



A Double Success

Tackling Global Warming While Growing the Economy
with an Improved Regional Greenhouse Gas Initiative



A Double Success

Tackling Global Warming While Growing the Economy
with an Improved Regional Greenhouse Gas Initiative

Environment New York
Research & Policy Center

Tony Dutzik and Elizabeth Ridlington,
Frontier Group

Rob Sargent,
Environment America
Research & Policy Center

Spring 2013

Acknowledgments

The authors thank BreAnda Northcutt of Cater Communications, Luis Martinez of the Natural Resources Defense Council and N. Jonathan Peress of the Conservation Law Foundation for their review and insightful feedback on drafts of this report. The authors would also like to thank Benjamin Davis at Frontier Group for providing editorial support.

Environment New York Research & Policy Center is grateful to the Energy Foundation and the John Merck Fund for making this report possible.

The authors bear responsibility for any factual errors. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or expert reviewers.

© 2013 Environment New York Research & Policy Center

Environment New York Research & Policy Center is a 501(c)(3) organization. We are dedicated to protecting our air, water and open spaces. We investigate problems, craft solutions, educate the public and decision-makers, and help the public make their voices heard in local, state and national debates over the quality of our environment and our lives. For more information about Environment New York Research & Policy Center or for additional copies of this report, please visit www.environmentnewyorkcenter.org.

Frontier Group conducts independent research and policy analysis to support a cleaner, healthier and more democratic society. Our mission is to inject accurate information and compelling ideas into public policy debates at the local, state and federal levels. For more information about Frontier Group, please visit www.frontiergroup.org.

Cover photos: *Insulation*, Christina Richards/Shutterstock.com; *Lightbulb*, Silverlining56/iStockphoto.com; *Sunrise viewed from Long Island Beach, New Jersey*, Steve Greer/iStockphoto.com.

Graphic Design: Harriet Eckstein Graphic Design

Table of Contents

Executive Summary	1
Introduction	5
RGGI Is a Key Part of the Fight against Global Warming	7
Global Warming Threatens the Northeast	7
The Northeast Is an Important Player in the Fight against Global Warming	9
RGGI Reduces Global Warming Pollution	10
Strengthening RGGI Would Be an Important Step	15
Conclusion	17
RGGI Is Critical to the Northeast's Economic Future	18
Global Warming Threatens the Northeast's Economy	18
Fossil Fuel Dependence Drains Resources from the Northeast	20
Strengthening RGGI Would Reduce the Region's Dependence on Fossil Fuels	21
Cutting Emissions and Growing the Economy Go Hand in Hand	21
Strengthening RGGI Would Speed the Transition to a Clean Energy Economy while Benefiting the Economy	22
Conclusion	23
Policy Recommendations: Building a Stronger RGGI	24
Notes	26

Executive Summary

The Regional Greenhouse Gas Initiative (RGGI) is a central strategy in the Northeastern states' efforts to protect the region from global warming. The program, which took effect in 2009, has succeeded in cutting carbon dioxide emissions and demonstrating the effectiveness of cap-and-trade as a global warming solution while helping to sustain a growing regional economy.

Now, nine Northeastern states are considering strengthening RGGI to drive additional reductions in global warming pollution. Strengthening RGGI would be a "win-win" for the Northeast, making an important contribution toward protecting the region from global warming while speeding the transition to a clean energy future.

RGGI helps to address the threat of global warming to the Northeast.

- Hurricane Irene in 2011 and Hurricane Sandy in 2012 demonstrated that the Northeast has much to lose from global warming. Hurricane Irene was responsible for 45 deaths and more than \$6.5 billion in damage, while

Hurricane Sandy was responsible for 72 deaths in the Northeast and Mid-Atlantic. The storm caused \$65 billion in damage in the U.S. and other affected countries. Should current emission trends continue, scientists anticipate that the Northeast will be vulnerable to more extreme storms, rising seas, higher temperatures and other threats from global warming.

- The Northeast can make a meaningful contribution to reducing the impacts of global warming. In 2010, the 10 Northeastern states then participating in RGGI emitted 533 million metric tons (MMT) of carbon dioxide pollution from energy use. Were the Northeast its own country, its emissions would rank 10th in the world, ahead of the United Kingdom, Saudi Arabia, Mexico, Brazil and France. (See Figure ES-1.)
- RGGI is already reducing global warming pollution. Clean energy investments driven by RGGI through 2011 are expected to reduce global warming pollution by 12 million tons

over their lifetimes, the equivalent of taking 2 million cars off the road for a year.

- Strengthening RGGI would cut emissions further, avoiding 86 to 91 million tons of carbon dioxide pollution (78 million to 83 million metric tons) between 2013 and 2020 according to an analysis conducted by RGGI, Inc. That is the equivalent annual emissions from 16 million cars. Re-investment of RGGI allowance auction revenues in programs to reduce direct consumption of fossil fuels would lead to further emission reductions.

- RGGI provides an effective model that can be adopted by other states and regions and eventually expanded to other sectors of the economy. In the last year, the state of California and the Canadian province of Quebec have both implemented cap-and-trade programs.

RGGI is good for the Northeast's economic future.

- Global warming threatens public welfare and the Northeast's economy. More than \$2 trillion of private property and public infrastructure

Figure ES-1. The Northeast Can Make a Meaningful Contribution to Reducing Global Warming (Carbon Dioxide in the Northeast vs. Selected Countries, 2010)

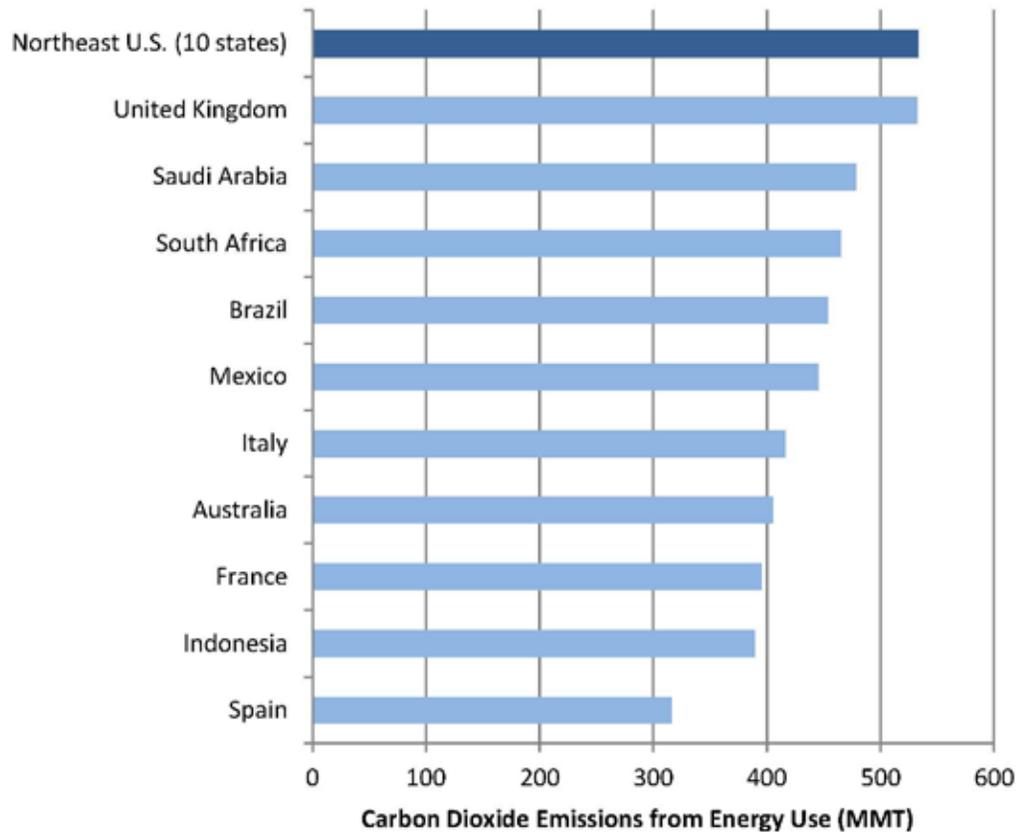
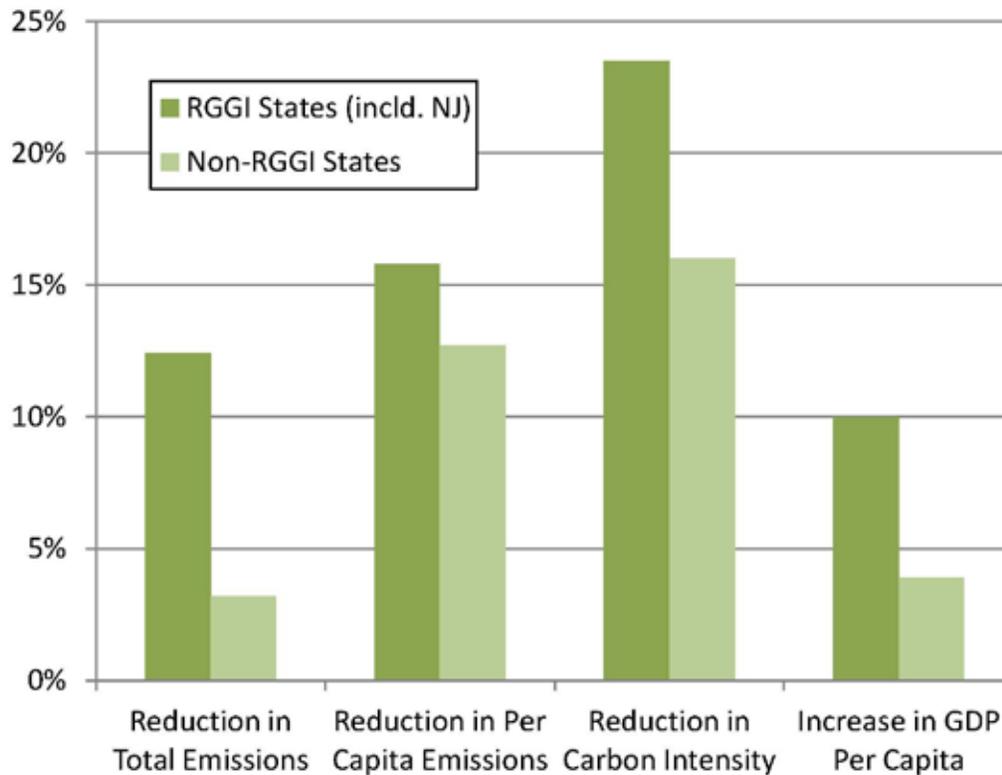


Figure ES-2. The Northeast Is Cutting Pollution and Growing its Economy Faster than the Rest of the Nation, 2000 to 2010



could be exposed to damage in the Baltimore, Boston, New York-Newark, Philadelphia and Providence areas in the event of a 0.65 meter (2.1 foot) increase in sea level by 2050.

- RGGI helps reduce the region’s dependence on fossil fuels. The Northeast spent nearly \$130 billion in 2010 on fossil fuels, 98.5 percent of which were imported from outside the region. RGGI helps drive investments in energy efficiency measures and home-grown renewable energy sources that keep money and jobs in the Northeast.
- Reducing global warming pollution goes hand in hand with growing the economy. Between 2000 and 2010, the

economies of the RGGI states grew twice as fast per capita as non-RGGI states while cutting carbon dioxide pollution 25 percent faster per capita. (See Figure ES-2.)

- RGGI has produced a \$1.6 billion economic boost (net present value) to the region through 2011, according to a study by Analysis Group. Strengthening RGGI would produce an additional \$8 billion in economic benefits, along with 124,800 additional job-years of employment, according to a recent analysis by Northeast States for Coordinated Air Use Management.

To protect the Northeast against the worst impacts of global warming and

to continue to move the region toward a clean energy economy, Northeastern states should do the following:

- Adopt the emission reductions proposed by the RGGI states in February 2013, limiting emissions to no greater than 91 million tons per year starting in 2014, with additional 2.5 percent annual emission reductions between 2015 and 2020. This would ensure significant emission reductions from current levels.
- Convince New Jersey to re-join the program, which would help the state lessen the dangers posed by increasingly severe storms and rising sea level while bolstering the state's economy.
- Establish limits on global warming pollution that go beyond the electricity sector, including for transportation and heating fuels. This could include expanding RGGI to other sectors.
- Implement the laws providing for economy-wide limits on global warming pollution in Maryland, New Jersey, Connecticut and Massachusetts.
- Lay the groundwork for expanding RGGI to other states.
- Encourage the U.S. Environmental Protection Agency to move forward with regulating global warming pollution from existing power plants in all states.

Introduction

Hurricane Sandy was the most devastating natural disaster to hit the Northeast in decades. It was also a jarring reminder of the region's vulnerability to global warming.

In New York, Hurricane Sandy inflicted more than \$32 billion worth of damage, destroying or damaging more than 300,000 homes and disrupting essential links in the state's transportation network.¹ In New Jersey, Sandy was the state's worst-ever natural disaster, destroying or inflicting structural damage on more than 30,000 homes and businesses and causing \$29 billion worth of damage.² Connecticut experienced \$360 million worth of damage due to Sandy, with Massachusetts and Rhode Island also sustaining significant impacts.³ The storm caused a total of \$65 billion in economic losses along its path from the Caribbean to Canada.⁴ Communities in the Appalachian Mountains of Maryland, Pennsylvania and West Virginia were buried under more than two feet of snow, leaving some without power for a week.⁵ In the Northeast and mid-Atlantic regions, 72 people lost their lives as a direct result of Hurricane Sandy, making it the deadliest tropical cyclone to

hit the region in at least four decades.⁶

Sandy was so powerful that the storm literally reshaped the East Coast. New inlets were cut in barrier islands in New York and New Jersey. The average New Jersey beach was estimated to have become 30 to 40 feet narrower.⁷

Every weather event now bears the imprint of a warmer climate and Hurricane Sandy was no exception. The storm and its effects may have been magnified by higher ocean temperatures (which provide more energy to tropical cyclones) and by the 1 foot rise in sea level that has already taken place along the East Coast over the last century.⁸

The bad news for the Northeast is that damaging storms such as Hurricane Sandy—or 2011's destructive Hurricane Irene—are likely to become more common and severe as the planet continues to warm. The good news, however, is that the Northeast can do a great deal, starting now, to prevent the worst impacts of global warming—the dramatic rises in sea level, temperature, extreme precipitation and other phenomena that threaten profound and lasting changes to the region.

The Northeast can address global warming while continuing to grow the region's economy. Repowering the region's economy with clean energy and reducing energy waste through improved efficiency can and will help make the Northeast more economically competitive while reducing the amount of money that flows out of the region to pay for fossil fuels.

The Regional Greenhouse Gas Initiative (RGGI) is an important example of

how reducing global warming pollution is a “win-win” for the region—helping to protect the region and the world from the dangers posed by global warming while generating economic benefits. As Northeast states consider strengthening RGGI, decision makers must understand how the program can help position the region, its people, its natural environment and its economy for a better future.

RGGI Is a Key Part of the Fight against Global Warming

The Northeast has much to lose from global warming. From more powerful storms like Hurricane Sandy to higher sea level, and from more frequent heat waves to dirtier air, global warming will have profound impacts on life in the Northeast.

The Regional Greenhouse Gas Initiative (RGGI) is making an important contribution in the fight to limit the impacts of global warming. The Northeast is a globally significant source of carbon dioxide pollution. By reducing pollution from a major source—power plants—RGGI helps the region do its share in the fight against global warming. At the same time, RGGI represents an effective policy model that can be expanded and built upon elsewhere.

Global Warming Threatens the Northeast

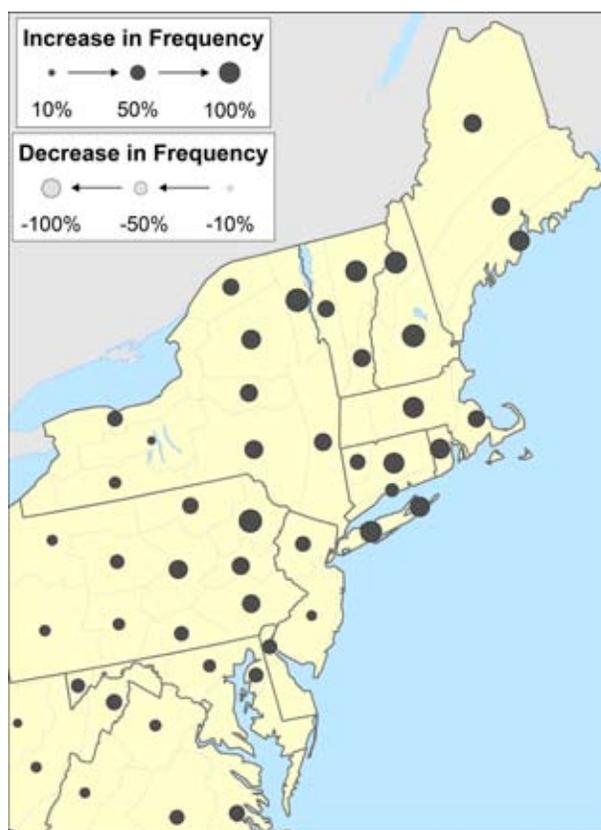
Global warming already affects the Northeast, and climate science tells us that its impacts are likely to become more severe

over time—especially if the region and the world continue to release carbon dioxide and other global warming pollutants in line with current trends.

The climate of the Northeast has already changed in startling ways.

- On average, the Northeast was nearly 2° Fahrenheit warmer in 2011 than it was in the late 19th century.⁹
- Extreme precipitation events—those with the most intense rainfall and snowfall—are occurring more frequently. In New England, intense rain and snow storms occurred 85 percent more often in 2011 than they did in 1948, while in the mid-Atlantic region, the most intense storms occurred 55 percent more frequently.¹⁰ (See Figure 1.)
- Sea level has risen by approximately a foot over the past century in the Northeast, a rate of rise higher than the global average.¹²
- Countless changes have occurred in natural communities throughout the

Figure 1. Change in Frequency of Extreme Downpours, 1948-2011¹¹



region. Migratory birds have begun to arrive sooner and bird species have extended their ranges northward.¹³ Snow depths in parts of New England have been decreasing, and lakes are experiencing “ice-out” earlier in the spring.¹⁴

The changes that have already occurred in the region’s climate pose significant threats to the Northeast. Higher sea level increases the potential for dangerous coastal flooding during major storms. More extreme precipitation creates the potential for damaging inland flooding. Changes in climate also create openings for pests to wreak havoc on important ecosystems, such as the region’s forests.¹⁵

But the changes that have occurred thus far are minor compared to those in store

for the future, particularly if the region and the world continue to release increasing amounts of carbon dioxide and other global warming pollutants. For example, scientists predict that if global emission trends continue:

- Average temperatures in the Northeast could increase by 6.5° F to 8.5° F by 2085 under a high emission scenario.¹⁶
- The Northeast will be vulnerable both to more extreme downpours—with the potential of severe flooding—and to drought.¹⁷
- Global sea level could rise by 8 inches to 6.6 feet by the end of the 21st century, and possibly even more in the

Northeast due to land subsidence and changes in ocean currents.¹⁸ Sea level rise could lead to a tripling in the frequency of severe coastal flooding events (those that have occurred once every 10 years in the historical record).¹⁹

The Northeast Is an Important Player in the Fight against Global Warming

There is still time to prevent the worst impacts of global warming. The climate of the Northeast will continue to change in coming decades due to global warming pollutants already in the atmosphere. But the steps we take today can help prevent

the worst, most catastrophic impacts from occurring in the future.

Following a lower emission pathway could reduce the increase in temperatures in the Northeast to 3.5° F to 5.5° F by 2085—compared with 6.5° F to 8.5° F in a higher emission scenario.²⁰ Aggressive global action could reduce the long-term impacts of global warming even further.

The Northeast is a significant contributor to global warming. In 2010, the 10 Northeastern states that participated in RGGI released 533 million metric tons (MMT) of carbon dioxide—the leading global warming pollutant—from the burning of fossil fuels and other forms of energy use.²¹ Were the Northeast its own country, its emissions would rank 10th in the world, ahead of the United Kingdom, Saudi Arabia, Mexico, Brazil and France.²² (See Figure 2.)

Figure 2. Carbon Dioxide Emissions from Energy Use, Selected Countries, 2010²³

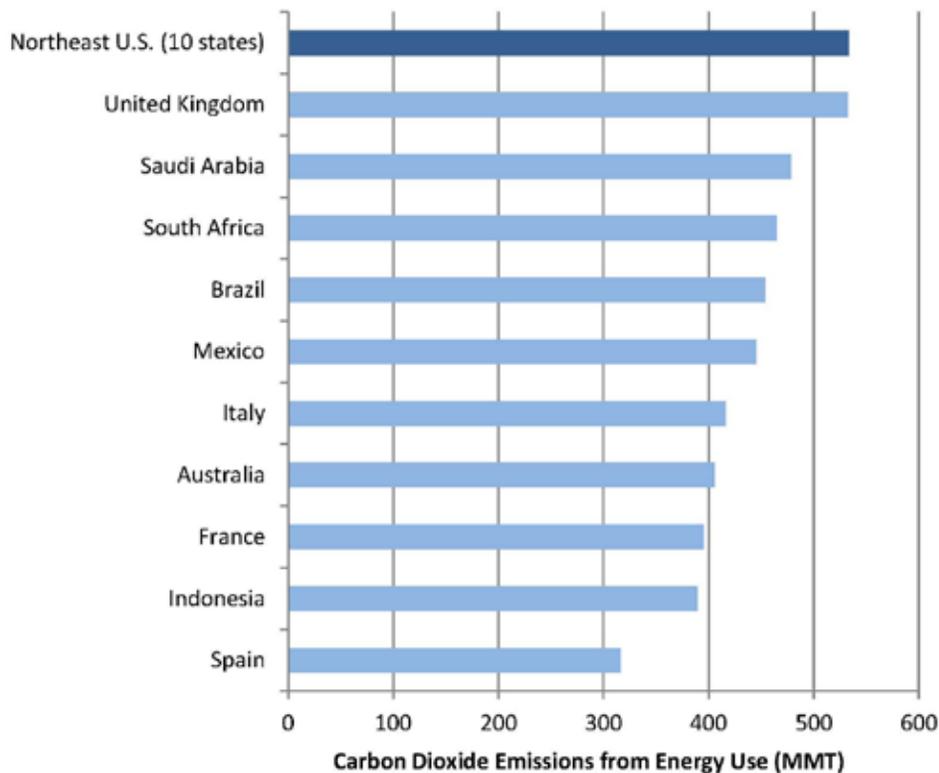
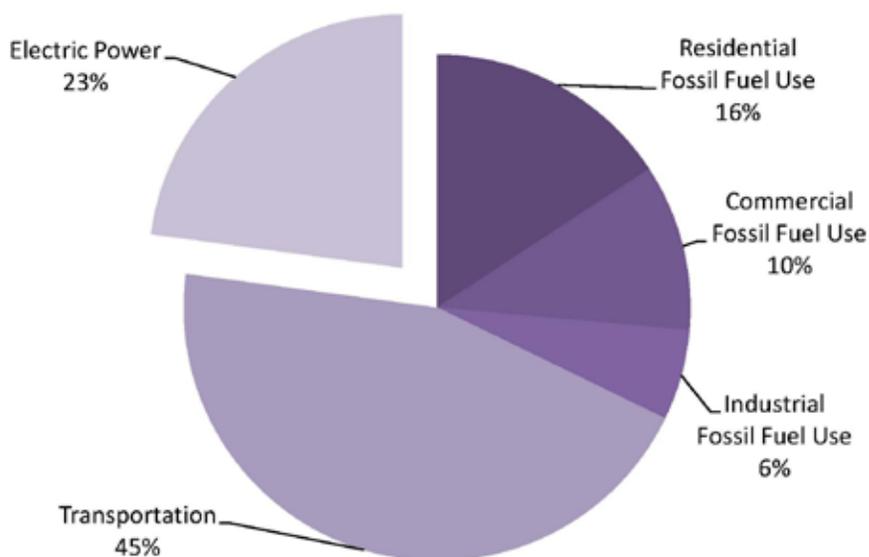


Figure 3. Carbon Dioxide Emissions in the Northeast (10 States) by Source, 2010²⁵



Electric power plants are the region's second-largest source of carbon dioxide, after the region's transportation system. In 2010, electric power plants accounted for approximately 23 percent of the region's carbon dioxide emissions.²⁴ (See Figure 3.)

As will be discussed further below (see page 12), the Northeast has already succeeded in reducing emissions of carbon dioxide. The 10 Northeastern states released 7.4 percent less carbon dioxide in 2010 than they did in 1990—a reduction of 42 million metric tons per year.²⁶

Nothing the region does on its own can prevent the worst impacts of global warming. But preventing the worst impacts of global warming will be impossible unless the Northeast and other significant sources of emissions take immediate and strong action.

RGGI Reduces Global Warming Pollution

The Regional Greenhouse Gas Initiative (RGGI) is a key strategy in the fight against global warming. RGGI takes aim at carbon pollution from a major source: electric power plants. It generates revenue that is reinvested in energy efficiency improvements and clean energy projects that provide lasting benefits to the region's environment. RGGI also serves as an important precedent demonstrating the effectiveness of coordinated, regional policy in the fight against global warming—providing a model that other states and regions can adapt to their own circumstances.

How RGGI Works

The Regional Greenhouse Gas Initiative (RGGI) is a landmark agreement among a

group of Northeastern states to limit, and ultimately reduce, carbon dioxide pollution from power plants.

The seeds for RGGI were sown in 2003 when New York Governor George Pataki wrote to other Northeastern governors asking them to join him to “develop a strategy that will help the region lead the nation in the effort to fight global climate change.”²⁷ Over the course of the next two years, a team of officials from Northeastern states and a wide range of stakeholders from industry, government and the non-profit sector hammered out the details, with states signing a memorandum of agreement establishing the program in late 2005. The program took effect in 2009.

RGGI was originally designed to limit carbon dioxide emissions from the region’s power plants to projected 2009 levels until 2014, followed by a 10 percent emission reduction to be achieved by 2018.²⁸

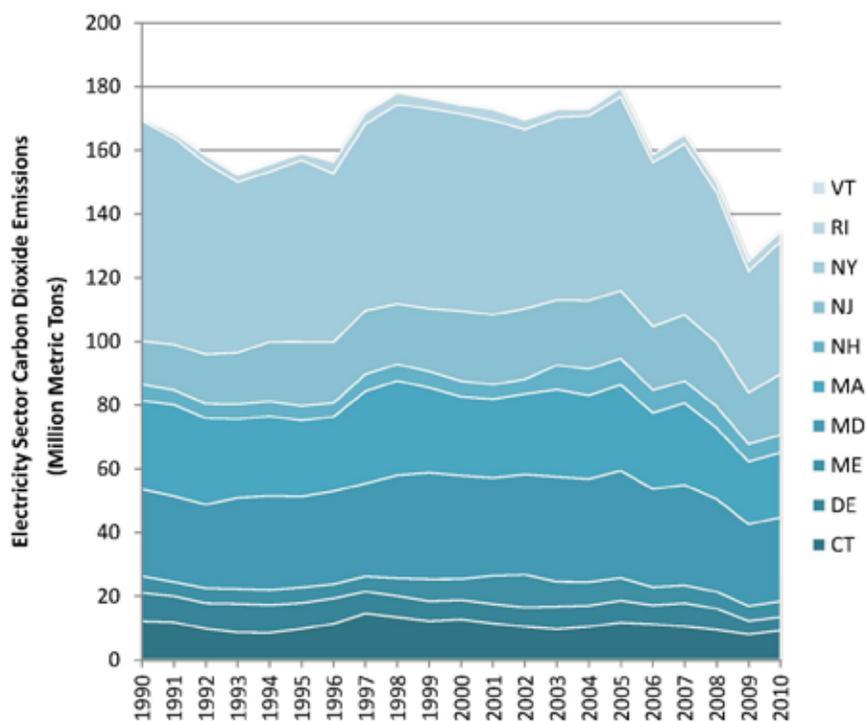
To comply with the program, power plant owners are required to obtain emission permits or “allowances” corresponding with their releases of carbon dioxide. Those allowances are sold by the RGGI states in quarterly auctions, with the price of the allowances determined by supply and demand. The decision to sell, rather than give away, pollution permits was a pioneering step for RGGI—the program’s first allowance auction, in 2008, was the largest carbon dioxide auction ever to occur in the world to that point.²⁹

Revenues from the sale of allowances are returned to the states, with at least one-quarter of those revenues required to be dedicated to a “consumer benefit or strategic energy purpose.”³⁰ In practice, most RGGI states have dedicated the vast majority of their auction revenues to programs that assist consumers and investments in energy efficiency or clean renewable energy.



The Brandon Shores coal-fired power plant in Maryland is one of the facilities regulated by RGGI.

Figure 4. Electricity Sector Carbon Dioxide Emissions, Northeast (million metric tons)³²



RGGI also includes a variety of provisions to limit the impact of the program on consumers. Polluters may use qualified offsets—emission reductions obtained through activities other than cleaning up power plants—to reduce the number of allowances they must obtain, and also may bank unused allowances for later use. Rules for offsets and compliance with the program are loosened in the event that allowance prices hit a certain threshold. Thus far, allowance prices in the program have remained low and the thresholds for these additional cost-containment mechanisms have not come into effect.

RGGI also includes a mechanism called a “reserve price” to prevent allowance prices from falling too low. The reserve price ensures that, whatever the level of demand for allowances, polluters are paying at least a low, minimum price for the carbon pollution they release to the atmosphere. The inclusion of a reserve price in the program

has ensured that consistent resources have flowed to the states to support clean energy programs and other public benefits.

Lowering Global Warming Pollution from Power Plants

Emissions from power plants in the RGGI region have fallen dramatically in recent years. Between 1990 and 2010, the second year of the RGGI program, carbon dioxide pollution from electric power plants in the 10 Northeastern states fell by 21 percent, with the bulk of the decline taking place since 2005.³¹ (See Figure 4.)

Emissions have continued to fall since RGGI went into effect in 2009. Emissions from power plants during the 2009-2011 period were 23 percent lower than during the previous three-year period, demonstrating that the means to reduce pollutant emissions were available and more cost effective than initially projected.³³

The energy efficiency and renewable

energy investments enabled by RGGI auction revenues have contributed to these emission reductions. Clean energy investments made as a result of the investment of RGGI allowance funds through 2011 are expected to reduce global warming pollution by 12 million tons over their lifetimes, the equivalent of taking more than 2 million cars off the road for a year.³⁴

Region-wide emissions have been below RGGI's emission cap, for several reasons. The cap itself was set at a weak level that limited its potential to reduce global warming pollution from power plants. In addition, reducing emissions proved to be more cost effective and achievable than the RGGI states had initially envisioned. In 2012, for example, emissions in the region were 43 percent below the RGGI emission cap.³⁵

Driving the Transition to Clean Energy

RGGI is helping the Northeast rebuild its economy on a foundation of clean energy, supporting needed investments in energy efficiency improvements that reduce energy

waste in the region's homes and businesses, as well as investments in the clean energy sources of the future.

Two out of every three dollars raised in RGGI compliance auctions through 2011 were invested in programs to improve the energy efficiency of the Northeast's economy.³⁶ Those investments—totaling more than \$400 million—will leverage \$1.1 billion in consumer energy savings over their lifetimes, fueling economic growth in the region.³⁷

Among the clean energy programs that have received investment as a result of RGGI are the following:

- Energy audits and energy efficiency improvements for small businesses and homeowners,
- Rebates on energy efficient appliances and discounts on efficient light bulbs,
- Direct assistance to industry for the implementation of energy efficiency improvements in factories,



Investments in solar energy have helped provide clean electricity for the Northeast. Credit: NREL/Aeon Solar

- Grants to homeowners and businesses seeking to install solar panels or wind turbines,
- Programs to encourage energy efficiency improvements and the use of renewable energy in publicly owned buildings such as schools and municipal offices,
- Programs to promote the commercial and industrial use of combined heat-and-power, which saves energy by using the same energy to provide heat and electricity to a facility.³⁸

Clean energy investments supported through RGGI from 2009 to 2011 are

expected to save 27 million megawatt-hours of electricity over their lifetimes—roughly equivalent to the amount of electricity needed to power all of Maryland’s homes for a year—as well as an additional 26.7 trillion Btu of oil, gas and other fuels.³⁹

Demonstrating the Effectiveness of Cap-and-Trade

RGGI has demonstrated that market-based approaches to reducing global warming pollution can work effectively. In the first three years of the program, RGGI conducted 14 allowance auctions, selling close to \$1 billion worth of pollution allowances.⁴⁰ The RGGI auctions are overseen by an independent, professional market oversight company, Potomac Economics,

RGGI Helps Clean Our Air

RGGI is designed to reduce power plant emissions of carbon dioxide, the leading global warming pollutant. By encouraging a shift toward cleaner forms of electricity generation, the program also reduces the release of other pollutants that threaten our health.

Analysis conducted for the 2012 RGGI program review suggests that strengthening RGGI would significantly reduce power plant emissions in the Northeast. Specifically, the program would:

- Reduce emissions of nitrogen oxides—a component of ozone smog—by more than 9,000 tons per year by 2020.
- Reduce emissions of sulfur dioxide—which contributes to the formation of soot—by more than 15,000 tons per year by 2020.
- Reduce emissions of mercury—a potent neurotoxicant that accumulates in aquatic organisms, eventually affecting human health via fish consumption—by 71 pounds per year by 2020.⁵¹

These reductions are significant, ranging from 20 percent to 27 percent reductions in emissions from the region’s power plants relative to projected emission levels under the current RGGI program. Reduced fossil fuel combustion in homes, businesses and vehicles resulting from the investment of RGGI auction proceeds in energy efficiency and clean energy programs would reduce air pollution even further.

which also monitors several of the nation's major electric power spot markets.

Among the signs the system is working well:

- The vast majority of allowances have been auctioned directly to power plant owners required to comply with the program, signaling that allowances are not being hoarded by speculators.⁴¹
- Auctions have attracted a significant number of bidders, preventing the exercise of market power by one or a small group of bidders. The presence of large numbers of bidders protects against manipulation, although the market monitor's 2011 report also credited the existence of a reserve price "floor" as ensuring the competitiveness of the auction.⁴²
- The program's market monitor has not detected any basis for concerns regarding the operation of the auction system or evidence of anti-competitive conduct.⁴³

Four years into the program, RGGI's pioneering carbon dioxide market has worked transparently and fairly—demonstrating the potential of cap-and-trade as an effective mechanism to limit emissions of global warming pollution.

Strengthening RGGI Would Be an Important Step

In February 2013, the nine RGGI states announced plans to strengthen the program's cap on carbon dioxide emissions from power plants to deliver additional emission reductions between 2014 and 2020. Strengthening RGGI is an important step—producing a significant reduction in



Energy audits have helped identify opportunities for improving energy efficiency. Credit: NREL.

carbon dioxide pollution while positioning the Northeast for the more substantial emission reductions scientists believe will be necessary in the years ahead if the United States and the world are to avoid the worst impacts of global warming.

Reducing Carbon Pollution from Power Plants

The RGGI states' proposal would limit emissions of carbon dioxide pollution from power plants in the Northeast to roughly today's levels and require emission reductions of 2.5 percent per year between 2015 and 2020.⁴⁴ Assuming that RGGI states adjust the program to require the retirement of old excess allowances, emissions at affected plants in 2020 would be approximately 82 to 88 million short tons, representing a reduction of more than 45 percent compared with emissions in 2005, the year the original RGGI agreement was signed.⁴⁵

Strengthening RGGI would result in the avoidance of 86 to 91 million tons of

carbon dioxide emissions between 2013 and 2020.⁴⁶ That is more carbon dioxide than is currently emitted in Maryland or Massachusetts each year, about as much as is emitted annually in the nations of Hong Kong or Kuwait, and as much as is released each year by 16 million of today's cars or 22 typical power plants.⁴⁷

The region will achieve additional emission reductions from investment of RGGI allowance auction revenues in fossil fuel energy efficiency improvements. Some RGGI states, such as Vermont and New York, have invested a large share of their RGGI allowance proceeds in programs to reduce the direct use of oil and natural gas in homes and businesses. These investments will provide further reductions in global warming pollution.

Paving the Way for Future Emission Reductions

The scientific consensus is that industrialized nations such as the United States must reduce their emissions of global warming pollutants by at least 80 to 95 percent by 2050 for the world to have a chance to avoid the worst impacts of global warming.⁴⁸ Achieving those emission targets will require much more than simply reducing our consumption of power from the dirtiest power plants. It will require a wholesale transformation of our economy from one reliant on fossil fuels to one that makes efficient use of renewable energy sources such as the sun and the wind.

RGGI's cap on power plant emissions plays a critical role in reducing emissions in the short term. But the investment of auction revenues in clean energy will make it easier for the region to become more efficient and develop new clean energy technologies to achieve the even more ambitious emission reduction targets that will be required in coming decades.

Many of the measures funded by RGGI allowance auctions will reduce fossil fuel consumption or electricity use for 15 to

20 years into the future.⁴⁹ As the Northeast continues to invest in more efficient homes, offices and factories over time, the region will become better able to ramp down its dependence on dirty sources of energy without risk to the economy. At the same time, the region will develop a growing legion of businesses with expertise in delivering clean energy products and services, expanding access to those products and services and reducing costs—leaving the region better able to reduce emissions further beyond 2020.⁵⁰

Laying the Groundwork for Further Action

RGGI's importance goes well beyond its ability to reduce global warming pollution and promote clean energy in the Northeast. RGGI also serves as a model of effective action against global warming—providing a platform that could be expanded to other jurisdictions and sectors of the economy or emulated by other states and regions.

RGGI remains a pioneering effort. It was the first carbon dioxide cap-and-trade program in the United States, the first multi-state regional program, and the first greenhouse gas cap-and-trade program in the world to auction the bulk of its pollution allowances and reinvest the proceeds in clean energy. As a result, the Northeast's experience with the program is of keen interest to those in other states and regions considering similar efforts.

Over the past several years, RGGI has proven the effectiveness of cap-and-trade as a tool to reduce global warming pollution. Since the signing of the RGGI memorandum of agreement in 2005, other jurisdictions in North America have moved forward with cap-and-trade programs, including:

- California launched an economy-wide cap-and-trade system in late 2012. The state's first carbon auction, which

took place in November 2012, raised approximately \$290 million through sales of 23.1 million tons worth of carbon dioxide emission allowances.⁵²

- The Canadian province of Quebec implemented a cap-and-trade program for certain industrial emitters of carbon dioxide at the beginning of 2013.⁵³

A strong RGGI would benefit and facilitate the development of stronger emission reduction policies in the United States and elsewhere by:

- Setting high standards of integrity and effectiveness for new cap-and-trade programs, ensuring that the public derives the maximum benefits from the system in terms of environmental impact, economic development and consumer protection.
- Providing a platform to which other states or other sectors of the economy could be added to the cap-and-trade system at a later date.
- Providing real-world experience in the operation of cap-and-trade—giving governments considering the measure more confidence in its ultimate application as an effective tool to reduce global warming pollution.

The Northeast's pioneering efforts to reduce global warming pollution are being

watched worldwide. By maintaining and strengthening RGGI, the region can set a powerful example that can leverage emission reductions far from the region.

Conclusion

The Northeast is a globally significant source of carbon dioxide pollution, with the region's power sector a major contributor. The significant threats posed by global warming to the Northeast demand that the region do its share to reduce the danger. RGGI has already reduced global warming pollution in the Northeast by investing in energy efficiency and renewable energy projects that curb the region's consumption of fossil fuels. A stronger RGGI will lead to direct reductions of carbon dioxide emissions from the region's power plants while driving investment in clean energy technologies that will further reduce emissions in the short term and lay the foundation for the deeper cuts in emissions that science tells us are necessary to prevent the worst impacts of global warming. At the same time, a stronger RGGI will set an example of effective action that can be expanded to incorporate other jurisdictions and sources of emissions over time—magnifying the impact of the program and further reducing the dangers posed by global warming to the Northeast and the world.

RGGI Is Critical to the Northeast's Economic Future

Global warming and dependence on fossil fuels—most of them imported from outside the region—are twin threats to the future of the Northeast's economy and well-being. Global warming raises the specter of more damaging storms like Hurricane Irene and Hurricane Sandy and will impose billions of dollars in costs to protect or relocate buildings and infrastructure threatened by climate change. Fossil fuel dependence, meanwhile, drains tens of billions of dollars from the region's economy each year.

A strong response to global warming is an economic winner for the Northeast.



Hurricane Sandy over the Northeast, as viewed from space. Credit: NASA.

By reducing dependence on fossil fuels, the region can keep a greater share of its energy dollars in the region, spurring economic growth. And by reducing the threat of global warming, the region can minimize the costly disruptions to life, health, infrastructure and key industries that global warming may bring in the decades to come.

Global Warming Threatens the Northeast's Economy

Hurricane Sandy was a prime example of the dangers the Northeast will face in a warming world. The storm affected residents, the economy and infrastructure up and down the East Coast. The impacts, however, did not come as a complete surprise. Scientists and public officials have long known that coastal communities in the Northeast are vulnerable to global warming. As early as 1989, scientists warned that the nation faced a cumulative bill of \$152 billion to \$233 billion over the next century to protect coastal ecosystems and property from rising seas, with

a significant share of those costs in the Northeast.⁵⁴

The Northeast is extraordinarily vulnerable to the effects of global warming. For example:

- Nearly 1.6 million people in the 10 Northeastern states live within the Federal Emergency Management Agency’s 100-year coastal flood zone.⁵⁵ (See Table 1.) Coastal flooding events will become far more common in a warming world; a 2009 New York City report estimated that 1-in-100 year coastal floods could be expected to occur once every 15 to 35 years by the end of the century.⁵⁶
- More than \$2 trillion of private property and public infrastructure could be exposed to damage in Baltimore, Boston, New York-Newark, Philadelphia and Providence in the event of a 0.65 meter (2.1 foot) increase in sea level by 2050.⁵⁷
- Further inland, river flooding—fueled by the increasingly wet storms that have been hitting the Northeast in recent years—puts billions of additional dollars of infrastructure at risk. Hurricane Irene—whose greatest damage was inflicted by its torrential rains rather than heavy winds—showed the destructive potential of extreme precipitation, causing \$6.5 billion in damage, much of it in the Northeast and killing 45 people.⁵⁸

Damage to buildings and infrastructure is not the only economic threat posed by global warming. Climate change threatens key economic sectors—from winter sports-based recreational economies in inland regions to the productivity of the region’s farms.⁶⁰ Carbon dioxide also contributes to ocean acidification, which threatens the Northeast’s seafood industry.⁶¹

Table 1. Population of Areas in FEMA 100-Year Coastal Flood Zone⁵⁹

State	Coastal Flood Zone Residents
Connecticut	119,000
Delaware	46,000
Maine	33,000
Maryland	148,000
Massachusetts	174,000
New Hampshire	11,000
New Jersey	496,000
New York	494,000
Rhode Island	55,000
Vermont	-
Northeast	1,576,000

The economic impacts of climate change for the region will be significant. A 2010 study by researchers at the Sandia National Laboratory estimated that the economic cost of uncertainty in rainfall alone due to climate change would cost the region’s economy more than \$200 billion between 2010 and 2050 along with more than 1 million job-years of employment.⁶² (See Table 2.) These impacts do not include economic damage from other aspects of climate change, or the impacts of flooding events or other destructive events caused by extreme weather or of sea level rise between now and 2050.

As the planet warms, the Northeast will also find itself compelled to invest billions of dollars in preventive or adaptive measures—from restoration of salt marshes to construction of storm surge barriers to the relocation of people from vulnerable coastal communities.

Aggressive actions by the Northeast and other jurisdictions in the United States and around the world can reduce these threats—safeguarding the pillars of the region’s economy for the future.



Hurricane Sandy caused extensive damage in the Northeast, including at this location in Deal, New Jersey. Credit: FEMA

Table 2. Economic and Job Losses from Precipitation-Related Impacts of Climate Change, 2010-2050, Summary Impacts⁶³

State	GDP loss from precipitation uncertainty (billion \$2008)	Job loss (job years)
Connecticut	\$9.5	36,400
Delaware	\$4.8	30,300
Maine	\$0.3	4,400
Maryland	\$23.7	163,000
Massachusetts	\$9.0	37,800
New Hampshire	\$1.8	12,100
New Jersey	\$38.9	205,900
New York	\$122.9	560,400
Rhode Island	\$0.7	3,200
Vermont	\$0.7	5,500
Northeast	\$212.3	1,059,000

Fossil Fuel Dependence Drains Resources from the Northeast

In 2010, the Northeast states spent nearly \$130 billion on fossil fuels—98.5 percent of which were imported from outside the region or outside the country.⁶⁴ (See Table 3.) The region’s dependence on fossil fuels supports jobs and economic activity in places from Dallas to Dubai but not, by and large, here at home in the Northeast.

RGGI invests funds from the sale of global warming pollution allowances in clean energy technologies that reduce expenditures on fossil fuels over the long run—supporting industries with a growing presence in Northeastern states. According to the U.S. Bureau of Labor Statistics, more than 580,000 people in the Northeast were employed in “green jobs” in 2010, including jobs in the growing renewable energy and energy efficiency sectors.⁶⁶

Table 3. Fossil Fuel Expenditures by State, 2010⁶⁵

State	Fossil Fuel Expenditures (millions)
Connecticut	\$ 9,567
Delaware	\$ 2,463
Maine	\$ 4,888
Maryland	\$ 14,253
Massachusetts	\$17,656
New Hampshire	\$ 3,963
New Jersey	\$ 27,210
New York	\$ 40,664
Rhode Island	\$ 2,902
Vermont	\$5,499
Northeast	\$129,064

Strengthening RGGI Would Reduce the Region's Dependence on Fossil Fuels

RGGI is already helping to transition the region away from dirty energy. RGGI auction revenues invested in energy efficiency through 2011 will create 27 million megawatt-hours of lifetime electricity savings.⁶⁷

Unfortunately, RGGI's inflated emission cap, coupled with the lower-than-predicted cost of reducing pollution, has meant that demand for pollution allowances—and, therefore, their price—has remained very low. Strengthening RGGI's emission cap would lead to increased competition and prices for allowances, enabling Northeastern states to ramp up their investments in clean energy.

Analysis conducted by Northeast States for Coordinated Air Use Management (NESCAUM) in February 2013 estimated that a strengthened RGGI would bring in \$3.8 billion in allowance revenue through 2020, compared with just \$1.5 billion in a scenario in which RGGI's emission cap is

not strengthened.⁶⁸ In essence, strengthening the emission cap would more than double the amount of resources available to states through RGGI to invest in energy efficiency and other measures to transition the region's economy away from dependence on fossil fuels.

Cutting Emissions and Growing the Economy Go Hand in Hand

Recent experience shows that reducing global warming pollution and growing the economy can go hand in hand. In recent years, RGGI states have grown their economies faster than the rest of the nation, even as they have cut emissions of global warming pollution faster than the nation as a whole.

Between 2000 and 2010, RGGI states (including New Jersey, which participated in the program through 2011):

- Reduced total emissions of carbon dioxide from energy use nearly four times as fast as non-RGGI states (12.5 percent versus 3.3 percent).
- Reduced emissions per capita 25 percent faster than non-RGGI states.
- Reduced the carbon intensity of the economy (emissions of carbon dioxide per dollar of gross state product) nearly 50 percent faster than the rest of the nation.⁶⁹

At the same time, the economies of the 10 RGGI states grew more than twice as fast on a per-capita basis as those in non-RGGI states.⁷⁰ (See Figure 5.)

These data do not prove that adopting RGGI and taking other steps to reduce global warming pollution have improved

the Northeastern economy. They do demonstrate, however, that reducing global warming pollution is compatible with maintenance of a vigorous and growing economy.

Reductions in pollution from power plants—the sector of the economy governed by RGGI—have been an important component of the overall decline in emissions in the Northeast. About 45 percent of all the emission reductions that took place in the Northeast between 2000 and 2010 were the result of reduced emissions from power plants.⁷²

Seven of the 10 RGGI states posted greater than average reductions in per-capita emissions and carbon intensity, as well as GDP growth, during the 2000 to 2010 period. Delaware led the region for emission reductions due to a dramatic reduction in emissions from power plants and industry.

Strengthening RGGI Would Speed the Transition to a Clean Energy Economy while Benefiting the Economy

The recent track record of emission reductions and economic growth in the Northeast is not the only evidence of the economic benefits of reducing global warming pollution. Indeed, two recent studies have documented the positive impact of RGGI on the Northeast’s economy.

According to Analysis Group, RGGI produced \$1.6 billion (2011 net present value) in added economic value in the region in its first three years of operation, while creating 16,000 additional job-years of employment.⁷⁴ Rather than increase the cost of electricity—as would be expected with a program that imposes new costs on the owners of pollution-emitting power

Figure 5. Measures of Carbon Dioxide Emissions and Economic Growth in RGGI and Non-RGGI States, 2000-2010⁷¹

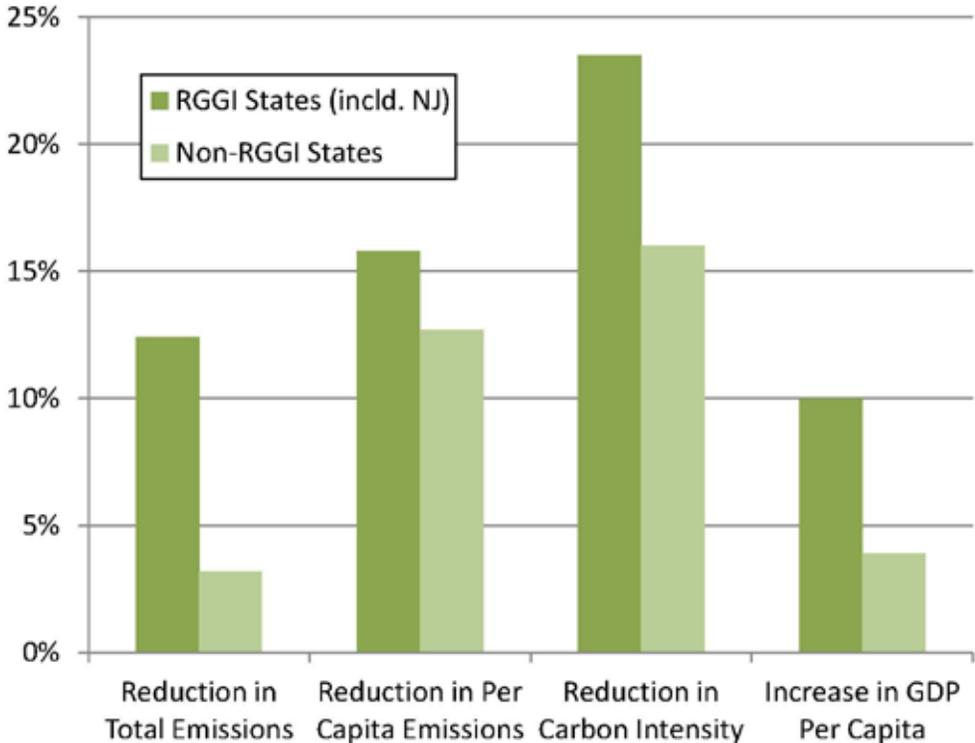


Table 4. Changes in Emissions and Economic Growth by State, RGGI Region, 2000-2010⁷³

State	Change in Carbon Intensity	State	Change in Per Capita Emissions	State	Change in GDP Per Capita
Delaware	-41%	Delaware	-37%	Maryland	15%
New York	-30%	Maine	-20%	New York	14%
Maryland	-27%	New York	-20%	Rhode Island	12%
Maine	-23%	Connecticut	-18%	Vermont	11%
Vermont	-22%	Maryland	-17%	Massachusetts	10%
Massachusetts	-22%	Massachusetts	-14%	New Hampshire	7%
Connecticut	-19%	Vermont	-13%	Delaware	6%
U.S. AVERAGE	-17%	U.S. AVERAGE	-13%	U.S. AVERAGE	5%
Rhode Island	-15%	New Jersey	-9%	New Jersey	4%
New Hampshire	-15%	New Hampshire	-9%	Maine	3%
New Jersey	-12%	Rhode Island	-5%	Connecticut	2%

plants—the report found that RGGI will *reduce* consumer electricity bills by \$1.1 billion as a result of the re-investment of auction proceeds in energy efficiency programs that reduce the amount of electricity used by consumers.⁷⁵

Strengthening RGGI is expected to lead to additional economic benefits. A recent analysis by NESCAUM estimated that the proposed strengthening of RGGI will increase gross state product in the region by \$8 billion (2010\$) and create 124,800 additional job-years of employment.⁷⁶ While those increases are small in the context of the region’s overall economy, they demonstrate yet again that reducing the region’s dependence on fossil fuels and curbing global warming pollution are compatible with a thriving economy.

Conclusion

The Regional Greenhouse Gas Initiative is central to the Northeast’s economic future. By hastening the region’s transition away from fossil fuels—which bleed tens of billions of dollars from the region each year—and toward homegrown sources of clean energy, RGGI can help grow the region’s economy. Over the past decade, the Northeast has proven that reducing carbon dioxide emissions and growing the economy can go hand in hand by cutting emissions faster than the rest of the nation while simultaneously enjoying more robust economic growth. Recent studies have shown that RGGI itself is delivering important economic benefits to the region and creating jobs, and that strengthening RGGI will magnify those benefits.

Policy Recommendations: Building a Stronger RGGI

The Regional Greenhouse Gas Initiative is a “win-win” for the Northeast—helping to protect our citizens from the dangers posed by global warming while building a thriving clean energy economy well-positioned for future growth.

Recognizing the benefits of RGGI, the nine RGGI states have proposed strengthening the program. Their plan, unveiled in February 2013, would fix the program’s most glaring weakness—the inflated amount of emissions allowed by the cap—while putting the region on a steady trajectory toward cleaner sources of power.

Specifically, the plan would reset the regional emission cap to 91 million tons in 2014 (as opposed to 165 million tons under the current program) and reduce emissions by 2.5 percent per year from 2015 to 2020. It would also address the surplus of unused allowances purchased and banked by power plant owners during the first few years of the program, and make changes to cost control mechanisms and other aspects of the program.

To maximize the benefits of RGGI to the environment and economy, the RGGI states should:

- Adopt the revised Model Rule proposed in February 2013 by the end of the year, putting the Northeast on track to significant additional reductions in global warming pollution.

In addition:

- New Jersey should re-join RGGI at the soonest opportunity. New Jersey benefited from participation in the first few years of RGGI and will experience greater benefits by re-joining a stronger RGGI program now.
- RGGI states should consider establishing limits on carbon pollution that go beyond the electricity sector, including transportation and heating fuels. This could include expanding RGGI to other sectors.
- States with economy-wide caps on global warming pollution—including Maryland, New Jersey, Connecticut and Massachusetts—should fully implement those caps, driving reductions in emissions and the adoption of clean energy throughout the economy.

- Regional leaders should lay the groundwork for expanding RGGI to other states.
- RGGI states should encourage the U.S. Environmental Protection Agency

to move forward with regulating global warming pollution from existing power plants in all states. Current federal standards limit pollution from new power plants but do not address pollution from existing facilities.

Notes

- 1 New York Governor's Office, *Governor Cuomo Holds Meeting with New York's Congressional Delegation, Mayor Bloomberg and Regional County Executives to Review Damage Assessment for the State in the Wake of Hurricane Sandy* (press release), 26 November 2012.
- 2 New Jersey Office of the Governor, *Christie Administration Releases Total Hurricane Sandy Damage Assessment of \$36.9 Billion* (press release), 28 November 2012.
- 3 Ken Dixon, "Sandy Storm Damage Tops \$360M in State," *Connecticut Post*, 14 November 2012.
- 4 AON Benfield, *Annual Global Climate and Catastrophe Report, Impact Forecasting—2012*, downloaded from thoughtleadership.aonbenfield.com/Documents/20130124_if_annual_global_climate_catastrophe_report.pdf, 11 March 2013.
- 5 National Climatic Data Center, National Oceanic and Atmospheric Administration, *Storm Events Database: Strong Wind: Fayette County, Pennsylvania, 29 October 2012*, accessed at www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=417879, 19 February 2013.
- 6 Eric S. Blake, et al., National Hurricane Center, *Tropical Cyclone Report: Hurricane Sandy (AL182012), 22-29 October 2012*, 12 February 2013.
- 7 National Climatic Data Center, National Oceanic and Atmospheric Administration, *Storm Events Database: Flood, Mercer County, New Jersey, 29 October 2012*, accessed at www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=417336, 19 February 2013.
- 8 Radley Horton, et al., "Climate Risks," in Cynthia Rosenzweig, et al., (eds.), New York State Energy Development Research Authority, *Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation in New York State*, November 2011.
- 9 Kenneth E. Kunkel, et al., National Oceanic and Atmospheric Administration, *Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 1: Climate of the Northeast U.S.*, January 2013. Based on 0.16° F per decade increase in temperatures from 1895 to 2011.
- 10 Travis Madsen, Frontier Group, and Nathan Willcox, Environment America

Research & Policy Center, *When It Rains, It Pours: Global Warming and the Increase in Extreme Precipitation from 1948-2011*, Summer 2012.

11 Map supplied by Travis Madsen, Frontier Group, based on data prepared for Travis Madsen, Frontier Group, and Nathan Willcox, Environment America Research & Policy Center, *When It Rains, It Pours: Global Warming and the Increase in Extreme Precipitation from 1948-2011*, Summer 2012.

12 See note 8; and John Boon, "Evidence of Sea Level Acceleration at U.S. and Canadian Tide Stations, Atlantic Coast, North America," *Journal of Coastal Research*, 28 (6): 1437-1445.

13 Lindsey Rustad, et al., U.S. Forest Service, *Changing Climate, Changing Forests: The Impacts of Climate Change on Forests of the Northeastern United States and Eastern Canada*, 2012.

14 Snow depths: See note 9. Ice out: see examples in Lawrence C. Hamilton, Barry D. Keim and Cameron P. Wake, "Is New Hampshire's Climate Warming?," *Carsey Institute New England Policy Brief*, Summer 2010; Alan K. Betts, Vermont Agency of Natural Resources, *Climate Change in Vermont*, June 2011.

15 See note 13.

16 Based on A2 scenario from Kenneth E. Kunkel, et al., National Oceanic and Atmospheric Administration, *Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 1: Climate of the Northeast U.S.*, January 2013.

17 See, for example, Radley Horton, et al., "Chapter 3: Climate Observations and Projections" in New York City Panel on Climate Change (ed.), *Climate Change Adaptation in New York City: Building a Risk Management Response*, *Annals of the New York Academy of Sciences*, 1196: 41-62, May 2010, doi: 10.1111/j.1749-6632.2009.05314.x.

18 National Oceanic and Atmospheric Administration, *Global Sea Level Rise Scenarios for the United States National Climate Assessment*, 6 December 2012.

19 Based on figures for New York City from Radley M. Horton, et al., "Climate Hazard Assessment for Stakeholder Adaptation Planning in New York City," *Journal of Applied Meteorology and Climatology*, 50(11): 2247-2266, November 2011, doi: 10.1175/2011JAMC2521.1. Other areas of the Northeast can also expect a significant increase in the frequency of major coastal flooding as well. See: Claudia Tebaldi, Benjamin H. Strauss and Chris E. Zervas, "Modeling Sea Level Rise Impacts on Storm Surges Along U.S. Coasts," *Environmental Research Letters*, 7(1): 014032, 2012. doi:10.1088/1748-9326/7/1/014032.

20 See note 9.

21 Including New Jersey, which subsequently withdrew from the program.

22 International emissions of carbon dioxide from U.S. Department of Energy, Energy Information Administration, *International Energy Statistics Database: Total Carbon Dioxide Emissions from the Consumption of Energy*, downloaded from www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm#, 19 February 2013; State carbon dioxide emissions from U.S. Department of Energy, Energy Information Administration, *State CO₂ Emissions*, 31 January 2013.

23 Ibid.

24 U.S. Department of Energy, Energy Information Administration, *State CO₂ Emissions*, 31 January 2013.

25 Ibid. Includes New Jersey, which subsequently withdrew from RGGI.

26 Ibid.

27 Maine Department of Environmental Protection, *States Reach Agreement on Rules*

for the Nation's First Cap-and-Trade Program to Address Climate Change (press release), 15 August 2006.

28 Regional Greenhouse Gas Initiative, *Memorandum of Understanding*, 20 December 2005.

29 Regional Greenhouse Gas Initiative, *The Regional Greenhouse Gas Initiative (RGGI) Is ...*, downloaded from www.rggi.org/docs/RGGI_Executive_Summary.pdf, 20 January 2012.

30 See note 28.

31 See note 24. Includes New Jersey, which subsequently withdrew from RGGI.

32 Ibid.

33 Regional Greenhouse Gas Initiative Inc., *97% of RGGI Units Meet First Compliance Period Obligations* (press release), 4 June 2012.

34 Regional Greenhouse Gas Initiative Inc., *Regional Investment of RGGI CO₂ Allowance Proceeds, 2011*, November 2012.

35 2012 emission cap: Regional Greenhouse Gas Initiative, Inc., *About the Regional Greenhouse Gas Initiative (RGGI)* (factsheet), 28 September 2012. Emissions data: Regional Greenhouse Gas Initiative, Inc., *CO₂ Allowance Tracking System (RGGI-COATS)*, accessed at rggi-coats.org/eats/rggi/, 11 March 2013.

36 See note 34.

37 Ibid. \$400 million figure based on energy efficiency receiving 66 percent of \$617.9 million in allowance revenue investments. Figures do not include investments made by New Jersey during its participation in the program.

38 See note 34.

39 27 million megawatt-hours: See note 34; "all of Maryland's homes for a year"

based on average residential electricity consumption from U.S. Department of Energy, Energy Information Administration, *Table 5A. Residential average monthly bill by Census Division, and State 2011*, downloaded from www.eia.gov/electricity/sales_revenue_price/xls/table5_a.xls, 20 February 2013.

40 Potomac Economics, *Annual Report on the Market for RGGI CO₂ Allowances: 2011*, prepared for RGGI Inc., May 2012.

41 Ibid.

42 Ibid.

43 Ibid. See also similar market monitor reports for 2009 and 2010.

44 RGGI Inc., *RGGI States Propose Lowering Regional CO₂ Emissions Cap 45%, Implementing a More Flexible Cost-Control Mechanism* (press release), 7 February 2013.

45 Ibid.

46 Converted from 78 to 83 million metric tons. RGGI Inc., *RGGI IPM Analysis: Amended Model Rule*, 8 February 2013.

47 "Massachusetts or Maryland" compared with U.S. Department of Energy, Energy Information Administration, *State CO₂ Emissions*, 31 January 2013; "Hong Kong or Kuwait" based on U.S. Department of Energy, Energy Information Administration, *International Energy Statistics Database: Total Carbon Dioxide Emissions from the Consumption of Energy*, downloaded from www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm#, 19 February 2013; car and power plant comparison based on U.S. Environmental Protection Agency, *Clean Energy: Calculations and References*, accessed at www.epa.gov/cleanenergy/energy-resources/refs.html, 20 February 2013.

48 S. Gupta, et al., "Policies, Instruments, and Co-operative Arrangements," in *Climate Change 2007: Mitigation*,

Contribution of Working Group III to the Fourth Assessment Report of the IPCC, 2007, 776. Assumes a scenario in which temperature increases are held to below 2° C.

49 Northeast States for Coordinated Air Use Management, *REMI Economic Impact Analysis Assumptions and Results: 91 Cap Bank Potential Scenario*, 7 February 2013.

50 A study of utility energy efficiency programs in Massachusetts, for example, found that the cost per unit of energy savings declined as total investment in energy efficiency increased. See Doug Hurley, et al., Synapse Energy Economics, *Costs and Benefits of Electric Utility Energy Efficiency in Massachusetts*, August 2008.

51 All reductions are calculated based on the difference between the RGGI Reference Case scenario (RGGI Inc., *Reference Case Results Revised* (Excel spreadsheet), 13 August 2012) and the “91 Cap Bank Model Rule scenario” (RGGI Inc., *Data: IPM Electricity Sector Modeling Results 91 Cap Bank Model Rule*, 11 February 2013).

52 Ricardo Lopez, “California’s First Carbon-Credit Auction Raises \$290 Million,” *Los Angeles Times*, 20 November 2012.

53 Government of Quebec, *The Carbon Market*, accessed at www.mddep.gouv.qc.ca/changements/carbone/index-en.htm, 20 February 2013.

54 Joel B. Smith and Dennis Tirpak (eds.), U.S. Environmental Protection Agency, *The Potential Effects of Global Climate Change on the United States*, December 1989. Dollar figures adjusted from 1986 dollars to 2012 dollars using the U.S. Bureau of Labor Statistics, *CPI Inflation Calculator*, accessed at www.bls.gov/data/inflation_calculator.htm, 20 February 2013.

55 Includes CT, DE, ME, MD, MA, NH, NJ, NY, RI and VT. Source: Mark Crowell, et al., “An Estimate of U.S.

Population Living in 100-Year Coastal Flood Hazard Areas,” *Journal of Coastal Research*, 26(2):201-211, March 2010.

56 New York City, *Mayor Bloomberg Releases New York City Panel on Climate Change Report that Predicts Higher Temperatures and Rising Sea Levels for New York City* (press release), 17 February 2009.

57 Tim Lenton, Anthony Footitt and Andrew Dlogolecki, WWF-World Wide Fund for Nature and Allianz, *Major Tipping Points in the Earth’s Climate System and Consequences for the Insurance Sector*, November 2009.

58 National Oceanic and Atmospheric Administration, *Service Assessment: Hurricane Irene, August 21-30, 2011*, September 2012.

59 Mark Crowell, et al., “An Estimate of U.S. Population Living in 100-Year Coastal Flood Hazard Areas,” *Journal of Coastal Research*, 26(2):201-211, March 2010.

60 Peter C. Frumhoff, et al., Northeast Climate Impacts Assessment, *Confronting Climate Change in the U.S. Northeast*, July 2007.

61 For a summary of the possible effects of ocean acidification, see Secretariat of the Convention on Biological Diversity, *Scientific Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity*, 2009.

62 George Backus, et al., Sandia National Laboratories, *Assessing the Near-Term Risk of Climate Uncertainty: Interdependencies among the U.S. States*, May 2010. Cost based on 0% discount rate.

63 Ibid.

64 Based on net consumption (fossil fuel consumption in Btu minus fossil fuel production in Btu) from U.S. Department of Energy, Energy Information Administration, *State Energy Data 2010*, 29 June 2012.

65 U.S. Department of Energy, Energy Information Administration, *State Energy Data 2010*, 29 June 2012.

66 U.S. Department of Labor, Bureau of Labor Statistics, *Employment in Green Goods and Services – 2010* (news release), 22 March 2012.

67 See note 34.

68 See note 49.

69 RGGI states reduced emissions per unit of gross state product 47 percent faster than non-RGGI states. Based on state-by-state data on carbon dioxide emission trends from U.S. Department of Energy, Energy Information Administration, *State CO₂ Emissions*, 31 January 2013; *Gross Domestic Product by State* from U.S. Bureau of Economic Analysis, *Regional Data: GDP & Personal Income*, accessed at www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1&isuri=1&acrnd=1#reqid=70&step=1&isuri=1, 31 January 2013; and population figures from U.S. Census Bureau, *The 2012 Statistical Abstract*, 2012.

70 U.S. Bureau of Economic Analysis, *Regional Data: GDP & Personal Income*,

accessed at www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1&isuri=1&acrnd=1#reqid=70&step=1&isuri=1, 31 January 2013.

71 Based on state-by-state data on carbon dioxide emission trends from U.S. Department of Energy, Energy Information Administration, *State CO₂ Emissions*, 31 January 2013; *Gross Domestic Product by state* from U.S. Bureau of Economic Analysis, *Regional Data: GDP & Personal Income*, accessed at www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1&isuri=1&acrnd=1#reqid=70&step=1&isuri=1, 31 January 2013; and population figures from U.S. Census Bureau, *The 2012 Statistical Abstract*, 2012.

72 See note 24.

73 See note 71.

74 Paul J. Hibbard, et al., Analysis Group, *The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States*, 15 November 2011.

75 Ibid.

76 See note 49.