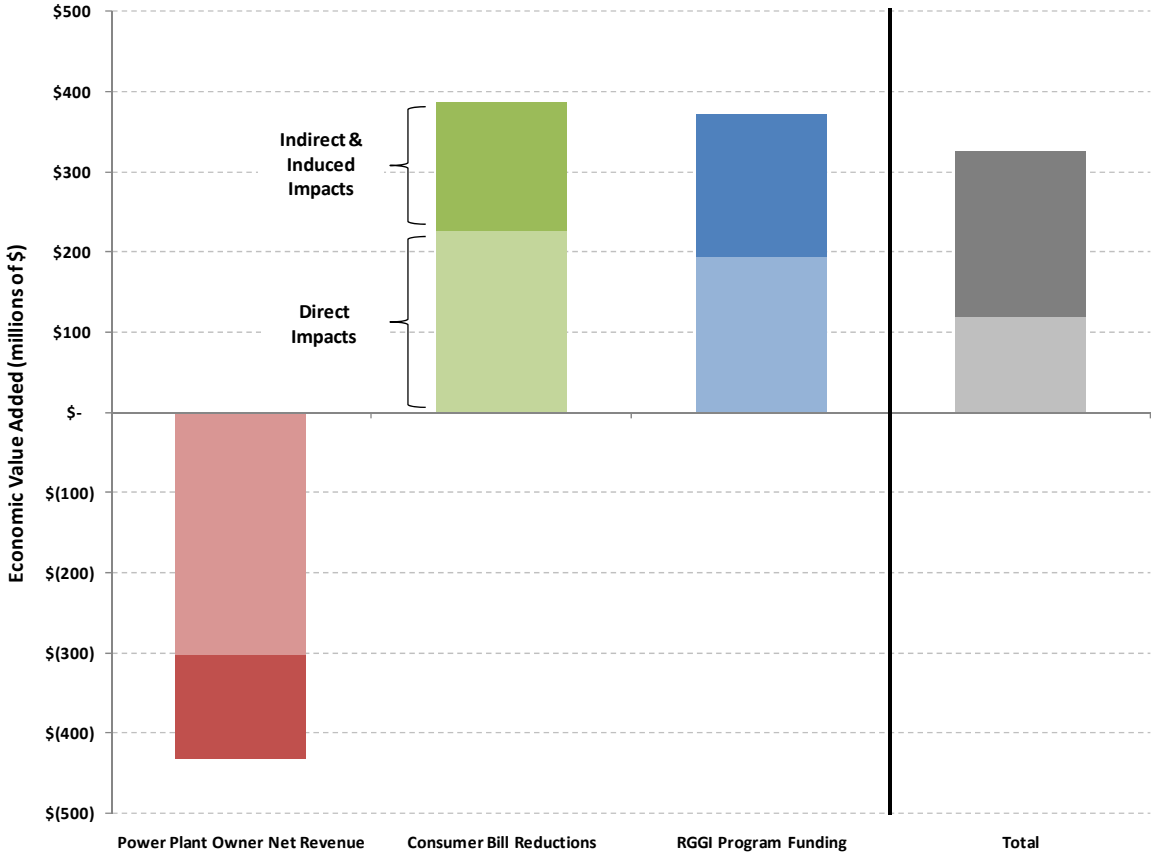
RGGI also resulted in positive economic value to the New York economy, amounting to $325 million.[39] The positive gains from recirculating RGGI funds through the economic offset the net negative impacts experienced in the electric sector. The overall result and the pieces contributing to it are presented in Figure 15.

[37] From the perspective of the New England residential and business energy consumer, the impact of the reduced consumption and price impacts on electricity consumers is a net present value benefit of approximately $720 million across the region. Consumers that participate in an energy efficiency program funded by RGGI proceeds would experience a level of savings much higher than the average savings for all consumers. In addition, consumers save approximately $38 million through RGGI programs focused on reducing consumption of oil and natural gas to heat homes in New England.

[38] Under a 7 percent private discount rate, fossil fuel payments to out-of-region providers decrease by approximately $195 million in New England.

[39] Under a 7 percent private discount rate, net economic impacts in New York are approximately $125 million.

Figure 15
Net Economic Impacts for New York (2011$)



Notes: Figures represent dollars discounted to 2011 using a 3% public discount rate.

Although the net electricity price increases to New York consumers from 2009–2011 were relatively small (0.8 percent), because New York spent much of its RGGI funds outside the electric sector, the positive gains fell outside of the electric market impacts. (New York spent a large amount of RGGI funds for general fund purposes, in addition to supporting energy efficiency programs.) While electricity consumers enjoyed over time additional bill savings through reduced electricity purchases,[40] these savings did not offset the net present value of revenue loss experienced by power plant owners over the modeling period.[41]

[40] From the perspective of the New York residential and business energy consumer, the impact of the reduced consumption and price impacts on electricity consumers is a net present value benefit of approximately $145 million across the region. Consumers that participate in an energy efficiency program funded by RGGI proceeds would experience a level of savings much higher than the average savings for all consumers. In addition, consumers save approximately $85 million through RGGI programs focused on reducing consumption of oil and natural gas to heat homes in New York.

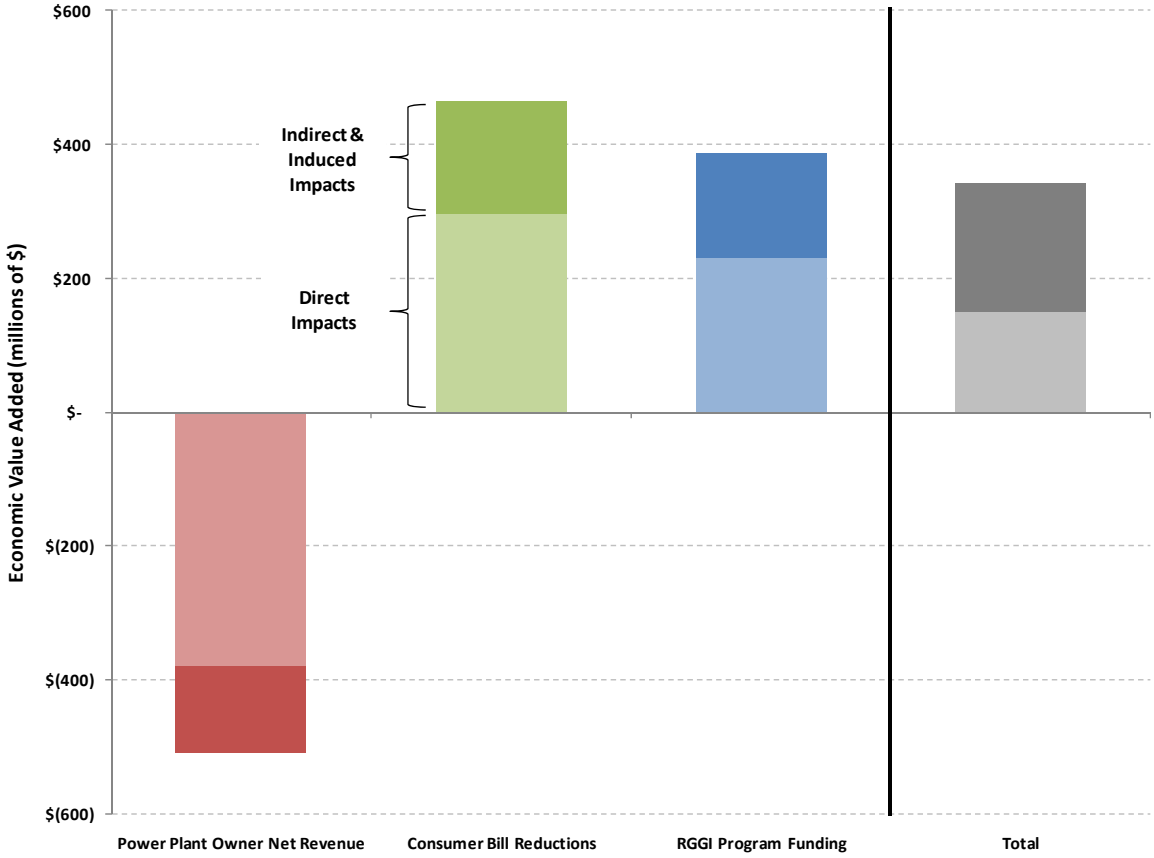
[41] From the perspective of New York's power generation sector, RGGI program compliance during the first compliance period decreased supplier revenues on a net present value basis by approximately $430 million. These reductions come in the form of costs incurred to purchase allowance that exceeded the recovery of such costs in wholesale markets, an overall reduced level of revenue due to the combination of lower overall load levels (due to energy efficiency investments) and lower prices for power sold, and reduced capacity market revenues.

In addition to an economic benefit, RGGI proceeds led to programs producing approximately 4,600 job-years in the region, and reduced payments to out-of-region providers of fossil fuels by approximately $120 million.[42]

RGGI States in PJM

The overall impact of RGGI on the economies of the PJM states (Delaware, Maryland, and New Jersey) was also positive, with $341 million in added value to these three states.[43] These impacts reflect the combined effects on the electric sector and the use of RGGI allowance proceeds on programs, rebates, administrative obligations, and government functions. The overall result and the pieces contributing to it are presented in Figure 16.

Figure 16
Net Economic Impacts for the RGGI States in PJM (2011$)



Notes: Figures represent dollars discounted to 2011 using a 3% public discount rate.

[42] Under a 7 percent private discount rate, fossil fuel payments to out-of-region providers decrease by approximately $115 million in New York.
[43] Under a 7 percent private discount rate, net economic impacts in Delaware, Maryland, and New Jersey are approximately $180 million.

Consumers experienced longer term savings in electricity[44] and energy bills that offset the minor increases (0.7 percent) in electricity bills during 2009–2011. These savings were not large enough to fully offset the net revenue losses to power plant owners.[45] Even so, the overall macroeconomic impacts of RGGI-funded program expenditures did offset the revenue losses to producers.

Additionally, RGGI-funded programs resulted in a positive employment impact amounting to approximately 3,700 job-years in the region. RGGI also reduced payments to out-of-region providers of fossil fuels by approximately $435 million.[46]

Observations

These outcomes suggest a number of themes about the RGGI experience to date. Some are important for providing the RGGI states with information about how the policy is performing relative to some (but not all) of its original goals. The observations are also relevant to other states and national policy makers if and when they decide to adopt a CO_2 control program.

Mandatory, Market-Based Carbon Control Mechanisms are Functioning Properly and Can Deliver Positive Economic Benefits

Based on the initial three years of experience from the nation's first mandatory carbon control program, market-based programs are providing positive economic impacts while meeting emission objectives. The pricing of carbon in Northeast and Mid-Atlantic electricity markets has been seamless from an operational point of view, and successful from an economic perspective.

Our review of the first three-year compliance period from the first market-based carbon control program in the country found positive economic impacts. This result holds whether or not one believes there are other reasons for or benefits from carbon control (e.g., addressing climate change risks). The economic impacts we studied flow from the revenues generated from the sale of allowances, and how those revenues were redistributed in the economies of the RGGI states.

The use of RGGI allowance revenues has produced positive economic impacts while administration of the RGGI program has proceeded smoothly. Thirteen auctions have been held, and the auctions resulted in the distribution of the majority of available allowances. Allowances have been traded in the secondary market throughout the first compliance period, and the market monitor has found no evidence of market power in the RGGI auctions or the secondary market. Allowance revenues were quickly and efficiently distributed to states, and states have disbursed nearly all of the allowance revenues for various uses. The

[44] From the perspective of the PJM RGGI states' residential and business energy consumer, the impact of the reduced consumption and price impacts on electricity consumers is a net present value benefit of approximately $235 million across the region. Consumers that participate in an energy efficiency program funded by RGGI proceeds would experience a level of savings much higher than the average savings for all consumers. In addition, consumers save approximately $50 million through RGGI programs focused on reducing consumption of oil and natural gas to heat homes in the PJM RGGI states.

[45] From the perspective of the power generation sector in the PJM RGGI states, RGGI program compliance during the first compliance period decreased supplier revenues on a net present value basis by approximately $540 million. These reductions come in the form of costs incurred to purchase allowance that exceeded the recovery of such costs in wholesale markets, an overall reduced level of revenue due to the combination of lower overall load levels (due to energy efficiency investments) and lower prices for power sold, and reduced capacity market revenues.

[46] Under a 7 percent private discount rate, fossil fuel payments to out-of-region providers decrease by approximately $450 million in Delaware, Maryland, and New Jersey.

carbon cap established by RGGI has been met (in part because of stagnant economic conditions).[47] RGGI, Inc. and the states have effectively tracked the use of allowance proceeds, and states continue to work cooperatively towards evolution of the program.

In short, based on a review of RGGI's first three years, it would seem that the design, administration, and implementation of a market-based carbon control mechanism can be an effective way to control carbon emissions, while potentially providing additional economic and policy benefits.

The States Have Used CO_2 Allowance Proceeds Creatively – Supporting Diverse Policy and Economic Outcomes

The states' use of allowance proceeds not only provides economic benefits, but also has helped them meet a wide variety of social, fiscal, and environmental policy goals, such as addressing state and municipal budget challenges, assisting low-income customers, achieving advanced energy policy goals, and restoring wetlands, among other things. While they started RGGI to address the impacts of climate change, they used auction proceeds to advance a wide variety of public policy interests of the states beyond mitigation of climate change risks, while achieving this economic benefit.

While we focus solely on economic benefit, we know that state interests legitimately go beyond this. We do not mean to suggest or imply that states should necessarily focus exclusively on economic impacts when deciding the proper use of allowance proceeds within a state's economic, environmental, and financial context. In fact, the evidence indicates that states have allocated RGGI funds to advance a number of different public policy objectives. For example, while the use of proceeds to provide rate relief for low-income customers may have a smaller multiplier effect in the economy than investments in energy efficiency, it supports an important public policy objective to assist customers that face default or increasing bill arrearages, and whose expenses for energy services are generally a disproportionate percentage of household expenses relative to non-low-income customers. Similarly, the retention of proceeds in the General Fund of a given state may help preserve critical

Case Studies:

- Supporting home energy improvements and "PACE" financing in VT
- Educating CT teachers and students on energy strategies
- Plugging budget shortfalls in NY, NJ, NH
- Assisting low-income customers in MD
- Modernizing energy-using equipment at ME paper mill
- Educating RI low-income customers on ways to save energy
- Providing seed-funding for new revolving load program for NH businesses
- Supporting new solar projects at colleges in NY & NJ
- Enabling efficiency actions to assist a MA town become a "green community"
- Helping operators at DE's ports reduce GHG through new motors and lamps

[47] RGGI, Inc. has reported that between 2008 and 2009, electric generation from RGGI-affected electric generation sources decreased by 17.9 million MWh, or 9.1 percent. During that same time period CO_2 emissions from RGGI electric generation sources decreased by 27.6 million short tons, or 18.4 percent. "CO_2 Emissions from Electricity Generation and Imports in the 10-State Regional Greenhouse Gas Initiative: 2009 Monitoring Report," RGGI, Inc., September 14, 2011.

state agency programs and services that otherwise would have to be reduced or eliminated in the face of budget challenges.

Finally, a common theme across many states is the use of RGGI proceeds as seed investments to communities or companies for the installation of renewable energy projects, in order to promote development of advanced energy sources and provide support for municipalities and businesses. These investments meet multiple policy objectives not necessarily or completely captured in a straight-up economic impact analysis. Consequently, by focusing on differences among allocation methods from the perspective of economic impacts only, we do not mean to suggest that that should be the only basis for determining the best use of RGGI allowance proceeds.

RGGI Reduces the Region's Payments for Out-of-State Fossil Fuels

RGGI helped lower the total dollars these states sent outside their region in the form of payments for fuel. The generating capacity mix in New England, New York, and the PJM RGGI states includes nuclear, hydro, and renewable resources in addition to the fossil-fueled resources that are subject to the requirements of RGGI. Note, in each of these regions, generation from the combined coal, oil, and natural gas fleets dominates the resource mix. However, nearly all of the fossil fuels that power these resources come from outside the RGGI states. This means that each year a significant portion of payments to power producers leaves the region in the form of payments for fuel coming from the U.S. Gulf, other coal-producing regions, Canada, or overseas.

Implementation of RGGI and the use of RGGI proceeds for energy efficiency and new renewable power production, through reducing generation and shifting the generation mix towards non-fossil resources (compared to the "without RGGI" case), reduces the flow of dollars that essentially pay for fossil fuels used in power production in the RGGI states.

The Design of the CO_2 Market in the RGGI States Affected the Size, Character, and Distribution of Public Benefits

The joint decision by the RGGI states to make their CO_2 allowances available to the market through a unified auction ended up generating substantial revenues for public use. This approach transferred emissions rights from the public sector to the private sector at a monetary cost (rather than transferring them for free). Had these allowances been given away for free, the states would not have had the benefit of the auction proceeds and instead would have transferred that economic value to owners of power plants (which, in the RGGI region, are merchant generators, not owned by electric distribution utilities). In the end, the cap level, the design of the auction mechanism, and the depressed economy meant that meeting the RGGI cap was not challenging, and CO_2 allowance prices decreased over time. This made it harder for power plant owners to recoup investment in purchasing allowances, and has reduced the funding available for public investment.

Notably, for a power plant owner, the value of an allowance – once in hand – is the same whether that allowance was received for free or purchased via auction. That is, the plant operator faces the same economic decision to price his/her power to recover the opportunity cost of the allowance, whether that owner bought or was given an allowance. Either way, the cost of generating power and emitting a ton of CO_2 is equal to the price of an allowance, either by needing to purchase it, or by losing the opportunity to sell it. However, how the allowances are distributed *does* affect who captures the initial value of the

emission rights that allowances under a cap represents, and what the ultimate economic and policy impact of the program will be.

Previous market-based emission control programs for NO_x and SO_2 have distributed allowances for free to the affected sources through formulas tied to historical heat input, emissions, or electrical output. This form of allowance allocation transfers the value of the allowance to the plant owner. In contrast, the joint decision by the RGGI states to make their allowances available to the market through a unified auction administered on behalf of the states retained the value of emission rights for the benefit of public use. Over the course of the auctions held during the first compliance period, this generated substantial revenues for use by state governments to meet public policy objectives. The use of these revenues, in turn, substantially influenced the fact that RGGI program implementation over the first compliance period lead to net economic benefits and a wide array of ancillary public policy achievements.

In the end, the cap level, the design of the auction mechanism, and the sinking economy meant that meeting the RGGI cap was less challenging than it otherwise might have been over these three years, and allowance prices and revenues have decreased over time. While this may have reduced the overall magnitude of benefits achieved, it does not change the fact that the decision on whether to auction or allocate for free the allowances under a market-based allowance trading program was a key decision point affecting the relative economic and policy impact of the RGGI program over the first three years.

How Allowance Proceeds Are Used Affects Their Economic Impacts

The RGGI MOU fully anticipates – if not encourages – states to place different weights on economic, environmental, social, energy security, and other goals as they implement the program. The states have used their RGGI dollars very differently, in ways that affect the net benefits within the electric sector and in the larger state economy. While all states originally committed to using at least 25 percent of auction proceeds for "public benefit or strategic energy" purposes,[48] some states contributed a much larger amount to those ends.

But from a strictly economic perspective, some uses of proceeds clearly deliver economic returns more readily and substantially than others. For example, RGGI-funded expenditures on energy efficiency depress regional electrical demand, power prices, and consumer payments for electricity. This benefits all consumers through downward pressure on wholesale prices, even as it particularly benefits those consumers that actually take advantage of such programs, implement energy efficiency measures, and lower both their overall energy use and monthly energy bills. These savings stay in the pockets of electricity users directly. But there are also positive macroeconomic impacts as well: the lower energy costs flow through the economy as collateral reductions in natural gas and oil in buildings and increased consumer disposable income (from fewer dollars spent on energy bills), lower payments to out-of-state energy suppliers, and increased local spending or savings. Consequently, there are multiple ways that investments in energy efficiency lead to positive economic impacts; this reinvestment thus stands out as

[48] The RGGI MOU states that "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."

the most economically beneficial use of RGGI dollars. Other uses also provide macroeconomic benefits, even if they do not show up in the consumers' pockets in the form of lower energy bills.

RGGI Produced New Jobs

Taking into account consumer gains, power plant owners' losses, and net positive economic impacts, RGGI led to overall job increases. Some may be permanent jobs; others may be part-time or temporary. But the net effect is that, according to our analysis, the first three years of RGGI will lead to over 16,000 new job-years, with each of the ten states showing net job additions.

In the context of the entire workforce in the ten-state RGGI region, 16,000 new job-years is small (about one tenth of one percent of the total employment in September 2011). But considering the fact that the ten states' civilian labor force dropped by 73,400 from September 2010 to September 2011 (from 25,165,100 to 25,091,700), the jobs produced by RGGI spending (or, conversely, the absence of thousands of additional jobs, had RGGI not been in place) is significant.[49]

Jobs related to RGGI activities are located around the economy, with examples including engineers who perform efficiency audits; workers who install energy efficiency measures in commercial buildings; staff performing teacher training on energy issues; the workers in state-funded programs that might have been cut had a state not used RGGI funds to close budget gaps.

Timing Differences in Program Costs Versus Benefits Affects Results

Costs associated with RGGI program implementation in the first compliance period were incurred by power generators – and to the extent possible passed on to consumers as incurred – during the years 2009–2011. Yet, positive economic impacts associated with the distribution and spending of allowance proceeds can lag these incurred costs by a year or more in many states. This is in part due simply to the time it takes to collect auction and allowance sale revenues, transfer them to states, distribute them to disbursement agencies, disburse the funds, make investments, and put the resulting resources, measures, or installations into service. Differences in lag times among the states affect results in a non-trivial way.

In addition, while the costs are incurred and passed on immediately, many of the economic impacts are stretched out over a relatively long period. For example, energy efficiency measures installed using RGGI allowance proceeds produce consumer savings, on average, for over 10 years; new renewable resources put into operation using RGGI proceeds continue to produce power for decades.[50]

Because the estimation of economic impacts over time involves discounting costs and benefits that occur in different timeframes, lags, or delays in program administration and installations tend to diminish the estimated net present value economic impact of RGGI proceed investment. Deliberate efforts by states to re-circulate RGGI allowance revenues back into the economy as quickly as possible could reduce the lag effects and increase the economic returns of the RGGI programs.

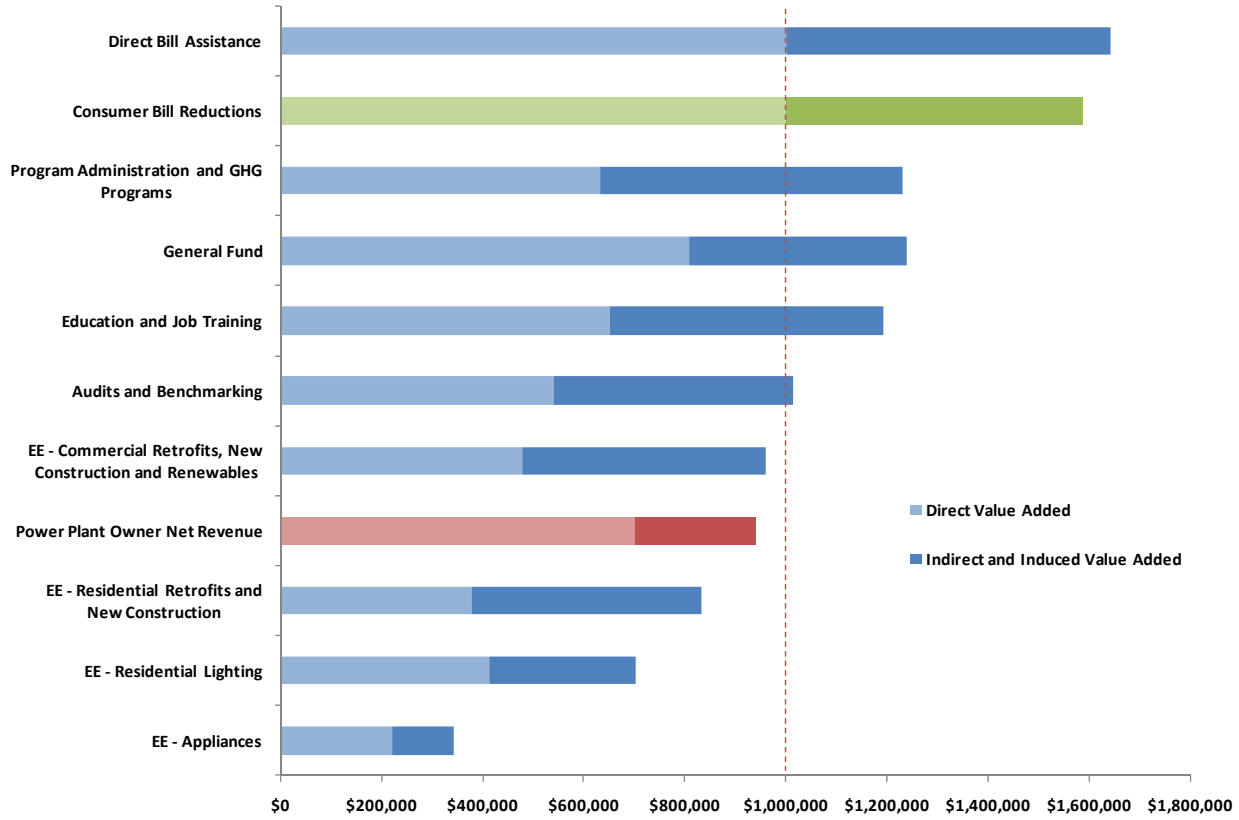
[49] Bureau of Labor Statistics, http://www.bls.gov/news.release/pdf/laus.pdf.
[50] As explained in more detail earlier, we truncate our economic analysis of program investments at ten years.

Value Added in the Economy for State Funding, Bill Reductions, and Education Strongly Outweigh the Direct and Induced Effects of Power Generator Revenue Loss

RGGI's impacts stretched in various corners of the economy. RGGI funds were spent on economic activities affecting the electric sector, other energy uses (e.g., natural gas and heating oil), support for low-income residents to meet their energy bills, educational activities, and general fund support. The positive economic multipliers associated with these expenditures contributed to net positive effects of the program for the RGGI states. These gains are larger than the direct impacts on the electric sector, where there were net positive consumer impacts but net revenue losses to power plant owners, from an NPV point of view.

Given the complex relationships within economies, the multiplier effects of the economic gains ends up having larger impacts that those attributable to power plant owners' revenue losses. For example, in the power generation sector, each $1 million of revenue loss leads to negative impacts on the economy – in the form of direct and induced effects – of approximately the same $1 million. By contrast, $1 million of added contribution to the general fund leads to positive impacts on the economy of approximately $1.2 million; $1 million going to directly reduce consumer electricity bills or into energy education programs generates positive economic impacts of approximately $1.6 and $1.2 million, respectively (see Figure 17). The relative magnitude of these economic multipliers strongly influences the overall positive economic impact of RGGI implementation in the first compliance period.

Figure 17
Average Multiplier Effects for RGGI Program Spending Categories



Note: Each bar represents the average value added to the ten RGGI states' economies as a result of spending $1 million in each of the areas that RGGI money is allocated in the states.

A Region's Pre-Existing Generating Mix Affects Economic Impacts

Since power generation resources have different CO_2 emission impacts – with coal-fired generation having higher combustion-related CO_2 emissions than other electricity generating resources – the amount of coal in a particular state's generating mix affects the costs of the RGGI program. Even so, every state experiences net positive benefits from RGGI, including in the more coal-heavy region (i.e., in the PJM states (New Jersey, Delaware, and Maryland)).

RGGI's First 3 Years of Program Investments Point to Some Best Practices

Based on our review of state program investments, it is clear that some states' practices can serve as best practices for others. First, speeding up the timing of when RGGI auction proceeds are used reduces the lag between CO_2 costs showing up in electricity prices and the time when benefits begin to flow to the region. Second, re-circulating RGGI auction proceeds back into the economy in the form of energy efficiency programs can dramatically increase the value of the RGGI program for electricity consumers and for the larger economy.

Finally, standardizing the collection, measurement and verification of data on RGGI dollar flows could significantly improve the ability to quickly translate program lessons into improved program design. Our economic impact analysis involved significant effort to collect, organize, and process the data on how states disburse and spend RGGI allowance revenues and on the character of program impacts on various recipients in the larger economy. The states and RGGI, Inc. have done a good job tracking expenditures and identifying or estimating program impacts, but there remain important differences in the level of detail of tracked data, collection of information on the effects of funded programs on energy generation and consumption, and the assumptions used to measure impacts with program implementation. Future program design efforts would be greatly facilitated by continued efforts to standardize the collection and centralization of data on the use of RGGI proceeds, the application of consistent reporting formats and underlying assumptions regarding program impacts, and the measurement and verification of results.