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

Review of RGGI's Second Three-Year Compliance Period (2012-2014)

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Acknowledgments

This is a report on the economic impacts of RGGI program implementation, primarily covering the second three-year period of the program (2012-2014, known as the second Compliance Period). This Report supplements a previous study completed by Analysis Group in November 2011, on RGGI's first three-year Compliance Period (2009-2011). The analytic method and structure of this Report were modeled closely on the prior report in order to ensure methodological consistency and provide continuity in focus, content and the consideration of lessons learned. Where relevant in this Report, we include data, information, and observations to summarize developments and outcomes in both Compliance Periods One and Two, covering the first six years of RGGI (2009-2014). The Report was completed by Analysis Group with funding from several foundations:

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About Analysis Group

Analysis Group provides economic, financial, and business strategy consulting to leading law firms, corporations, and government agencies. The firm has more than 600 professionals, with offices in Boston, Chicago, Dallas, Denver, Los Angeles, Menlo Park, New York, San Francisco, Washington, D.C., Montreal, and Beijing.

Analysis Group's energy and environment practice area is distinguished by expertise in economics, finance, market modeling and 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; start-up companies, and others.

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1. EXECUTIVE SUMMARY

Overview and Context

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 existing and new power plants.[1] 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 their development and implementation of the RGGI program, these states have gained first-mover policy experience and have collaborated to form a multi-state emission-control policy that has reduced CO_2 emissions and operated seamlessly with well-functioning and reliable 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, and may be relevant to other states and regions as they develop their own plans to reduce CO_2 emissions in response to the Environmental Protection Agency's ("EPA's") proposed Clean Power Plan.

This Report analyzes the economic impacts of RGGI's most recent three years, covering the years 2012 through 2014. This analysis follows on our prior November 2011 Report (hereafter "AG 2011 Report") that assessed the economic impacts of RGGI's first three years (2009-2011).[2] Since the time of our last economic review, the electric industry has experienced changes in power plant economics, emission-control requirements, and wholesale market structures in the RGGI region. In addition, the RGGI states completed a comprehensive program review during 2012, and modified elements of the program including, most importantly, adopting a significantly lower overall cap on CO_2 emissions in the RGGI region.

In light of all of these changes, we not only examine the program's performance in the 2012-2014 period, but we also review whether and to what extent the lessons learned from our prior assessment should be altered to reflect the economic realities of the three most-recent years. For this Report, we apply the same modeling approach as in the AG 2011 Report, but focus our analysis squarely on the economic impacts of the past three years.

In this report, Analysis Group has tracked the path of RGGI-related dollars as they leave the pockets of competitive-power generators who buy CO_2 allowances to demonstrate compliance, show up in electricity prices and customer bills, make their way into state accounts, and then roll out into the economy through various pathways. Our analysis is unique in this way – it focuses on the actual

[1] The ten states are Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. New Jersey participated in the first three years of the RGGI program, withdrawing its participation at the end of 2011.

[2] Paul J. Hibbard, Susan F. Tierney, Andrea M. Okie, and Pavel G. Darling, *The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States*, November 2011. The analytic method and structure of this Report were modeled closely on the prior report, and carry forward observations from RGGI's first three years (to the extent still relevant), in order to ensure methodological consistency and provide continuity in focus, content and the consideration of lessons learned.

observable flow of payments and economic activity: known CO_2 allowance prices; observable CO_2 auction results; dollars distributed from the auction 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 RGGI states' implementation of the program to date, based on real data, we hope to provide a solid foundation for observations that can be used by others in the design of CO_2 control programs going forward.

This review is timely for several reasons. First, as the RGGI states look forward to continued program administration in upcoming years, and to possible adoption of RGGI as the core of these states' plans to meet EPA's Clean Power Plan compliance requirements, they may benefit from more recent analysis of whether, and to what extent, past program and industry changes have affected the impact of power-sector carbon-control programs on the economies of the states in the Northeast. Such an analysis takes into account how changes in program design and the states' allocation of the proceeds of CO_2-allowance auctions has affected program pricing and the mix of economic costs and benefits.

Perhaps more importantly, the lessons learned from the RGGI program's implementation and impacts have potential usefulness beyond the RGGI states. With the issuance of EPA's proposed Clean Power Plan in June 2014 (and anticipating release of its final rule in mid-late summer 2015), states across the country have begun to consider compliance alternatives. Over the next several years, states will have to decide how to approach their Clean Power Plan compliance, including: what control measures and approaches to adopt; whether to select rate-based or mass-based compliance mechanisms;[3] whether to allow averaging or bubbling of emissions within states; whether to go it alone or enter into compliance agreements with other states; whether to join an existing (or create a new) regional CO_2 mass-based market trading system, like RGGI; and whether to opt for the EPA to issue a federal implementation plan, rather than develop a state plan. In this context, having historical real-world information on the economics and program-design features of an existing CO_2 compliance program may be a valuable input into state decision-making. Six years of successful administration of RGGI provides a wealth of data and insights into key decisional factors for states around prospects for collaboration, joint governance and administration, program design and evolution, electricity price changes, and impacts on state and regional economies.

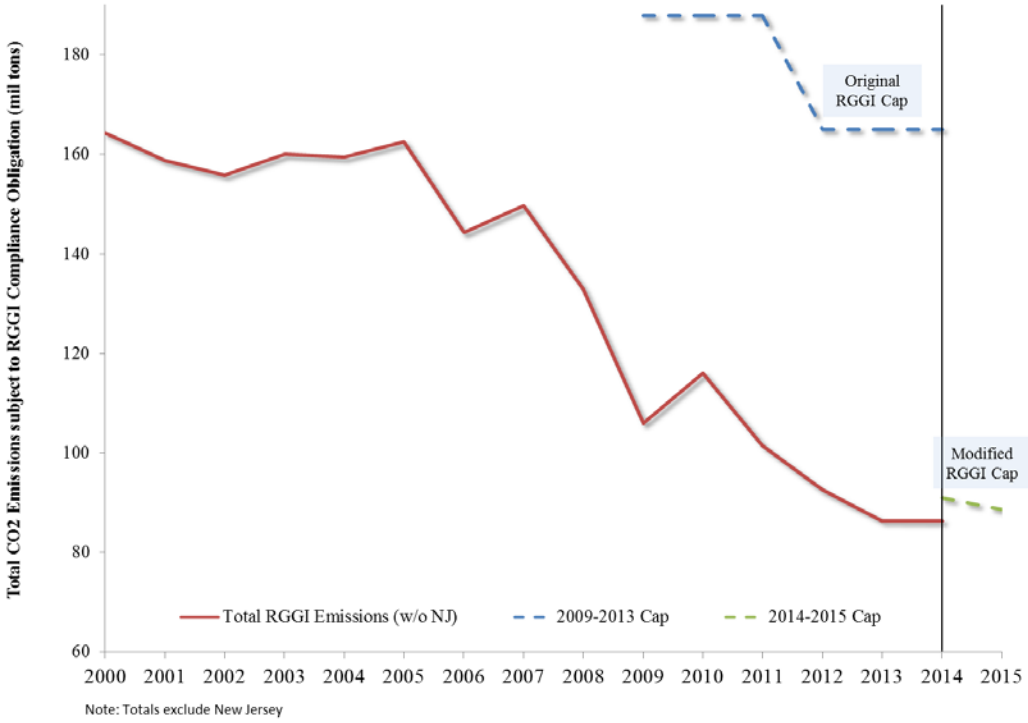
RGGI has now been operating for over six years. In every year, the emission allowances – or rights to emit CO_2 – have been almost entirely dispersed into the market through coordinated (centralized) regional auctions. Owners of fossil-fueled power plants have spent nearly $2 billion to buy CO_2 allowances over the six years, and include the cost of allowances in their offer prices in wholesale electricity markets in New England, New York, and parts of the PJM region. The grid operators in

[3] "Mass-based" is the term used by EPA in its proposed rule to describe a compliance option whereby states convert EPA's rate-based requirement (expressed in terms of a maximum rate of CO_2 emissions in pounds per megawatt-hour ("MWh") of electrical output (i.e., lbs/MWh)) into an equivalent total tonnage limit of CO_2 emissions from power plants across the state during a particular time period (i.e., "cap" on total emissions in the state from affected sources). The terms "mass-based" and "cap" refer to similar emission control program designs, and are both used throughout this document, depending on context.

these regions take these offer prices – including allowance costs – into account as they dispatch the plants on the system. As a result, consumers now pay electricity rates that reflect a price on CO_2 emissions without grid operators superimposing any other dispatch rule to account for emissions.

Throughout the RGGI program's implementation, power system reliability has been maintained and CO_2 emissions from power generation have decreased, affected by RGGI's original design, subsequent alteration of the RGGI cap, and broader economic and industry factors.[4] As shown in Figure ES-1, CO_2 emissions (shown through 2014) have declined throughout the RGGI program life. Figure ES-2 provides additional information about cap levels and events during the first years of the RGGI program.

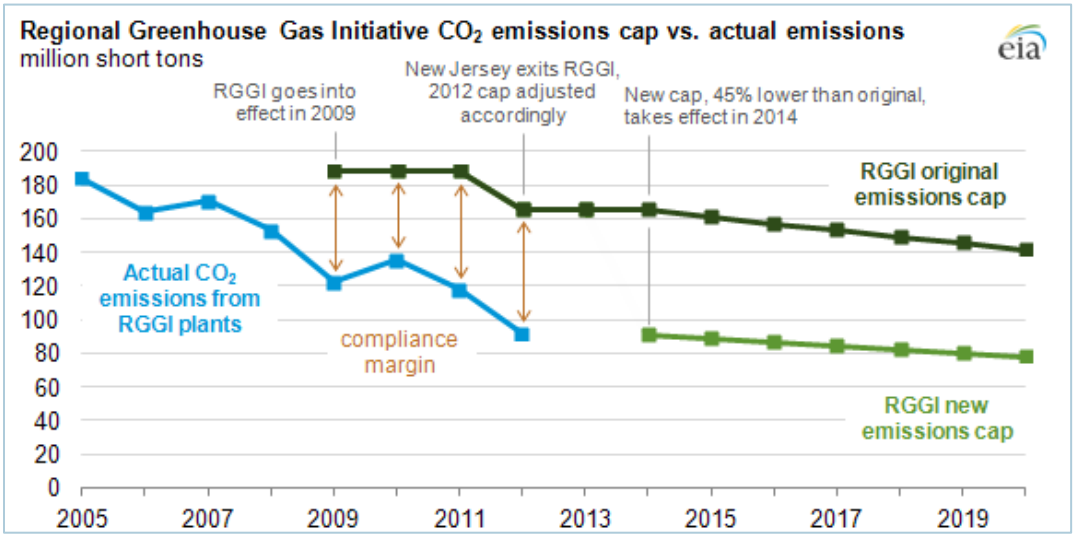
Figure ES-1
Actual CO_2 Emissions in the RGGI States, Relative to the Emissions Caps in Different Periods



Source: RGGI Inc.

[4] RGGI, Inc. has reported that electric generation from RGGI-affected electric generation sources decreased by 18.8 million MWh, or *10.6 percent* on average between 2010 and 2012 (compared to the average generation between 2006 and 2008). Yet during that same time period CO_2 emissions from RGGI electric generation sources decreased by 35.1 million short tons, or *25.4 percent*. "CO_2 Emissions from Electricity Generation and Imports in the Regional Greenhouse Gas Initiative: 2012 Monitoring Report," RGGI, Inc., August 11, 2014.

Figure ES-2
RGGI CO_2 Emissions Caps, Actual Emissions, and Other Events Since 2005

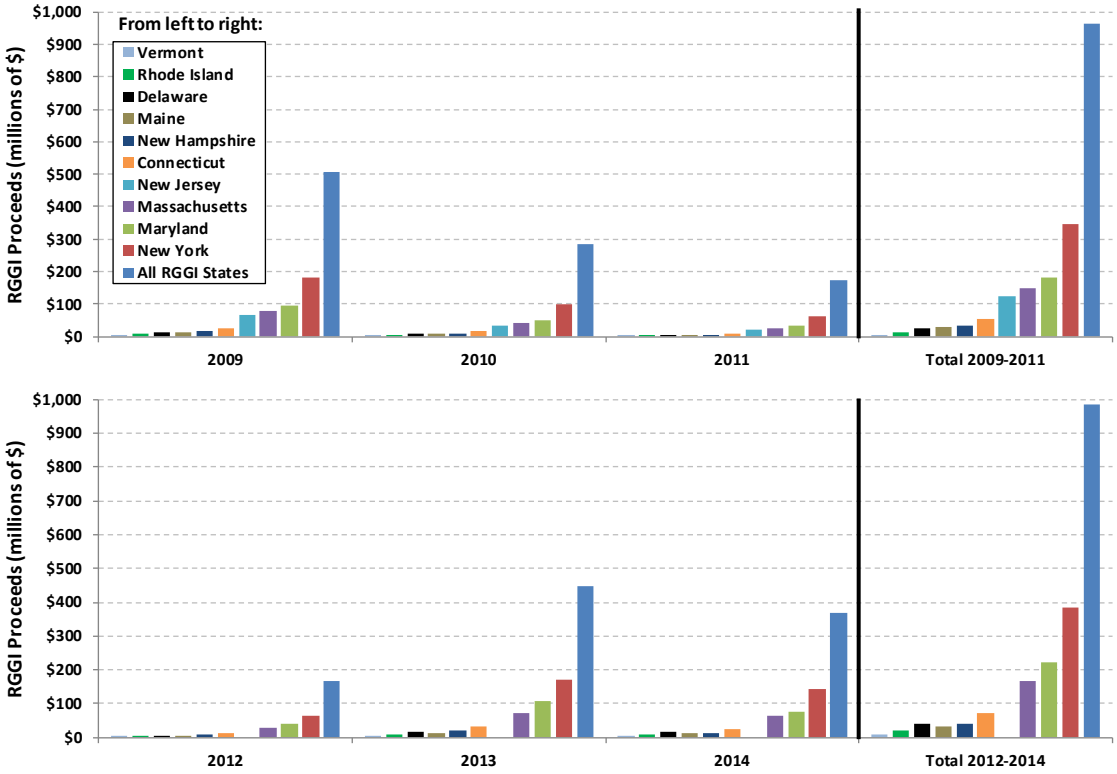


Source: Energy Information Administration, http://www.eia.gov/todayinenergy/detail.cfm?id=14851

Since 2009, the RGGI states have received and disbursed virtually all of nearly $2 billion in proceeds from CO_2-allowance auctions back into the economy in various ways, including on: energy efficiency measures; community-based renewable power projects; credits on customers' bills; assistance to low-income customers to help pay their electricity bills; greenhouse-gas-reduction measures; and education and job training programs. Figure ES-3 shows RGGI proceeds by state and region over the first two compliance periods.

During the 2012-2014 period, how has the RGGI program affected electricity markets, power producers' costs, electricity prices, and consumers' electricity bills? We examined this question in our 2011 AG Report, and we ask this same question again, along with others: What happened to the roughly $1 billion in proceeds collected over the 2012-2014 period from the sale of CO_2 allowances? Has the program continued to produce net economic benefits to these states in the second three-year period, or otherwise helped them pursue their goals for reliable electric supply and CO_2-emissions reductions? What has been learned to date? Finally, in this Report we consider the implications of RGGI for states as they develop Clean Power Plan compliance approaches.

Figure ES-3
RGGI Allowance Proceeds by State



Source: RGGI Inc.
Notes: Figures include Auctions 1-26 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.
New Jersey does not have auction proceeds after Compliance Period 1.

Results

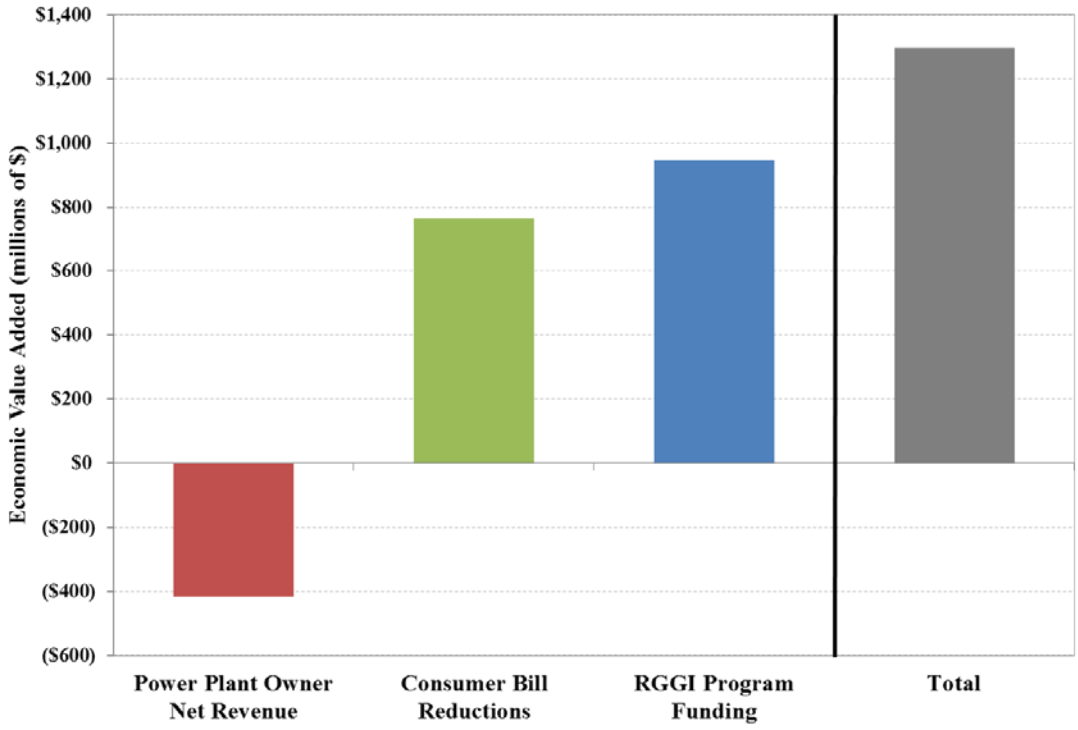
Over the last three years (2012-2014), the RGGI program led to $1.3 billion (net present value) of economic value to the nine-state region.

Similar to our findings with respect to the first three years of the RGGI program, its implementation in the second three-year period generates $1.3 billion in net economic benefits across the region.[5] The region's economy – and each state's as well – benefits from the expenditures of RGGI auction proceeds on various programs, with benefits flowing to consumers and the broader economy. When spread across the region's population, these economic impacts amount to over $31 in value added per capita in the region, on average. Figure ES-4 shows the net economic value broken out by the

[5] All results for Compliance Period 2 are reported in 2015 dollars. Results are reported using a 3 percent "public" discount rate. Using instead a "private" discount rate of 7 percent, economic benefits still total almost $900 million. See the Appendices for a discussion of public and private discount rates, and results calculated using both discount rates.

macroeconomic effects of RGGI on consumers and power plant owners, as well as effects that flow from direct spending of RGGI auction revenues.

Figure ES-4
Net Economic Impact to States in the RGGI Region (2015$)



Notes: Figures represent dollars discounted to 2015 using a 3% public discount rate.

This recent positive economic outcome from the RGGI program results in large part from the states' decision to sell CO_2 allowances via a centralized auction and then use the proceeds from the auction in various ways that address state policy objectives, primarily by returning funds to electric ratepayers and funding local investment in energy efficiency ("EE") and renewable energy ("RE") resources. During the 2012-2014 period, the states received, programmed, and disbursed virtually all the $1.0 billion in allowance proceeds back into the economy (shown in Figure ES-3). The money has been spent on energy efficiency measures, community-based renewable power projects, assistance to low-income customers to help pay their electricity bills, greenhouse gas reduction measures, and education and job training programs. The local investment keeps more of the RGGI states' energy dollars inside their region, reducing the amounts that leave the region to pay for fossil fuel production outside the RGGI states.

These economic benefits reflect the complex ways that RGGI dollars interact with local economies.

The states' use of RGGI auction proceeds on energy-efficiency programs, for example, 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.

The size of RGGI's positive economic benefits varies by state and region, in large part because the RGGI states spent their RGGI auction proceeds differently.[6] Different expenditures have different direct and indirect effects in their economies and different impacts on their electric systems. For example, a state's use of RGGI dollars to pay for energy efficiency programs that reduce energy consumption in the electric sector, and to invest in renewable projects that have low operating cost, both served to lower electricity prices in wholesale power markets (compared to a 'no-RGGI' scenario). This mitigated 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.

Local reinvestment of RGGI dollars in energy efficiency and renewable energy programs is offsetting the impact of increased electricity prices resulting from the cost of RGGI allowances.

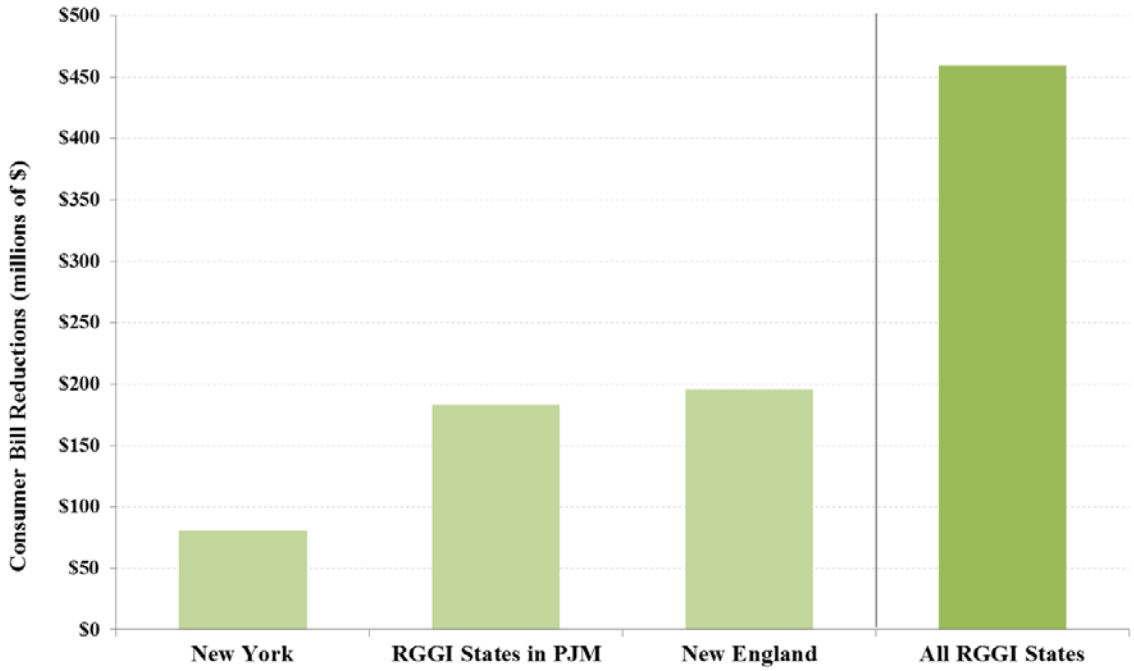
RGGI has also led to changes in consumers' overall expenditures on electricity: On the one hand, the inclusion of the cost of CO_2 allowances in wholesale prices increased retail electricity prices in the RGGI region throughout 2012-2014. But the near-term price impacts are more than offset during these years and beyond, because these states invested a substantial amount of the RGGI auction proceeds in energy-efficiency programs that reduce overall electricity consumption, and in renewable energy programs that displace higher-priced electricity generation resources. In the end, consumers gain because their overall electricity bills go down as a result of state RGGI allowance revenue investments, primarily in energy efficiency but also renewable energy-focused programs.

Energy consumers overall – households, businesses, government users, and others – have enjoyed a net gain of $460 million, as their overall energy bills drop over time.

The net positive benefits to consumers are spread across residential consumers and commercial and industrial customers. Consumers of electricity save $341 million, and natural gas and heating oil save $118 million. Figure ES-5 shows the net bill reductions to consumers in each of the RGGI wholesale market regions.

[6] Overall, the distribution of spending across the states was as follows: 59 percent on energy efficiency; 15 percent on renewable energy projects; 13 percent on bill-payment assistance to energy consumers; 12 percent on other greenhouse gas programs and program administration; and 1 percent on clean technology research and development. Individual state expenditures ranged significantly across these categories.

Figure ES-5
Net Bill Reductions to Consumers (2015$)

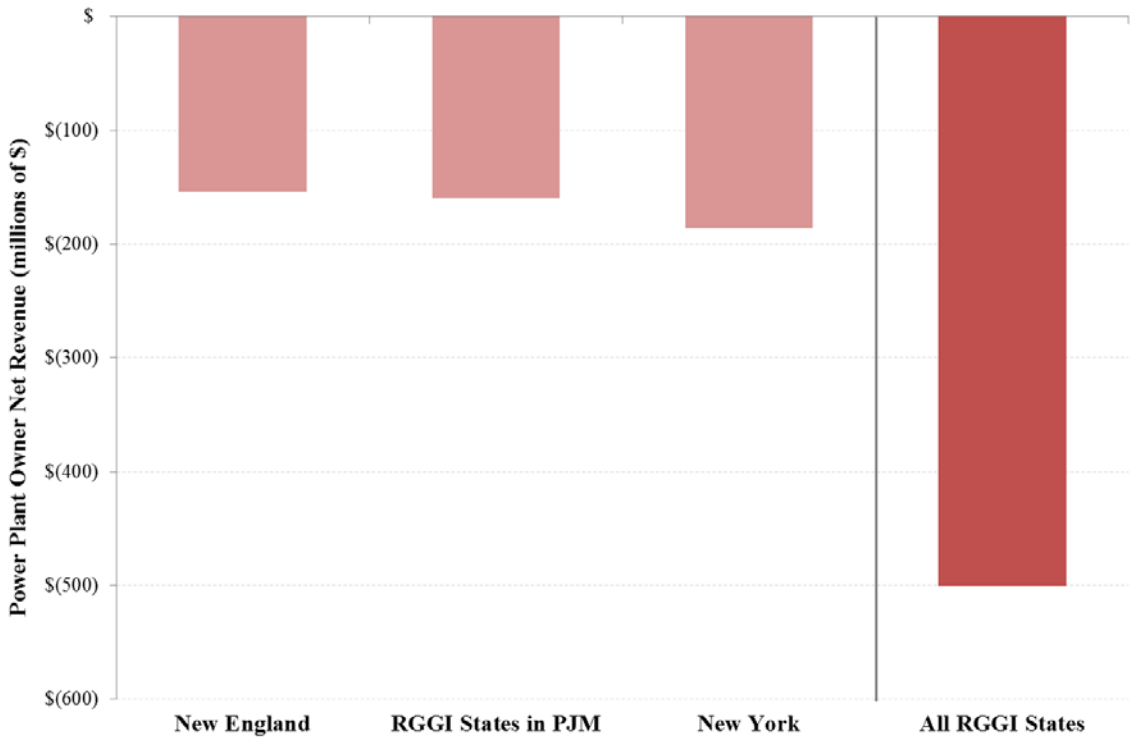


Notes: Figures include PROMOD outputs, non-electric benefit calculations, capacity market gain calculations, and direct bill assistance savings.
Figures represent dollars discounted to 2015 using a 3% public discount rate.

The power system experiences changes under RGGI: The order of power-plant dispatch changes somewhat; power plant owners recover the costs of CO_2 in the short run but experience lower output (and lower revenues) in the long run; and plants with lower CO_2 emissions have a competitive advantage.

Including a price on carbon emissions in the dispatch decisions in the region shifts output to lower-carbon-emitting sources of power. Although RGGI requires power plant owners to purchase CO_2 allowances, power plant owners as a group recover all of their early expenditures through the increase in electricity prices during the 2012–2014 period. In the near term, while all owners of emitting resources recover all of their costs to operate – including the cost of CO_2 allowances – the net effect of the program can reduce profits for owners of plants with relatively high carbon emissions (e.g., coal-fired power plants). On the other hand, owners of zero-carbon generating sources (e.g., nuclear, wind, solar, hydro) get the benefit of being paid higher market prices that reflect CO_2 allowance costs, without having to buy allowances. In the long run, however, RGGI-driven energy efficiency leads to lower demand for output from power plants as a whole, which ends up eroding power plant owners' electric market revenues. On an NPV basis, total actual and anticipated revenues to the power-generation sector drop by roughly $500 million through 2025. Figure ES-6 shows the net revenue impact on power plant owners. Among the power plant owners, RGGI has afforded a competitive advantage to power plants with lower CO_2 emissions in every year.

Figure ES-6
Net Revenue Change for Power Plant Owners (2015$)



Notes: Figures include PROMOD outputs, allowance true-up calculations and capacity market loss calculations. Figures represent dollars discounted to 2015 using a 3% discount rate.

Compared to RGGI's first three years (2009-2011), the total amount of emissions allowed in the region has been lowered, and with it, economic effects of RGGI have shifted.

The RGGI states decided in 2012 to lower the overall amount of CO_2 emissions allowed to be emitted from power plants in the region. (See Figure ES-2.) This tended to increase the price of CO_2 allowances, and in turn increase clearing prices in the region. With fewer CO_2 allowances to sell, however, the auction proceeds have also changed, with varying impacts on revenues available to states. These trends may continue as the cap continues to decline over time.

Insights and Observations

There are a number of observations that flow from the results described above, and others described in more detail in this Report. Some are important for providing the RGGI states with information about how the policy is performing relative to its original goals. The observations are also relevant in the context of these states' and other states' consideration of how to design their State Plans to comply with EPA's proposed Clean Power Plan. In this section we summarize our observations based on the power sector and economic analyses described in this Report.

Relative to the first three years of the RGGI program, the RGGI states' experience during 2012-2014 differed along a number of dimensions.

- The RGGI states benefitted from having had three years of prior program administration experience, and throughout 2012 undertook a top-to-bottom review of RGGI, with major changes implemented – including a lowering of the overall emissions cap;
- Many states adjusted how they spent RGGI auction proceeds over time, shifting the use of allowance revenues to reflect different program and state objectives;
- New Jersey exited the program at the end of 2011, requiring an adjustment to the overall emissions cap to remove that state's emissions' allocation;
- Fossil fuel prices (both relative and absolute) have changed significantly since the start of the program;
- Energy efficiency and grid-connected/distributed renewable energy resources have continued to grow at a rapid pace in many of the RGGI states, with increasing influence on power sector demand and dispatch; and
- Accelerated retirement of the regions' legacy generating units has continued, with more to come.

Each of these factors has had the potential to strongly influence the economic impacts of RGGI. For example, the lowering of the overall cap both increases allowance prices (and thus the marginal costs of affected generating units) and decreases allowance quantities, with varying impacts on revenues available to states. In addition, relatively low natural gas prices and increased energy efficiency and renewable energy in 2012-2014 relative to 2009-2011 affected the price of the marginal generator in these wholesale power markets and led to lower power prices. This, in turn, tended to dampen electricity-cost benefits of RGGI-funded programs (like energy efficiency and renewable energy). The combined effect was that initial price impacts were higher, and subsequent benefits of RGGI programs lower, than we found for RGGI's first three years.

Implementation of RGGI during the past three years continues to generate substantial economic benefits for the RGGI states while continuing to reduce emissions of CO_2.

Economic value added

Our analysis of RGGI impacts over the past three years took into consideration the program's effects on power system dispatch, costs to consumers, revenues to electric generators, and overall state economic performance. We found lower costs to electric consumers throughout the region, decreases in revenues to the owners of certain power plants, and positive economic impacts across all states, totaling approximately $1.3 billion in economic value added (in 2015 dollars) as a result of RGGI's second three years (2012-2014). This is on top of what we found for the first three years (2009-2011) of the program: $1.6 billion of economic value added (in 2011 dollars). Thus, considering results found in both our studies, the first six years of RGGI program implementation has continuously generated significant economic value for the RGGI states, while achieving the region's collective objectives in terms of reducing emissions of CO_2.

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 second three years of RGGI leads to nearly 14,200 new job years, with each of the nine states showing net job additions. This is on top of what we found for the first three years (2009-2011) of the program: 16,000 job-years. 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; or staff performing teacher training on energy issues.

Fossil fuel production and imports

Over the past three years, RGGI helped lower the total dollars these states sent outside their region in the form of payments for fossil fuels by over $1.27 billion. Most of the RGGI states' electricity comes from fossil fuels, even though these states produce virtually no coal, natural gas, or oil locally. Since the RGGI program lowered states total fossil-fired power production and lowered use of natural gas and oil for heating, RGGI reduced the total dollars sent out of state for these energy resources.

Continuation of program benefits from the first three years

Our findings on economic impacts of the second three years of the RGGI Program are consistent with previous findings and observations with respect to the first three years. As noted earlier, analysis following RGGI's first three years delivered net economic benefits to all of the states participating in the program, including growth in economic output, increased jobs, reinvestment of energy dollars in local/state economic activity, long-run electricity cost reductions, and successful emission reductions. Further, states found ways to reinvest auction proceeds through programs that distributed benefits broadly, across all classes of customers, including targeted investment in EE programs for low-income customers. States have demonstrated the ability to not only use allowance proceeds in ways that advance state policy objectives, but to do so with an eye towards fair distribution of reinvestment benefits across all customers.

The RGGI program's first six years (2009-2014) provides empirical evidence about carbon-control programs for the power sector that are useful in the current context.

Review of the nation's first multi-state, mass-based CO_2 emission control program provides information for states considering Clean Power Plan compliance alternatives.

EPA's Clean Power Plan has focused industry and state policymaker attention on the various alternatives for reducing emissions of CO_2 from the electricity sector, in part because EPA's proposal is structured to provide a high degree of flexibility and choice for states, including the possibility of (and incentives for) multi-state compliance planning, and the use of a mass-based program with tradable allowances.[7] Lessons learned in the six-plus years of RGGI implementation thus directly

[7] A recent study performed by researchers at the University of Texas at Austin summarized the results of a survey of electric companies and state officials with respect to several key issues, including attitudes about mass-based versus rate-based program designs: "The overwhelming majority of survey respondents favored the development of state compliance plans rather than federally-developed plans. There was broad support, among survey respondents, for mass-based trading programs….Support was found in both Democratic- and Republican-controlled states but was higher in the former than the latter…. Most survey respondents favored market-based compliance options. 68 percent of respondents indicated that they preferred mass-based trading over other market-based options. 11 percent of respondents listed rate-based trading as their preferred option. Almost two-thirds of survey respondents favored adoption of mass-based emissions targets, arguing that

relate to fundamental state economic, energy, and environmental policy questions tied to Clean Power Plan compliance choices. The deep experience of the RGGI region affords highly relevant data points for states that now must grapple for the first time with the development of state plans to reduce CO_2.

The experience of the RGGI states over the past ten-plus years, from conception of a regional market-based CO_2 control program, through six years of program administration, provides a wealth of data and lessons. Key themes that flow from a programmatic and quantitative economic analysis of RGGI include: the feasibility and value of multi-state approaches to controlling CO_2; the ability of states to work cooperatively and effectively together; and the ability of market-based allowance trading programs with state-driven auctions and local reinvestment of auction proceeds to help states meet EPA's Clean Power Plan requirements while generating positive economic benefits.

The positive impacts of RGGI on state economies are additive to the purpose and expected benefits of the program.

RGGI is not and was never meant to be an economic-development program. The purpose of the RGGI program is to reduce emissions of CO_2 from power plants in order to help mitigate the economic, social, and environmental risks of climate change, and to avoid the potentially substantial damages to human health and society that are expected to come with increasing concentrations of greenhouse gases in the atmosphere. And as shown in Figure ES1, the RGGI program has contributed to significant reductions in emissions of CO_2 across the RGGI region. In our analysis, however, we do not attempt to quantify the potential long-term benefits of reducing the risks of climate change. The focus of our analysis is specific and narrow – we review only the direct impacts of program implementation costs and state use of allowance revenues on state economies, in order to test the idea that controlling emissions of CO_2 will somehow lead to negative consequences from the perspectives of state economic growth and jobs. Our results – which instead reveal positive economic impacts – should be viewed as additive to whatever additional economic, social and/or environmental benefits flow from reducing climate change impacts.

The RGGI model has successfully achieved CO_2 reductions through a cooperative framework that preserves state authority.

The states that comprise the RGGI region are highly diverse in many ways – the political setting and state policy objectives vary widely across the states, and have also changed significantly *within* states over the timeframe of the first six years; state electricity generating portfolios differ substantially in size, technologies, fuel mix, and age; state industrial and commercial profiles and the bases of economic activity cover a wide range of technologies, products and activities across the RGGI region; the degree of development interest in traditional power generation sources, renewables, and energy

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they are easier to implement than the rate-based targets proposed by EPA. The bulk of survey respondents supported interstate cooperation on the Clean Power Plan, with 90 percent arguing that states should develop multi-state plans or single-state plans that preserve the option to trade across state lines. Melinda Taylor and Romany Webb, "EPA's Clean Power Plan: Implementation Options – Survey Results: Insights from Industry Experts and State Officials on Implementation of EPA's Clean Power Plan," Kay Bailey Hutchison Center for Energy, Law & Business, University of Texas at Austin, June 2015. http://kbhenergycenter.utexas.edu/files/2015/06/Final_Report-EPA-Clean-Power-Plan-Implementation-Options_6.23.2015.pdf.

efficiency differs; and states all have unique legal and regulatory structures that oversee energy, utility, and environmental policies.

Despite these differences, the RGGI states have successfully navigated the complications that can arise from efforts to coordinate regulatory and policy objectives across state lines. RGGI's experience confirms the possibility that states can work together, particularly when doing so is likely to lower compliance costs and generate economic benefits. Strong evidence of effective cooperation among politically and economically diverse states is found in RGGI states' ability to: successfully complete the nation's first multi-state CO_2 program consistent with sound economic principles; complete the stakeholder, legislative, and regulatory steps necessary over just several years; smoothly administer the program and integrate it with wholesale electricity markets; complete a top-to-bottom programmatic review mid-stream, complete with major changes, in just a year; and proactively work together on all design and administration issues, including potential adaptation of the program for compliance with the Clean Power Plan.

Mandatory, market-based carbon-control mechanisms are functioning properly in wholesale markets and have not affected power system reliability.

Based on six years of experience from the nation's first multi-state, mandatory carbon control program, market-based programs can provide positive economic impacts and meet emission objectives in a manner well-suited for the operation of power systems. The implementation of RGGI over six years has not adversely affected power system reliability in New England, New York, or PJM. The pricing of carbon in Northeast and Mid-Atlantic electricity markets has been seamless from an operational point of view and successful from the perspective of efficient pricing of emission control in regional markets.

The design of the CO_2 market in the RGGI states allows for the creative use of public funds, supporting diverse state policy and economic outcomes.

The joint decision by the RGGI states to make their CO_2 allowances available to the market through a unified auction has generated 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). 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.

How allowance proceeds are used affects their economic impacts: use of auction proceeds to invest in energy efficiency produces the biggest bang per buck, in terms of net positive benefits to consumers and to the economy

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 leads to lower regional electrical demand, lower power prices, and lower

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, and this reinvestment stands out as the most economically-beneficial use of emission allowance revenues. Other uses also provide macroeconomic benefits, even if they do not show up in consumers' pockets in the form of lower energy bills.

2. THE REGIONAL GREENHOUSE GAS INITIATIVE

Overview and Purpose

Starting with the first auction of CO_2 allowances in late 2008, ten states in the Northeast and Mid-Atlantic regions initiated RGGI, a multi-state market-based program to reduce emissions of CO_2.[8] 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 more 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.[9] Under the Revised Model Rule, released in February 2013 and discussed further below, the regional emissions cap was revised downward in 2014 to 91 million tons and the original 2.5 percent per year reduction to the regional RGGI cap for the years 2015 through 2020 was maintained. 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 set up by the states 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.[10]

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 Compliance Period 1 being 2009–2011 and Compliance Period 2 being 2011-2014), every affected source must retire a

[8] The nine states are Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. New Jersey participated in the first three years of the RGGI program, withdrawing its participation at the end of 2011.

[9] 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/.

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

number of allowances equal to the total tons of CO_2 emissions from the source over the three-year compliance period (one allowance equals one ton of emissions).

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.[11]

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 and 88.7 million are available for 2015. 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.

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 – that is, greenhouse gas (GHG) reduction projects outside the power sector.[12]

Allowance Disbursement to the RGGI States

Allowances are made available initially 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. 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

[11] 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 Delaware and Maryland, along with 11 other states and the District of Columbia outside of the RGGI MOU).

[12] The Revised Model Rule released in February 2013 provides a new offset category known as "sequestration of carbon due to reforestation, improved forest management or avoided conversion" that RGGI states may adopt in lieu of the previous "afforestation" category.

reserve (floor) price that is currently $2.05 per allowance) – are distributed to states, and states determine how to use the funds. The most recent auction as of this writing occurred in June 2015, with all of the approximately 15.5 million allowances offered for sale selling at an auction clearing price of $5.50 per allowance.[13]

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. The ways in which states used the auction proceeds during the time period reviewed in this study (that is, Compliance Period 2, covering 2012–2014) is discussed in detail below.

2012 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 included an evaluation of program successes, program impacts, the potential for additional reductions, imports and emissions leakage, and offsets. The process culminated in an Updated Model Rule released in February 2013, which reflected the outcome of an extensive regional stakeholder process that engaged the regulated community, environmental non-profits, consumer and industry advocates, and other interested stakeholders organizations with technical expertise in the design of cap-and-trade programs.

The program review revealed: (1) a significant excess supply of allowances relative to actual emission levels in the region; and (2) a finding that the then-current cost control measures in the program, which were based upon expansion of the percentage of offset allowances allowable for compliance, would likely be ineffective in controlling costs if the emissions cap was made binding. As a result, the RGGI states revised the original program cap downward[14] and established a Cost

[13] In addition, 10 million cost containment reserve allowances were also available for sale, none of which have been sold. As discussed further below, the CCR is a fixed additional supply of allowances that are only available for sale if CO2 allowance prices exceed certain price levels ($6 in 2015, $8 in 2016, $10 in 2017, and rising by 2.5 percent each year thereafter to account for inflation). As of this writing, all 10 million CCR allowances available for 2015 remain available for sale. See http://www.rggi.org/docs/Auctions/28/PR060515_Auction28.pdf

[14] Under the Updated Model Rule, the Regional Emissions Cap was set equal to 91 million tons for 2014. From there, the Regional Emissions Cap and each RGGI state's individual emissions budget will decline 2.5 percent each year from 2015 through 2020. The Updated Rule also addressed the bank of allowances held by market participants with two interim adjustments for banked allowances. The first adjustment will be made over a 7-year period (2014-2020) for the first control period private bank of allowances and a second adjustment will be made over a 6-year period (2015-2020) for the 2012-2013 period private bank of allowances. See https://www.rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Recommendations_Summary.pdf and https://www.rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Model_Rule_Summary.pdf.

Containment Reserve through the release of an Updated Model Rule.[15] These changes – and their impacts on power plant variable costs – flowed smoothly through the regions' power markets, with power producers, consumers, and electric grid operators adapting to these modifications seamlessly from an operational point of view.

The revised program cap under the Updated Model Rule has resulted in fewer allowances being sold, higher auction clearing prices (and thus higher compliance costs), and approximately the same dollar amount of auction proceeds to RGGI states when compared to the first compliance period. As summarized in Table 1 below, over 93 million fewer allowances were sold in Compliance Period 2 at a cost of $0.77 more per allowance. Auction proceeds sent to states participating in RGGI increased to $983 million during Compliance Period 2, slightly up from $952 million in Compliance Period 1.

Table 1
Summary of RGGI Auction Results
First Two Compliance Periods

Compliance Period 1 (2009-2011)							
Auction Number	**Date**	**Offering**	**Allowance Quantity Offered**	**Allowance Quantity Sold**	**% Allowances Sold**	**Clearing Price**	**Total Proceeds**
Auction 1*	9/25/2008	Current	12,565,387	12,565,387	100%	$3.07	$ 38,575,738
Auction 2	12/17/2008	Current	31,505,898	31,505,898	100%	$3.38	$ 106,489,935
Auction 3	3/18/2009	Current	31,513,765	31,513,765	100%	$3.51	$ 117,248,630
	3/18/2009	Future	2,175,513	2,175,513	100%	$3.05	
Auction 4	6/17/2009	Current	30,887,620	30,887,620	100%	$3.23	$ 104,242,445
	6/17/2009	Future	2,172,540	2,172,540	100%	$2.06	
Auction 5	9/9/2009	Current	28,408,945	28,408,945	100%	$2.19	$ 66,278,239
	9/9/2009	Future	2,172,540	2,172,540	100%	$1.87	
Auction 6	12/2/2009	Current	28,591,698	28,591,698	100%	$2.05	$ 61,587,121
	12/2/2009	Future	2,172,540	1,599,000	74%	$1.86	
Auction 7	3/10/2010	Current	40,612,408	40,612,408	100%	$2.07	$ 87,956,945
	3/10/2010	Future	2,137,992	2,091,000	98%	$1.86	
Auction 8	6/9/2010	Current	40,685,585	40,685,585	100%	$1.88	$ 80,465,567
	6/9/2010	Future	2,137,993	2,137,993	100%	$1.86	
Auction 9	9/10/2010	Current	45,595,968	34,407,000	75%	$1.86	$ 66,437,340
	9/10/2010	Future	2,137,992	1,312,000	61%	$1.86	
Auction 10	12/1/2010	Current	43,173,648	24,755,000	57%	$1.86	$ 48,224,220
	12/1/2010	Future	2,137,991	1,172,000	55%	$1.86	
Auction 11	3/9/2011	Current	41,995,813	41,995,813	100%	$1.89	$ 83,425,588
	3/9/2011	Future	2,144,710	2,144,710	100%	$1.89	
Auction 12	6/8/2011	Current	42,034,184	12,537,000	30%	$1.89	$ 25,477,200
	6/8/2011	Future	1,864,952	943,000	51%	$1.89	
Auction 13	9/7/2011	Current	42,189,685	7,487,000	18%	$1.89	$ 14,150,430
	9/7/2011	Future	1,864,951	0	--	--	
Auction 14	12/7/2011	Current	42,983,482	27,293,000	63%	$1.89	$ 51,583,770
	12/7/2011	Future	1,864,951	0	--	--	
Total (Current + Future)**			**527,728,751**	**411,166,415**	**78%**	**$ 2.32**	**$ 952,143,168**

[15] The Updated Model Rule established a Cost Containment Reserve (CCR), which is a reserved quantity of allowances, in addition to the cap, that are only available if defined allowance price triggers are exceeded. The allowances provided within the CCR will be equal to 5 million short tons in 2014 and 10 million short tons each year thereafter. See https://www.rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Recommendations_Summary.pdf and https://www.rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Model_Rule_Summary.pdf.

Compliance Period 2 (2012-2014)

Auction Number	Date	Offering	Allowance Quantity Offered	Allowance Quantity Sold	% Allowances Sold	Clearing Price	Total Proceeds
Auction 15	3/14/2012	Current	34,843,858	21,559,000	62%	$1.93	$ 41,608,870
Auction 16	6/6/2012	Current	36,426,008	20,941,000	57%	$1.93	$ 40,416,130
Auction 17	9/5/2012	Current	37,949,558	24,589,000	65%	$1.93	$ 47,456,770
Auction 18	12/5/2012	Current	37,563,083	19,774,000	53%	$1.93	$ 38,163,820
Auction 19	3/13/2013	Current	37,835,405	37,835,405	100%	$2.80	$ 105,939,134
Auction 20	6/5/2013	Current	38,782,076	38,782,076	100%	$3.21	$ 124,490,464
Auction 21	9/4/2013	Current	38,409,043	38,409,043	100%	$2.67	$ 102,552,145
Auction 22	12/4/2013	Current	38,329,378	38,329,378	100%	$3.00	$ 114,988,134
Auction 23	3/5/2014	Current	18,491,350	23,491,350	127%	$4.00	$ 93,965,400
Auction 24	6/4/2014	Current	18,062,384	18,062,384	100%	$5.02	$ 90,673,168
Auction 25	9/3/2014	Current	17,998,687	17,998,687	100%	$4.88	$ 87,833,593
Auction 26	12/3/2014	Current	18,198,685	18,198,685	100%	$5.21	$ 94,815,149
Total (Current + Future)**			**372,889,515**	**317,970,008**	**85%**	**$ 3.09**	**$ 982,902,776**

Notes:

*Six states participated in Auction 1.

** Average clearing price is weighted average clearing price based on actual allowances sold.

Souce:

RGGI Inc., https://www.rggi.org/market/co2_auctions/results

Prior Analysis Group Reviews of the RGGI Program

2011 Report on Economic Impacts of RGGI's First Compliance Period

At the request of four foundations,[16] Analysis Group measured the economic impacts of RGGI's first three years (i.e., Compliance Period 1). Our AG 2011 Report presents our analysis, which led us to the following observations about the RGGI experience with respect to Compliance Period 1:

- *Mandatory, market-based carbon control mechanisms are functioning properly and can deliver positive economic benefits.* During the initial three years of experience with RGGI, the pricing of carbon in Northeast and Mid-Atlantic electricity markets was seamless from an operational point of view, and generated economic value added to the RGGI region of roughly $1.6 billion. The amount consumers spent on electricity over time due to Compliance Period 1 was reduced by $1.1 billion, and the amount spent in RGGI states on out-of-state fossil fuels was reduced by over $765 million.[17]
- *The states 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.

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

[17] All Compliance Period 1 results are reported in 2011 dollars, on a net present value basis using a public discount rate of 3 percent. For additional results see the AG 2011 Report.

- *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 generates 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.
- *How allowance proceeds are used affected their economic impacts.* The RGGI states used their RGGI allowance proceeds very differently, in ways that affect the net benefits within the electric sector and in the larger state economy. 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 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. According to our analysis, the first three years of RGGI will lead to over 16,000 new job-years, with each of the RGGI states showing net job additions.
- *Timing differences in program costs versus benefits affects results.* Positive economic impacts associated with the distribution and spending of allowance proceeds tends to lag cost incurrence (and price impacts) by a year or more in many states. States can improve economic impacts by ensuring quick and efficient use of allowance revenues.
- *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, on a net present value (NPV) basis.

2014 Report on EPA's Clean Power Plan

Separately, in a July 2014 Analysis Group report entitled "EPA's Clean Power Plan: States' Tools for Reducing Costs & Increasing Benefits to Consumers,"[18] we drew on the broad experience of states already regulating carbon emissions, including the RGGI states, and found that states were well positioned to implement – and benefit from – the U.S. EPA's Clean Power Plan, which would cut carbon emissions from existing power plants. Our report evaluated the Clean Power Plan from the perspective of how it might impact consumers and examined how states' plans to control carbon emissions may affect owners of affected power plants, other market participants in the electric industry, and, in turn, consumers of electricity.

We examined RGGI as an example of a carbon control program that has been in operation for several years, to illustrate how such carbon-control compliance costs and benefits have evolved over the initial years of that program. The paper also reviews the normal ratemaking practices and other regulatory policies in states across the country that are designed to mitigate rate impacts of investments and program costs affecting production and delivery of power to consumers. Our analysis led us to the following observations and findings:

- *States have the tools they need to reduce the power sector's carbon footprint and comply with the Clean Power Plan.* One-fifth of the states already regulate carbon emissions, and all states currently have efficiency programs in place. States have a long track record of using various regulatory and other policy tools to encourage utility programs and investments that minimize the cost of electric service, consistent with the myriad of public policies (tax, environmental, reliability, labor, and other areas of policy that affect the provision of electricity).
- *Under the proposed Clean Power Plan, states will have the flexibility, experience and tools to prepare and implement State Plans that fit their circumstances, minimize costs of compliance, and provide benefits to customers.* Although states differ in many ways – including in terms of the electric systems, their regulatory culture, and their electric industry structure –all states have programs, policies and practices that will allow them to develop plans that align well with their different circumstances
- *Market-based mechanisms, such as the RGGI program, offer unique opportunities to minimize costs while also reducing CO_2 emissions from existing power plants. They can be done within a state or across a number of states.* Pricing carbon in this way sends efficient, market-based signals for investment and operation of the electric system. Experience shows that such programs can be designed to achieve a number of state policy objectives, can lower electricity bills, and can deliver positive net economic benefits.
- *States are well equipped through long-standing utility ratemaking principles and practices and implementation of energy programs to help protect low-income customers when*

[18] Paul Hibbard, Susan Tierney, and Andrea Okie, "EPA's Clean Power Plan: States' Tools for Reducing Costs and Increasing Benefits to Consumers," July 2014 (hereafter "AG 2014 Report").

electricity costs increase. Such tools include low-income rates and arrearage management plans, dedicated funding for low-income energy-efficiency and weatherization programs, utility-driven charitable contribution.

Observations from the First Six Years of Successful Administration of RGGI

Based on the analysis contained in our recent reports, we observe that impacts on electricity rates from well-designed CO_2 pollution control programs can be both modest and potentially accompanied by long-term benefits in the form of lower electricity bills and positive economic value to state and regional economies. There are sound reasons to be confident that a multi-state approach to carbon control can operate seamlessly as part of the electric system, lead to efficient price signals affecting power plant dispatch, reduce emissions, and provide opportunities to control compliance costs and enhance benefits to consumers, illustrated by the successful administration of the RGGI program over its first six years. RGGI's success can in part be attributed to:

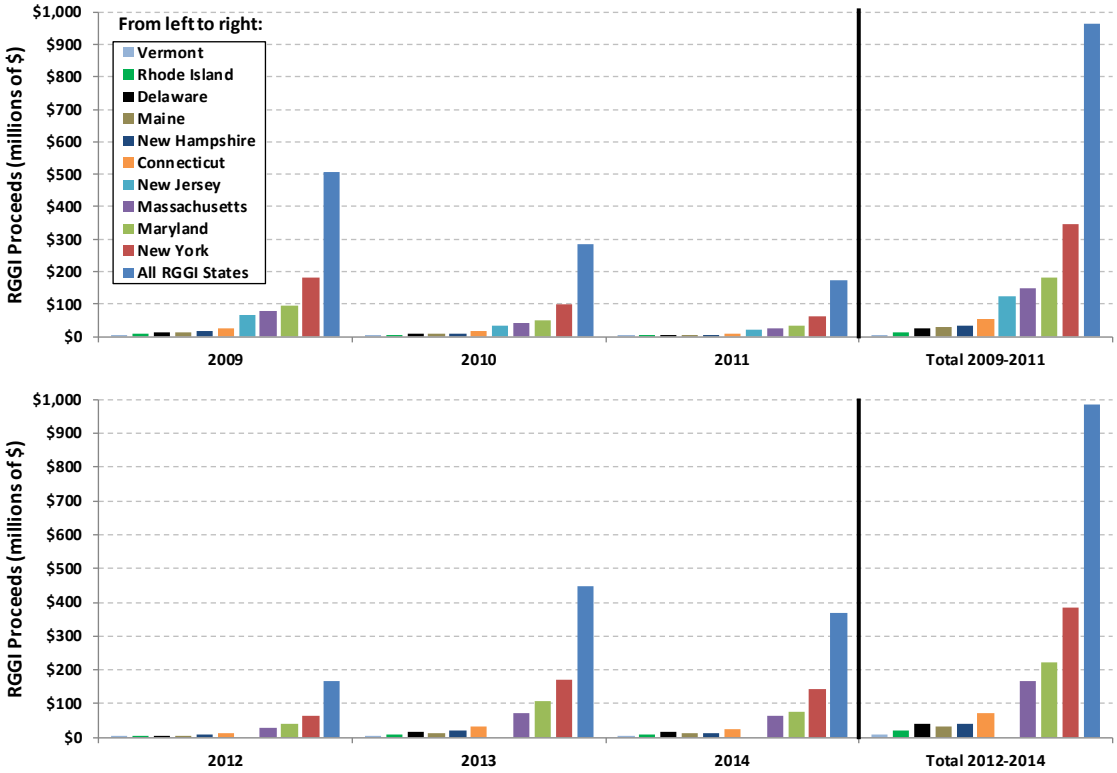
- *Careful auction and revenue assignment* – for example, establishing limits and allocation up-front; auctioning the allowances; allowing for the free trade of allowances subsequent to initial auction, up to the point at which compliance must be demonstrated; allocation of allowance revenues to states for reinvestment; and flexibility to allow states to use auction revenues in a manner consistent with their own policy objectives;
- *Program design and revision process* – both the initial design and the revisions made in 2013 under the Updated Model Rule occurred through collaborative processes involving a diverse set of states, including participation from state officials and industry, whereby each state that elected to join RGGI obtained authority to do so through its legislature and/or regulatory mechanisms. RGGI developed a 'model rule' that outlined the core design elements of the program, and then each state adopted its own enabling authority to allow it to participate. This meant that the participating states did not need to adopt a formal interstate compact under federal law, while still allowing the participating states to establish a coordinated and common mechanism for incorporating a carbon price into their power-system dispatch and operations;
- *Common auction and trading platforms* – ultimately, each RGGI state voluntarily decided to distribute the vast majority of CO_2 emission allowances through a common, centralized auction administered by the organization set up by states to run the program (RGGI, Inc.). This centralized administration and tracking of allowance ownership (which may exchange hands subsequent to the initial auction) provides participating RGGI states with administrative ease, allows for shared governance, and for effective monitoring of a single allowance trading market; and
- *State allowance revenue decisions* – the use of auction proceeds has varied across the states and over time, consistent with the enabling state legislation, regulation, and policy. However, as described more fully throughout this Report, the majority of RGGI funds have been reinvested in energy efficiency and renewable investment in part to mitigate the impact of the program on wholesale electricity prices and consumer electricity costs. This decision is the source of many of the electricity cost and economic benefits we find in our analysis.

3. PURPOSE AND METHOD FOR THE ANALYSIS OF COMPLIANCE PERIOD 2

Overview

From 2012 through 2014 (i.e., Compliance Period 2), the auction of RGGI CO_2 emission allowances has resulted in the collection and disbursement to states of nearly $983 million. See Figure 1.

Figure 1
RGGI Allowance Proceeds by State



Source: RGGI Inc.
Notes: Figures include Auctions 1-26 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.
New Jersey does not have auction proceeds after Compliance Period 1.

Consistent with the analysis in our AG 2011 Report, our analysis of Compliance Period 2 follows the allowance auction revenues and identifies 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 to demonstrate compliance, 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 that it focuses on the actual impacts of economic activity; known CO_2 allowance prices; observable CO_2 allowance proceeds (nearly $983 million in Compliance Period 2); 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 are four 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 an integrated analytic framework that separates and highlights RGGI-state impacts based on known historical program implementation data (i.e., during the second 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.
2. Next we conducted a thorough review of **data and information on use of revenues collected from the sale of RGGI allowances**. We began by relying on information provided in reports available on the RGGI, Inc. website, and then supplemented these data where needed from public sources focused on individual states. We used these data to develop a catalogue of how each state used its RGGI allowance proceeds. The purpose of this step was to track how RGGI revenues have been allocated and disbursed over Compliance Period 2, 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 different program expenditures provided job training, purchases of equipment, and so forth, as described further below).[19]
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 changes in the 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 investment in energy efficiency and advanced energy technologies. Our electric sector analysis was conducted using Ventyx's PROMOD model.[20]
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 nine 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,

[19] These various uses of allowance proceeds are described in the Appendix of this Report.
[20] The PROMOD model and our analysis of electric sector impacts are described in detail in the Appendix of this Report.

and the flow of RGGI-related dollars through other sectors of the economy. Our macroeconomic analysis was conducted using the IMPLAN model.[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 the core objectives of the RGGI program – namely, addressing the economic, social, health and environmental risks associated with climate change, health benefits associated with ancillary reductions in other pollutants, or reduced health and environmental impacts associated with other effects of fossil-fuel generation. While we recognize that these were the key motivators of states acting to control emissions of CO_2, we specifically and narrowly focus on the economic impacts of program design and administration.

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 under Compliance Period 2; 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 during Compliance Period 2.

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 only with RGGI's implementation during Compliance Period 2 (2012-2014) (the temporal perspective). Third, we wanted results that were grounded as much as feasible in actual, known expenditures, programs, and impacts (the empirical perspective).

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 second RGGI compliance period. We isolated the impacts of RGGI-related dollars associated with Compliance Period 2 only (2012-2014). This means that we included in power pricing the cost to power producers of obtaining RGGI

[21] The IMPLAN model and our analysis of macroeconomic impacts are described in detail in the Appendix of this Report.

allowances in the second three years of the program, and we included in power and economic sectoral investments only RGGI revenues that were collected during the second three years of the program.

Focusing on these three years of RGGI dollars, we tracked actual dollars collected from power producers during the 12 auctions that have occurred during Compliance Period 2, taking place from March 2012 through December 2014. The funds from these auctions flowed to the states immediately, with states spending them (or programming them for expenditures) during the 2012-2015 time period.[22] Within the electric system, the impacts of these initial auctions also show up during the 2012-2015 period, as power plant owners priced the value of CO_2 allowances into prices they offer in regional wholesale markets. The macroeconomic impacts occur over the time period that allowance proceeds are collected and spent (2012-2015), but there are longer-term effects associated with the imprint of energy efficiency and renewable resource expenditures made during that period on energy use for the following decade (through 2025). We thus track these direct effects of RGGI to date in the near term (i.e., Compliance Period 2), and in the long term track secondary impacts from expenditure of RGGI dollars by the states (for energy efficiency expenditures from 2012-2015, and from the implications of those energy efficiency measures on electricity use from 2012-2025).

From the perspective of modeling data and assumptions, we focus our analysis on known quantities associated with actual results from the second three years of the program. 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 those economic impacts associated with implementation of RGGI during Compliance Period 2: known allowance prices and revenues; known distribution of revenues to states; actual or committed expenditures associated with state proceeds; and observable impacts associated with RGGI-funded program implementation. In this sense, our analysis should be viewed as a snapshot of impacts associated with a finite period – Compliance Period 2 – 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 2012-2014 time period.

[22] Different budgeting and fiscal calendars in individual states sometimes meant that not all proceeds were spent in the same year that allowance proceeds were collected; thus spending impacts extend into 2015.

Data Collection and Processing

Overview

Our analysis began with the collection and processing of data related to RGGI program implementation in each of the nine states. Identifying and tracking the use of RGGI proceeds is fundamental to our analysis, and has been facilitated by states' reporting of their expenditures to RGGI, Inc. on a quarterly basis. This process also involved the translating of expenditures for energy efficiency measures and new renewable resources into impacts on power system energy consumption and electricity peak loads in various seasons and days of the year.

In the end, we were able to obtain most of the necessary data from the information reported to and by RGGI, Inc. Where information was missing or incomplete, we took successively deeper steps to fill in data gaps, sort out inconsistencies, establish proxy values, and arrive at a workably complete data set for use in the study.

Data Gathering

Approach

The first anchor point for our data analysis is the level of revenues collected through the quarterly auctions of allowances (nearly $983 million) during Compliance Period 2. This was the target amount of revenues that, in the end, we needed to match up with state program expenditures. We collected data on the sales of allowances into the market and on the allocation of those auction revenues to states. Total revenue allocations to states are shown in Figure 1.

During our prior analysis of the effects of RGGI during the program's first compliance period, 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. Since our AG 2011 Report, participating RGGI states have reported their spending of RGGI proceeds to RGGI, Inc. on a quarterly basis. RGGI, Inc. publishes these data and breaks expenditures down into the following seven investment categories: energy efficiency, clean and renewable energy, greenhouse gas abatement, direct bill assistance, administration, RGGI, Inc. administration, and transfers to the general fund.

Using these data, we traced and categorized in detail the actual use of RGGI auction proceeds for funding to various types activities, and identified 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 power system dispatch and economic impact through the PROMOD and IMPLAN modeling effort. For example, what are the annual household electricity savings, on- and off-peak, associated with energy efficiency programs? How many MWh of generation will flow annually from an installed solar photovoltaic system using RGGI dollars? Identifying such effects involved (1) collecting data and estimates by RGGI Inc. on such effects, and (2) 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 expenditures of RGGI auction proceeds and on estimated effects of RGGI-funded programs from all public sources. The public sources of information included publicly available reports on RGGI and/or separately on state energy efficiency programs.
- Using the existing data, we organized it for consistency. Since the information in some cases came from several sources, the data reflected varying levels of detail, requiring us to process the data to normalize it across the different sources, and to format the data for input into the PROMOD 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[23]), as well as for the entire RGGI footprint, are presented in Figures 2 through 5.

1) *Energy Efficiency and Other Utility Programs* – because much of the RGGI funds were spent on energy efficiency measures, and because different measures lead to different impacts on consumers' demand for electricity, we grouped information on energy efficiency programs into residential retrofit/new construction and commercial retrofit/new construction categories.
2) *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). We assume that this investment was largely supporting solar photovoltaic installations.
3) *Education and Job Training* – includes monies used for programs (i) to educate business and residential consumers about energy consumption and the 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.
4) *Clean Technology Research/Development* – includes grants and other funding to research or other public/private groups focused on the furthering research and development related to greenhouse gas emissions (including for example, clean technologies, alternative transportation, carbon sequestration, etc.).

[23] As described in further detail below, the nine 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 and Maryland are part of a larger electrical market administered by PJM.

5) *Direct Energy Bill Assistance* – includes use of RGGI funds to reduce bills paid by consumers for electricity and heating/cooling. In some cases, investments in this category are 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.

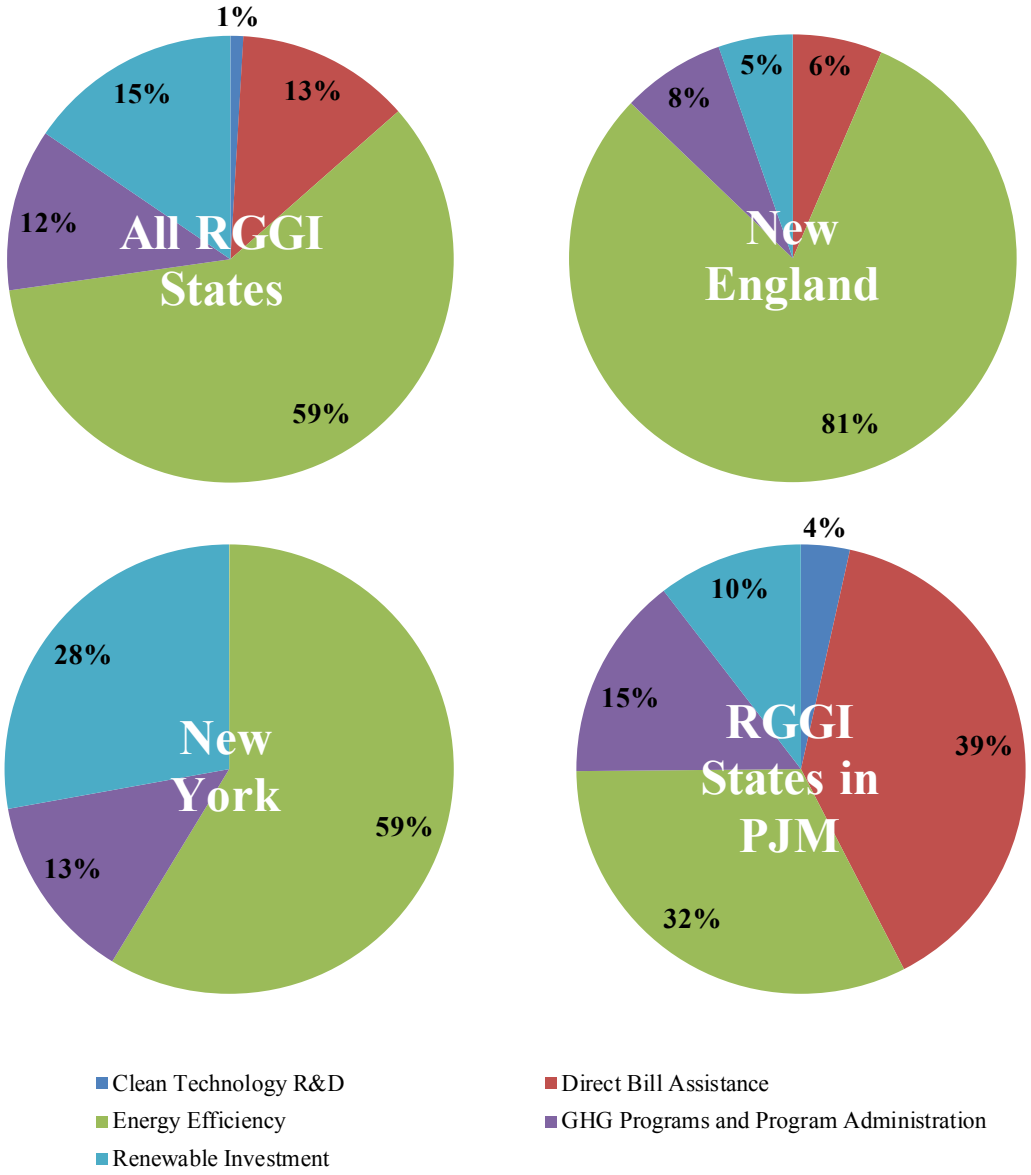
The amounts of funds spent by program category by region (and in the nine RGGI states as a whole) are show in Table 2 and Figure 2, below.

Table 2
Spending of RGGI Proceeds by State and Category
Compliance Period 2

	Clean Technology R&D	Direct Bill Assistance	Energy Efficiency	GHG Programs and Program Administration	Renewable Investment	Total
Connecticut	-	-	45,850,058	7,168,070	18,182,719	71,200,848
Maine	-	3,319,835	26,719,736	901,554	-	30,941,125
Massachusetts	-	-	151,830,811	14,266,301	-	166,097,112
New Hampshire	-	18,520,278	22,255,248	839,613	-	41,615,139
Rhode Island	-	-	18,760,694	1,846,553	-	20,607,248
Vermont	-	-	7,320,268	214,111	-	7,534,379
New England Subtotal	**-**	**21,840,113**	**272,736,815**	**25,236,203**	**18,182,719**	**337,995,849**
New York	-	-	224,990,831	51,685,650	106,677,226	383,353,707
New York Subtotal	**-**	**-**	**224,990,831**	**51,685,650**	**106,677,226**	**383,353,707**
Delaware	-	4,825,559	16,540,928	16,407,726	2,179,322	39,953,534
Maryland	9,145,611	96,967,773	68,309,433	22,043,389	25,133,479	221,599,686
RGGI States in PJM Subtotal	**9,145,611**	**101,793,332**	**84,850,361**	**38,451,115**	**27,312,800**	**261,553,219**
All RGGI States	**9,145,611**	**123,633,445**	**582,578,007**	**115,372,967**	**152,172,745**	**982,902,776**

Source: RGGI, Inc.
Note: For modeling purposes and due to their small size, education and job training proceeds were included in the energy efficiency category.

Figure 2
Summary of RGGI Proceed Spending
Compliance Period 2



Source: RGGI, Inc.

Note: For modeling purposes and due to their small size, education and job training proceeds were included in the energy efficiency category.

Modeling Approach

Overview

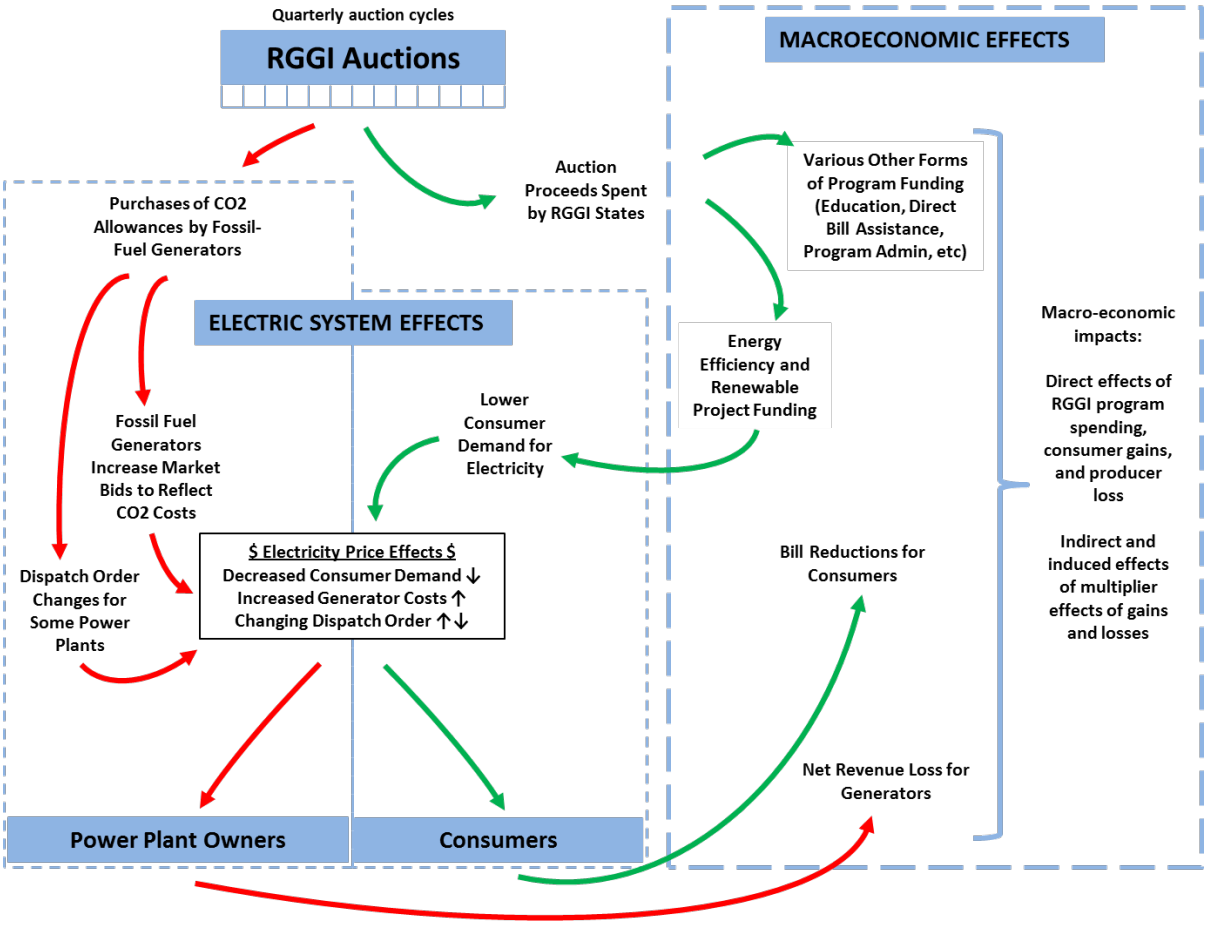
Since our goal was to track the impact on the economy resulting from the purchase of RGGI allowances by power producers and the states' use of those RGGI allowance proceeds during Compliance Period 2, we needed to construct a counterfactual electric system that did not reflect RGGI funding, and develop an analysis that followed the RGGI funds through the economy. We provide the details of our assessment tools in the Appendix of this Report, which describes the IMPLAN and PROMOD 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, many states reinvest allowance proceeds in the power sector to facilitate cost-effective reductions in power sector emissions of CO_2, and to mitigate the impact of the RGGI program on consumers' electricity costs. Thus, both 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 economy.

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 3.

Our modeling approach combines analysis of power sector effects (through modeling using PROMOD), 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 PROMOD model, we run a dispatch of the nine-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; and projections of fuel prices and allowance prices for NO_x and SO_2; etc. In the IMPLAN analysis, we start with economic relationships that exist among providers and users of goods and services in the nine RGGI states, and then we introduce the direct expenditures (RGGI proceeds) and the revenue gains and losses to electricity consumers and power producers (from the PROMOD model).

Figure 3
Flow of Data and Modeling Outcomes



The two cases in PROMOD 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 during Compliance Period 2. It includes all of the programs, measures, investments, and funding that are associated with the second RGGI compliance period, 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 the second compliance period. 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. But for these changes, all elements of the modeling process are identical across cases.

We then traced the dollar differences in these two PROMOD 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.

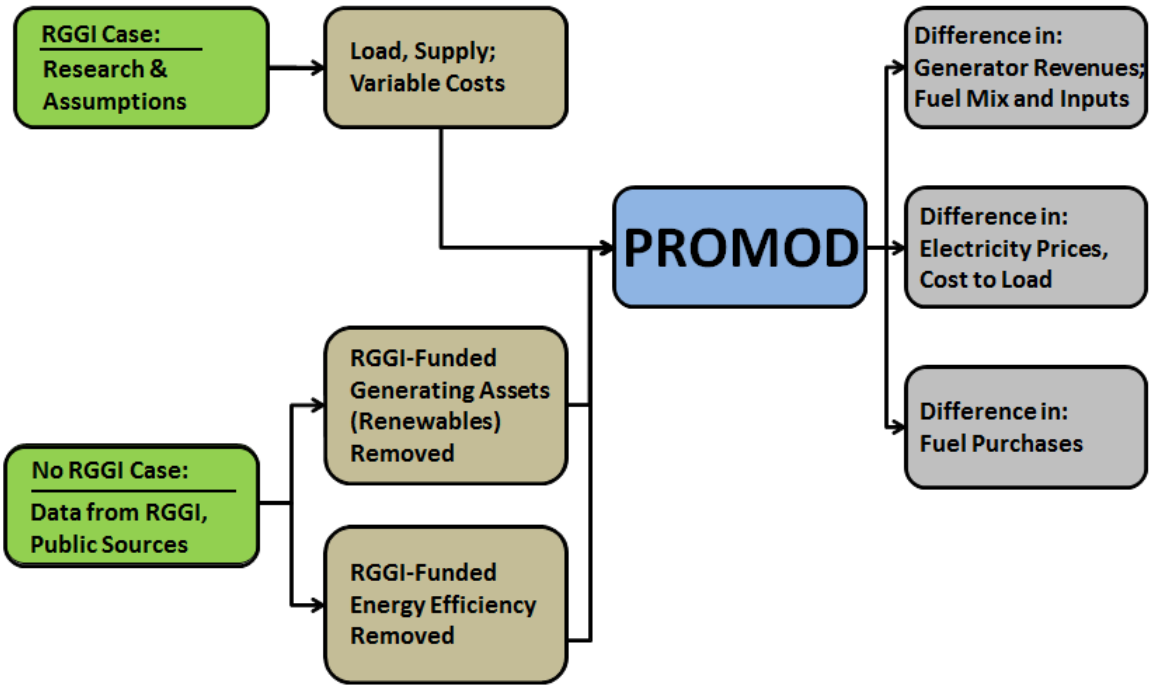
In the following sections, we summarize the power system and macroeconomic models, and highlight a few key factors of the modeling approach that help to interpret the results. More detail is available in the Appendix.

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, demand and marginal prices are at times decreased by energy efficiency measures installed, and renewable resources installed, with the use of RGGI allowance proceeds.

Using the PROMOD 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 in the second compliance period. (See the Appendix for a detailed description of the PROMOD modeling platform, whose core logic is explained briefly below.) These relationships are summarized in Figure 4. Using PROMOD, we created the "with RGGI" case (benchmarking the modeling results to the actual electric output that was observed in 2012-2014) and then constructed a counterfactual "no-RGGI" case. Comparing the results of the two cases provided information about the incremental effect of RGGI's Compliance Period 2 on power system users and producers.

Figure 4
Diagram of PROMOD 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 PROMOD 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 PROMOD 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 PROMOD 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 3 above, we simulated the dispatch of the three regional power systems that contain the RGGI states for each hour of the modeling period (January 2012 through December 2025) for both the "with RGGI" and "no-RGGI" cases.[24] 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 PROMOD 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 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.

[24] See the Appendix for more information about PROMOD and the modeling area.

Additionally, we use the output data from PROMOD 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 PROMOD model with all categories of the direct investment of RGGI allowance revenues in the macroeconomic model, IMPLAN.

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, 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 assumptions about the systems and economies that we are studying. These assumptions relate to: (1) the relevant boundaries (e.g., geographic, temporal) of 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 Compliance Period 2

First, the analysis does not specifically control for pricing for carbon or for any additional RGGI-funded investments in energy efficiency or generation before or after the program's second compliance period. For modeling purposes alone, and in order to isolate the incremental effects only of Compliance Period 2, we made no assumptions about RGGI continuing beyond 2014, nor did we model any differences in impacts associated with the first compliance period – that is, both the base case and the but-for case include power system conditions as they have evolved, including as influenced by RGGI investments in its first three years. 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 2025). 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 is specifically intended to allow for isolating the specific impacts of RGGI implementation during Compliance Period 2, holding all else equal and without judging how emission control programs may evolve.

Timing of Economic Impacts that Affect the Power Sector

The focus on actual expenditures and impacts in only the second 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 immediately, during the first three years of the modeling period (i.e., Compliance Period 2), while the benefits to a certain extent flow to consumers over the entire study period (through 2025). Conversely, the benefits flow to owners of power plants early on (when marginal power prices are higher), with outer-year effects diminishing those net positive revenues received during the three years of the second 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

Given the various uses of RGGI funds for EE, there are two major analytic challenges in the PROMOD 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.

As part of our AG 2011 Report of RGGI's first compliance period, we reviewed where available 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. Consistent with that approach, we adopted the same ten-year measure life for our analysis of the second compliance period.

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). We used the analysis done in our AG 2011 Report for the same purpose here, using information about specific programs and breakdowns of timing for when savings occurred.

Using these characterizations of EE program impacts found during our AG 2011 report, we calculated hourly adjustments to load for each EE program, and in aggregate for all programs used these to adjust hourly load in the PROMOD 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 second three years of operation (i.e., Compliance Period 2). Thus, it sheds light only on economic issues associated directly with program implementation, and does not address the many other objectives that underpinned the RGGI states' adoption of the program, or economic impacts that flow over time from reducing damages associated with climate change.[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 the market at market prices (rather than for free, as was largely done in the SO_2 and NO_x allowance programs). The decisions to distribute allowances in this manner reflected complex determinations by each state, which allowed for the use of auction proceeds to pursue specific energy- and non-energy-related public policies, including providing an opportunity to both address some of the potential cost impacts of RGGI program implementation, and to pursue other key public policy objectives.

RGGI auctions for the Compliance Period 2 produced $983 million. These auction revenues were distributed to (or held by) states in the following amounts:

[25] The RGGI States' 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." The MOU also declares a 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.

- $71.2 million for Connecticut
- $40.0 million for Delaware
- $30.9 million for Maine
- $221.6 million for Maryland
- $166.1 million for Massachusetts
- $41.6 million for New Hampshire
- $383.4 million for New York
- $20.6 million for Rhode Island
- $7.5 million for Vermont

See Figure 1(above) for proceeds received in each year by the nine 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 nine states, and for the RGGI region as a whole, are summarized in Table 3. This summary points out the bottom line: RGGI has produced positive economic outcomes for each RGGI state and for the region as a whole.

Table 3
Summary of Economic Impacts, by RGGI State and Region

State/Region	Value Added [1] ($2015 Millions)	Employment [2] (Cumulative job-years)
Connecticut	$56.2	863
Maine	122.3	1,113
Massachusetts	243.3	2,718
New Hampshire	67.3	583
Rhode Island	16.6	195
Vermont	14.8	177
New England Subtotal	**$520.5**	**5,649**
New York	$385.5	4,463
New York Subtotal	**$385.5**	**4,463**
Delaware	$107.3	952
Maryland	213.8	2,475
RGGI States in PJM Subtotal	**$321.1**	**3,428**
Regional Impact [3]	**$69.6**	**615**
All RGGI States	**$1,296.7**	**14,155**

Notes:
[1] Value Added reflects the actual economic value added to the state and regional economies and thus does not include the costs of goods purchased from or manufactured outside of the state or region.
[2] Employment represents cumulative job-years over the 2012-2025 period as output from IMPLAN.
[3] Regional Impact reflects the indirect and induced impacts within the RGGI region as a result of state dollar impacts.
[4] Results are discounted to 2015 dollars using a 3% social discount rate and reflect adjustments for inflation.

The RGGI States Combined

Impact on the General Economy

Overall, RGGI's second compliance period produced a net present value economic benefit of $1.3 billion.[27] As can be seen in Table 3, all regions experience positive economic impacts.[28]

Generally speaking, these positive impacts result 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

[27] For calculating benefits associated with the states' RGGI Program, we use a social discount rate of 3 percent. Using instead a 7 percent private discount rate, the NPV benefit is $0.9 billion.
[28] Note that individual region totals do not reflect their specific Regional Impact, which is summarized in aggregate at the bottom of Table 3. See the section below titled "Regional Differences" for results including region-specific Regional Impacts.

impacts associated with a loss of power plant owner net revenues from allowance purchases and power system dispatch and price effects (see below). The first two more than offset the latter, resulting in a net positive economic benefit over the modeling period.

Impact on the Electric Sector

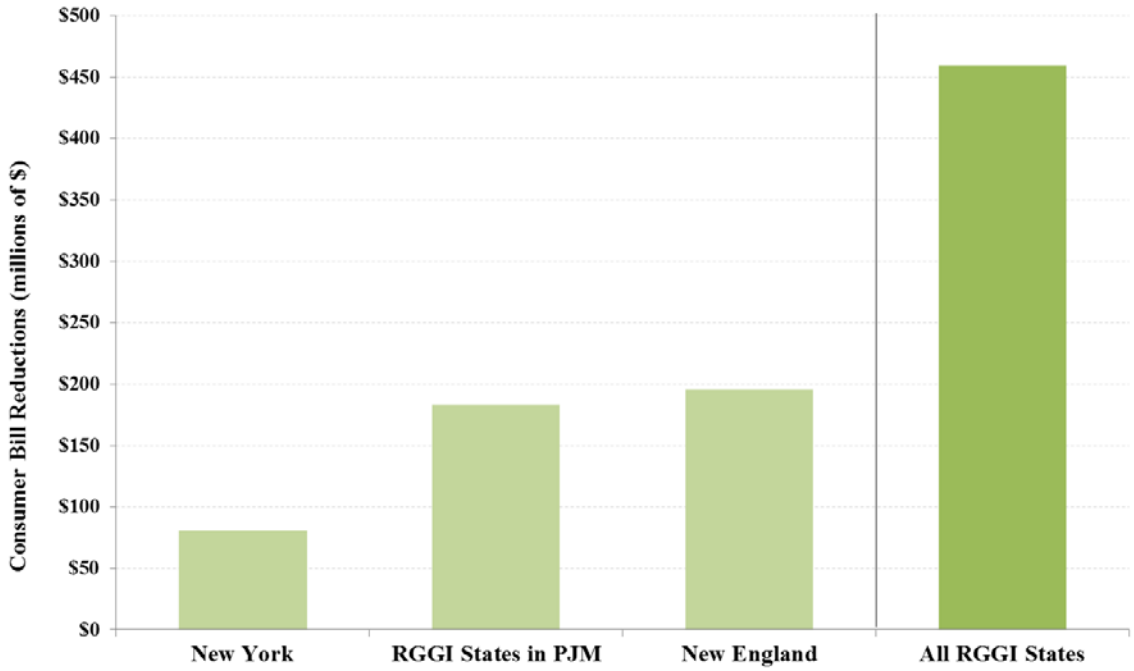
From a consumer perspective, RGGI program impacts are net positive over the study period. Although CO_2 allowances tend to raise electricity prices in the near term, there is also a lowering of prices over time primarily because the states invest so much of the allowance proceeds on energy efficiency 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. In addition, 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 electricity price increases, consumers gain because their overall electricity bills (and heating 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 $459 million, as their energy bills drop over time.[29]

This reflects average savings spread across residential, commercial and 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 $118 million through RGGI programs that reduce consumption of oil and natural gas heat homes (either directly or as a result of electricity-focused measures). These savings are above and beyond those experienced in the electric system.

Figure 5 summarizes the overall gains to consumers by region, including bill savings in electricity, gas, and oil markets.

[29] Under a 7 percent private discount rate, gains to electricity consumers overall are nearly $150 million.

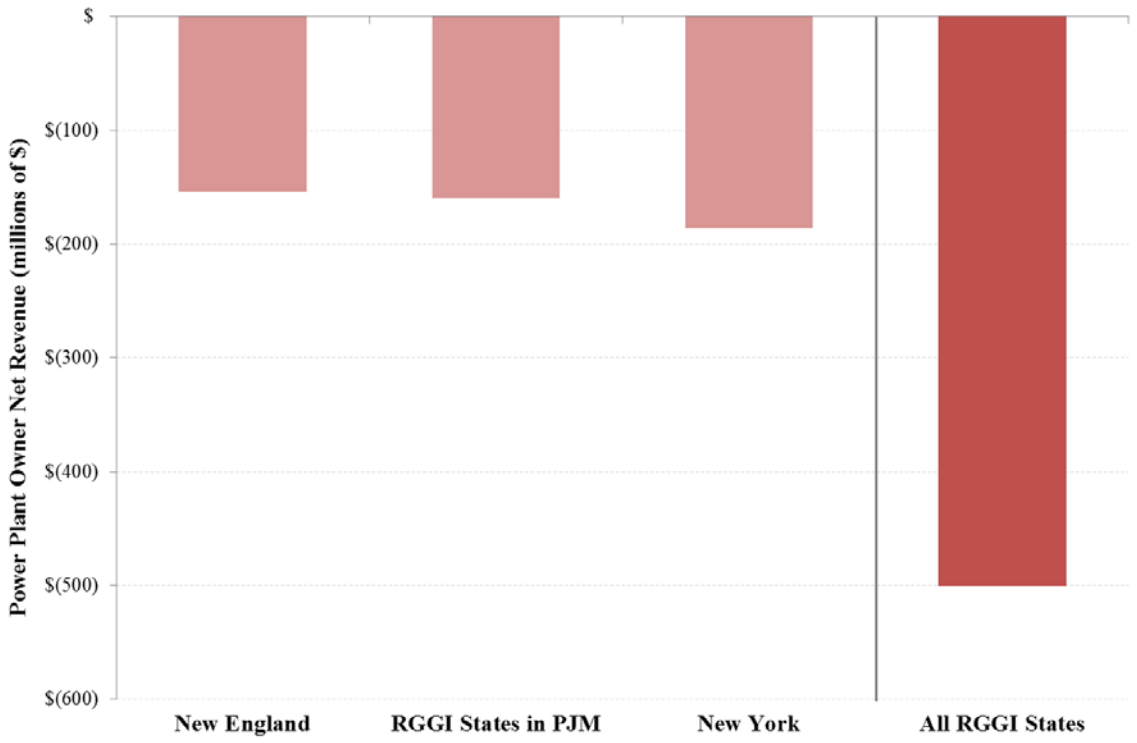
Figure 5
Consumer Bill Reductions by Region (2015$)



Notes: Figures include PROMOD outputs, non-electric benefit calculations, capacity market gain calculations, and direct bill assistance savings.
Figures represent dollars discounted to 2015 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 to owners of generating assets of approximately $500 million. Although power plant owners have to purchase CO_2 allowances, they recover all of their early expenditures during the 2012–2014 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 region in Figure 6. However, these impacts are not distributed equally across power plant owners; RGGI affords a competitive advantage to power plants with lower CO_2 emissions than their competitors.

Figure 6
Net Revenue Change for Power Plant Owners (2015$)



Notes: Figures include PROMOD outputs, allowance true-up calculations and capacity market loss calculations. Figures represent dollars discounted to 2015 using a 3% 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 nearly 14,200 new job-years (see Table 3), and reduced payments to out-of-region providers of fossil fuels by just over $1.27 billion.

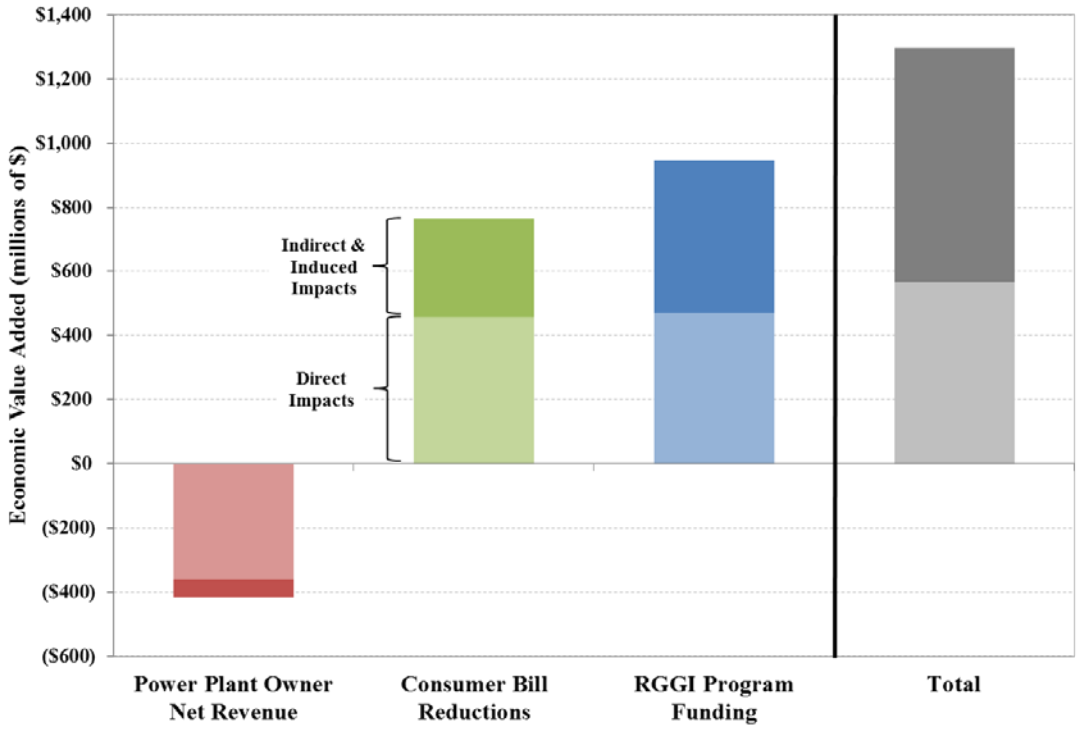
Contributions to Economic Impact

As noted above, RGGI's second compliance period produced a net present value economic benefit of $1.3 billion. 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.[30] As these individual impacts ripple through the economy, they have the net effect of

[30] Note that analyzing the economic value added means that a dollar of direct spending does not translate into a direct effect of one dollar of value added. For example, if a dollar is spent in region on light bulbs, the direct value added is only the net revenue and income of the retail store where the light bulb was purchased, thus excluding the manufacturing costs of the light bulb itself. The same holds true for the direct revenue change to power plant owners (direct consumer bill impacts are assumed to be equal to the value added to consumers).

producing positive economic value. This can be seen in Figure 7, which shows the direct, indirect, and induced economic impacts to the nine-state region from the individual components described above.

Figure 7
Net Economic Impacts for the Nine State RGGI Region (2015$)



Notes: Figures represent dollars discounted to 2015 using a 3% public discount rate.

Regional Differences

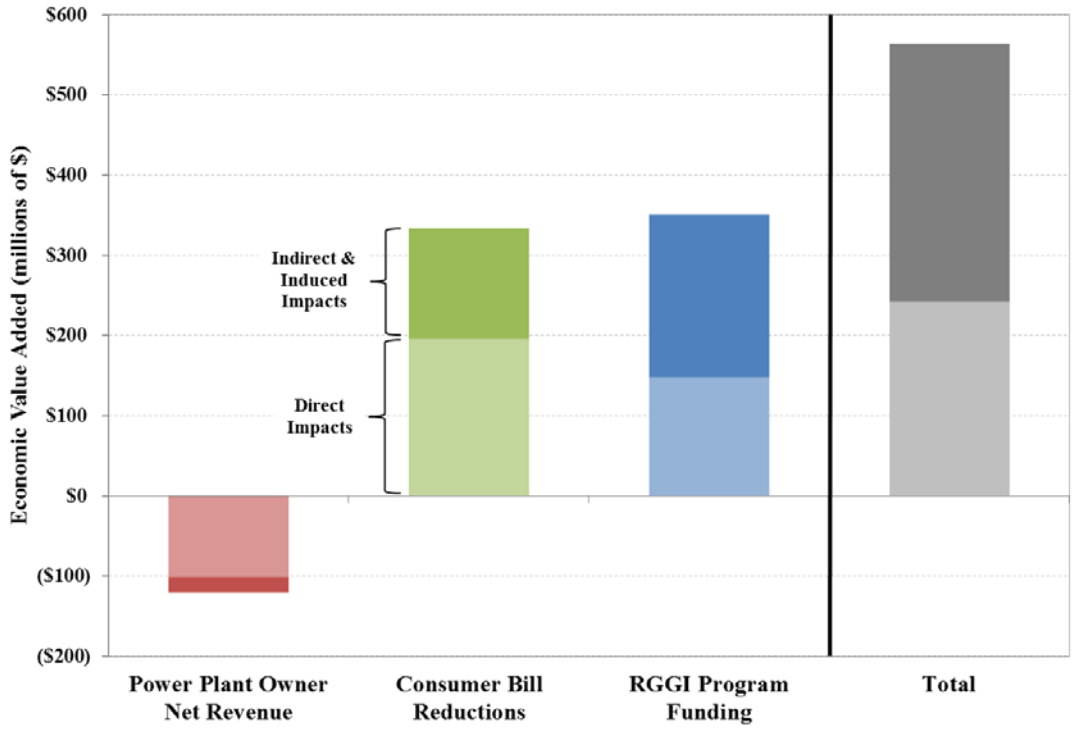
Because the nine RGGI states fall into three electrical regions, each with a common electric market, we also analyzed the impacts of RGGI on a regional basis. The three electric regions are: the New England states (with a market operated by ISO-NE); New York (with a market administered by NYISO); and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

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.

New England

In New England, over $560 million of positive overall macroeconomic impacts accrue to the six-state region. These effects include net positive electric sector impacts (see above) and the net positive impacts of direct spending on programs, research, bill assistance, and administrative obligations. See Figure 8.

Figure 8
Net Economic Impacts for the States in New England (2015$)



Notes: Figures represent dollars discounted to 2015 using a 3% public discount rate.

As shown, net negative impacts to power producers are offset by net positive impacts on consumer spending for electric and non-electric energy services.[31] Although New England consumers faced net electricity price increases from 2012–2014, the long-term gains more than offset these initial increases in electricity bills and are greater than the net revenue losses to power producers from a

[31] 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 $333 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. As part of this, consumers save approximately $29 million in heating bills through RGGI programs focused on reducing consumption of oil and natural gas to heat homes in New England.

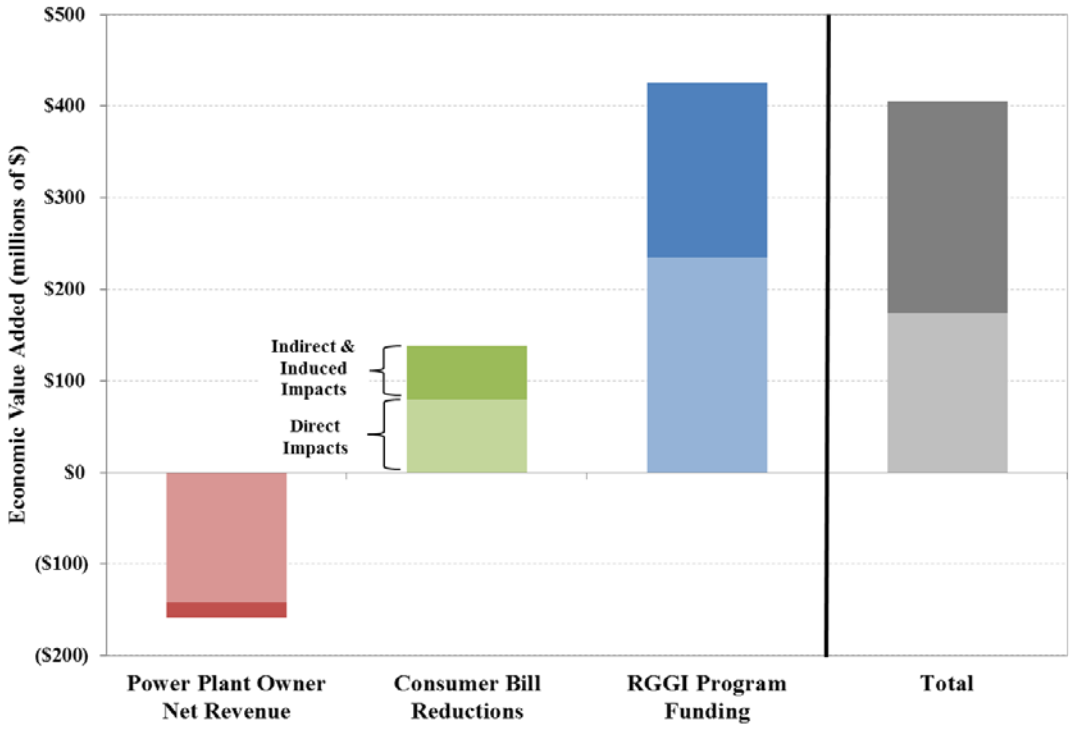
total local economic impact perspective. These combine with the direct and induced impacts associated with the injection of RGGI dollars into the purchase of economic goods and services with positive multiplier effects on the New England economy.

Additionally, RGGI proceeds end up producing positive employment impacts, amounting to an increase of over 5,600 new job-years in New England, and reduced payments to out-of-region providers of fossil fuels of approximately $407 million.

New York

RGGI also resulted in positive economic value to the New York economy, amounting to over $400 million in economic value added. The positive gains from recirculating RGGI funds through the economy offset the net impacts experienced in the electric sector. The overall result and the pieces contributing to it are presented in Figure 9.

Figure 9
Net Economic Impacts for New York (2015$)



Notes: Figures represent dollars discounted to 2015 using a 3% public discount rate.

Although New York faced net electricity price increases from 2012–2014, because New York spent much of its RGGI funds outside the electric sector, the majority of positive gains fell outside of the electric market impacts. While electricity consumers over time enjoy additional bill savings through

reduced electricity purchases,[32] these savings are less than the net present value of revenue loss experienced by power plant owners over the modeling period.[33]

In addition to an economic benefit, RGGI proceeds led to programs producing almost 4,500 job-years in the region, and reduced payments to out-of-region providers of fossil fuels by approximately $342 million.

RGGI States in PJM

The overall impact of RGGI on the economies of the PJM states (Delaware and Maryland) was also positive, with almost $330 million in economic value added to these two states. These impacts reflect the combined effects on the electric sector and the use of RGGI allowance proceeds on energy efficiency programs, rebates, administrative obligations, and government functions. The overall result and the pieces contributing to it are presented in Figure 10.

As shown, net negative impacts to power producers are less than the net positive impacts on consumer spending for electric and non-electric energy services.[34] Although consumers faced net electricity price increases from 2012–2014, the long-term gains more than offset these initial increases in electricity bills. 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 economy.

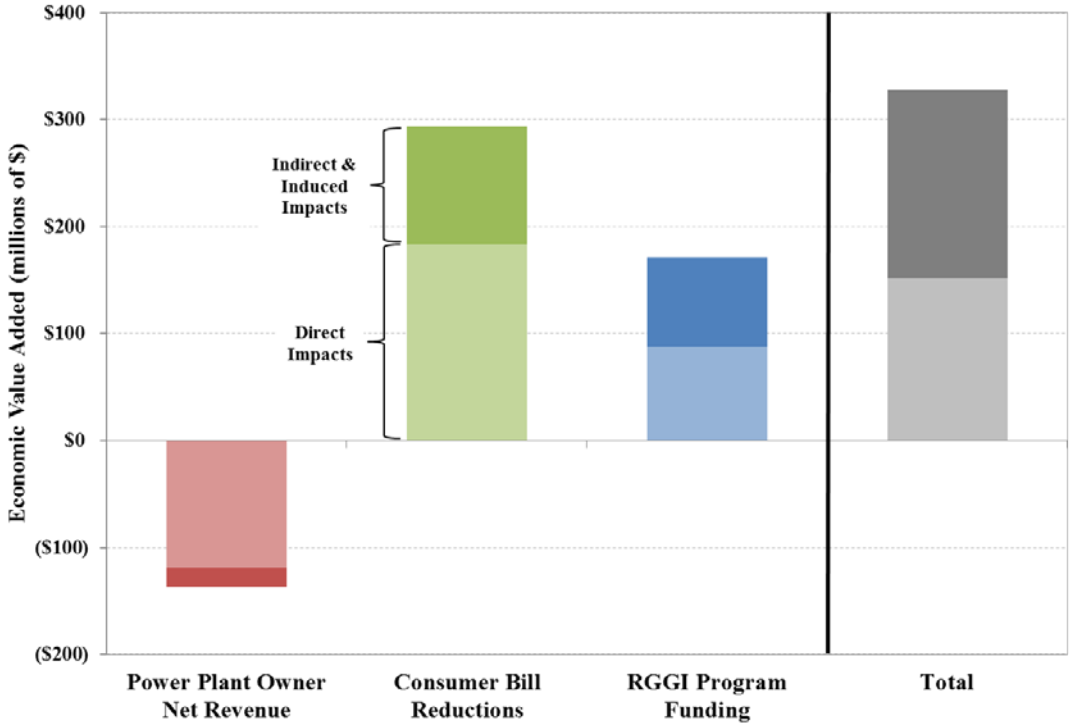
Additionally, RGGI-funded programs resulted in a positive employment impact amounting to over 3,400 job-years in Delaware and Maryland. RGGI also reduced payments to out-of-region providers of fossil fuels by approximately $521 million.

[32] 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 $138 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. As part of this, consumers save approximately $54 million in heating bills through RGGI programs focused on reducing consumption of oil and natural gas to heat homes in New York.

[33] From the perspective of New York's power generation sector, RGGI program compliance during the second compliance period decreased supplier revenues on a net present value basis by approximately $159 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.

[34] 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 $294 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 $35 million in heating bills through RGGI programs focused on reducing consumption of oil and natural gas to heat homes in the PJM RGGI states.

Figure 10
Net Economic Impacts for the RGGI States in PJM (2015$)



Notes: Figures represent dollars discounted to 2015 using a 3% public discount rate.

5. OBSERVATIONS AND CONCLUSIONS

The results presented in the prior section, combined with our prior reviews of RGGI program administration and effects on electricity consumers and the economies of the RGGI states, 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 its original goals. The observations are also highly relevant to states as they consider alternative for compliance with EPA's Clean Power Plan.

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

Based on the first six 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 CO_2 in Northeast and Mid-Atlantic electricity markets has been seamless from an operational point of view, and successful from an economic perspective.

As with our review of the first RGGI Compliance Period, our review of Compliance Period 2 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). Importantly, our review of six years of the nation's first CO_2 cap and trade program does not suggest that CO_2 control programs will always generate net economic benefits. What the analysis does demonstrate, however, is that *one can not assume* that meeting states' and EPA's goals of reducing the social, economic and environmental risks of climate change will harm the economy. Our analysis provides strong evidence to the contrary – the design and administration of a mass-based, allowance trading system in the RGGI states – with revenues reinvested locally in energy efficiency, renewable energy, consumer bill reductions, and other programs – has for six years generated positive economic impacts for the participating states, beyond any health benefits of reducing pollution.

The use of RGGI allowance revenues has produced positive economic impacts while administration of the RGGI program has proceeded smoothly. Twenty-six auctions were held over the first two compliance periods, and the auctions resulted in the distribution of the majority of available allowances. Allowances have been traded in the secondary market throughout the program's first six years, 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 carbon caps established by RGGI have been met, with decreasing emissions of CO_2 across the RGGI states. RGGI Inc. and the states have effectively tracked the use of allowance proceeds, and states successfully completed a major program modification (including necessary stakeholder processes and regulatory proceedings) following the first Compliance Period. All states continue to work cooperatively and constructively towards evolution of the program, and towards adaptation of the program to meet EPA's Clean Power Plan compliance requirements.

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

Review of the Nation's First Multi-State, Mass-Based CO_2 Emission Control Program Can Provide Valuable Lessons for States Considering Clean Power Plan Compliance Alternatives

EPA's Clean Power Plan has focused industry and state policymaker attention on the various alternatives for controlling emissions of CO_2 from the electricity sector, in part because EPA's proposal is structured to provide a high degree of flexibility and choice for states, including the possibility of (and incentives for) multi-state compliance planning, and the use of a mass-based program with tradable allowances.[35] Lessons learned in the six-plus years of RGGI implementation thus directly relate to fundamental state economic, energy and environmental policy questions tied to Clean Power Plan compliance choices: What are the best compliance alternatives? Will joint, multi-state compliance help individual states or all states? What makes sense from the perspectives of developing in-state resources to meet state electricity demand? What will be the impact of various compliance opportunities on state economic outcomes?

The states that agreed to establish the RGGI program began with a design cut from whole cloth, expecting that they did so at some risk to economic activity, and with little historical basis for understanding the potential impact on energy markets and policy. There are now six complete years of administration of the RGGI program, with *many* lessons that may be learned with respect to the ability to collaboratively design and administer a multi-state program; options to structure a market-based trading platform; the processes involved at the individual state level; mechanisms to preserve state authority and flexibility; the interaction of such a program with wholesale electricity markets; the features that determine ultimate costs to consumers; and the influence of compliance designs on local and regional economic impacts. The deep experience of the RGGI region afford highly relevant data points for states that now must grapple for the first time with the development of state plans for CO_2 controls.

Many of the connections to EPA's proposed Clean Power Plan flow from the observations that follow with respect to RGGI program implementation.

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[35] A recent study performed by researchers at the University of Texas at Austin summarized the results of a survey of electric companies and state officials with respect to several key issues, including attitudes about mass-based versus rate-based program designs: "The overwhelming majority of survey respondents favored the development of state compliance plans rather than federally-developed plans. There was broad support, among survey respondents, for mass-based trading programs….Support was found in both Democratic- and Republican-controlled states but was higher in the former than the latter…. Most survey respondents favored market-based compliance options. 68 percent of respondents indicated that they preferred mass-based trading over other market-based options. 11 percent of respondents listed rate-based trading as their preferred option. Almost two-thirds of survey respondents favored adoption of mass-based emissions targets, arguing that they are easier to implement than the rate-based targets proposed by EPA. .The bulk of survey respondents supported interstate cooperation on the Clean Power Plan, with 90 percent arguing that states should develop multi-state plans or single-state plans that preserve the option to trade across state lines. Melinda Taylor and Romany Webb, "EPA's Clean Power Plan: Implementation Options – Survey Results: Insights from Industry Experts and State Officials on Implementation of EPA's Clean Power Plan," Kay Bailey Hutchison Center for Energy, Law & Business, University of Texas at Austin, June 2015. http://kbhenergycenter.utexas.edu/files/2015/06/Final_Report-EPA-Clean-Power-Plan-Implementation-Options_6.23.2015.pdf.

The RGGI Model Has Successfully Achieved CO_2 Reductions through a Cooperative Framework that Preserves State Authority

The states that comprise the RGGI region are highly diverse in many ways – the political setting and state policy objectives vary widely across the states, and have also changed significantly *within* states over the timeframe of the first six years; state electricity generating portfolios differ substantially in size, technologies, fuel mix, and age; state industrial and commercial profiles and the bases of economic activity cover a wide range of technologies, products and activities across the RGGI region; the degree of development interest in traditional power generation sources, renewables, and energy efficiency differs; and every state has unique legal and regulatory structures that oversee energy, utility, and environmental policies.

Despite these differences, the RGGI states have successfully navigated the complications that can arise from efforts to coordinate regulatory and policy objectives across state lines. RGGI's experience confirms the possibility that states can work together, particularly when doing so is likely to lower compliance costs and generate economic benefits. The degree of effective cooperation is evidenced by RGGI states' ability to:

- Take the idea of joint, market-based carbon control from concept to reality in just over five years, despite the fact that there was no prior model or experience to draw upon, and that the states had to (a) conduct the necessary analysis, modeling, and negotiations to support program objectives, expected costs, cap levels, and state allocations; (b) agree among themselves on controversial program design features (e.g., cap level, dispersal of allowances, organization and governance, etc.), (c) establish a model rule for regional cooperation and program administration; (d) do so within the context of a regional stakeholder process; and (e) *then* carry out individual state processes, including stakeholder and regulatory review, to establish the laws, regulations and policies within each state's jurisdiction to enable participation in the program;
- Establish and successfully administer regional governance to address all issues through decisions of a Board made up of individual state representatives, and create staff committees to monitor the program, review key program issues, and support program administration;
- Create a regional organization (RGGI Inc.) to administer regional allowance auctions, convene and facilitate the Board's decision-making process, provide analytic and administrative support to the states, administer contracts for auctions, market monitoring and other support activities, and record program data/results and changes to program design and administration;
- Conduct a top-to-bottom program design review after the first Compliance Period, deliberate over and agree on major changes to program cap levels and program administration, and administer such changes through regional and individual state review processes; and
- Proactively work together to consider the potential impact of the Clean Power Plan on state CO_2 reduction targets, file comments in EPA's proceeding, and deliberate on how the RGGI program may be adapted to comply with final EPA requirements.

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 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. Yet 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).

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 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 two compliance periods, 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 six years lead to net economic benefits and a wide array of ancillary public policy achievements. 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 two compliance periods.

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,[36] some states contributed a much larger amount to those ends.

[36] 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

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 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.

States Have Demonstrated the Capabilities to Manage RGGI Program Costs and Benefits Effectively, and in a Way that is Fair and Protects Low-Income Customers

As described in our AG 2014 Report, states have demonstrated the ability to develop RGGI implementation strategies in a manner that spreads the benefits of reinvestment of RGGI auction proceeds fairly among electric customers, and protects low-income consumers. This is a function of both a focus on public policy objectives when considering the investment of auction proceeds, as well as normal ratemaking practices and other regulatory policies in states across the country that are designed to mitigate rate impacts of investments and program costs affecting production and delivery of power to consumers. Although states differ in many ways – including in terms of the electric systems, their regulatory culture, and their electric industry structure –all states have programs, policies and practices that will allow them to develop plans that align well with their different circumstances.

Market-based mechanisms, such as the RGGI program, offer unique opportunities to minimize costs while also reducing CO_2 emissions from existing power plants. They can be done within a state or across a number of states. Pricing carbon in this way sends efficient, market-based signals for investment and operation of the electric system. Experience shows that such programs can be designed to achieve a number of state policy objectives, can lower electricity bills, and can deliver positive net economic benefits. While the trading of emission allowances can be viewed as providing CO_2-emitting generators a high degree of compliance flexibility (e.g., by being able to purchase allowances rather than controlling emissions "inside the fence"), it is precisely this flexibility that ensures a state meets its bottom-line emission goal (or cap) at the lowest possible cost to all business and residential consumers. This is particularly relevant for CO_2, since the health impacts that flow from CO_2 emissions are not tied to direct exposure to stack emissions of the pollutant.

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."

Finally, states are well equipped through long-standing utility ratemaking principles and practices and implementation of energy programs to help protect low-income customers when electricity costs increase. Such tools include low-income rates and arrearage management plans, dedicated funding for low-income energy-efficiency and weatherization programs, utility-driven charitable contributions. States have demonstrated the focus, interest, and capability needed to ensure that any price impacts associated with emission control programs do not disproportionately fall on any particular class of electric customers.

RGGI Produced New Jobs

Taking into account consumer gains, power plant owners' losses, and net positive economic impacts, RGGI has 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 second three years of RGGI will lead to nearly 14,200 new job-years, with each of the nine 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; the workers in state-funded programs that might have been cut had a state not used RGGI funds to close budget gaps.

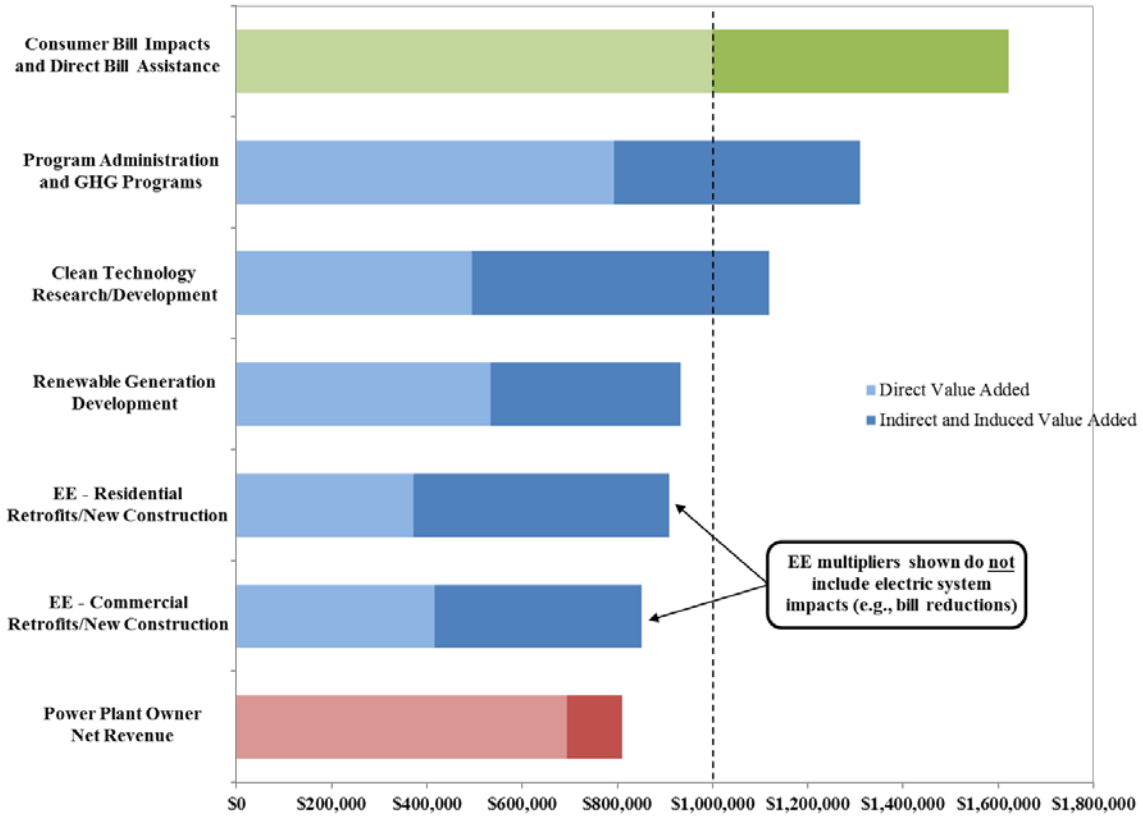
Value Added in the Economy for State Funding, Bill Reductions, and Education Strongly Outweigh the Direct and Induced Effects of Power Generator Revenue Loss

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 only approximately $800 thousand.[37] By contrast, $1 million of added contribution to clean technology and development leads to positive impacts on the economy of approximately $1.1 million; $1 million going to directly reduce consumer electricity bills generates positive economic impacts of approximately $1.6 million, (see Figure 11). The relative magnitude of these economic multipliers strongly influences the overall positive economic impact of RGGI implementation in Compliance Period 2.

[37] In the power generation sector, as with other areas of the economy, a loss (or gain) of $1 in sales does not reflect an equal loss (or gain) of $1 in economic value added, due to the cost of inputs needed to generate those sales. The power generation sector, however, has a lower multiplier effect than other sectors (in the form of indirect and induced impacts), which in turn is why that sector ends up having less than a 1-to-1 ratio of sales to total economic value added impacts.

Figure 11
Average Multiplier Effects for RGGI Program Spending Categories



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 (Delaware and Maryland)).

The Successful Implementation of RGGI Provides a Useful Point of Reference for States Evaluating Clean Power Plan Compliance Options

The experience of the RGGI states over the past ten-plus years, from conception of a regional market-based CO_2 control program, through six years of program administration, provides a wealth of data and lessons that may be useful to states deliberating Clean Power Plan compliance alternatives. As detailed in this Report, key messages that flow from a programmatic and quantitative economic analysis of RGGI include the following:

- The RGGI experience conclusively demonstrates the feasibility and value of coordinated multi-state approaches to controlling CO_2. The RGGI experience provides information on the ability of diverse states to jointly design and administer such a program, and may be studied by states considering this as a compliance option;
- States can work effectively and cooperatively together to achieve Clean Power Plan compliance requirements while fully preserving state jurisdiction, autonomy, and control;
- Multi-state, mass-based programs, with open trading of allowances, have the potential to reduce or even minimize the costs to states of meeting EPA's Clean Power Plan compliance requirements, and depending on program design can reduce electricity costs for consumers and generate net economic benefits and jobs; and
- Such market-based compliance programs can be designed and implemented in a way that ensures equitable treatment across customers, helps achieve energy policy goals, and delivers local economic benefits to the states; important in this respect are key design decisions related to the auctioning of allowances, free trading across states, and how allowance revenues are reinvested within the states and inclusion of both new and existing generating resources.

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APPENDICES

MODELING OF ELECTRIC SYSTEM IMPACTS:

PROMOD

Electric System Model Overview: PROMOD

The PROMOD Model

PROMOD is an electric market simulation model marketed by Ventyx. PROMOD provides a geographically and electrically detailed representation of the topology of the electric power system, including generation resources, transmission resources, and load. This detailed representation allows the model to capture the effect of transmission constraints on the ability to flow power from generators to load, and thus calculates Locational Marginal Prices ("LMPs") at individual nodes within the system. PROMOD and similar dispatch modeling programs are used to forecast electricity prices, understand transmission flows and constraints, and predict generation output. Ventyx simulation-ready data includes data on Eastern Interconnection network structure, resources, fuel prices, basis differentials, and demand.

To calculate the impacts of RGGI on power system operations and outcomes, we used PROMOD to simulate the "with RGGI" and "without RGGI" systems that serve the 9 RGGI states,[1] with the difference between the two simulations being the direct incremental impacts of RGGI on the power system. These two simulation runs otherwise maintained the same inputs, in terms of fuel prices, power plants available to be dispatched, power plant operational characteristics, NO_x and SO_2 allowance costs, baseline load levels, and so forth. The "with RGGI" case was benchmarked to actual power system operations in the historical months of the 2012-2014 time period (in New England, New York, PJM). With this as a starting point, several core assumptions (e.g., load levels that change as a result of energy efficiency investments, removal of the cost of RGGI CO_2 allowances, timing of generic capacity additions) were changed, and the model re-run to simulate the "without RGGI" case. As described further below, the simulation period is the historical 2012-2014 period, along with a 11-year tail period (through 2025) to capture the implications of energy efficiency programs implemented through use of RGGI allowance proceeds generated to date. PROMOD outputs include changes in power plant operations, emissions, prices, customer payments, and producer revenues.

Fuel Prices in the Power Sector

Natural Gas

Natural gas prices are calculated as a Henry Hub base price plus a regional Hub basis differential. From January 2012 through September 2014, the Henry Hub price is based on Ventyx/PROMOD data. From October 2014 through April 2015, the Henry Hub price is a monthly average of historical daily NYMEX spot prices. From May 2015 through April

[1] As described below, we simulated these systems (PJM, NYISO, ISO-NE) using a database that also includes Canada's system (which is interconnected to NY and ISO-NE) and Midwest ISO (which is interconnected to PJM).

2017, the Henry Hub price is based on NYMEX futures prices. From May 2017 through December 2025, the base Henry Hub NYMEX price is grown at the rate of change in the Energy Information Administration's (EIA's) Annual Energy Outlook (AEO) Henry Hub spot price.[2] To capture the delivered price of natural gas into the region of interest, we use the regional basis price differentials from PROMOD throughout the whole study period. These basis differentials may change based on assumed infrastructure improvements over time.

Other Fuels

Distillate oil and Residual oil prices are based on Ventyx fuel price forecasts. Coal prices are based on Ventyx unit-level fuel price forecasts.

Power Plants: Existing Units, Unit Retirements and Additions

The set of power plants is based on actual plants operating within eastern PJM, NYISO, ISO-NE, Ontario, and MISO. We made changes to this dataset (identical in the "with RGGI" and "without RGGI" runs) to reflect unit retirements and power plant additions (e.g., to meet the states' renewable portfolio standards (RPS)). Unit retirement decisions are based on assumed retirements in the PROMOD generator dataset, which rely on information from Ventyx as of September 2014. Some of these retirements have been adjusted as the result of a review of planning documents published by PJM, NYISO, and ISO-NE, along with press releases. Unit additions listed in PROMOD's generator dataset have not been adjusted.

Renewables

RPS MWh targets by state are sourced from Lawrence Berkeley National Labs for PJM and NYISO and from the updated ISO-NE RPS Workbook for ISO-NE. Beginning in 2016, we add renewable capacity sufficient to meet 50 percent of the renewable target in each region (New England, New York, PJM) and assume that the other 50 percent of each state's RPS target is met through alternative compliance payments rather than new renewable energy. The composition of incremental renewable capacity is based on the proportional distribution of renewable technology types in the current interconnection queues of each region. To determine the incremental capacity required to meet this energy demand, average historical capacity factors by technology type and by region were obtained from the SNL power plant database.

[2] In all cases where NYMEX data is grown at an AEO growth rate, the method is as follows:

- The growth rate used is the rate of change between two specific AEO annual data points, rather than the overall AEO growth rate for a particular fuel.
- The growth rate is applied to the data point for the same month in the prior year, rather than the immediately preceding month.

Generic Capacity Additions to Meet Resource Adequacy

After the incremental addition of renewable capacity and retirement of units as discussed above, we analyzed the extent to which each region's capacity satisfied forecasted resource adequacy requirements in each year, based on each region's capacity planning process. This review determined that additional resources were required in each of the regions and scenarios, so new capacity was added based on generic natural gas combined cycle and gas turbine plants. The operating characteristics of these new plants are assumed to be the same as recently built natural gas generating units. The units were placed on the high-voltage transmission network in each region to maximize deliverability. Combined cycle and gas turbine plants were both added to the system.

Emissions costs

RGGI-Related CO_2 Allowance Prices

Prices for CO_2 allowances were modeled for each month in Compliance Period 2 using the most-recent quarter's actual CO_2 allowance price as revealed by auction clearing prices for auctions 15 through 26. No CO_2 price was assumed after December 2015, in light of the assumption that all needed CO_2 allowances had been purchased as of the 26th auction to cover CO_2 emissions during the second three-year compliance period.

NO_x and SO_2 Allowance Prices

NO_x and SO_2 allowance prices are based on Ventyx price forecasts.

Load Forecasts

RTO-level load forecasts are provided by Ventyx, and based on RTO planning documents. ISO-NE data is based on EE-adjusted load from the 2014 CELT Report. NYISO data is based on EE- and PV- adjusted load from the 2014 Gold Book. PJM data is based on EE-unadjusted load from the 2014 PJM Load Forecast Report.

Load Profiles

To account for the impact of energy efficiency savings on hourly load in the "with RGGI" case, energy efficiency data from each RGGI state were aggregated by program type. Total energy savings from each program type were divided among summer and winter on-peak and off-peak hours. This distribution of total savings was estimated using the same proportions as in the 2011 Report. From these load groupings, hourly state savings for each year were determined and modeled in each RGGI zone. Similarly, state spending on renewables was assumed to be for distributed solar PV, and converted to state load savings using NEEP average solar costs and SNL capacity factors. Total state load savings were proportionally assigned to constituent service areas based on native load in each area.

General Adjustments

Outages

Random generator outages are calculated once using PROMOD's algorithm, and fixed between the "with RGGI" and "without RGGI" cases.

Generator Maintenance

Scheduled generator maintenance is fixed between the "with RGGI" and "without RGGI" cases to fulfill unit maintenance requirements.

MODELING OF MACROECONOMIC IMPACTS:

IMPLAN

Macroeconomic Model Overview: IMPLAN

Our analysis of macroeconomic impacts of RGGI uses the "IMPLAN" model. IMPLAN (which stands for "IMpact analysis for PLANning") is a social accounting/input-output model that attempts to replicate the structure and functioning of a specific economy.[3] IMPLAN is widely used for economic impact assessments in the public and private sectors.

Input/output models are based on long-standing, well-established and broadly accepted methodologies designed to estimate the impacts on a regional economy of a change in economic activity. Such models are based on a methodology established decades ago by economists for tracking the effects on changes in the inputs or outputs of an industry (or some other segments of an economy) as they ripple through the economy.

The broad conventional approach to examining these economic flows is to rely on national economic input-output account survey data. These data are based on census information collected from businesses that track the flows of dollars into and out of enterprises. The data make up the basis for the input/output tables that reflect the movement of dollars within an economy and the multiplier effects that reflect the role of dollars in influencing different multiplier effects in different segments of economies. The Bureau of Economic Analysis within the U.S. Department of Commerce collects information related to these relationships among different segments of regional economies. Over the years, these economic accounts are verified and serve as the basis for a wide variety of macroeconomic metrics (such as Gross Domestic Product, Gross State Product, and countless other economic variables). The IMPLAN databases used for the RGGI region (and the nine RGGI states individually) are rooted in these national economic account information sources.

The IMPLAN model allows one to investigate various interactions in a defined economy (in this case, 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, assistance in helping customers pay their energy bills, lost revenues for owners of power plants, etc.) involves money flows around the economy.

IMPLAN relies on a detailed system of accounting for relationships among different parts of the economy, and relies on national economic data for the specified region. The model 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 (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.

Specifically, the model captures various effects, including:

[3] Information provided on IMPLAN's website, available at http://www.implan.com/. IMPLAN (now known as IMPLAN Pro) is a proprietary tool with accompanying data files for different regions which provides the ability to create complete, extremely detailed Social Accounting Matrices and Multiplier Models of local economies.

- *Employment effects* (the total number of jobs created or lost);
- *Income effects* (the total change in income to employees that results from the economic activity); and
- *"Value-added" effects* (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 focused on added value, since this is the overall measure of change in macroeconomic activity.

There are various ways in which the new activity creates impacts, each of which is separately tracked by the model:

- *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 ("producers") as a whole, on energy "consumers" (consumers 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, bill-payment assistance for low income consumers, etc.).
- *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 may 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.

Direct effects are determined by an "Event" as defined by the user (i.e. a $10 million dollar purchase of worker training is a $10 million dollar direct effect; a $10 million dollar contribution to clean energy R&D is a different $10 million dollar direct event).[4] The indirect effects are determined by the amount of the direct effect spent within the study region on supplies, services, labor and taxes. Finally the induced effect measures the money that is re-spent in the study area as a result of spending from the indirect effect. Each of these steps recognizes an important leakage from the economic study region spent on purchases outside of the defined area. Eventually these leakages will stop the cycle.

[4] Note that analyzing the economic value added means that a dollar of direct spending does not translate into a direct effect of one dollar of value added. For example, if a dollar is spent in region on light bulbs, the direct value added is only the net revenue and income of the retail store where the light bulb was purchased, thus excluding the manufacturing costs of the light bulb itself.

More specifically, the effects are:

- *Direct effects* - The set of expenditures applied to the predictive model (i.e., I/O multipliers) for impact analysis. It is a series of (or single) production changes or expenditures made by producers/consumers as a result of an activity or policy. These initial changes are determined to be a result of this activity or policy. Applying these initial changes to the multipliers in an IMPLAN model will then display how the region will respond, economically, to these initial changes.
- *Indirect effects* - The impact of local industries buying goods and services from other local industries. The cycle of spending works its way backward through the supply chain until all money leaks from the local economy, either through imports or by payments to value added.
- *Induced effects* - The response by an economy to an initial change (direct effect) that occurs through re-spending of income received by a component of value added. IMPLAN's default multiplier recognizes that labor income (employee compensation and proprietor income components of value added) is not a leakage out of the regional economy. This money is recirculated through the household spending patterns causing further local economic activity.

State Economic Database

Our IMPLAN analysis of the RGGI states was based on the most recent state data files (2013) for each of the 9 states, as available from IMPLAN. These state-level data files include information for a set of highly disaggregated industries, sorted generally by their 4 and 5 digit NAICS codes.[5]

IMPLAN data files are compiled from a wide variety of sources including the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor, and the U.S. Census.[6] They include information about regional employment, income, value-added, household and government consumption. Examples include: employee compensation; proprietary income; federal, state and local taxes affecting income, sales, real estate, and so forth; personal consumption expenditures at nine income levels; federal government purchases (military and non-military) and investments; purchases by local and state governments (including educational institutions); inventory purchases; capital formation; foreign exports; and inter-institutional

[5] NAICS codes are tied to the North American Industry Classification System, which is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

[6] The IMPLAN data files use federal government data sources including the following federal programs: Bureau of Economic Analysis Benchmark I/O Accounts of the US and Output Estimates; Bureau of Labor Statistics Covered Employment and Wages (ES202) Program and Consumer Expenditure Survey; Census Bureau County Business Patterns, Decennial Census and Population Surveys, Censuses and Surveys; Department of Agriculture Crop and Livestock Statistics; and US Geological Survey.

transfers. They also include unique national input-output structural matrices and unique annual trade flow models.

Expenditure Categories Used in IMPLAN Modeling

In our IMPLAN analysis, we assigned RGGI expenditures into a variety of IMPLAN sector categories, based on assumptions about the character of the economic activity tied to each particular category of RGGI programs.

For example, expenditures on energy efficiency were modeled mainly as either residential (construction of new single- or multi-family structures, or maintenance and repair of residential structures) or commercial/industrial (construction of new commercial structures or maintenance and repair of non-residential structures). Other non-energy efficiency examples include RGGI-related expenditures on: education and outreach programs (modeled as other other educational services); consumer bill reductions and direct bill assistance (modeled based on IMPLAN defined demand for electricity in a particular state); revenue losses to power plant owners (modeled as fossil fuel electric power generation); administration (modeled as other administrative services); and renewable generation development (modeled as construction of new power and communication structures).

DISCOUNT RATE

Discount Rate Overview

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 the RGGI auctions that took place in 2012 through 2014, the impact of these allowances in electricity prices during this time period, and the impact of RGGI-funded programs on electric system outcomes and the macro-economy from 2012-2025. Thus the study period, in one way or another, spans from 20012 to 2025.

To compare these benefits and costs properly, we discount all dollar flows into net present values as of 2015. 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.

The discount rate is the tool that accounts for the time value of money – the concept that a dollar today is typically worth more than the same amount of money in the future because of the opportunity cost of money. A dollar today could be put into an investment or an interest-bearing activity that will typically cause it to grow in value, so that dollar today is worth more to its holder than a dollar received in the future. Further, inflation diminishes the purchasing power of dollars over time. And uncertainty about future economic outcomes, combined with a preference for nearer-term gratification, typically causes a dollar in hand today to be worth more than one tomorrow. The higher the discount rate, the lower is the present value of future cash flows.

Our analysis required choosing an appropriate discount rate. Our analysis reflects dollars in the hands of producers, who are largely private enterprises, and consumers, made up of households, businesses, government energy users, and others. RGGI-funded activities add value to the macro economy of a wide range of actors in the nine RGGI states in the Northeastern and Mid-Atlantic region. The choice of an appropriate discount rate needs to properly reflect the opportunity costs of these various private and public entities in society.

There is a deep literature on the proper discount rate to use in analyzing certain public policies or activities involving society rather than particular producers or consumers.

- **A private discount rate** is used when analyzing the investment options of private enterprises. The appropriate private discount rate varies, depending upon whether the economic analysis focuses on a single company (where that company's weighted average cost of capital would be appropriate) versus a group of companies (where the appropriate discount rate would reflect their collective opportunity costs).

- **A different discount rate** may be appropriate for use by government agencies when they analyze investments, when consumers look at their economic options, or when evaluating the rate at which society as a whole is willing to trade off present for future benefits.

- **Government discount rate**: For example, in 1992, the federal government's Office of Management and Budget issued OMB Circular No. A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs." This document established guidance for discount rates used in benefit-cost and other types of economic analysis by federal agencies, with updates on certain discount rates to use when the interest rate and inflation assumptions in the budget are changed. Because "public investments and regulations displace both private investment and consumption," OMB's recommended discount rate for public investments was a real discount rate of 7 percent, which "approximates the marginal pretax rate of return on an average investment in the private sector in recent years."[7] Various analyses that involve "internal government investments" with effects on increased government revenues or decreased government costs (like "an investment in an energy-efficient building system that reduces Federal operating costs") should use a discount rate reflecting a Treasury bond with a comparable maturity to the investment. But where a government activity provides "a mix of both Federal cost savings and external social benefits," where possible the "Federal cost savings and their associated investment costs may be discounted at the Treasury rate, while the external social benefits and their associated investment costs should be discounted at the 7 percent real rate." At the time the circular was written in 1992, a 10-year Treasury was 7 percent nominal and 3.6 percent real; in 2015, these Treasury rates were 2.8 percent nominal and 0.9 percent real.[8]

- **Consumption discount rate:** Real-world conditions create differences between opportunity costs of consumers relative to private actors and governments: "Among other things, private sector returns are taxed (often at multiple levels), capital markets are not perfect, and capital investments often involve risks reflected in market interest rates. These factors drive a wedge between the *social rate* at which consumption can be traded through time (the pre-tax rate of return to private investments) and the rate at which *individuals* can trade consumption over time (the post-tax consumption rate of interest). …[For example:] …Suppose the market rate of interest, net of inflation, is 5%, and that taxes on capital income amount to 40 percent of the net return. In this case, private investments will yield 5%, of which 2% is paid in taxes to the government, with individuals receiving the remaining 3%. From a social perspective, consumption can be traded from the present to the future at a rate of 5%. But individuals effectively trade consumption through time at a rate of 3% because they owe taxes on investment earnings. As a result, the

[7] OMB Circular No. A-94 (1992), "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs." http://www.whitehouse.gov/omb/circulars_a094/

[8] OMB Budget Assumptions – Nominal and Real Treasury Interest Rates for Different Maturities (from the annual budget assumptions for the first year of the budget forecast) December 10, 2014. http://www.whitehouse.gov/sites/default/files/omb/assets/a94/dischist.pdf

consumption rate of interest is 3%, which is substantially less than the 5% social rate of return on private sector investments (also known as the social opportunity cost of private capital)."[9]

- **Social discount rate**: "Social discounting… is discounting from the broad society-as-a-whole point of view that is embodied in benefit-cost analysis (BCA). *Private discounting*, on the other hand, is discounting from the specific, limited perspective of private individuals or firms. Implementing this distinction can be complex… using a given private discount rate instead of a social discount rate can bias results as part of a BCA."[10]

Recent guidance provided by the U.S. Environmental Protection Agency makes the following recommendations for discount rates to use in analyzing programs that involve 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."[11]

> "Calculate the NPV using the consumption rate of interest. This is appropriate for situations where all costs and benefits occur as changes in consumption flows rather than changes in capital stocks, i.e., capital displacement effects are negligible. As of the date of this publication, current estimates of the consumption rate of interest, based on recent returns to Government-backed securities, are close to 3%. Also calculate the NPV using the rate of return to private capital. This is appropriate for situations where all costs and benefits occur as changes in capital stocks rather than consumption flows. The Office of Management and Budget estimates a rate of 7% for the opportunity cost of private capital."[12]

For these various reasons, we used both a 3 percent ("public" or "social") discount rate, as well as a 7 percent ("private") discount rate in our analysis.

[9] US Environmental Protection Agency (National Center for Environmental Economics, Office of Policy), "Guidelines for Preparing Economic Analyses," EPA 240-R-10-001, December 17, 2010 (updated May 2014)" ("EPA Guidelines"), page 6-6.

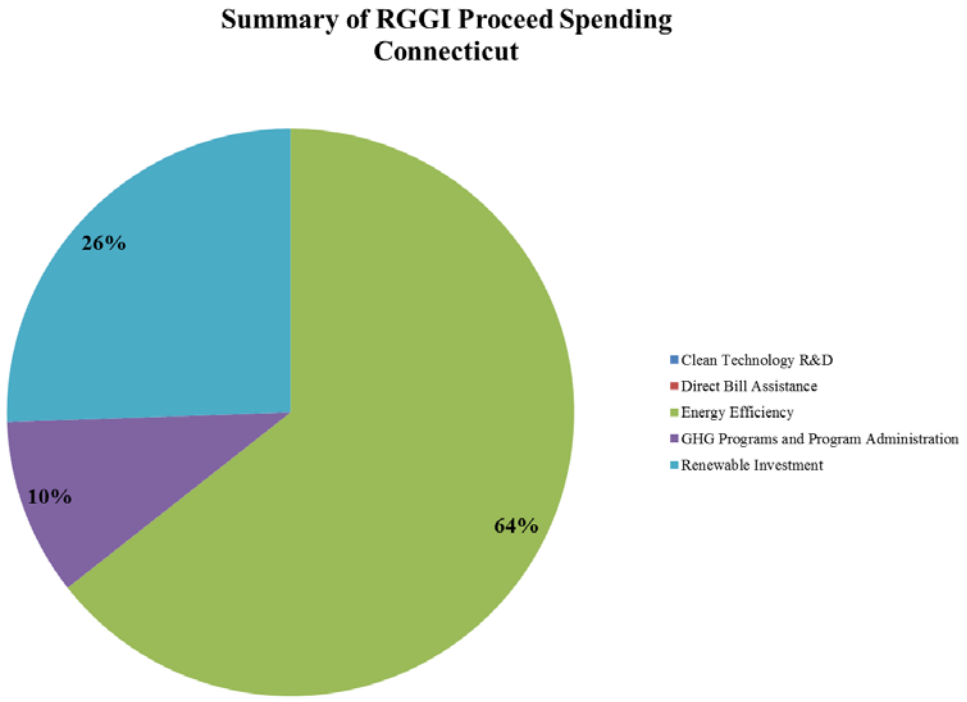
[10] EPA Guidelines, page 6-1.

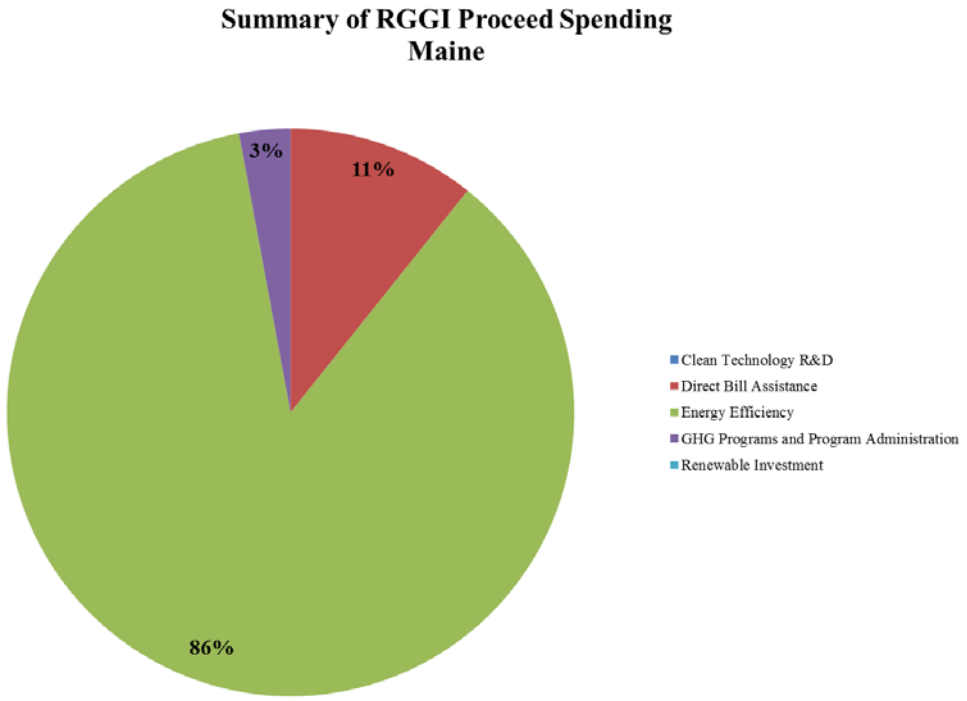
[11] EPA Guidelines, page 6-4.

[12] EPA Guidelines, page 6-19.

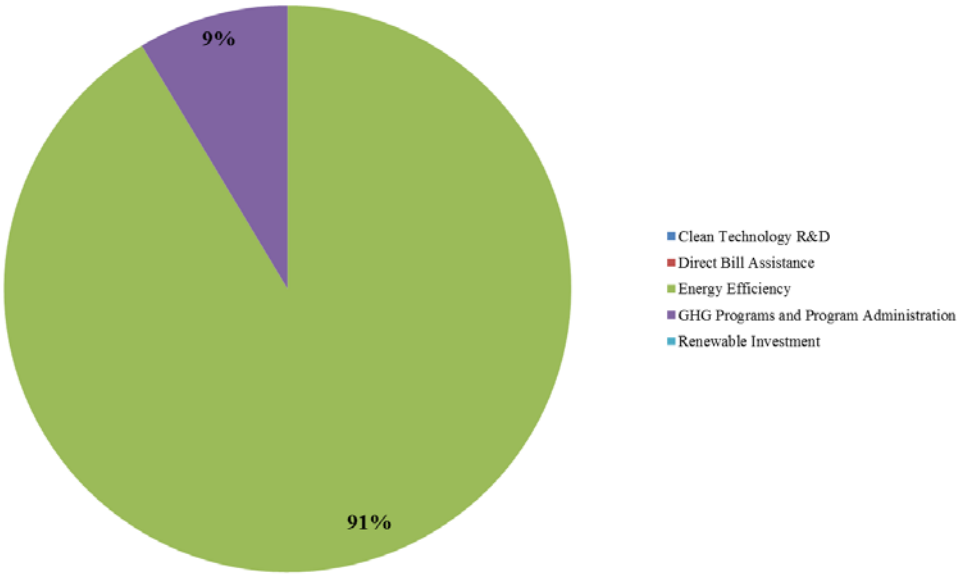
DETAILED RESULTS

RGGI Proceed Spending by State

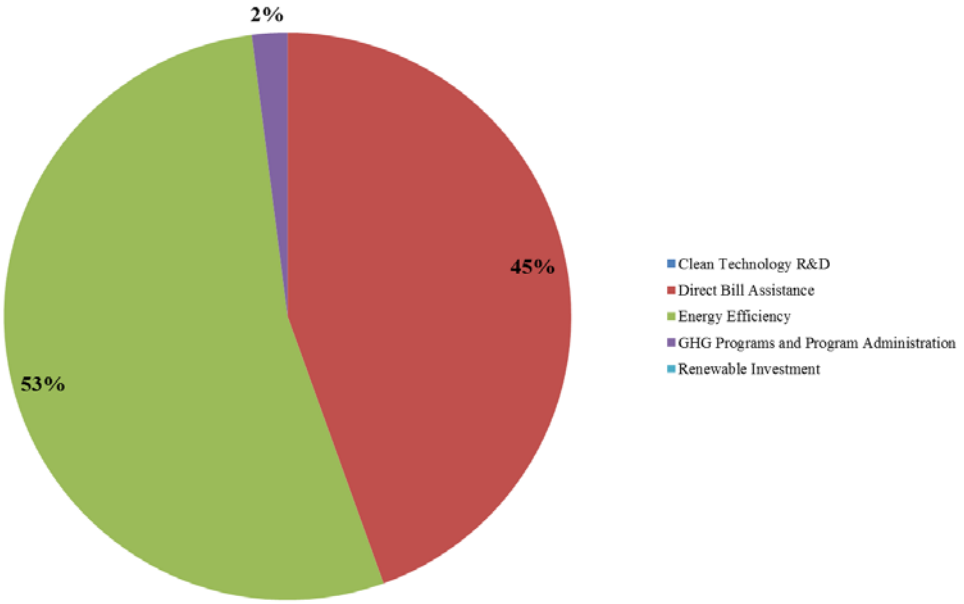




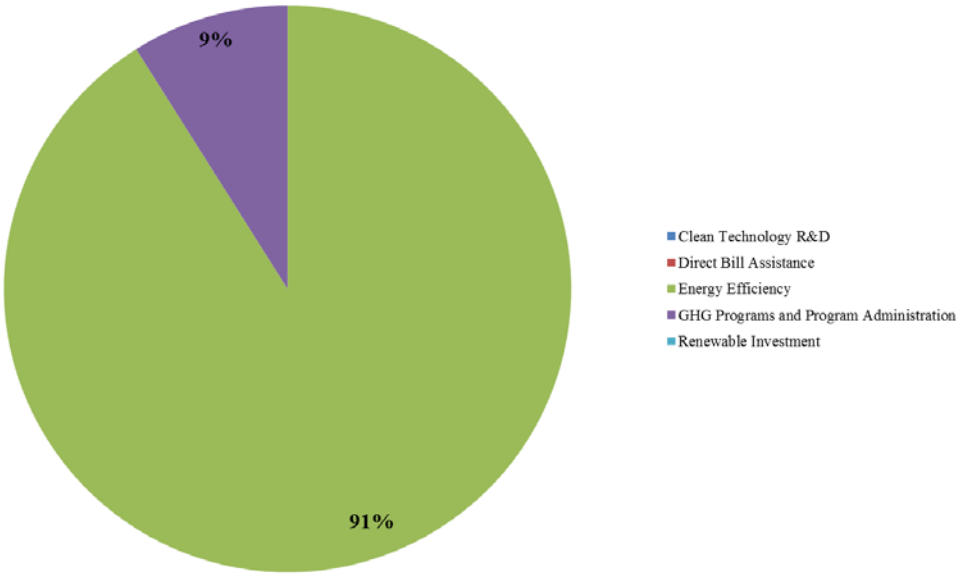
Summary of RGGI Proceed Spending
Massachusetts



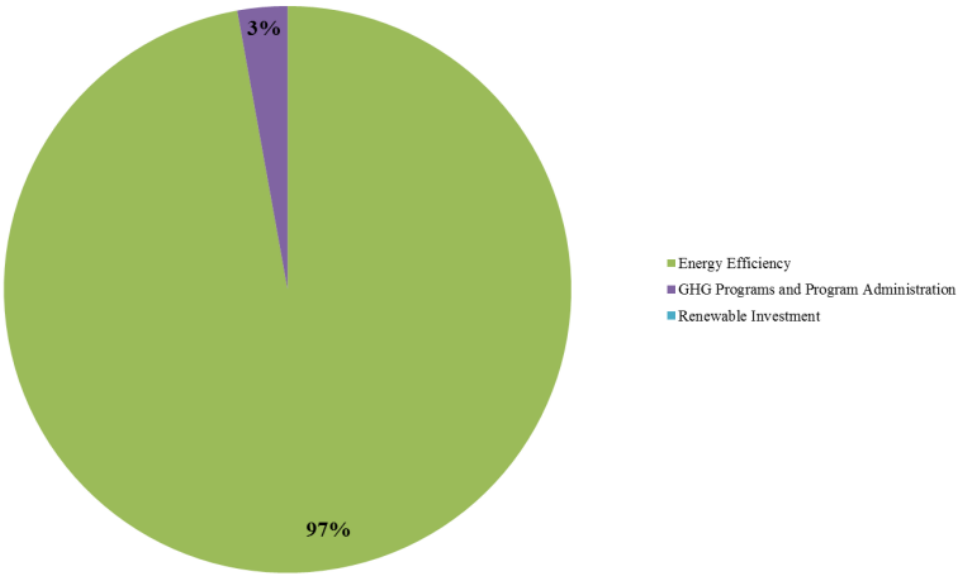
Summary of RGGI Proceed Spending
New Hampshire



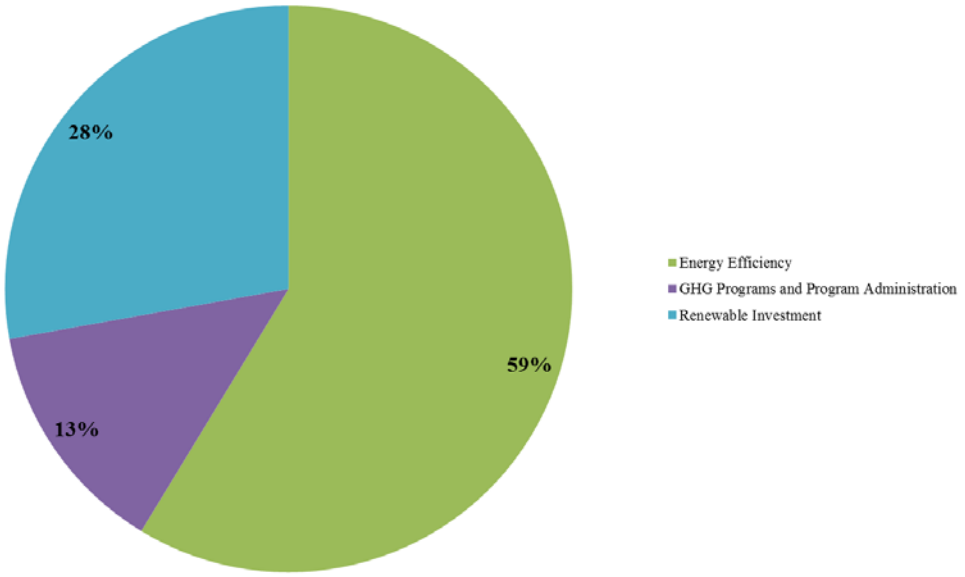
Summary of RGGI Proceed Spending
Rhode Island



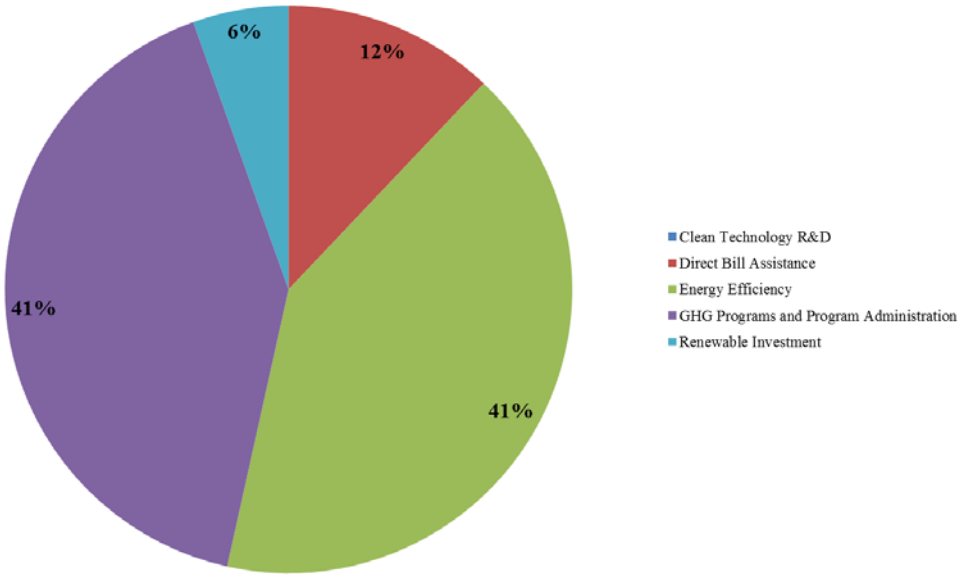
Summary of RGGI Proceed Spending
Vermont



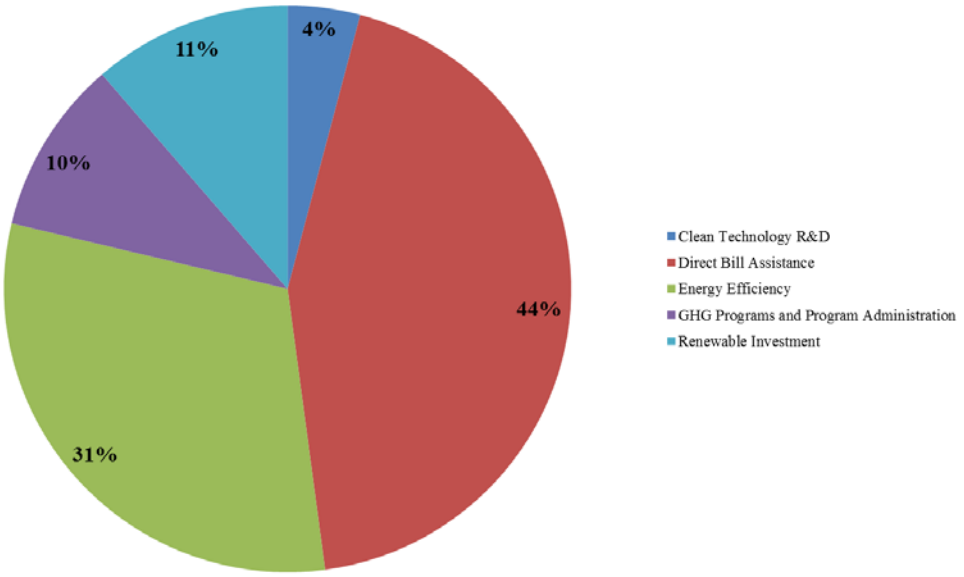
Summary of RGGI Proceed Spending
New York



Summary of RGGI Proceed Spending
Delaware



Summary of RGGI Proceed Spending
Maryland



Tables of State, Regional, and Aggregate Results

Summary of State Spending of RGGI Allowance Proceeds

	Clean Technology R&D	Direct Bill Assistance	Energy Efficiency	GHG Programs and Program Administration	Renewable Investment	Total
Connecticut	-	-	45,850,058	7,168,070	18,182,719	71,200,848
Maine	-	3,319,835	26,719,736	901,554	-	30,941,125
Massachusetts	-	-	151,830,811	14,266,301	-	166,097,112
New Hampshire	-	18,520,278	22,255,248	839,613	-	41,615,139
Rhode Island	-	-	18,760,694	1,846,553	-	20,607,248
Vermont	-	-	7,320,268	214,111	-	7,534,379
New England Subtotal	**-**	**21,840,113**	**272,736,815**	**25,236,203**	**18,182,719**	**337,995,849**
New York	-	-	224,990,831	51,685,650	106,677,226	383,353,707
New York Subtotal	**-**	**-**	**224,990,831**	**51,685,650**	**106,677,226**	**383,353,707**
Delaware	-	4,825,559	16,540,928	16,407,726	2,179,322	39,953,534
Maryland	9,145,611	96,967,773	68,309,433	22,043,389	25,133,479	221,599,686
RGGI States in PJM Subtotal	**9,145,611**	**101,793,332**	**84,850,361**	**38,451,115**	**27,312,800**	**261,553,219**
All RGGI States	**9,145,611**	**123,633,445**	**582,578,007**	**115,372,967**	**152,172,745**	**982,902,776**

Source: RGGI, Inc.

Note: For modeling purposes and due to their small size, education and job training proceeds were included in the energy efficiency category.

Summary of Direct, Indirect, and Induced Impacts
Discounting Dollars using a Social Discount Rate

State/Region	Value Added [1] ($2015 Millions)	Employment [2] (Cumulative job-years)
Connecticut	$56.2	863
Maine	122.3	1,113
Massachusetts	243.3	2,718
New Hampshire	67.3	583
Rhode Island	16.6	195
Vermont	14.8	177
New England Subtotal	**$520.5**	**5,649**
New York	$385.5	4,463
New York Subtotal	**$385.5**	**4,463**
Delaware	$107.3	952
Maryland	213.8	2,475
RGGI States in PJM Subtotal	**$321.1**	**3,428**
Regional Impact [3]	**$69.6**	**615**
All RGGI States	**$1,296.7**	**14,155**

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 manufactored outside of the state or region.

[2] Employment represents cumulative job-years over the 2012-2025 period as output from IMPLAN.

[3] Regional Impact reflects the indirect and induced impacts within the RGGI region as a result of state dollar impacts.

[4] Results are discounted to 2015 dollars using a 3% social discount rate and reflect adjustments for inflation.

Summary of Direct, Indirect, and Induced Impacts
Discounting Dollars using a Private Discount Rate

State/Region	Value Added [1] ($2015 Millions)	Employment [2] (Cumulative job-years)
Connecticut	$34.3	863
Maine	101.1	1,113
Massachusetts	168.6	2,718
New Hampshire	61.7	583
Rhode Island	10.2	195
Vermont	9.5	177
New England Subtotal	**$385.4**	**5,649**
New York	$236.5	4,463
New York Subtotal	**$236.5**	**4,463**
Delaware	$85.2	952
Maryland	125.7	2,475
RGGI States in PJM Subtotal	**$210.8**	**3,428**
Regional Impact [3]	**$64.6**	**615**
All RGGI States	**$897.4**	**14,155**

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 manufactored outside of the state or region.

[2] Employment represents cumulative job-years over the 2012-2025 period as output from IMPLAN.

[3] Regional Impact reflects the indirect and induced impacts within the RGGI region as a result of state dollar impacts.

[4] Results are discounted to 2015 dollars using a 7% private discount rate and reflect adjustments for inflation.