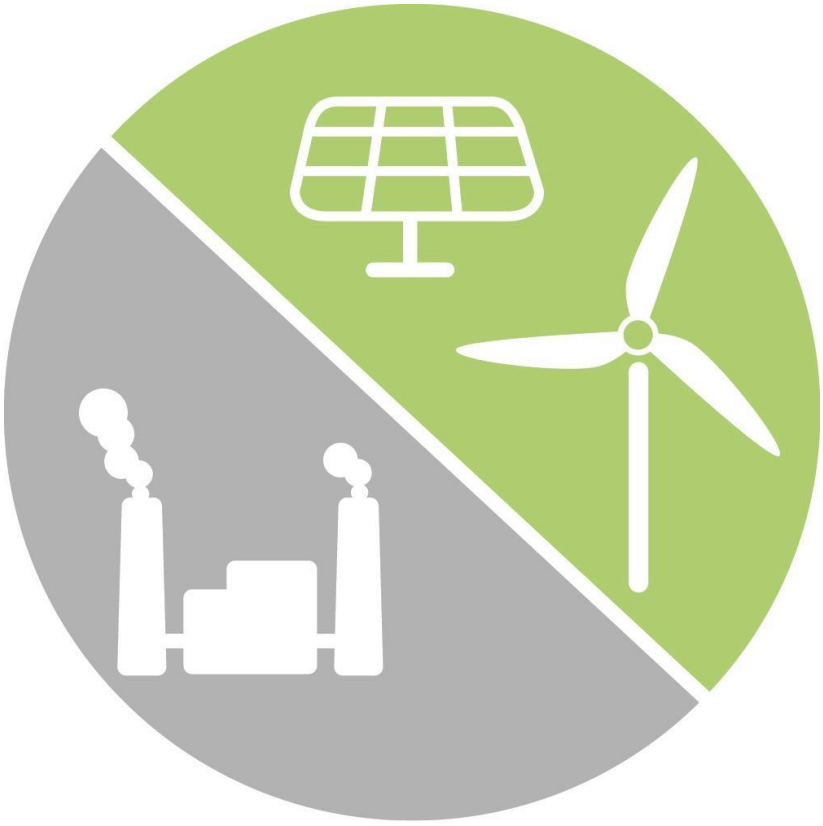
The Regional Greenhouse Gas Initiative: Performance To-Date and the Path Ahead

MAY 2014



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1. Introduction – An Effective Program

During five plus years of operations, RGGI has helped Northeast and Mid-Atlantic States[1] achieve significant reductions in emissions of carbon dioxide (CO_2) and other dangerous pollutants from the electric power sector. At the same time the program has generated significant economic benefits in the region.

RGGI demonstrates that emissions can be reduced faster and at lower cost than typically assumed. Fuel-switching, improved energy efficiency, and growing renewable energy output have caused emissions to drop by 18% since RGGI launched,[i] while electricity prices are lower than they were before RGGI took effect. The rate of pollution reductions continues to outpace expectations, with emissions falling 5% below a more stringent cap set just last year.[i] The fact that CO_2 pollution is already dropping below the new cap reinforces a historic trend of underestimating the capacity of flexible markets to meet environmental goals. Against this backdrop of declining emissions, RGGI state economies have outpaced the rest of country, showing that the link between economic growth and emissions has broken in the region and demonstrating that we can address the threat of climate change while promoting continuing prosperity.

While RGGI states are at the forefront of reducing emissions, other states are seeing emissions reductions due to similar trends. Outdated and inefficient coal plants are shuttering across the country, while improvements in energy efficiency accelerate and renewable energy output continues to grow. As states develop plans to comply with federal carbon pollution standards, RGGI provides both a proven template for state action and an example of the capacity to clean up the power sector while benefitting consumers.

After five years of successful operation and recent reforms to strengthen the program, RGGI has largely achieved its initial goals. Power generators have incorporated RGGI requirements into normal business operations, and the electric sector as a whole has adapted to the shifting economics of different generation sources while continuing to provide a reliable supply of electricity. Requiring electric generators to pay for disposing of CO_2 into the atmosphere has led the market to incorporate the cost of pollution into planning decisions, while at the same time raising revenue for states to reinvest in clean energy and consumer programs that drive additional emissions reductions and economic growth.

Key Facts:

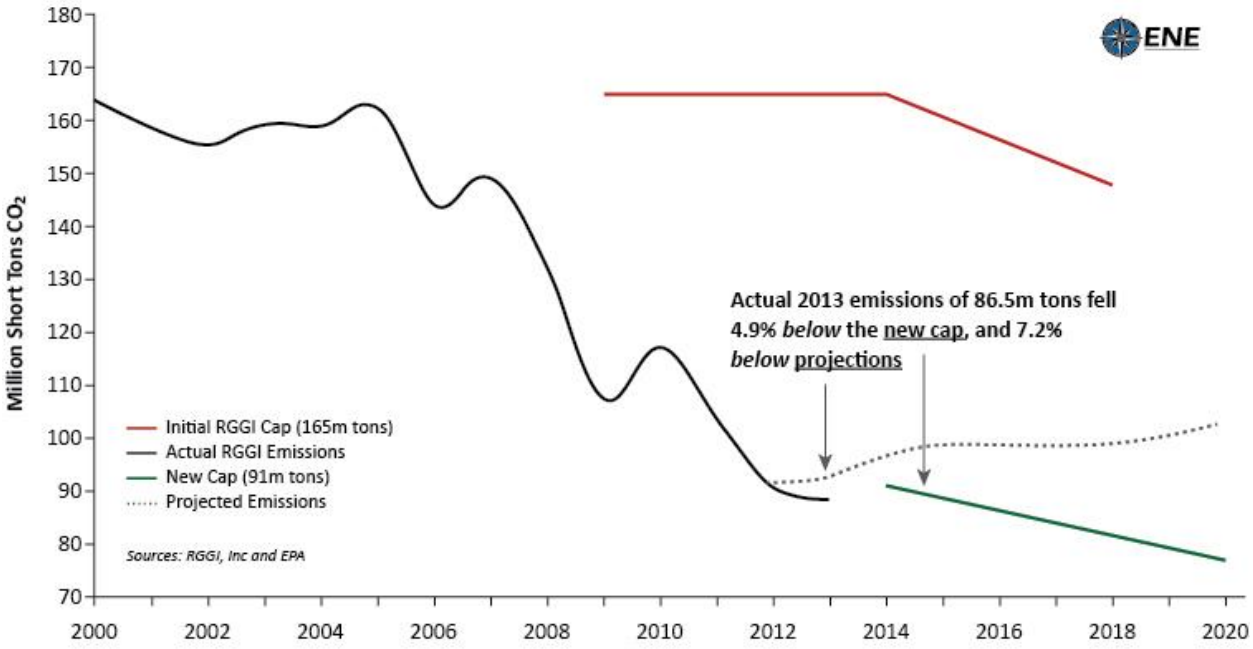
- 2013 emissions of 86,568,410 tons of CO_2 fell 4.9% below the new RGGI cap
- Hazardous criteria emissions (SO_x, NO_x, and Hg) from power plants in the RGGI program have dropped even more than CO_2 emissions, and will continue to fall through 2020.
- Electricity prices across the region have decreased by 8% on average since RGGI took effect.
- Electric sector trends responsible for low emissions – including increasing natural gas and renewable generation, growing investments in energy efficiency, and decoupling of economic growth and emissions – show no signs of reversing.
- Similar trends are likely to cause emissions to decline across the country.
- RGGI is a cost-effective effective mechanism for states to comply with EPA's Carbon Pollution Standards, though minor program modifications could be required.

[1] Analysis in this report covers the participating RGGI states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. New Jersey stopped participating in RGGI after 2011, but the withdrawal has been overturned in court and New Jersey may rejoin the program. [*Footnotes elaborate on points within this report, whereas endnotes cite references and provide detailed analytic methodologies where relevant.*]

1.1 Emissions Reductions

Emissions in 2013 continued the downward trend of recent years, reinforcing the importance of the RGGI states' decision to reduce the emissions cap during the 2012 Program Review. CO_2 emissions from the 167 power plants covered by RGGI totaled 86,568,410 short tons of CO_2 in 2013, which was 47.6% below the 2013 emissions cap of 165,184,246 tons[ii] At the start of 2014 the cap was reset at 91,000,000 tons, and 2013 emissions fell 4.9% below even this new, more stringent cap.

The fact that RGGI emissions continue to decline indicates how important it was to adjust the cap, and to further account for surplus allowances already in circulation.[2] By setting the new cap based on actual 2012 emissions, rather than on projections, states were able to minimize the inherent policymaking bias of overestimating emissions.



[2] In order to ensure that allowances purchased prior to the cap reduction do not inflate the new cap, states are holding two 'interim adjustments' to account for banked allowances. For more detail, see: http://rggi.org/docs/ProgramReview/Program_Review_%20Summary_of_Proposed_RGGI_Cap_Changes_13_11_21.pdf

1.2 Electricity Prices

Contrary to expectations, electricity prices have declined since RGGI took effect. Comparing average retail electricity prices[iii] from 2008 (before RGGI's launch) to 2013 shows that prices dropped by 2% to 14% in states other than Vermont,[3] and prices have dropped by 8% on average across the region. During the same 2008-2013 period electricity prices in non-RGGI states increased by 6%.[iii] While RGGI's precise impact on electricity prices (and other trends described in this report) is difficult to isolate from other factors, it is important to note that the program has not caused electricity prices to increase across the region.

TABLE 1: ELECTRIC PRICES SINCE RGGI'S LAUNCH

	CT	DE	ME	MD	MA	NH	NJ	NY	RI	VT	RGGI
2008	17.8	12.4	13.8	13.0	16.3	14.6	14.4	16.6	16.0	12.3	15.4
2013	15.7	11.0	11.9	11.7	14.5	14.3	13.7	15.6	13.9	14.5	14.2
% Change	-12%	-11%	-14%	-10%	-11%	-2%	-5%	-6%	-13%	+17%	-8%

1.3 Economic Impacts

RGGI has generated significant economic benefits for states participating in the program. By selling allowances (permits to emit CO_2), RGGI states raise revenue to reinvest in energy efficiency, renewable energy, and other consumer programs that increase economic activity in participating states. The majority of program revenue (65% through 2012[iv]) has been invested in energy efficiency programs that reduce consumers' bills and reduce demand for power. Lower power demand means fewer emissions from power plants, and less money leaving the region to pay for imported fossil fuels. Consumers' energy bill savings are spent in part within the local economy, benefiting businesses that offer goods and services in the region. Independent macroeconomic analysis found that programs supported with revenue raised over RGGI's first two and half years of operation would generate $1.1 billion in electric bill savings, and $174 million in savings on natural gas and heating oil over 10 years. These savings create $1.6 billion in net economic gains and 16,000 job years of employment.[v]

Additional benefits of auction revenue are presented in the table below from RGGI, Inc.'s latest analysis of state reinvestment plans.[vi]

[3] VT buys more of its power through long term contracts than other states in the region. This approach has stabilized prices, but means that VT is insulated from wholesale price trends, which have recently decreased power prices in other states in the region. It is also worth noting that Vermont's RGGI revenue supports thermal efficiency programs for customers using propane, fuel oil, and natural gas. While thermal efficiency programs generate greater cost and GHG savings than electricity programs in Vermont, electric price suppression is not as significant as in other states that direct RGGI revenue to electric efficiency programs.

Participating Households
To-Date: 3.2 million

Energy Bill Savings
To-Date: $240 million
Lifetime: $2 billion

CO_2 Emissions Avoided
To-Date: 792,000 short tons
Lifetime: 8 million short tons

Participating Businesses
To-Date: 12,000

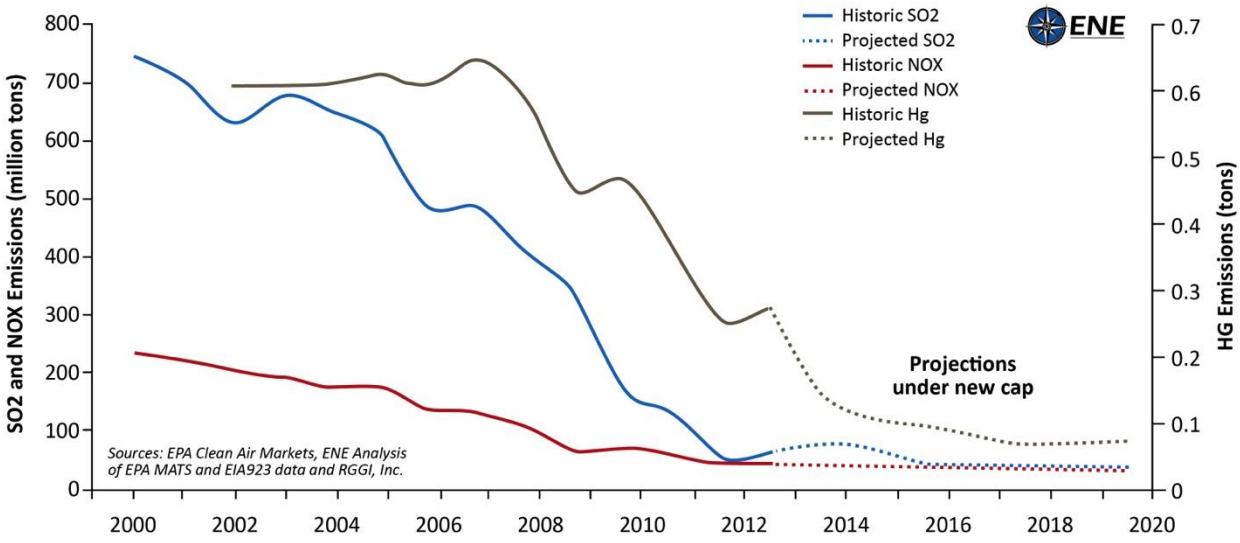
Megawatt Hours Saved
To-Date: 928,000
Lifetime: 8.5 million

Equiv. Cars Taken Off the Road
To-Date: 149,000
Lifetime: 1.4 million

Workers Trained
To-Date: 3,600

Million BTU Saved
To-Date: 2.5 million
Lifetime: 37 million

1.4 Health Impacts



The decline in carbon dioxide emissions from power plants in the RGGI region has been accompanied by an even more significant decline in hazardous pollutants that threaten public health. Emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and mercury (Hg) are all down significantly, and will drop even more under the new RGGI cap. Both SO_2 and NO_x can trigger asthma attacks and difficulty breathing, and NO_x can increase the risk of developing infectious disease.[vii] SO_2 and NO_x also react in the air to form more dangerous pollutants, including ground level ozone – which increases susceptibility to respiratory illnesses like pneumonia and bronchitis – as well as particulate matter – which is breathed deep into the lungs and can cause or contribute to heart attacks, stroke, and increases the risk of premature death in infants and young children as well as adults.[viii] Mercury deposited in waterways and accumulated in seafood has adverse neurological and reproductive impacts.[ix] As described in the table below, emissions of all of these hazardous pollutants have dropped by significant quantities. Reducing

emissions of hazardous pollutants leads to health savings by avoiding illness, hospitable visits, lost work days, and premature deaths. In monetary terms, the reduction in hazardous emissions from 2009 (when RGGI launched) to 2013 translates into $10.4 billion for SO_2 and NO_x alone, and additional reductions in hazardous emissions under the new RGGI cap will lead to an additional $1.6 billion in health savings through 2020.[x]

TABLE 2: TO-DATE AND PROJECTED REDUCTIONS IN HAZARDOUS EMISSIONS

	SO2	Nox	Mercury
2009-1013			
Avoided Emissions (tons)	271,521	23,052	0.1820
% Reduction (annual emissions)	82%	35%	40%
Health Benefits (million $)	$10,263.5	$129.5	--
2014-2020			
Avoided Emissions (tons)	40,334	10,604	0.0697
% Reduction (annual emissions)	52%	255	49%
Health Benefits (million $)	$1,524.6	$59.6	--

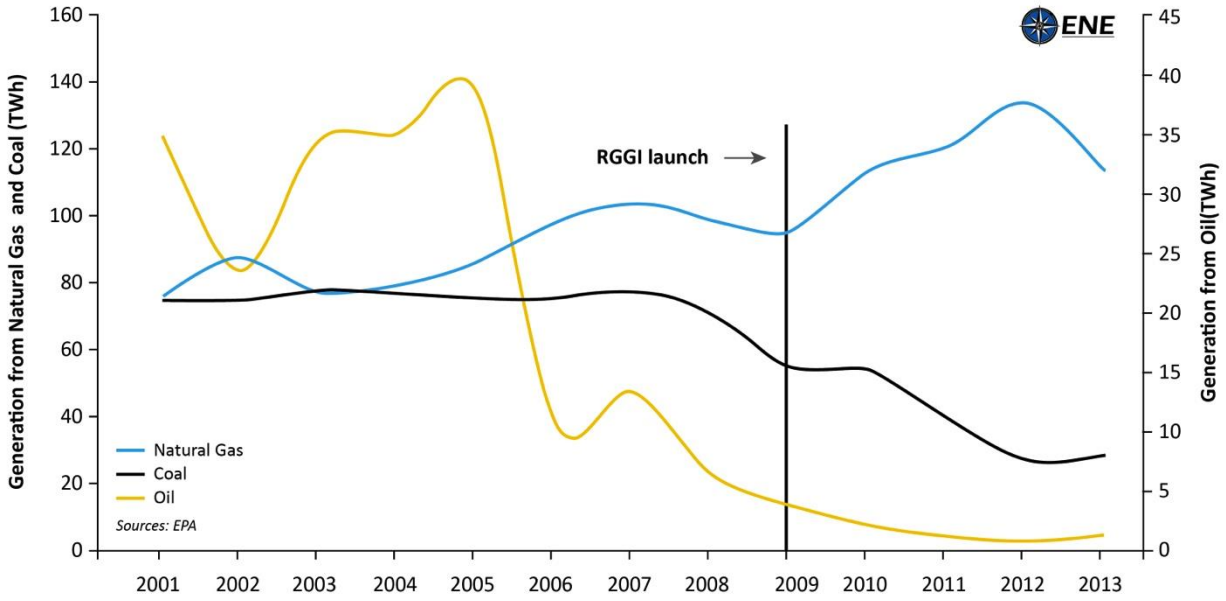
While these emissions reductions and health savings were caused by broader electric trends described in this report and regulations specific to hazardous pollutants, RGGI did contribute to reducing hazardous emissions. Power plants that emit large quantities of pollutants like SO_2, NO_x and mercury also emit large quantities of CO_2. Requiring these plants to pay for CO_2 emissions makes it less economical to operate dirtier plants in comparison to cleaner generating sources. Thus, while market-based programs like RGGI allow for flexibility in achieving emission-reduction targets for CO_2, they also support existing controls for hazardous pollutants. Since the impact of CO_2 is global rather than local, providing flexibility to achieve CO_2 targets most cost-effectively facilitates greater CO_2 emissions reductions at lower cost.

2. Electric Sector

Electric sector carbon dioxide emissions are determined by two main factors: 1) what source the electricity comes from; and 2) how much electricity is consumed.

Electric Sector Trend: *Fossil Generation*

Electric generation from fossil fuels is increasingly shifting to lower-priced natural gas. The relative prices of natural gas, residual fuel (oil), and coal in the RGGI region determine which fuels are used to generate power. Since RGGI took effect in 2009 generation has decreased from residual fuel (-79%) and coal (-60%), while natural gas generation increased (+15%). This fuel switching from coal and oil to natural gas has had a significant impact on emissions, as natural gas emits 44% less carbon than coal and 33% less carbon than fuel oil when burned to produce heat,[xi] and natural gas plants are more efficient.[4] During recent cold winters, some RGGI states – particularly in New England – have increased utilization of coal and oil in the winter, when building heating consumes the majority of natural gas supply. However, with 2013 emissions falling below the new cap, it appears that this temporary[5] uptick on oil and coal generation is not increasing emissions significantly.



[4] Note that natural gas direct stack emissions are much lower than coal and oil, but there is increasing concern about upstream GHG and other pollution from natural gas, which needs to be more thoroughly investigated and quantified.

[5] Additional natural gas pipeline capacity (the Algonquin Incremental Market expansion) will deliver 345 million cubic feet of natural gas into New England in 2016, and increasing investment in demand side solutions (natural gas and electric energy efficiency, demand-response, combined heat and power) will alleviate problems caused by overreliance on natural gas.

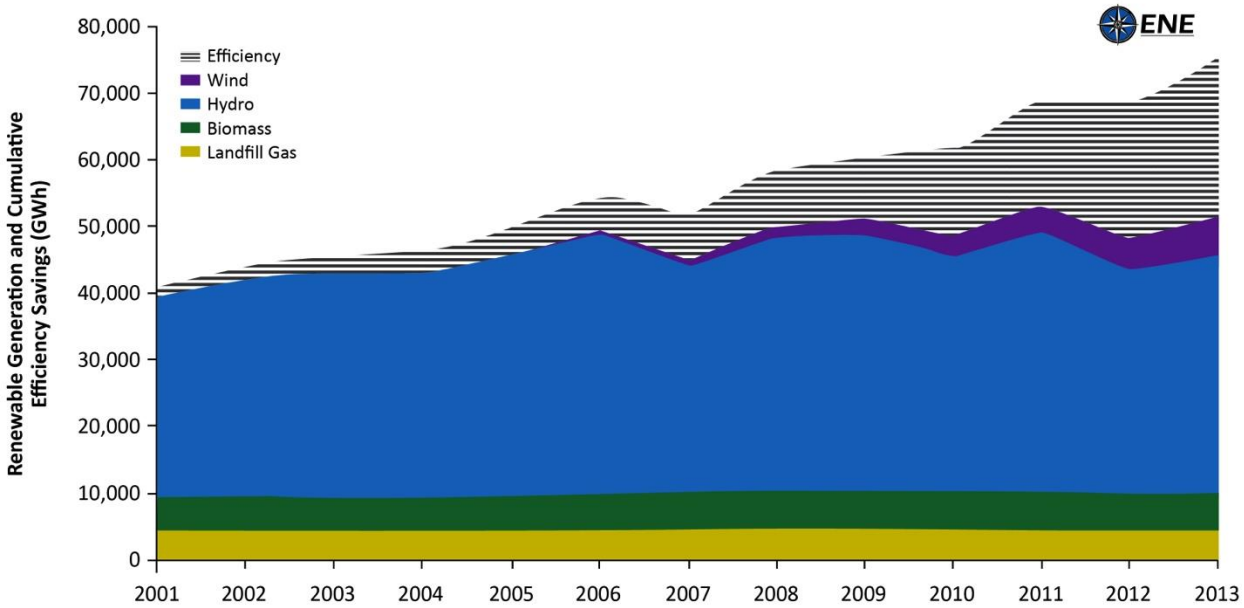
Reliance on Natural Gas

Concerns about overreliance on natural gas and about the environmental impacts of extracting, processing, and transporting natural gas have raised important questions about how RGGI interacts with other energy and environmental priorities. Due to their higher carbon-intensity, coal- and oil-fired power plants have to purchase more RGGI allowances than natural-gas-fired generators. However, it is important to note that gas generators still have to purchase allowances, making natural gas less competitive than non-emitting sources of power.

Furthermore, reinvesting revenue from the sale of emissions allowances in energy efficiency reduces direct consumption of natural gas in buildings and reduces power plant consumption of natural gas to generate electricity. Thermal efficiency programs funded by RGGI through 2012 saved 2.5 trillion BTU, and are projected to save an additional 37 trillion BTU over their (typically 10-year) measure lifetimes[vi]. If only half of these savings are from natural gas, [6] this would translate into approximately 1.25 million cubic feet (MMcf) of avoided natural gas in demand through 2012, and 19 MMcf in lifetime savings. Electric efficiency programs avoid demand for electricity and the need to burn natural gas at power plants. With natural gas used to generate 44% of electricity in the RGGI region in 2012 (EIA), electricity savings of 928,000 MWhs[vi] avoided the combustion of an additional 409 MMcf of natural gas at power plants. Over their lifetimes these electric efficiency investments will avoid the consumption of an additional 3,750 MMcf of natural gas.[xii]

2.1 Electric Sector Trend: *Energy Efficiency and Non-Emitting Generation*

Energy efficiency programs are reducing demand for electricity across the region, while electricity supply is increasingly being supplied by non-emitting sources of energy. State data shows that energy efficiency programs in RGGI states have saved a cumulative total of 15,564 GWh of electricity since RGGI launched in 2009. During the same period renewable energy generation – led by hydroelectricity, as well as landfill gas, biomass, and wind – has increased by 1,758 GWh in RGGI states, according to EIA.



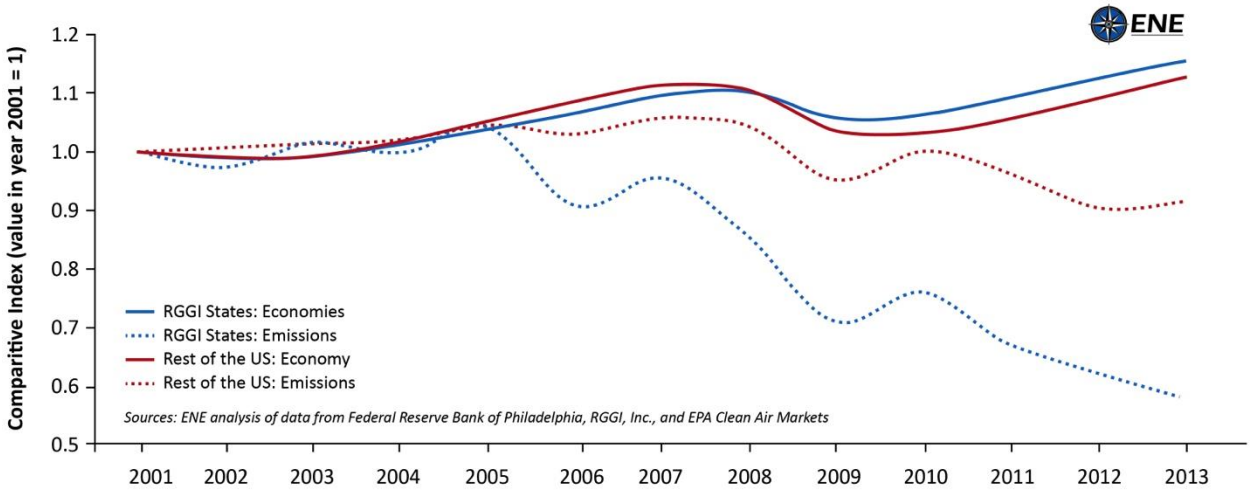
[6] Division of thermal savings between natural gas and other fuels not available, but efficiency programs in a number of RGGI states are fuel-blind, or mingle use of revenue.

Both energy efficiency and non-emitting generation are projected to continue increasing in years ahead. In the nine RGGI states investments in energy efficiency programs grew from $680 million in 2008 to $1.94 billion in 2012, an increase of 186%. (During the same 2008-2012 period energy efficiency investments in non-RGGI states increased from $3 billion to $6.3 billion, a 110% increase.)[xiii] Furthermore, escalating annual electricity savings requirements in eight of the nine RGGI states will require increasing investments in future years.[xiv] Renewable generation is also projected to continue increasing nationwide according to EIA,[xv] and all nine RGGI states have Renewable Portfolio Standards that require electric utilities to procure increasing quantities of renewable electricity.[xvi]

It is worth noting that with the exception of steady, incremental growth in wind capacity and modest natural gas additions, the decline in electric sector emissions has occurred without the addition of significant new capacity or capital expenditures. This low-cost transition to lower regional emissions suggests that reducing emissions can be far more cost-effective than commonly assumed.

2.2 Electric Sector Trend: *Decoupling of Economic Expansion and Emissions Growth*

As the regional economy has become less energy-intensive and efficiency investments have increased, the relationship between economic growth and emissions has broken, and emissions in RGGI states have declined faster than in other states, even as economic growth in the region has outpaced growth in non-RGGI states.



Electricity demand has historically been tied to economic growth, with electricity consumption and related emissions increasing during periods of economic expansion, and decreasing in economic downturns. However, emissions from power plants in the RGGI states and the rest of the country have been declining since about 2007. Contrary to common assumptions, the decline in emissions is not primarily attributable to the economic downturn, and emissions have continued to drop even as the economy has recovered. Furthermore, within the RGGI region, emissions dropped 2.7 times faster than the rest of the country since RGGI was established, even as RGGI's states' economies have grown 2.5 times faster than other states.[xvii]

3. EPA Regulations

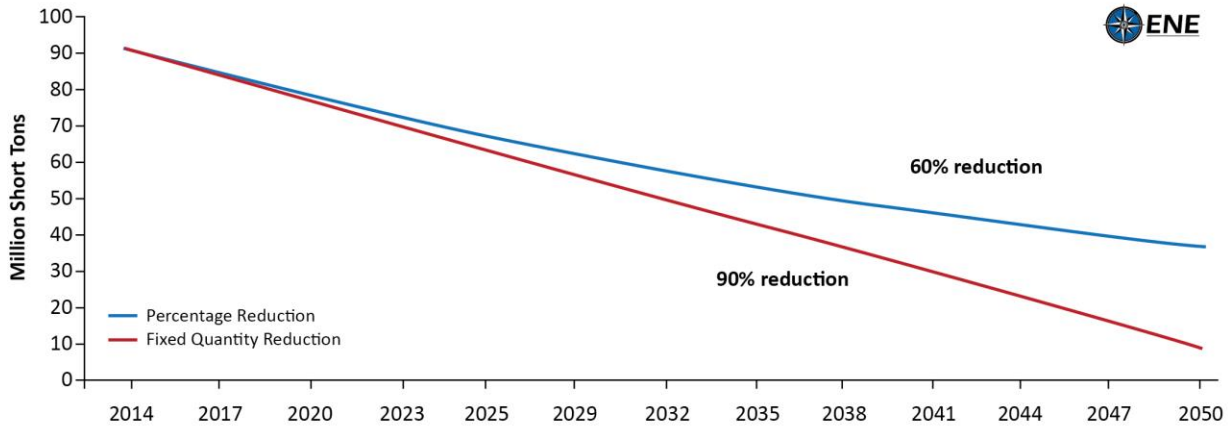
Forthcoming carbon pollution standards from the Environmental Protection Agency (EPA) may require modest revisions to RGGI, but – more importantly – will create an environment for other states to build on RGGI's successful model by establishing their own state or regional markets or joining the RGGI program. The regulatory process for reducing carbon pollution from existing power plants begins June 2nd, when the release of draft regulations will set in motion a process requiring all fifty states to implement GHG reduction programs by the end of the decade. Legal experts believe that the inherent flexibility of section 111(d) of the Clean Air Act (under which EPA would regulate) and EPA's historic deference to effective state-proposed solutions will allow RGGI to serve as a means of complying with federal requirements. [xviii]

3.1 Potential Revisions

Modest revisions to RGGI's structure may be required in order for EPA to determine that the program will deliver intended emissions reductions in the near and long term. Specifically, RGGI's allowance reserve and cap decline mechanisms may require revisions, and the viability of offsets is not yet clear.

Cost Containment Reserve – In order to mitigate price volatility, RGGI states established a Cost Containment Reserve (CCR) that mints additional allowances when price thresholds are reached. By 2020 the additional allowances released from the CCR could add up a whole year's worth of emissions, thus inflating the supply of allowances beyond the level determined by the cap alone.[7] In order for EPA to determine that RGGI will achieve the targets reflected by the cap, RGGI states may be required to transition from minting allowances to setting allowances aside from future years' supply. This approach (utilized in California's program) provides for a reserve capable of reducing price increases, while not increasing the supply of allowances.

Cap Decline – The manner in which RGGI's cap declines will also require revision to ensure achievement of long-term emission reduction objectives. RGGI's new cap declines by 2.5% annually, but instead of declining by a fixed *quantity of allowances*, the yearly step-down is based on a *percentage of the prior year's cap*. By 2050 the difference between these two means of reducing the cap is significant, with the current percentage reduction approach reducing the cap 60%, in comparison with a 90% reduction when reducing the cap by a fixed quantity of allowances each year.



[7] RGGI's CCR provides for 5 million additional allowances in 2014, and 10 million additional allowances each year from 2015-2020, for a total of 65 million allowances, or 83% of the 2020 cap level of 78 million tons. For additional detail see http://rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Model_Rule_Summary.pdf

Offsets – Offsets (emissions reductions from beyond the power sector) have not previously been utilized under the Clean Air Act, and opinion is divided as to whether offsets could qualify under section 111(d). The viability of offsets will depend on EPA's confidence that offsets can deliver verifiable, enforceable, and legally defensible emissions reductions.

3.2 Broader Appeal

Other states may find the RGGI approach an attractive option for complying with federal requirements. RGGI's flexible, market-based system reduces emissions at lower cost than alternative approaches (see text box). Additionally, states' control over key decisions related to allocation of allowances and auction proceeds provides the flexibility to achieve distinct local objectives. RGGI is also simple to administer and familiar to regulators and emitters alike. Power plant owners in the majority of the country are already accustomed to market based environmental programs that regulate emissions responsible for acid rain, smog, and other hazardous pollutants.[8] This familiarity with market-based programs is one reason that the power sector appears more receptive to carbon standards than political discourse would suggest.[9]

Cap & Trade – The Cheapest Solution

RGGI's market-based approach requires emitters to purchase pollution permits (called 'allowances') from a supply that declines over time. Power companies that reduce emissions purchase fewer allowances, thus reducing allowance prices and consumer costs. This approach rewards innovative and flexible power companies that take advantage of new market opportunities, and reduces emissions at lower cost than more prescriptive approaches that rely on specific technologies or administratively-determined measures.

Market-based programs also have a history of achieving objectives at lower costs than anticipated, as the capacity to realize profits drives innovation in business operations and technological advancement. The landmark Acid Rain Program, which utilizes an allowance trading approach to reduce emissions of acid rain-causing sulfur dioxide (SO_2), was projected to have allowance costs of $250-$500/ton. However, in order to realize cost savings, power plant operators were able to reduce emissions far faster than expected by switching to cleaner sources of coal and driving advances in technology to remove SO_2 pollution from smokestacks using "scrubbers." These market-driven innovations meant that actual allowance prices were only $100-$200/ton, or less than half the anticipated cost.[xix] RGGI itself follows this pattern. Before RGGI launched, states projected that the program would cause the price of electricity to *increase* by approximately 1.25% by 2012.[xx] In practice, electricity prices have actually *decreased*, falling by 8% across the region since RGGI launched (see page 3 of this report).

The tendency to overestimate the costs of market-based programs helps to illustrate the inherent effectiveness of market-based programs. Before RGGI or the Acid Rain Program launched, no one could predict how emissions would be reduced. By design, market-based programs drive innovations that are difficult to predict, but are natural in response to new profit opportunities.

[8] 27 states comprising the majority of the Midwest, South, Mid-Atlantic, and Northeast are currently included in the 3 market-based Clean Air Interstate Rules, see http://www.epa.gov/airmarkets/progress/ARPCAIR12.html

[9] Some of the largest power companies in the country – including Calpine, Consolidated Edison, Exelon, National Grid, New York Power Authority, and NextEra – submitted joint comments to with the environmental community calling for EPA to recognize RGGI as a compliance mechanism for current states and any other states wishing to join. See: http://energy.pace.edu/sites/default/files/publications/RGGI%20EPA%20Collaborative%20Dec%205%20with%20Signatories.pdf

4. Conclusion

RGGI has successfully demonstrated the viability of a market-based program to reduce CO_2 emissions from the power sector while generating significant benefits for participating states. Trends that have contributed to emissions reductions – fuel-switching, improved energy efficiency, and increases in renewables – show no sign of reversing in the RGGI region, and are echoed nationwide. These trends suggest that emissions can be reduced at lower costs than anticipated. As states develop plans to comply with new EPA carbon regulations, RGGI presents an attractive model that is flexible, administratively-straightforward, and capable of reducing emissions at lowest cost.

Endnotes

[i] ENE analysis of emissions data from RGGI, Inc., at: https://rggi-coats.org/eats/rggi/index.cfm?fuseaction=search.rggi_summary_report_input&clearfuseattribs=true

[ii] 2013 cap level and emissions from RGGI, Inc., at: http://rggi.org/

[iii] Energy Information Administration (EIA) 826 Dataset, http://www.eia.gov/electricity/data/eia826/

[iv] RGGI, Inc., 2014, *Regional Investment of RGGI CO_2 Allowance Proceeds, 2012*, available at: http://rggi.org/docs/Documents/2012-Investment-Report.pdf

[v] Analysis Group, 2012, The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States, available at: http://www.analysisgroup.com/rggi.aspx

[vi] Id.

[vii] *American Lung Association Energy Policy Development: Electricity Generation Background Document*, 2011, http://www.lung.org/healthy-air/outdoor/resources/electricity-generation.pdf

[viii] Id.

[ix] EPA, 1997, *Characterization of Human Health and Wildlife Risks from Mercury Exposure in the United States*, http://www.epa.gov/ttn/oarpg/t3/reports/volume7.pdf

[x] The monetized health benefits of avoided SO_2 and NO_x emissions were approximated using EPA's sector-based benefit per ton estimates of $PM_{2.5}$ precursors. SO_2 and NO_x emissions reductions data to-date (2009-2013) are from EPA's Clean Air Markets Division (http://www.epa.gov/airmarket/emissions/). Projected emissions reductions (2014-2020) are from *IPM Electricity Sector Modeling Results* prepared by ICF International for RGGI, Inc. (http://rggi.org/docs/ProgramReview/February11/Results_91_Cap_Alt_Bank_MR.xls). Emissions data covers RGGI regulated units for the nine states currently in RGGI. Approximate monetized health benefits were calculated by multiplying the to-date and projected emissions reductions by sector-based $PM_{2.5}$-related benefit per ton (BPT) estimates. The EPA provides several reduced-form tools for calculating $PM_{2.5}$-related health benefits, including updated versions of the BPT tables (http://www.epa.gov/airquality/benmap/sabpt.html) published in *Characterizing the $PM_{2.5}$-related health benefits of emission reductions for 17 industrial, area and mobile emission sectors across the U.S.* (Fann, Baker and Fulcher, 2012) (http://www.sciencedirect.com/science/article/pii/S0160412012001985). The methodology is detailed in the Technical Support Document, *Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 17 Sectors* (http://www.epa.gov/airquality/benmap/models/Source_Apportionment_BPT_TSD_1_31_13.pdf). Fann, Baker and Fulcher (2012) assess the incidence of $PM_{2.5}$-related deaths and illnesses, including non-fatal heart attacks, hospital admissions, emergency department visits, respiratory symptoms, cases of acute bronchitis, cases of aggravated asthma, and lost work days. For this analysis, we used the 2016 BPT estimates for SO_2 and NO_x for Electricity Generating Units. These values are national estimates in 2010 dollars, which were adjusted to 2013 dollars. The sector-based BPT estimates are based on the Krewski et al. (2009) $PM_{2.5}$ mortality risk estimate and reflect a 3% discount rate. The 2016 estimates use emissions, population and income growth projections for 2016, and use baseline mortality incidence rate projections for 2015 (best available data). The resulting health benefits (shown in Table 2 of this report) offer a simplified quantification of the avoided health impacts of SO_2 and NO_x emissions, but should not be interpreted as a substitute for more detailed, comprehensive analyses of the per-ton benefits of reducing SO_2 and NO_x emissions in the RGGI region. For more on the limitations of this simplified approach, see *Economic value of U.S. fossil fuel electricity health impacts* (Machol and Rizk, 2013) (http://www.sciencedirect.com/science/article/pii/S0160412012000542).
Hg data from 2002-2010 is from EPA's MATS portal (http://www.epa.gov/ttn/atw/utility/utilitypg.html). 2011-2013 Hg data is based on EPA MATS HG Emission Factors and EIA 923 Boiler Fuel Consumption Data. The EPA has not developed reduced-form tools for calculating Hg health benefits, and our research did not uncover suitable health benefit multipliers from other sources.

[xi] Carbon emissions factors for natural gas (117.0 lbs CO_2/MMBtu), residual fuel oil (173.7 lbs CO_2/MMBtu) and coal (210.0 lbs CO_2/MMBtu) from EIA: www.eia.doe.gov/oiaf/1605/excel/Fuel%20Emission%20Factors.xls

[xii] Gas savings from electric efficiency programs assumes EIA average natural gas power plant efficiency of 1mcf/MWh (http://www.eia.gov/tools/faqs/faq.cfm?id=667&t=2).

[xiii] Combined electric and natural gas efficiency program budgets from the Consortium for Energy Efficiency (electric-only efficiency budgets not provided). See *Efficiency Program Industry by State and Region, Appendices*, at: http://library.cee1.org/content/efficiency-program-industry-state-and-region-appendices-2012

[xiv] See American Council for an Energy Efficient Economy (ACEEE) for information on state efficiency programs: http://aceee.org/sector/state-policy

[xv] EIA, 2014, *Annual Energy Outlook 2014: Early Release Overview*, Available at: http://www.eia.gov/forecasts/aeo/

[xvi] For additional information on State Renewable Energy Portfolios see the Department of Energy's EERE State Activities & Partnerships, Available at: http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm

[xvii] From 2008 (the year before RGGI took effect) to 2013, RGGI emissions dropped 32% and emissions in other states dropped by 12%. Over the same period RGGI states' economies grew by 4.8%, while other states' economies grew by 1.9%, based on economic indicators from the Federal Reserve Bank of Philadelphia (http://www.philadelphiafed.org/research-and-data/regional-economy/indexes/coincident/) weighted by gross state product (http://www.bea.gov/newsreleases/regional/gdp_state/2013/xls/gsp0613.xls).

[xviii] Section 111(d) of the Clean Air Act allows sufficient flexibility for states to utilize programs like RGGI (see Litz et. al. *What's Ahead for Power Plants and Industry? Using the Clean Air Act to Reduce Greenhouse Gas Emissions, Building on Existing Regional Programs*, available at: http://pdf.wri.org/working_papers/whats_ahead_for_power_plants_and_industry.pdf and Wannier et. al. *Prevailing Academic View on Compliance Flexibility under § 111 of the Clean Air Act*, available at: http://www.rff.org/RFF/Documents/RFF-DP-11-29.pdf).

[xix] See: http://ny.water.usgs.gov/projects/NAPAP/NAPAP_2011_Report_508_Compliant.pdf

[xx] See "Updated Reference, RGGI Package – 10/11/06" available at: http://rggi.org/design/history/modeling