

# Regional Greenhouse Gas Initiative

an Initiative of the Northeast and Mid-Atlantic States of the U.S.

## CO<sub>2</sub> Emissions from Electricity Generation and Imports in the Regional Greenhouse Gas Initiative: 2013 Monitoring Report

August 7, 2015

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The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort of Northeast and Mid-Atlantic states to reduce emissions of carbon dioxide (CO<sub>2</sub>), a greenhouse gas that causes global warming.

RGGI, Inc. is a non-profit corporation created to provide technical and administrative services to the states participating in the Regional Greenhouse Gas Initiative.

## Executive Summary

This report, the fifth report in a series of annual monitoring reports, summarizes data for the period from 2005 through 2013, for electricity generation, electricity imports, and related carbon dioxide (CO<sub>2</sub>) emissions for the nine states<sup>1</sup> that participated in the Regional Greenhouse Gas Initiative (RGGI) second control period. These monitoring reports were called for in the 2005 RGGI Memorandum of Understanding (MOU) in response to expressed concerns about the potential for the RGGI CO<sub>2</sub> Budget Trading Program to result in “emissions leakage<sup>2</sup>”.<sup>3</sup>

In the Northeast and Mid-Atlantic states, CO<sub>2</sub> emissions from the regional electric power sector are a function of highly dynamic wholesale electricity markets. The cost of compliance with the RGGI CO<sub>2</sub> Budget Trading Program is only one of multiple factors that influence the dispatch of electric generation, and resulting CO<sub>2</sub> emissions, through the operation of these markets. As a result, this report presents data without assigning causality to any one of the factors influencing observed trends. A key metric presented in this report that may provide a preliminary indication of *potential* emissions leakage, or a lack thereof, is electric generation and related CO<sub>2</sub> emissions from all non-RGGI affected electric generation that serves electric load in the nine-state RGGI region. It should be emphasized that this report does not provide indicators of CO<sub>2</sub> emissions leakage, but merely tracks electricity generation and imports and related CO<sub>2</sub> emissions in the RGGI region for 2011 through 2013 relative to baseline years prior to implementation of the RGGI program.

The observed trends in electricity demand, net electricity imports, and electricity generation from multiple categories of generation sources (including electricity imports), show there has been no significant change in CO<sub>2</sub> emissions or the CO<sub>2</sub> emission rate (pounds of CO<sub>2</sub> per megawatt hour or lb CO<sub>2</sub>/MWh) from total non-RGGI electric generation serving load in the nine-state RGGI region during the period of the RGGI program, 2011 – 2013, when compared to the base period of 2006-2008.

### **Summary of Results**

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<sup>1</sup> The “nine-state RGGI region” consists of Delaware, Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

<sup>2</sup> “Emissions leakage” is the concept that compliance with the RGGI CO<sub>2</sub> Budget Trading Program, and the incorporation of related CO<sub>2</sub> compliance costs by electric generators that are subject to the program, could result in a shift of electricity generation and emissions from CO<sub>2</sub>-emitting sources that are subject to RGGI to CO<sub>2</sub>-emitting sources that are not subject to RGGI.

<sup>3</sup> The Memorandum of Understanding called for monitoring electricity imports into the RGGI participating states commencing from the start of the RGGI CO<sub>2</sub> Budget Trading Program and reporting the results of such monitoring on an annual basis beginning in 2010.

**Average Total Electric Load (Demand for Electricity) and Average Total Generation**

- For 2011 to 2013, the annual **average electricity load** in the nine-state RGGI region was 12.3 million MWh less than the average 2006 to 2008 electricity load, about a 3.2% reduction.
- For 2011 to 2013, the annual **average total electric generation** in the nine-state RGGI region (fossil and non-fossil) decreased by 26.8 million MWh, or 8.1 percent, from the 2006 to 2008 average.

When the 2013 calendar year is compared to the annual average for the baseline period of 2006 to 2008, the results similarly show a reduction in electric load and generation (MWhs) from total electric generation sources.

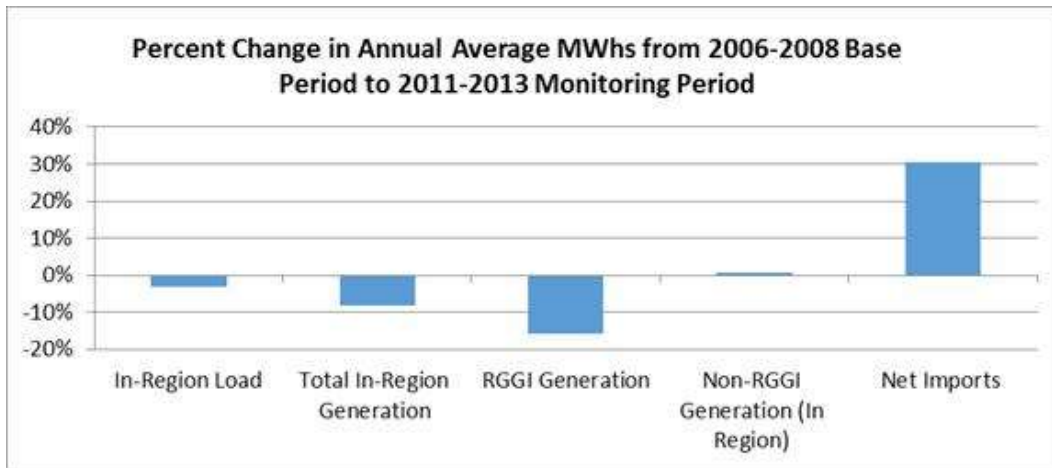


Figure 1. Comparison of percentage changes in electricity load and generation MWhs serving the 9-state RGGI Region from 2011 through 2013 to the base period of 2006 to 2008 for the 9-state RGGI Region.

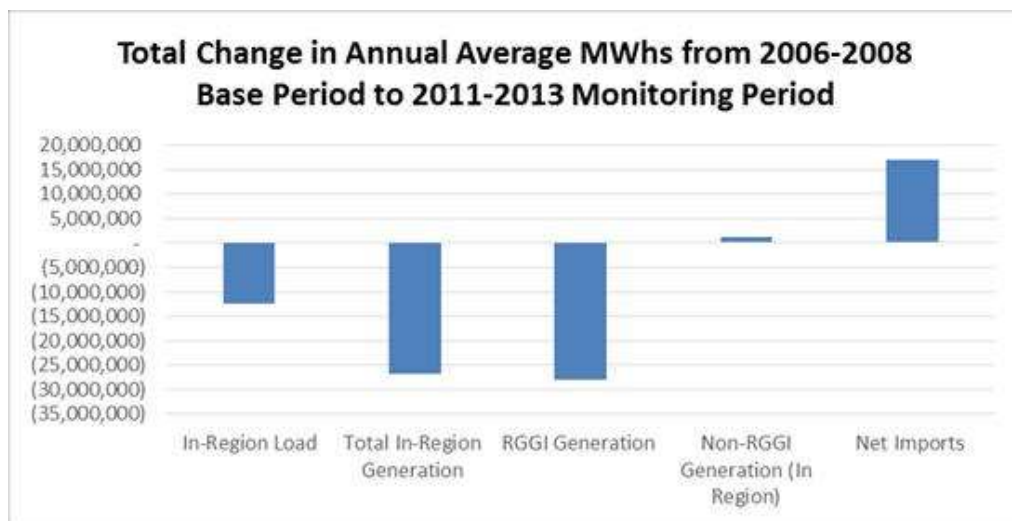


Figure 2. Comparison of difference in electricity load and generation MWhs serving the 9-state RGGI Region from 2011 through 2013 to the base period of 2006 to 2008 for the 9-state RGGI Region.

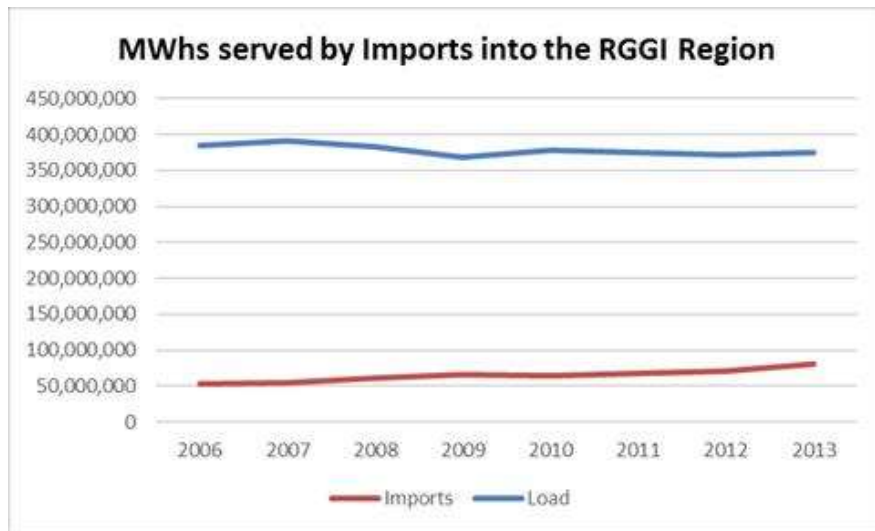


Figure 3. MWhs of load served by imports to the RGGI region from 2006-2013

### ***Non-RGGI Emissions, Non-RGGI Emissions Rate, and Non-RGGI Generation***

The monitoring results indicate there was no significant change in CO<sub>2</sub> emissions from non-RGGI electric generation in 2011 to 2013 relative to the base period of 2006 to 2008. The decrease in emissions from non-RGGI in-region electric generation offsets the slight increase in emissions related to electric generation from imports into the 9-state RGGI region.

- A comparison of the 2011 to 2013 average to the base period of the 2006 to 2008 average shows **CO<sub>2</sub> emissions** from all non-RGGI electric generation sources serving load in the nine-state RGGI region decreased by 235.5 thousand short tons of CO<sub>2</sub>, or 0.5 percent.
- A comparison of the 2011 to 2013 average to the base period of the 2006 to 2008 average shows the **CO<sub>2</sub> emission rate** for this category of electric generation decreased by 35.7 lb CO<sub>2</sub>/MWh, or 8.5 percent.
- A comparison of the 2011 through 2013 annual average to the base period of 2006 to 2008 annual average shows the total **electric generation from all non-RGGI electric generation sources** serving load in the 9-state RGGI region increased, by 18.2 million MWh, an increase of 8.7 percent.

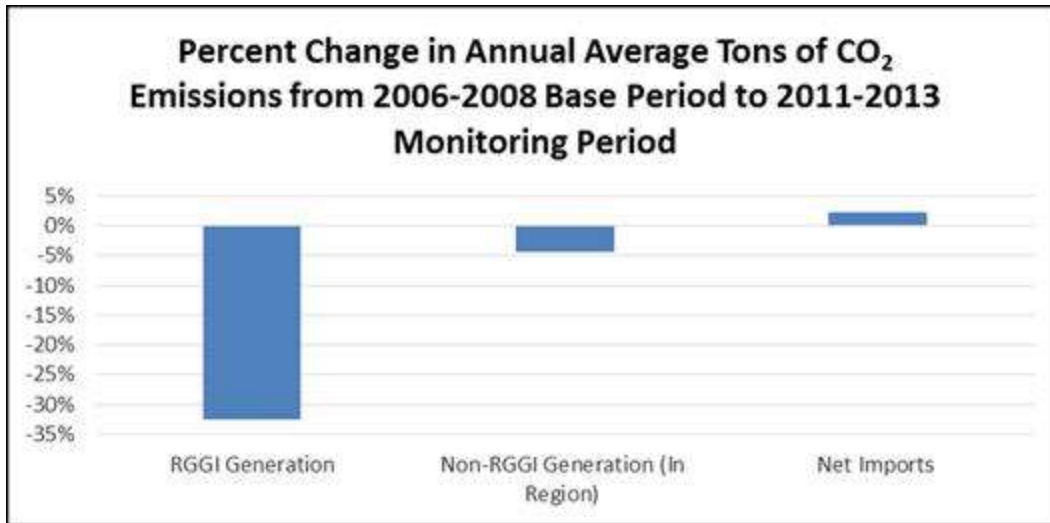


Figure 4. Comparison of percentage changes in emissions (CO<sub>2</sub> tons) serving the 9-state RGGI Region from 2011 to 2013 to the base period of 2006 to 2008 for the 9-state RGGI Region.

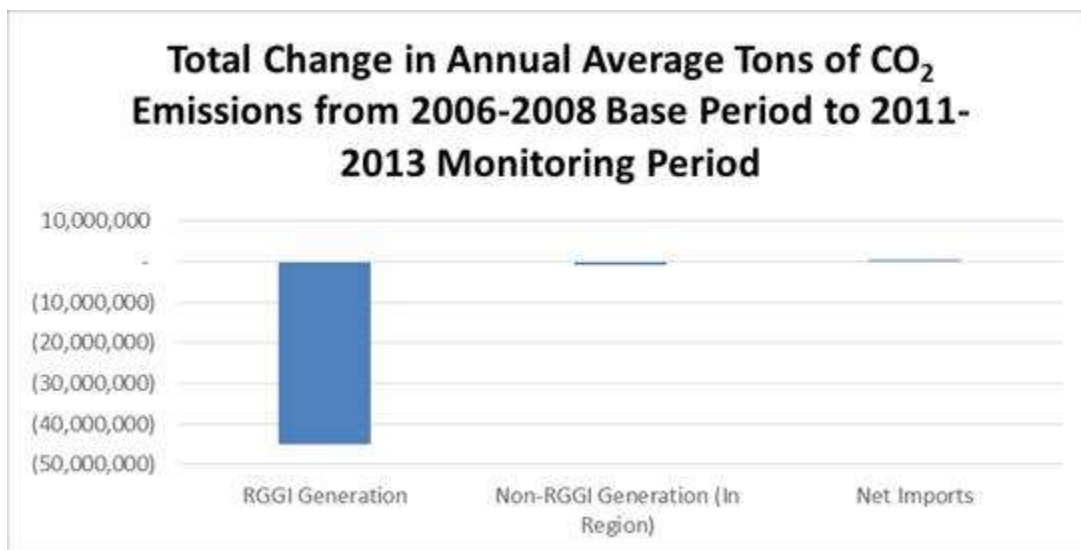


Figure 5. Comparison of the difference in emissions (CO<sub>2</sub> tons) serving the 9-state RGGI Region from 2011 to 2013 to the base period of 2006 to 2008 for the 9-state RGGI Region.

### ***RGGI Emissions, RGGI Emissions Rate, and RGGI Generation***

- A comparison of the 2011 to 2013 average to the base period of the 2006 to 2008 average shows **CO<sub>2</sub> emissions** from RGGI electric generation sources decreased by 45.0 million short tons of CO<sub>2</sub>, or 32.5 percent.
- A comparison of the 2011 to 2013 average to the base period of the 2006 to 2008 average shows the **CO<sub>2</sub> emissions rate** for RGGI electric generation sources decreased by 310 lb CO<sub>2</sub>/MWh, or 19.8 percent.

- A comparison of the 2011 to 2013 average to the base period of the 2006 to 2008 average shows the **electric generation** from RGGI-affected electric generation sources decreased by 28.0 million MWh, or 15.8 percent.
- When the 2013 calendar year is compared to the annual average for the baseline period of 2006 to 2008, the results similarly show a reduction in electric generation and CO<sub>2</sub> emissions from RGGI electric generation sources.

### **Monitoring Approach**

The data summarized track electricity generation and imports in each of the three independent system operator (ISO) regions fully or partially subject to the RGGI CO<sub>2</sub> Budget Trading Program (ISO-New England – “ISO-NE”, New York ISO – “NYISO”, and PJM). The data track total MWhs of electricity used to serve electric load in each ISO (or portion of an ISO subject to RGGI in the case of PJM) and the actual or estimated related CO<sub>2</sub> emissions. For each ISO, data are tracked for the following categories:

- **RGGI-Affected Generation**: Electric generation and CO<sub>2</sub> emissions for electric generation units subject to a CO<sub>2</sub> allowance compliance obligation under a state CO<sub>2</sub> Budget Trading Program.
- **Non-RGGI Generation**: Total electricity generation (MWh), CO<sub>2</sub> emissions, and lb CO<sub>2</sub>/MWh emission rate for all non-RGGI electric generation serving electric load in the nine-state RGGI region (includes both in-region electric generation and net electricity imports).
  - **Non-RGGI In-Region Generation**: Electric generation and CO<sub>2</sub> emissions for electric generation units located in the nine-state RGGI region that are not subject to a CO<sub>2</sub> allowance compliance obligation (e.g., generators under 25 megawatts electrical (MWe) capacity and non-fossil fuel-fired electric generators).
  - **Net Imports**: Net electricity imports from adjacent control areas (or portion of a control area) outside the nine-state RGGI region and CO<sub>2</sub> emissions related to these net imports (can be fossil or non-fossil generation).

### **Conclusions**

It should be emphasized that this report does not provide indicators of CO<sub>2</sub> emissions leakage, but merely tracks electricity generation and imports and

related CO<sub>2</sub> emissions in the RGGI region for 2011 through 2013 relative to baseline years prior to implementation of the RGGI program. A key metric presented in this report that may provide a preliminary indication of *potential* emissions leakage, or a lack thereof, is electric generation and related CO<sub>2</sub> emissions from all non-RGGI affected electric generation that serves electric load in the nine-state RGGI region. The monitoring results show there has been a 0.5% decrease in in average annual CO<sub>2</sub> emissions from non-RGGI electric generation during the three years of RGGI program operation, 2011 through 2013, compared to the average annual CO<sub>2</sub> emissions during 2006 to 2008. The decrease in emissions from non-RGGI in-region electric generation offsets the slight increase in emissions related to electric generation from imports into the 9-state RGGI region.



## I. Background

This annual report summarizes monitoring data for electricity generation and imports in the nine-state RGGI region, and related CO<sub>2</sub> emissions for the period from 2005 through 2013. This monitoring was called for in the 2005 RGGI MOU in response to expressed concerns about the potential for the nine RGGI CO<sub>2</sub> Budget Trading Programs<sup>4</sup> to result in “emissions leakage”.<sup>5</sup> The monitoring approach that was used to compile the data summarized in this report was specified in a March 2007 report from the RGGI Staff Working Group, *Potential Emissions Leakage and the Regional Greenhouse Gas Initiative (RGGI): Evaluating Market Dynamics, Monitoring Options, and Possible Mitigation Mechanisms*.<sup>6,7</sup>

The report provides data for evaluating CO<sub>2</sub> emissions related to electricity generation and imports in the nine-state RGGI region. The report tracks trends in electricity demand, net electricity imports, electricity generation from multiple categories of generation sources (including electricity imports), and the CO<sub>2</sub> emissions related to these categories of electric generation. The report should not be used to draw definitive conclusions about whether or not CO<sub>2</sub> emissions leakage has occurred, as it does not address the causes of changes in electricity generation and related CO<sub>2</sub> emissions among different categories of electric generation serving load in the nine-state RGGI region. This report is only an analysis of CO<sub>2</sub> emissions and does not speak to other greenhouse gases.

## II. Monitoring Approach

The data summarized in this report track electricity generation and electricity use in each of the three ISO regions fully or partially subject to the RGGI CO<sub>2</sub> Budget Trading Program. The data track all MWh of electricity used to serve electric load in each ISO (or portion of an ISO subject to RGGI in the case of PJM), the actual or estimated CO<sub>2</sub> emissions (in short tons of CO<sub>2</sub>) related to the generation of this electricity, and the associated lb CO<sub>2</sub>/MWh emission rate.<sup>8</sup>

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<sup>4</sup> RGGI is comprised of state CO<sub>2</sub> Budget Trading Programs. Under each of these state programs, a regulated power plant must hold CO<sub>2</sub> allowances equal to its emissions to demonstrate compliance at the end of a three-year control period. CO<sub>2</sub> allowances are issued by participating states in a finite amount, or “budget”, resulting in a regional cap on CO<sub>2</sub> emissions from the electric generation sector in the RGGI region. Regulated power plants are fossil fuel-fired electric generating units with an electric generation capacity of 25 megawatts (MWe) or greater.

<sup>5</sup> Specifically, the Memorandum of Understanding called for monitoring electricity imports into the RGGI participating states commencing from the start of the RGGI CO<sub>2</sub> Budget Trading Program and reporting the results of such monitoring on an annual basis beginning in 2010.

<sup>6</sup> The report also specified requested changes that were made to generator attribute tracking systems for ISO-NE and PJM to facilitate RGGI monitoring. The report is available at [http://www.rggi.org/docs/il\\_report\\_final\\_3\\_14\\_07.pdf](http://www.rggi.org/docs/il_report_final_3_14_07.pdf)

<sup>7</sup> This report for 2013 is the second of the annual monitoring reports to review the data as a 9-state program after New Jersey’s withdrawal from the program at the end of 2011.

<sup>8</sup> Throughout this report, references to “electric generation” and “electric load” include only that portion of electric generation or electric load dispatched or served through the regional transmission system administered by ISOs and tracked by individual ISOs. This excludes most electric generation output and electric load typically referred to as “behind-the-meter”, which refers to electric generation that is not dispatched by ISOs and electric load met through on-site electric

For each year 2005 through 2013, the following categories of data are presented for the nine-state RGGI region as well as each ISO:

- **RGGI-Affected Generation:** Electric generation (MWh), CO<sub>2</sub> emissions (short tons), and lb CO<sub>2</sub>/MWh emission rate for electric generators subject to the RGGI CO<sub>2</sub> Budget Trading Program. This category is limited to electric generating units subject to a CO<sub>2</sub> allowance compliance obligation under state CO<sub>2</sub> Budget Trading Program regulations.<sup>9</sup>
- **Non-RGGI Generation:** Total electricity generation (MWh), CO<sub>2</sub> emissions, and lb CO<sub>2</sub>/MWh emission rate for all non-RGGI electric generation serving electric load in the nine-state RGGI region (includes both in-region electric generation and net electricity imports).<sup>10</sup> In addition to total non-RGGI generation, data for the following subcategories of non-RGGI generation are also presented:
  - **Non-RGGI In-Region Generation:** Electric generation and CO<sub>2</sub> emissions for electric generation units located in the nine-state RGGI region that are not subject to a CO<sub>2</sub> allowance compliance obligation (e.g., generators under 25 megawatts electrical (MWe) capacity and non-fossil fuel-fired electric generators).
  - **Net Imports:** Net electricity imports (MWh) from adjacent control areas and CO<sub>2</sub> emissions and lb CO<sub>2</sub>/MWh emission rate related to these net imports.<sup>11</sup>

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generation facilities (e.g., industrial cogeneration and other smaller distributed generation resources, such as combined heat and power and solar photovoltaics). The electric generation MWh output that is not included in the monitoring results includes the portion of electric generation output used on-site, if an electric generating unit supplies only a portion of its output to the ISO grid, or all electric generation output, if an electric generating unit supplies no electricity to the ISO grid. However, note that behind-the-meter electric generators eligible for credit under state renewable portfolio standards typically voluntarily report electric generation to the PJM Generation Attribute Tracking System (GATS) and NE-ISO Generation Information System (GIS), which are discussed in Section V. Methodology. These behind-the-meter electric generators that report to PJM GATS and ISO-NE GIS are included in the monitoring results.

<sup>9</sup> For the purposes of this report, this category does not include electric generators that may be subject to a state CO<sub>2</sub> Budget Trading Program regulation, or portion of such regulation, but that are not subject to a CO<sub>2</sub> allowance compliance obligation that requires the generator to submit CO<sub>2</sub> allowances equivalent to its CO<sub>2</sub> emissions. For example, under Maryland's CO<sub>2</sub> Budget Trading Program regulations, certain industrial cogenerators may be subject to alternative CO<sub>2</sub> compliance obligations under certain conditions in lieu of submission of CO<sub>2</sub> allowances.

<sup>10</sup> In practice, this category includes MWh and related CO<sub>2</sub> emissions from all electric generation serving load in the RGGI region, after subtracting out electric generation and related CO<sub>2</sub> emissions from electric generation units subject to a RGGI CO<sub>2</sub> allowance compliance obligation. For ISO-NE and NYISO, the "RGGI region" represents the full ISO footprint. For PJM, the "RGGI region" represents the two-state portion of PJM subject to the RGGI CO<sub>2</sub> Budget Trading Program in 2012 (Delaware, and Maryland).

<sup>11</sup> For individual ISOs, net imports represent actual annual net electricity flows between ISOs, as reported by the ISOs. For PJM, net electricity imports represent inferred transfers of electricity from the non-RGGI geographic portion of PJM into the RGGI geographic portion of PJM.

### III. Summary of Monitoring Results

Monitoring results are summarized below for the nine-state RGGI region. Results are presented in detail for the nine-state RGGI region, as well as for each individual ISO, under Section VI – Monitoring Results.

#### ***Electric Load (Demand for Electricity) and Generation***

- For 2011 to 2013, the **annual average electricity load** in the nine-state RGGI region was 12.3 million MWh less than the average 2006 to 2008 electricity load, or 3.2 percent.
- For 2011 to 2013, the **annual average total electric generation** in the nine-state RGGI region (fossil and non-fossil) decreased by 26.8 million MWh, or 8.1 percent from the 2006-2008 average.
- For calendar year 2013, a comparison of the **electricity load** in the nine-state RGGI region to the annual average for the base period of 2006 to 2008, shows a decrease of 11.5 million MWh, or 3.0 percent.
- For calendar year 2013, a comparison of the **total electric generation** in the nine-state RGGI region (fossil and non-fossil) to the annual average for the base period of 2006 to 2008 shows a decrease of 32.2 million MWh, or 9.7 percent.

#### ***Non-RGGI Emissions, Emission Rate, and Generation***

- The monitoring results indicate that **CO<sub>2</sub> emissions** from non-RGGI electric generation decreased in 2011 through 2013 relative to the base period of 2006 to 2008. The decrease in emissions from non-RGGI in region electric generation is offset by the slight increase in emissions related to electric generation from imports into the 9-state RGGI region.
  - A comparison of the 2011 to 2013 annual average to the base period of the 2006 to 2008 annual average shows **CO<sub>2</sub> emissions** from all non-RGGI electric generation sources serving load in the nine-state RGGI region decreased by 235.5 thousand short tons of CO<sub>2</sub>, or 0.5 percent.
  - A comparison of the 2011 to 2013 annual average to the base period of the 2006 to 2008 annual average shows the **CO<sub>2</sub> emission rate** for this category of electric generation decreased by 35.7 lb CO<sub>2</sub>/MWh, or 8.5 percent.
- A comparison of the 2011 to 2013 annual average to the base period of 2006 to 2008 annual average shows the **total electric generation** from all

non-RGGI electric generation sources serving load in the 9-state RGGI region increased, by 18.2 million MWh, an increase of 8.7 percent.

- A comparison of the 2011 to 2013 annual average to the base period of 2006 to 2008 annual average shows **CO<sub>2</sub> emissions related to net electricity imports** into the nine-state RGGI region increased by 563 thousand, or 2.2 percent.
  - The monitoring results show an increase of annual 2013 **CO<sub>2</sub> emissions related to net electricity imports** into the nine-state RGGI region compared to the annual average during base period of 2006 to 2008 of 2.0 million tons, or 8.0 percent.
- A comparison of the 2011 to 2013 annual average to the base period of 2006 to 2008 annual average shows **CO<sub>2</sub> emissions related to non-RGGI generation in the nine state RGGI region that are not subject to state CO<sub>2</sub> Budget Trading Program regulations** decreased by 798 thousand tons, or 4.3 percent.
  - The monitoring results show an increase of annual 2013 **CO<sub>2</sub> emissions related to non-RGGI generation in the nine state RGGI region that are not subject to state CO<sub>2</sub> Budget Trading Program regulations** compared to the annual average during base period of 2006 to 2008 of 707 thousand tons, or 3.8 percent.

### ***RGGI Emissions, Emission Rate, and Generation***

- A comparison of the 2011 to 2013 annual average to the base period of the 2006 to 2008 annual average shows **CO<sub>2</sub> emissions** from RGGI electric generation sources decreased by 45.0 million short tons of CO<sub>2</sub>, or 32.5 percent.
- A comparison of the 2011 to 2013 annual average to the base period of the 2006 to 2008 annual average shows the **CO<sub>2</sub> emissions rate** for RGGI electric generation sources decreased by 310 lb CO<sub>2</sub>/MWh, or 19.8 percent.
- A comparison of the 2011 to 2013 annual average to the base period of the 2006 to 2008 annual average shows the **electric generation** from RGGI-affected electric generation sources decreased by 28.0 million MWh, or 15.8 percent.
- When the 2013 calendar year is compared to the annual average during the baseline period of 2006 to 2008, the results similarly show a reduction

in electric generation and CO<sub>2</sub> emissions and CO<sub>2</sub> emissions rate from RGGI electric generation sources.

#### **IV. Evaluation of Monitoring Data**

This section addresses issues considered in evaluation of the monitoring data, including the selection of base periods for comparison of data and general monitoring limitations.

##### **Base Period**

In this report, 2011 through 2013 monitoring data is compared to data from the base period, of the three-year period of 2006 through 2008. Conditions may change significantly during a base period and influence conclusions.

The period of 2006 through 2008, the three year period immediately prior to the start of the program, was selected for the base period to provide a three-year point of comparison that is comparable to the three-year compliance periods of the RGGI program. For 2009, 2010, and 2011 data comparisons were made to the base period for the ten-state region, please see the CO<sub>2</sub> Emissions from Electricity Generation and Imports in the 10-State Regional Greenhouse Gas Initiative: 2009, 2010, and 2011 Monitoring Reports.<sup>12</sup> For 2012, data comparisons were made to the base period for the nine-state region, reflecting the states participating in RGGI during that time period<sup>13</sup>. New York Control Area (NYCA) data from years 2005-2011 was adjusted and corrected by New York State Department of Public Service (NYSDPS) to account for previous year's misclassifications of certain generators in 2011 Monitoring Report. The conclusions of the reports in 2009 and 2010 were not affected by these adjustments and corrections.

##### **Key Metrics**

A key metric presented in this report that may provide a preliminary indication of *potential* emissions leakage, or a lack thereof, is electric generation and related CO<sub>2</sub> emissions from all non-RGGI affected electric generation that serves electric load in the nine-state RGGI region. This includes electric generation in the nine-state RGGI region from electric generating units that are not subject to a CO<sub>2</sub> allowance compliance obligation under a state CO<sub>2</sub> Budget Trading Program (e.g., small fossil units not subject to RGGI or non-fossil units not subject to RGGI), as well as net imports of electricity into the nine-state RGGI region. If CO<sub>2</sub> emissions leakage were to occur, it would manifest as an increase

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<sup>12</sup> Reports available at [http://www.rggi.org/docs/Documents/Elec\\_monitoring\\_report\\_11\\_09\\_14.pdf](http://www.rggi.org/docs/Documents/Elec_monitoring_report_11_09_14.pdf), [http://www.rggi.org/docs/Documents/Elec\\_Monitoring\\_Report\\_12\\_07\\_30\\_Final.pdf](http://www.rggi.org/docs/Documents/Elec_Monitoring_Report_12_07_30_Final.pdf), and [http://www.rggi.org/docs/Documents/Elec\\_monitoring\\_report\\_2011\\_13\\_06\\_27.pdf](http://www.rggi.org/docs/Documents/Elec_monitoring_report_2011_13_06_27.pdf).

<sup>13</sup> Report available at [http://www.rggi.org/docs/Documents/Elec\\_monitoring\\_report\\_2012\\_15\\_08\\_11.pdf](http://www.rggi.org/docs/Documents/Elec_monitoring_report_2012_15_08_11.pdf)

in CO<sub>2</sub> emissions from this category of non-RGGI electric generation, assuming all other factors that impact electricity system dispatch and CO<sub>2</sub> emissions, such as electricity demand, relative fossil fuel prices, and wholesale electricity prices, did not change. As a result, an increase in CO<sub>2</sub> emissions from this category of electric generation in a year subsequent to implementation of RGGI, relative to a baseline prior to the implementation of RGGI, could be an indicator of potential CO<sub>2</sub> emissions leakage.

### **General Limitations**

It should be emphasized that this report does not provide indicators of CO<sub>2</sub> emissions leakage, but merely tracks electricity generation and imports and related CO<sub>2</sub> emissions in the RGGI region for 2011 through 2013 relative to baseline years prior to implementation of the RGGI program. Changes in these data over time may point to potential CO<sub>2</sub> emissions leakage as a result of the RGGI CO<sub>2</sub> Budget Trading Program, or a lack thereof, but may also be the result of wholesale electricity market and fuel market dynamics unrelated to the RGGI program, or a combination of these factors.

The data and analysis in this Monitoring Report do not take into account the full lifecycle of sources of fuel. For example, the direct emissions of CO<sub>2</sub> and the lb CO<sub>2</sub>/MWh emission rates from non-RGGI non-fossil fuel units in this report do not reflect the biomass lifecycle carbon reduction of atmospheric CO<sub>2</sub> levels resulting from uptake of CO<sub>2</sub> from the atmosphere as a result of forest and biomass growth. Likewise for municipal solid waste combustors, direct emissions of CO<sub>2</sub> are presented with no analysis of the lifecycle of the components of the waste. The analysis of lifecycle reductions and contributions of fuels used in non-RGGI non-fossil fuel units is not within the scope of this report and this report does not provide indicators of total atmospheric reductions or contributions from the fuels used in non-RGGI non-fossil fuel units.

This report cannot draw definitive conclusions about whether or not CO<sub>2</sub> emissions leakage has occurred, as it does not address the causes of shifts in electricity generation and related CO<sub>2</sub> emissions among different categories of electric generation serving load in the nine-state RGGI region. However, the results demonstrate that there has been no significant change in CO<sub>2</sub> emissions or lb CO<sub>2</sub>/MWh emission rate from non-RGGI electric generation during the years of RGGI program operation, 2011 through 2013, compared to an annual average during 2006 – 2008.

Determining whether CO<sub>2</sub> emissions leakage has occurred requires the evaluation of a hypothetical counterfactual – the amount of CO<sub>2</sub> emissions from non-RGGI electric generation that would occur, assuming there is no shift in electric generation to CO<sub>2</sub>-emitting non-RGGI electric generators as a result of the implementation of the RGGI CO<sub>2</sub> Budget Trading Program (i.e., assuming no CO<sub>2</sub> emissions leakage).

In theory, an increase in CO<sub>2</sub> emissions or CO<sub>2</sub> emission rate from non-RGGI electric generation as compared to a historical baseline year could occur in a scenario in which CO<sub>2</sub> emissions leakage does not occur. Conversely, leakage could theoretically occur in a scenario in which CO<sub>2</sub> emissions and CO<sub>2</sub> emission rate for non-RGGI electric generation decreased as compared to a historical baseline year, if such emissions would have decreased further under a hypothetical counterfactual where no CO<sub>2</sub> emissions leakage occurs.

## V. Methodology

### Data Sources

For ISO-NE and PJM, the data presented are primarily from the NEPOOL Generation Information System (GIS) and PJM Generation Attribute Tracking System (GATS),<sup>14</sup> supplemented by ISO electricity import/export data, and CO<sub>2</sub> emissions data for RGGI-affected electric generation from the RGGI CO<sub>2</sub> Allowance Tracking System (RGGI COATS) for 2009 to 2013 and emissions statement data reported to state environmental agencies in the RGGI participating states for 2005-2008. For non-RGGI electric generation, CO<sub>2</sub> emissions are based on CO<sub>2</sub> emissions for individual electric generation facilities in the NE GIS and PJM GATS tracking systems.

A summary of data sources for ISO-NE and PJM is provided in Appendix A.

For NYISO, MWh data were compiled by the NYSDPS from NYISO data (MWh generation data) and PJM and Hydro Quebec data (MWh electricity net import data). This MWh data was supplemented by CO<sub>2</sub> emissions data compiled by the New York State Department of Environmental Conservation (NYSDEC). 2009 – 2013 CO<sub>2</sub> emissions data for RGGI-affected electric generation units were taken from RGGI COATS and 2005-2008 CO<sub>2</sub> emissions data for these units were compiled from NYSDEC emissions statement program data. CO<sub>2</sub> emissions data for fossil fuel-fired electric generation units that are non-RGGI affected were taken or extrapolated from reports compiled by NYSDEC. A summary of data sources for NYISO is provided in Appendix A.

For each ISO, CO<sub>2</sub> emissions related to net electricity imports from each adjacent control area<sup>15</sup> are the product of a lb CO<sub>2</sub>/MWh emission rate and the

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<sup>14</sup> These ISO tracking systems track every MWh of electric generation for each electric generator that participates in the ISO wholesale market. Modifications were made to both systems at the request of the RGGI Staff Working Group to facilitate the tracking presented in this report. (See Staff Working Group, *Potential Emissions Leakage and the Regional Greenhouse Gas Initiative (RGGI): Evaluating Market Dynamics, Monitoring Options, and Possible Mitigation Mechanisms*, pp. 18-26; available at [http://www.rggi.org/docs/il\\_report\\_final\\_3\\_14\\_07.pdf](http://www.rggi.org/docs/il_report_final_3_14_07.pdf).) These systems do not fully capture the portion of electric generation that is “behind the meter” and used to serve on-site electric load (e.g., MWh supplied from industrial cogeneration to meet on-site industrial electricity load).

<sup>15</sup> For PJM, this represents inferred imports from the non-RGGI geographic portion of PJM.

reported MWh of net imports. The CO<sub>2</sub> emission rate for electricity imports is based on the system average CO<sub>2</sub> emission rate for the respective exporting adjacent control area.<sup>16</sup> For ISO-NE and NYISO, net electricity imports are based on actual flow data for electricity transfers between adjacent control areas.<sup>17</sup> For PJM, net electricity imports are inferred and represent “transfers” of electricity from the non-RGGI geographic portion of PJM into the RGGI geographic portion of PJM (Delaware and Maryland). This data is compiled from PJM GATS, which reports data for both the non-RGGI and RGGI geographic portions of PJM. Inferred net imports are based on total MWh load in the RGGI geographic portion of PJM minus total electric generation in the RGGI geographic portion of PJM. Any shortfall in generation relative to load is assumed to be met through an inferred “import” of electricity from the non-RGGI geographic portion of PJM into the RGGI geographic portion of PJM.<sup>18</sup>

When aggregating individual ISO net import data, the reported regional net imports of electricity and related CO<sub>2</sub> emissions from net imports presented in this report represent net imports from adjacent regions not subject to the RGGI CO<sub>2</sub> Budget Trading Program. Some of the individual ISO net import subtotals represent net imports from another ISO (or portion of an ISO) that is also subject to the RGGI CO<sub>2</sub> Budget Trading Program (for example, from ISO-NE into NYISO and vice versa). In order to avoid inappropriate double counting of MWh and related CO<sub>2</sub> emissions, the net import subtotals from adjacent ISOs (or portion of ISO) subject to the RGGI CO<sub>2</sub> Budget Trading Program were not included when rolling up the individual ISO data into regional summary totals, as the electricity and CO<sub>2</sub> emissions represented by these net imports are included in the electric generation subtotals for each ISO. In rolling up total regional net imports, NYISO net imports from PJM represent a prorated portion of total net imports from PJM that are assumed to originate from the non-RGGI geographic portion of PJM. For each year, this proration is based on the percentage of total PJM MWh generation that occurred in the non-RGGI geographic portion of PJM. (See next subsection for further discussion).

### **Monitoring Limitations**

The monitoring approach used in this report is subject to certain inherent limitations. These limitations primarily involve tracking for the PJM ISO, as well as how net exports from PJM to NYISO are addressed when rolling up ISO-specific data into regional totals for the nine-state RGGI region.

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<sup>16</sup> This assumes that power transferred originates in the adjacent control area and is delivered for use in the receiving control area. This assumption does not account for the wheeling of power through control areas.

<sup>17</sup> The exception is net import data from Hydro Quebec into NYISO, which represents net scheduled electricity imports. Scheduled flows are those flows that are scheduled at an ISO interface for a defined period, while actual flows are the metered flows at an ISO interface for a defined period. Differences between the two can arise from transactions scheduled on contract paths that do not fully correspond to the physical paths on which the electricity related to the transaction actually flows.

<sup>18</sup> For PJM, this category of data does not technically represent an import of electricity, as PJM is dispatched as a single control area.



For ISO-NE and NYISO, net electricity import data is based on the tracking of actual electricity flows between adjacent control areas.<sup>19</sup> This type of tracking is not possible for the RGGI portion of PJM, as PJM is dispatched as a single control area, and electricity flows between geographic subsets of PJM on a state-by-state basis are not available. As a result, “electricity imports” into the two-state RGGI portion of PJM (Delaware and Maryland) from the rest of PJM must be inferred.

This also means that net electricity exports from the non-RGGI portion of PJM into NYISO cannot be determined based on actual electricity flows, as the actual monitored flows of electricity between PJM and NYISO do not allow for a differentiation between these two geographic subsets of PJM. As a result, certain assumptions must be made in order to prorate the portion of net exports from the non-RGGI portion of PJM into NYISO. For this report, this proration is based on the annual percentage of electric generation in the non-RGGI portion of PJM for a respective reporting year, as a percentage of total PJM generation for that year. The actual monitored net electricity flows from PJM into NYISO are multiplied by this percentage to derive an estimate of net electricity exports from non-RGGI PJM into NYISO. These assumed flows may not be fully representative of the actual electric generation source of net exports from non-RGGI PJM into NYISO.

A more modest monitoring limitation involves the electric generation data tracked by the three ISOs. ISO tracking does not include electric generation that is not dispatched into the ISO.<sup>20</sup> This typically involves the portion of industrial cogeneration of electricity used on-site at industrial facilities as well as smaller distributed combined heat and power and renewable energy generation (sometimes referred to as “behind-the-meter” generation).

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<sup>19</sup> The exception is net import data from Hydro Quebec into NYISO, which represents net scheduled electricity imports.

<sup>20</sup> This includes most electric generation and electric load typically referred to as “behind the meter”, which refers to electric generation that is not dispatched by ISOs and electric load met through on-site electric generation facilities (e.g., industrial cogeneration and other smaller distributed generation resources, such as combined heat and power and solar photovoltaics). However, behind-the-meter electric generators eligible for credit under state renewable portfolio standards typically voluntarily report electric generation to the PJM Generation Attribute Tracking System (GATS) and NE-ISO Generation Information System (GIS). MWh data for these behind-the-meter electric generators that report to PJM GATS and ISO-NE GIS are included in the monitoring results. CO<sub>2</sub> emissions data for behind-the-meter electric generation that is RGGI-affected are also included in this report. In addition, only electricity output from cogeneration facilities is reported by ISOs, meaning that the average lb CO<sub>2</sub>/MWh emission rate for all reporting years in this report is for electricity generation dispatched to the ISO grid only and does not account for behind-the-meter MWh output or useful steam output from cogeneration facilities.

## VI. Monitoring Results

Monitoring results are provided below for the full nine-state RGGI region. These results provide a compilation of data from each ISO fully or partially subject to the RGGI CO<sub>2</sub> Budget Trading Program: ISO-NE, NYISO, and PJM. For PJM, monitoring data is compiled for the two-state portion of PJM affected by RGGI (Delaware and Maryland). Monitoring data for each ISO is presented in Appendix B.

Monitoring results for the 9-state RGGI region for 2005 through 2013 are summarized below in Table 1 and Figures 2 through 5.<sup>21</sup>

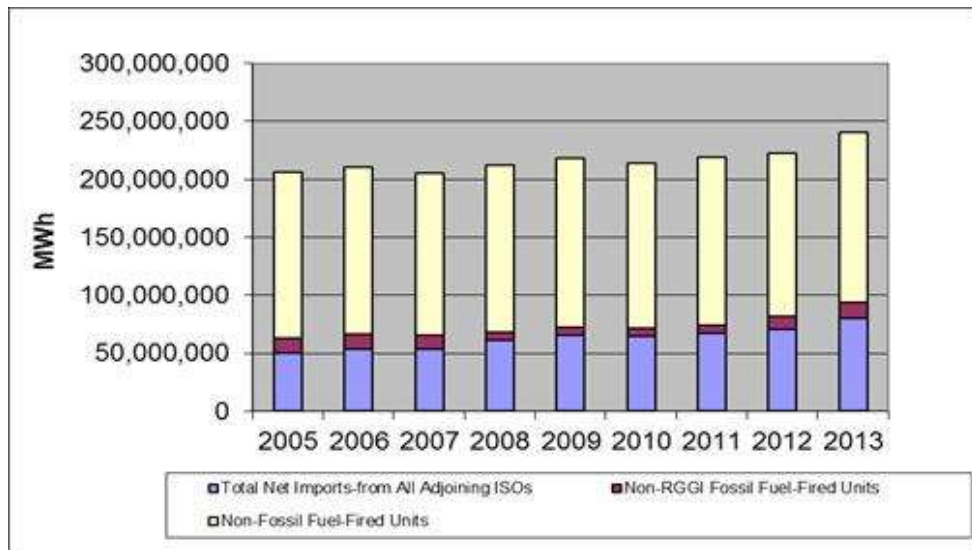
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<sup>21</sup> Note that reported regional net imports of electricity represent net imports from adjacent control areas (or portion of a control area) not subject to the RGGI CO<sub>2</sub> Budget Trading Program. As a result, the net electricity imports and related CO<sub>2</sub> emissions as reported in tabular summaries for each ISO provided in Appendix B do not add up to the reported total regional net imports and related CO<sub>2</sub> emissions. This is because some of the individual ISO net import subtotals represent net imports from another ISO that is also subject to the RGGI CO<sub>2</sub> Budget Trading Program. In order to avoid inappropriate double counting of MWh and related CO<sub>2</sub> emissions, these net import subtotals were not included when rolling up the individual ISO data into regional summary totals, as the electricity and CO<sub>2</sub> emissions represented by these net imports are included in the electric generation subtotals for each ISO.

**Table 1. 2005 – 2013 Monitoring Summary for 9-State RGGI Region**

<b>MWh</b>									
	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Electricity Demand</b>									
Total in RGGI	393,135,125	384,993,562	391,243,211	383,034,165	368,848,273	378,723,230	375,309,279	372,082,306	374,872,244
Net Imports - from Ontario to NY	1,898,020	3,672,282	2,637,442	6,162,902	6,463,657	3,872,635	3,318,681	5,749,461	7,593,954
Net Imports - from Quebec to NY & NE	7,375,317	8,982,749	11,912,292	15,141,014	17,065,805	13,549,209	18,681,204	22,312,689	24,566,017
Net Imports - from New Brunswick to NE	1,620,000	1,047,000	896,000	1,285,000	1,569,000	737,000	846,000	643,000	3,711,000
Net Imports - from non-RGGI PJM to NY	6,967,235	8,837,899	9,452,157	9,917,356	7,760,904	11,489,286	10,452,544	7,926,652	8,700,473
Net Imports - from non-RGGI PJM to RGGI PJM	31,878,151	30,716,157	28,944,540	28,386,914	33,089,871	35,142,720	34,250,993	34,442,085	35,843,247
Total Net Imports - from All Adjoining ISOs	49,738,723	53,256,087	53,842,431	60,893,186	65,949,237	64,790,850	67,549,422	71,073,887	80,414,691
<b>Electricity Generation</b>									
RGGI-Affected Units	186,747,917	175,006,362	185,936,729	170,552,364	151,406,757	165,483,896	157,544,937	152,145,642	137,862,378
Non-RGGI Fossil Fuel-Fired Units	13,470,422	12,878,596	11,431,101	7,405,729	6,621,598	6,920,343	6,815,348	10,417,967	13,553,456
Non-Fossil Fuel-Fired Units	143,309,339	144,088,563	140,249,677	144,034,126	145,330,499	142,317,557	144,941,142	141,089,579	146,939,303
All Non-RGGI Units	156,779,761	156,967,159	151,680,778	151,439,855	151,952,097	149,237,900	151,756,490	151,507,546	160,492,759
All Units	343,396,401	331,737,475	337,400,780	322,140,979	302,899,036	313,931,380	307,759,857	301,007,419	294,458,553
<b>Summary Data</b>									
Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	206,518,484	210,223,246	205,523,209	212,333,041	217,901,334	214,028,750	219,305,912	222,581,433	240,907,450
<b>tons CO2</b>									
	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Electricity Demand</b>									
Total in RGGI	201,544,289	186,429,034	189,347,375	170,936,211	145,617,647	160,228,032	144,431,599	133,556,180	133,116,452
Net Imports - from Ontario to NY	460,286	769,120	604,715	1,154,884	712,496	554,950	336,556	602,081	795,236
Net Imports - from Quebec to NY & NE	30,081	39,607	39,262	41,725	65,841	37,339	45,304	71,327	78,530
Net Imports - from New Brunswick to NE	696	547,053	455,316	736,564	968,535	406,202	400,999	290,602	1,677,178
Net Imports - from non-RGGI PJM to NY	4,460,362	5,484,024	5,801,823	5,999,390	4,381,845	6,656,944	5,952,203	4,287,069	4,822,624
Net Imports - from non-RGGI PJM to RGGI PJM	20,408,108	19,059,750	17,766,431	17,172,335	18,682,706	20,361,849	19,504,235	18,627,737	19,867,713
Total Net Imports - from All Adjoining ISOs	25,359,533	25,899,553	24,667,547	25,104,898	24,811,423	28,017,283	26,239,297	23,878,816	27,241,280
<b>Electricity Generation</b>									
RGGI-Affected Units	159,287,880	139,924,128	145,789,425	129,374,761	105,958,243	116,053,938	101,456,734	92,212,271	86,517,389
Non-RGGI Fossil Fuel-Fired Units	10,309,984	10,134,399	8,443,421	4,662,824	4,263,698	5,355,842	5,401,761	6,459,299	8,193,802
Non-Fossil Fuel-Fired Units	6,586,892	10,470,954	10,446,982	11,793,728	10,584,284	10,800,970	11,333,807	11,005,795	11,163,981
All Non-RGGI Units	16,896,876	20,605,352	18,890,403	16,456,552	14,847,982	16,156,812	16,735,567	17,465,094	19,357,783
All Units	176,184,756	160,529,481	164,679,828	145,831,312	120,806,225	132,210,749	118,192,302	109,677,364	105,875,172
<b>Summary Data</b>									
Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	42,256,409	46,504,906	43,557,950	41,561,450	39,659,405	44,174,095	42,974,865	41,343,910	46,599,063
<b>lb CO2/MWh</b>									
	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Electricity Demand</b>									
Total in RGGI	1025	968	968	893	790	846	770	718	710
Net Imports - from Ontario to NY	485	419	459	375	220	287	203	209	209
Net Imports - from Quebec to NY & NE	8	9	7	6	8	6	5	6	6
Net Imports - from New Brunswick to NE	1	1045	1016	1146	1235	1102	948	904	904
Net Imports - from non-RGGI PJM to NY	1280	1241	1228	1210	1129	1159	1139	1082	1109
Net Imports - from non-RGGI PJM to RGGI PJM	1280	1241	1228	1210	1129	1159	1139	1082	1109
Total Net Imports - from All Adjoining ISOs	1020	973	916	825	752	865	777	672	678
<b>Electricity Generation</b>									
RGGI-Affected Units	1706	1599	1568	1517	1400	1403	1288	1212	1255
Non-RGGI Fossil Fuel-Fired Units	1531	1574	1477	1259	1288	1548	1585	1240	1209
Non-Fossil Fuel-Fired Units	92	145	149	164	146	152	156	156	152
All Non-RGGI Units	216	263	249	217	195	217	221	231	241
All Units	1026	968	976	905	798	842	768	729	719
<b>Summary Data</b>									
Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	409	442	424	391	364	413	392	371	371

The monitoring results indicate that from 2011 through 2013, total average annual electric generation from all non-RGGI electric generation serving load in the nine-state RGGI region increased, by 18.2 million MWh, an increase of 8.7 percent, from the average annual generation from the benchmark period of 2006 to 2008. In a comparison of the 2011 to 2013 annual average to the 2006 to 2008 base period annual average, the CO<sub>2</sub> emissions from this category of electric generation decreased by 235.5 thousand short tons of CO<sub>2</sub>, a reduction of 0.5 percent, and the CO<sub>2</sub> emission rate decreased by 35.7 lb CO<sub>2</sub>/MWh, a reduction of 8.5 percent. (See Figures 6, 7, and 8)



**Figure 6. Non-RGGI Generation Serving Load in RGGI Region (MWh)**

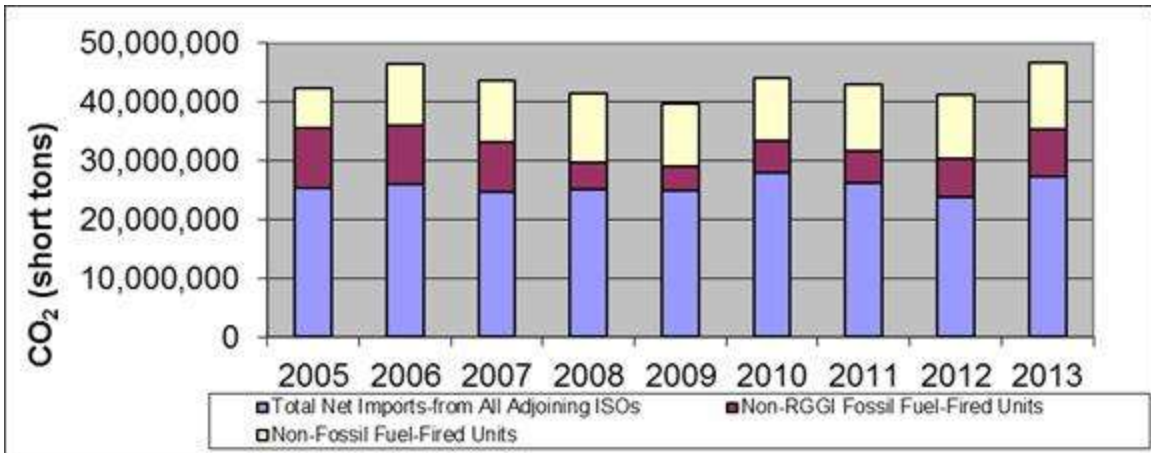


Figure 7. CO<sub>2</sub> Emissions from Non-RGGI Generation Serving Load in RGGI Region (short tons CO<sub>2</sub>)

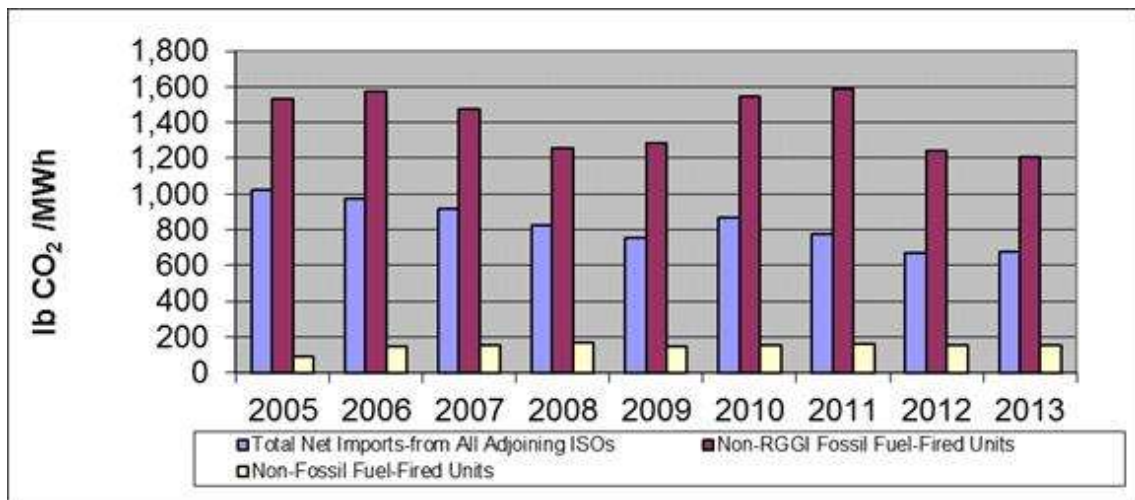


Figure 8. CO<sub>2</sub> Emission Rate for Non-RGGI Generation Serving Load in RGGI Region (lb CO<sub>2</sub>/MWh)

The 2011 to 2013 annual average electricity load in the 9-state RGGI region decreased by 12.3 million MWh, or 3.2 percent, from the 2006 to 2008 base period annual average. In total, electric generation in the nine-state RGGI region (fossil and non-fossil) decreased by 26.8 million MWh, or 8.1 percent, from the base period annual average.

Electric generation from RGGI-affected generation decreased by 28.0 million MWh during this period, or 15.8 percent, and CO<sub>2</sub> emissions from RGGI-affected generation decreased by 45.0 million short tons, or 32.5 percent. The CO<sub>2</sub> emission rate of RGGI-affected electric generation decreased by 310 lb CO<sub>2</sub>/MWh, a decrease of 19.8 percent. Electric generation from non-RGGI

generation sources located in the 9-state RGGI region decreased by 1.2 million MWh, or 0.8 percent, during this period, and CO<sub>2</sub> emissions from this category of electric generation decreased by 798.0 thousand short tons, a reduction of 4.3 percent. The CO<sub>2</sub> emission rate of non-RGGI electric generation located in the nine-state RGGI region decreased by 12 lb CO<sub>2</sub>/MWh, a reduction of 5.0 percent.

Average annual net electricity imports into the 9-state RGGI region increased by 17.0 million MWh, or 30.4 percent, during the 2011 to 2013 average compared to the 2006 to 2008 base period annual average. CO<sub>2</sub> emissions related to these net electricity imports increased by 562.5 thousand short tons, or 2.2 percent, during this period, indicating a reduction in the average CO<sub>2</sub> emission rate of the electric generation supplying these imports of 195.7 lb CO<sub>2</sub>/MWh, a reduction of 21.6 percent. (See Figures 9 and 10).

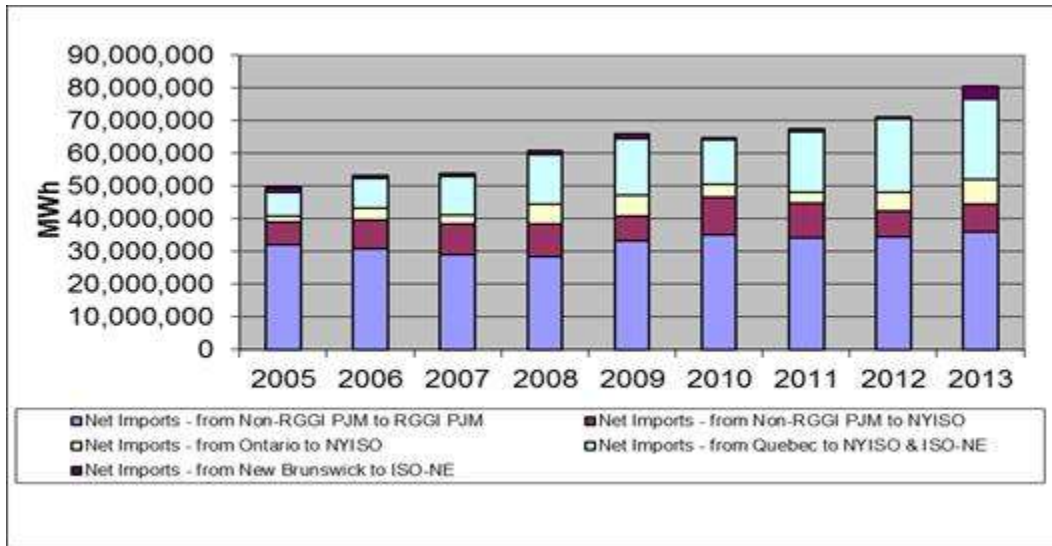
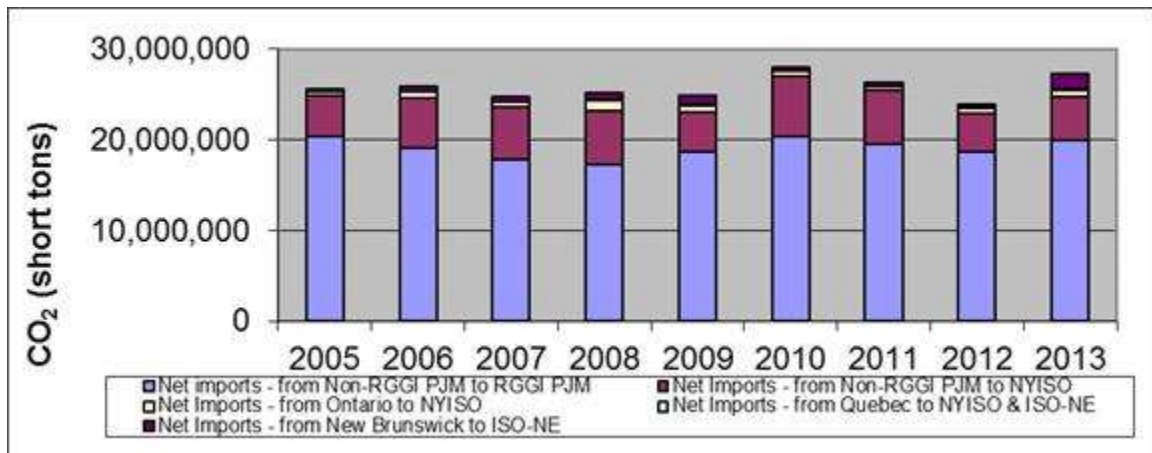


Figure 9. Net Electricity Imports to 9-State RGGI Region (MWh)



### **Figure 10. CO<sub>2</sub> Emissions Related to Net Electricity Imports to 9-State RGGI Region (short tons CO<sub>2</sub>)**

Compared to the annual average during a multi-year 2006 – 2008 base period, 2013 total electricity load in the nine-state RGGI region decreased by 11.5 million MWh, or 3.0 percent. Compared to the 2006 – 2008 annual average, total electric generation in 2013 in the nine-state RGGI region decreased by 32.2 million MWh, or 9.7 percent.

Compared to the annual average during a multi-year 2006 – 2008 base period, 2013 electric generation from RGGI-affected generation decreased by 39.3 million MWh, or 22.2 percent, and CO<sub>2</sub> emissions from RGGI-affected generation decreased by 51.8 million short tons of CO<sub>2</sub>, or 37.5 percent. The CO<sub>2</sub> emission rate of RGGI-affected electric generation decreased by 306 lb CO<sub>2</sub>/MWh, a reduction of 19.6 percent. Compared to the 2006 – 2008 annual average, 2013 electric generation from non-RGGI generation sources located in the nine-state RGGI region increased by 7.1 million MWh, or 4.6 percent, and CO<sub>2</sub> emissions from this category of electric generation increased by 707 thousand short tons, an increase of 3.8 percent. The CO<sub>2</sub> emission rate of non-RGGI electric generation located in the nine-state RGGI region decreased by 2 lb CO<sub>2</sub>/MWh, an decrease of 0.7 percent.

Compared to the annual average during a multi-year 2006 – 2008 base period, 2013 net electricity imports into the nine-state RGGI region increased by 24.4 million MWh, or 43.6 percent. CO<sub>2</sub> emissions related to these net electricity imports increased by 2.0 million short tons of CO<sub>2</sub>, or 8.0 percent, during this period. The average CO<sub>2</sub> emission rate of the electric generation supplying these imports decreased 227 lb CO<sub>2</sub>/MWh, a reduction of 25.1 percent.

## **VII. Discussion**

In the context of the multiple market factors outlined below that influence dispatch of electric generation, CO<sub>2</sub> allowance costs in 2009 through 2013, the first five years of RGGI operation, were relatively modest compared to other electric generation cost components that impact wholesale electricity prices. This modest price signal is consistent with monitoring data in this report that indicate a modest net decrease in CO<sub>2</sub> emissions for non-RGGI electric generation in the annual average of 2011 to 2013 compared to the annual average during 2006 to 2008.

Across the three ISOs subject to RGGI, CO<sub>2</sub> allowance costs accounted for 0.2 percent to 2.5 percent of the average all-in wholesale electricity price in

2013.<sup>22</sup> Wholesale prices fell steadily between 2008 to 2012, except for 2010, but increased in 2013. Higher fuel prices in 2010, coupled with increased economic activity and hot weather led to an increase in wholesale prices in 2010 relative to 2009. Average electricity prices decreased in 2011 relative to 2010, primarily due to a decrease in natural gas prices and mild winter temperatures in late 2011.<sup>23</sup> This decline in electricity prices continued through 2012 as the price of natural gas continued to fall and temperatures remained mild through the winter. Higher natural gas prices, especially during winter months, resulted in higher electricity prices in 2013.<sup>24</sup>

A number of market drivers have changed dramatically during the 2005 through 2013 monitoring timeframe. These changes are due to a number of factors, including, additional investments in energy efficiency and renewable energy, including investments funded by RGGI auction proceeds; complimentary state clean energy programs and policies; lower natural gas prices (changes in relative fuel prices); changes in the generation mix, including additional renewable generation; and weather trends. An analysis of these changes, and their estimated impact on CO<sub>2</sub> emissions in the 10-state RGGI region from 2005 to 2009, was completed by the New York State Energy Research and Development Authority (NYSERDA).<sup>25</sup>

The dynamics of a competitive wholesale electricity market could drive emissions leakage if they provide a sufficient net financial incentive to shift electric generation to units not subject to CO<sub>2</sub> regulation. The extent of this impact is likely to depend, at least in part, on the market value of CO<sub>2</sub> allowances (and the related \$/MWh CO<sub>2</sub> costs incorporated into bids by generators subject to the RGGI CO<sub>2</sub> Budget Trading Program) in relation to other economic factors associated with the generation and delivery of electricity. These factors include:

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<sup>22</sup> For 2013, the average all-in wholesale electricity price was \$53.92/MWh for PJM, \$63.10/MWh for ISO-NE, and \$59.13/MWh for NYISO (energy only) (See ISO-NE Selectable Wholesale Load Cost Data; NYISO, *Power Trends 2013*, p. 18; Monitoring Analytics, *2013 State of the Market Report for PJM*, Section 1, Introduction, p. 15). The CO<sub>2</sub> allowance component is based on a 2013 average CO<sub>2</sub> allowance spot price of \$2.92 per CO<sub>2</sub> allowance (See Potomac Economics, *Annual Report on the Market for RGGI CO<sub>2</sub> Allowances: 2013* p. 6). For PJM, the CO<sub>2</sub> allowance component of the Locational Marginal Price (LMP) for 2013 was \$0.13 per MWh (See Monitoring Analytics, *2013 State of the Market Report for PJM*, Section 2p. 104). ISO-NE and NYISO do not report the CO<sub>2</sub> allowance component of wholesale electricity prices. Both the New England and New York analyses used a 2013 average CO<sub>2</sub> allowance spot price of \$2.92 as a starting point for deriving a CO<sub>2</sub> allowance wholesale price component. The ISO-NE CO<sub>2</sub> allowance wholesale price component was calculated by assuming the ISO-NE Locational Marginal Unit, with a CO<sub>2</sub> emission rate of 0.465 short tons of CO<sub>2</sub> per MWh (see *2013 New England Electric Generator Air Emissions Report, January 2015, Table 5-6*). The NYISO CO<sub>2</sub> allowance wholesale price component was calculated by assuming that a natural gas plant is the marginal unit, with a 2010 fleet average heat rate of 8886Btu per kWh and a CO<sub>2</sub> emission rate of 117 pounds per MMBtu. For both ISO-NE and NYISO, the CO<sub>2</sub> emission rate of the assumed marginal unit was used to translate the annual average spot price for CO<sub>2</sub> allowances (\$2.92) into a dollar per MWh value. For ISO-NE, this resulted in an average CO<sub>2</sub> allowance wholesale price component of approximately \$1.36 per MWh. For NYISO, this resulted in an initial average CO<sub>2</sub> allowance wholesale price component of \$1.50 per MWh. Since Canada and Pennsylvania are not RGGI participating jurisdictions, electricity imported into NYISO from these areas is not assumed to be associated with a CO<sub>2</sub> allowance wholesale price component in NYISO. Therefore, the initial \$1.50 per MWh CO<sub>2</sub> allowance wholesale price component for NYISO was reduced to \$0.68 to account for the amount of marginal electricity imported from these areas.

<sup>23</sup> See, for example, Monitoring Analytics, *2011 State of the Market Report for PJM*, Section 1, Introduction; Potomac Economics, *2011 State of the Market Report New York ISO*, pp. ii-iv; ISO New England Internal Market Monitor, *2011 Annual Markets Report*, May 2011, pp. 1-2.

<sup>24</sup> See, for example, *NYISO 2013 Annual Report*, p. 13.

<sup>25</sup> New York State Energy Research and Development Authority (NYSERDA), *Relative Effects of Various Factors on RGGI Electricity Sector CO<sub>2</sub> Emissions: 2009 Compared to 2005*, November 2010; available at [http://www.rggi.org/docs/Retrospective\\_Analysis\\_Draft\\_White\\_Paper.pdf](http://www.rggi.org/docs/Retrospective_Analysis_Draft_White_Paper.pdf).



locational marginal pricing (LMP), which includes both transmission congestion charges and line loss costs; standard transmission pricing; relative fuel prices; natural gas supply and costs which can be influenced by pipeline constraints; and relative heat rates of generation units<sup>26</sup>. Reliability constraints also play a role in determining the dispatch of electric generation units to the extent that units supply needed generation capacity and ancillary services in a specified region or location on the electricity grid.

A key factor impacting the potential for emissions leakage is the relative cost of electric generation inside and outside the RGGI region (both with and without the incorporation of CO<sub>2</sub> allowance costs), and the relationship of this cost differential with physical transmission capability, the all-in market costs of inter-region power transmission, and the market impacts of transferring significant incremental amounts of power into the RGGI region. The dynamic and highly specific nature of market factors and physical constraints that may cause or mitigate emissions leakage make both a retrospective analysis and future projections of emissions leakage difficult. The factors that may result in emissions leakage are likely to be both temporally and geographically specific, given the dynamic operation of the electric power system.

LMP can be expected to affect the market response to the imposition of a CO<sub>2</sub> allowance cost adder to generation in the RGGI region. LMP is based on the principle that the generation of power has different values at different points in the electric power network. LMP is the cost of supplying the last MWh of generation dispatched at a specific location, which reflects transmission constraints and the marginal cost of generation units. Market participants utilize finite transmission resources, and transfers of power in a region can impact the local generation economics in that area, due to the physics of the electric transmission network. Transmission “congestion” occurs when available, low-cost electric generation supply cannot be delivered to the demand location due to transmission network limitations. When electricity from the least-cost electric generation source in a region cannot be delivered to electricity load in a transmission-constrained area, higher cost units in this constrained area are dispatched to meet that load. The result is that the wholesale price of electricity in the constrained area is higher than in the unconstrained area due to a combination of electricity demand, transmission limitations, and the marginal cost of local generation.

If the cost of RGGI CO<sub>2</sub> compliance on a per MWh basis is lower than the aggregate per MWh price signal of mitigating market factors, which are discussed below, no net market dynamic driving emissions leakage would be expected to occur. This net market signal would be a function of the relationship between the generation cost differential due to RGGI CO<sub>2</sub> compliance and the all-in market cost of transferring incremental power into the RGGI region or

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<sup>26</sup> Heat rate is a measure of electric generator energy efficiency, represented as Btu of fuel input per kWh of electricity output.

shifting generation to other unregulated smaller fossil fuel-fired generation sources within the RGGI region. Market factors that may impact the economics of importing incremental power in response to a CO<sub>2</sub> allowance price signal include:<sup>27</sup>

- *Existing Generator Economics* – Including a CO<sub>2</sub> compliance cost into the generation costs of an individual electric generator may make that generator uneconomic relative to a competitor. However, whether this occurs depends on the operating costs of each electric generator, both with and without CO<sub>2</sub> compliance costs. Key factors that influence electric generator operating costs include fuel prices, generator heat rate (Btu of fuel input per kWh of electric generation output), and costs for air pollutant emissions (nitrogen oxides (NO<sub>x</sub>), sulfur dioxide (SO<sub>2</sub>), and CO<sub>2</sub>). As a result, inclusion of a CO<sub>2</sub> allowance cost must be sufficient to supplant any preexisting generator cost differentials in order to shift generation from a RGGI source to a non-RGGI source.
- *Existing Locational Generation Price Differentials* – Differential LMPs between regions represent the presence of transmission constraints and line losses that require the dispatch of higher priced electric generation in a certain region. Electricity demand, in particular, can have a large impact on LMPs in a specific region. For example, in 2013 the real-time average LMP by jurisdiction in DE was \$1.39 and in MD was \$3.58 per MWh above the average PJM LMP, indicating the presence of existing transmission congestion and line losses.<sup>28</sup>
- *Congestion Charges* – Congestion charges and the standard cost of transmitting electricity may make significant incremental imports into the RGGI region uneconomic as a response to a modest generation price differential resulting from RGGI CO<sub>2</sub> allowance costs. As an example, in PJM, power transmission is subject to congestion charges, which are based on the difference between LMPs at the source (generator location, or “generator bus”) and LMPs at the sink (electric distribution utility location, or “load serving entity (LSE) bus”). Thus, in addition to standard transmission charges, entities importing power into the RGGI region would need to pay congestion charges based on the differential between LMPs in the uncapped non-RGGI region where the generator is located and LMPs in the capped RGGI region where the electricity is delivered.<sup>29</sup>

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<sup>27</sup> Some of these factors may also impact the economics of shifting dispatch to smaller in-region fossil fuel-fired electric generation in the nine-state RGGI region that is not subject to regulation of CO<sub>2</sub>.

<sup>28</sup> Monitoring Analytics, *2013 State of the Market for PJM*, 2013; Section 2, Energy Market pp. 102 and Appendix C pp. 426.

<sup>29</sup> As an example, the congestion component of the 2013 average day-ahead, load weighted LMP in the Delmarva Power & Light zone (Delaware and Maryland) zone of PJM was \$1.56 per MWh. For the Baltimore Gas & Electric zone (Maryland), the congestion component was \$3.46 per MWh. See, Monitoring Analytics, *2013 State of the Market for PJM*; Section 11, Table 11-4, p. 325.

- *Line loss charges* – The greater the distance that electricity is transmitted, and as more power is transmitted through a power line, the greater the loss of the power initially put into the line, based on the physics of the electricity transmission network. As a result, the costs of transmission line-losses impact the economics of importing power. For example, in PJM line losses are accounted for in the calculation of LMP through the application of a line loss “penalty factor.” If the dispatch of an electric generator would result in an increase in system line losses in a certain location, a positive penalty factor is applied to the generator’s bid into the wholesale market, making the unit look less economically attractive to dispatch.<sup>30</sup>
- *Long-Term Contracts* – Other factors, such as existing long-term power purchase agreements, can be expected to mitigate emissions leakage.

## VIII. Conclusions

This report presents data and trends for electricity generation, imports and related CO<sub>2</sub> emissions without assigning causality to any one of the factors influencing observed trends in electricity generation and related CO<sub>2</sub> emissions among different categories of electric generation serving load in the 9-state RGGI region. The monitoring results show there has been a 0.5% decrease in average annual CO<sub>2</sub> emissions from non-RGGI electric generation during the three years of RGGI program operation, 2011 through 2013, compared to the average annual CO<sub>2</sub> emissions during 2006 to 2008. If emissions leakage were to occur, it would manifest through an increase in CO<sub>2</sub> emissions from this aggregate category of non-RGGI electric generation, assuming all other factors that impact electric generator dispatch and CO<sub>2</sub> emissions, such as electricity demand, relative fossil fuel prices, and wholesale electricity prices, did not change.

Given that the monitoring results presented in this report do not address causality, the results should be evaluated in context with market dynamics. The monitoring data for 2011 through 2013, which show no increase from the base period of 2006 to 2008 in CO<sub>2</sub> emissions from non-RGGI electric generation serving electricity load in the nine-state RGGI region, are consistent with expectations, given the relatively modest CO<sub>2</sub> allowance prices evident in 2009 through 2013. The average CO<sub>2</sub> allowance price in 2011 through 2013 represented approximately 2.5 percent or less of the average wholesale electricity price in the three ISOs fully or partially subject to RGGI. The monitoring results are consistent with market dynamics given the modest CO<sub>2</sub> allowance prices that result in CO<sub>2</sub> compliance costs on a per MWh basis. The RGGI allowances prices are likely lower than the aggregate per MWh price signal of mitigating market factors discussed in this report that would counter emissions

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<sup>30</sup> As an example, the line loss component of the 2013 average day-ahead, load weighted LMP in the Delmarva Power & Light (Delaware and Maryland) zone of PJM was \$1.89 per MWh. Similarly, for the Baltimore Gas & Electric zone (Maryland), the line loss component of LMP was \$1.69 per MWh. See, Monitoring Analytics, 2013 *State of the Market for PJM*; Section 11, Table 11-4, p. 325.

leakage. Considering these factors, with modest CO<sub>2</sub> allowance prices, no net market dynamic driving emissions leakage would be expected to occur.

This report is the fifth in a series of annual monitoring reports, as called for in the 2005 RGGI MOU. This continued monitoring is warranted because both electricity market drivers and non-market drivers that impact CO<sub>2</sub> emissions have shifted dramatically from year to year during the 2005 to 2013 time period evaluated in this report. Ongoing monitoring will further evaluate changes in market and non-market drivers that impact CO<sub>2</sub> emissions related to electricity generation and imports in the RGGI region.

## Appendix A. 9-state ISO Monitoring Sources

**Table 2. Summary of Data Sources for ISO-NE**

Code	Monitoring Category Associated with Data Elements at Right	MWh	CO <sub>2</sub> lb/MWh	CO <sub>2</sub> Tons
<b>Electricity Demand (Annual)</b>				
A-1	Total Electricity Use in ISO-NE	ISO-NE <sup>1</sup>	CO <sub>2</sub> tons divided by MWh	Sum of A-3 and B-5
A-2	Net Electricity Imports - from New York	ISO-NE <sup>1</sup>	B-5	MWh multiplied by CO <sub>2</sub> /MWh
A-2	Net Electricity Imports - from Quebec	ISO-NE <sup>1</sup>	Environment Canada <sup>3</sup>	MWh multiplied by CO <sub>2</sub> /MWh
A-2	Net Electricity Imports - from New Brunswick	ISO-NE <sup>1</sup>	Environment Canada <sup>3</sup>	MWh multiplied by CO <sub>2</sub> /MWh
A-3	Total Net Electricity Imports - from All Adjoining ISOs	ISO-NE <sup>1</sup>	CO <sub>2</sub> tons divided by MWh	Sum of A-2s
<b>Electricity Generation (Annual)</b>				
B-1	RGGI-Affected Units	NEPOOL-GIS <sup>2</sup>	CO <sub>2</sub> tons divided by MWh	State reported data for 2005-2008; RGGI COATS for 2009 to 2013. <sup>4</sup> Includes only sources subject to a state CO <sub>2</sub> Budget Trading Program CO <sub>2</sub> allowance compliance obligation. Does not include biomass-derived CO <sub>2</sub> emissions.
B-2	Non-RGGI Units (Fossil Fuel-Fired; <25MW)	NEPOOL-GIS <sup>2</sup>	CO <sub>2</sub> tons divided by MWh	NEPOOL-GIS <sup>2</sup>
B-3	Non-RGGI Units (Non-Fossil Fuel-Fired)	NEPOOL-GIS <sup>2</sup>	CO <sub>2</sub> tons divided by MWh	NEPOOL-GIS <sup>2</sup>
B-4	All Non-RGGI Units (Fossil and Non-Fossil)	Sum of B-2 and B-3	CO <sub>2</sub> tons divided by MWh	Sum of B-2 and B-3
B-5	All Units	ISO-NE <sup>1</sup>	CO <sub>2</sub> tons divided by MWh	Sum of B-1 and B-4

**Table Notes:**

1. ISO-NE, Historical Data Reports, "Net Energy and Peak Load by Source" (Annual Summary). Available at <http://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-tree/net-ener-peak-load>.
2. NEPOOL Generation Information System. Available at <http://www.nepoolgis.com>.
3. Environment Canada, *National Inventory Report 1990–2012: Greenhouse Gas Sources and Sinks in Canada*, Environment Canada, June 10, 2014. In Part 3, see Table A13-5 "Electricity Generation and GHG Emission Details for New Brunswick"; Table A13-6 "Electricity Generation and GHG Emission Details for Quebec". Available at [http://unfccc.int/national\\_reports/annex\\_i\\_ghg\\_inventories/national\\_inventories\\_submissions/items/7383.php](http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php). Note that New Brunswick and Quebec emission factors were updated for every year, as compared to the previous year's report.
4. Historical 2005 – 2008 CO<sub>2</sub> emissions data reported by RGGI participating states compiled from CO<sub>2</sub> emissions data reported to U.S. EPA pursuant 40 CFR Part 75 and from CO<sub>2</sub> emissions and fuel use data reported to state emissions statement programs. 2009 through 2013 CO<sub>2</sub> emissions data is from data reported to the RGGI CO<sub>2</sub> Allowance Tracking System (RGGI COATS), available at <http://www.rggi-coats.org>.

**Table 3. Summary of Data Sources for NYISO**

Code	Monitoring Category Associated with Data Elements at Right	MWh	CO <sub>2</sub> lb/MWh	CO <sub>2</sub> Tons
<b>Electricity Demand (Annual)</b>				
A-1	Total Electricity Use in NYISO	Sum of A-3 and B-5	CO <sub>2</sub> tons divided by MWh	Sum of A-3 and B-5
A-2	Net Electricity Imports - from Hydro Quebec	Hydro Quebec <sup>1</sup>	Environment Canada <sup>6</sup>	MWh multiplied by CO <sub>2</sub> /MWh
A-2	Net Electricity Imports - from ISO-NE	ISO-NE <sup>2</sup>	ISO-NE system average <sup>7</sup>	MWh multiplied by CO <sub>2</sub> /MWh
A-2	Net Electricity Imports - from Ontario	Ontario Independent Electricity System Operator <sup>3</sup>	Environment Canada <sup>6</sup>	MWh multiplied by CO <sub>2</sub> /MWh
A-2	Net Electricity Imports - from PJM	PJM Annual State of the Market Report <sup>4</sup>	PJM GATS <sup>8</sup>	MWh multiplied by CO <sub>2</sub> /MWh
A-3	Total Net Electricity Imports - from All Adjoining ISOs	Sum of A-2s	CO <sub>2</sub> tons divided by MWh	Sum of A-2s
<b>Electricity Generation (Annual)</b>				
B-1	RGGI-Affected Units	NYDPS Calculation <sup>5</sup>	CO <sub>2</sub> tons divided by MWh	State reported data for 2005-2008; RGGI COATS for 2009 to 2013 <sup>3</sup> Includes only sources subject to a state CO <sub>2</sub> Budget Trading Program CO <sub>2</sub> allowance compliance obligation.
B-2	Non-RGGI Units (Fossil Fuel-Fired; < 25 MW)	NYDPS Calculation <sup>5</sup>	CO <sub>2</sub> tons divided by MWh	NYSDEC Emissions Report <sup>10, 11</sup>
B-3	Non-RGGI Units (Non-Fossil Fuel-Fired)	NYDPS Calculation <sup>5</sup>	CO <sub>2</sub> tons divided by MWh	NYSDEC Emissions Report <sup>11</sup>
B-4	All Non-RGGI Units (Fossil and Non-Fossil)	Sum of B-2 and B-3	CO <sub>2</sub> tons divided by MWh	Sum of B-2 and B-3
B-5	All Units	Sum of B-1 and B-4	CO <sub>2</sub> tons divided by MWh	Sum of B-1 and B-4

**Table Notes:**

1. Hydro Quebec response to information request.
2. ISO-NE, Historical Data Reports, "Net Energy and Peak Load by Source" (Annual Summary). Available at <http://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-tree/net-ener-peak-load>.
3. Ontario IESO response to information request.
4. Monitoring Analytics, *State of the Market for PJM* (2005 through 2013 reports).

5. NYDPS calculation based on MWh for each generator reported by NYISO and assignment of each generator to appropriate monitoring classification.
6. Environment Canada, *National Inventory Report 1990–2012: Greenhouse Gas Sources and Sinks in Canada*, Environment Canada, June 10, 2014. In Part 3, see Table A13-6 “Electricity Generation and GHG Emission Details for Quebec”; Table A13-7 “Electricity Generation and GHG Emission Details for Ontario”. Available at [http://unfccc.int/national\\_reports/annex\\_i\\_ghg\\_inventories/national\\_inventories\\_submissions/items/7383.php](http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php) Note that Ontario and Quebec emission factors were updated for every year, as compared to the previous year’s report.
7. Calculated average, based on Row B-5 in Table 2 above.
8. PJM Generation Attribute Tracking System, accessible at <http://www.pjm-eis.com>.
9. Historical 2005 – 2008 CO<sub>2</sub> emissions data reported by RGGI participating states compiled from CO<sub>2</sub> emissions data reported to U.S. EPA pursuant 40 CFR Part 75 and from CO<sub>2</sub> emissions and fuel use data reported to state emissions statement programs. 2009 through 2013 CO<sub>2</sub> emissions data is from data reported to the RGGI CO<sub>2</sub> Allowance Tracking System (RGGI COATS), available at <http://www.rggi-coats.org>.
10. MWh and CO<sub>2</sub> emissions data include Linden Cogeneration, units 005001 – 009001, and for 2012 only Bayonne Energy Center, units CTG1 – CTG8, as these units are physically located in New Jersey, but dispatch electricity into NYISO.
11. NYDPS calculation based on NYSDEC emissions data and other state data.

**Table 4. Summary of Data Sources for RGGI PJM**

Code	Monitoring Category Associated with Data Elements at Right	MWh	CO <sub>2</sub> lb/MWh	CO <sub>2</sub> Tons
	<b>Electricity Demand (Annual)</b>			
A-1	Total Electricity Use in RGGI PJM	Sum of A-3 and B-5	CO <sub>2</sub> tons divided by MWh	Sum of A-3 and B-5
A-2	Net Electricity Imports - from Non-RGGI PJM	PJM GATS <sup>1</sup>	PJM GATS <sup>1</sup>	MWh multiplied by CO <sub>2</sub> /MWh
A-2	Net Electricity Imports - from NYISO	PJM Annual State of the Market Report <sup>2</sup>	B-5	MWh multiplied by CO <sub>2</sub> /MWh
A-3	Total Net Electricity Imports - from All Adjoining ISOs	Sum of A-2s	CO <sub>2</sub> tons divided by MWh	Sum of A-2s
	<b>Electricity Generation (Annual)</b>			
B-1	RGGI-Affected Units	PJM GATS <sup>1</sup>	CO <sub>2</sub> tons divided by MWh	State reported data for 2005-2008; RGGI COATS for 2009 through 2013. Includes only sources subject to a state CO <sub>2</sub> Budget Trading Program CO <sub>2</sub> allowance compliance obligation; does not include Maryland LIESA sources; does not include Linden Cogeneration units 005001-009001. <sup>3,4</sup>
B-2	Non-RGGI Units (Fossil Fuel-Fired; < 25 MW)	PJM GATS <sup>1</sup>	CO <sub>2</sub> tons divided by MWh	PJM GATS <sup>1</sup>
B-3	Non-RGGI Units (Non-Fossil Fuel-Fired)	PJM GATS <sup>1</sup>	CO <sub>2</sub> tons divided by MWh	PJM GATS <sup>1</sup>
B-4	All Non-RGGI Units (Fossil and Non-Fossil)	Sum of B-2 and B-3	CO <sub>2</sub> tons divided by MWh	Sum of B-2 and B-3
B-5	All Units	Sum of B-1 and B-4	CO <sub>2</sub> tons divided by MWh	Sum of B-1 and B-4

**Table Notes:**

1. PJM Generation Attribute Tracking System, accessible at <<http://www.pjm-eis.com>>.
2. Monitoring Analytics, *State of the Market for PJM* (2005 through 2013 reports) at [http://www.monitoringanalytics.com/reports/PJM\\_State\\_of\\_the\\_Market/2013.shtml](http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2013.shtml).
3. Historical 2005 – 2008 CO<sub>2</sub> emissions data reported by RGGI participating states compiled from CO<sub>2</sub> emissions data reported to U.S. EPA pursuant 40 CFR Part 75 and from CO<sub>2</sub> emissions and fuel use data reported to state emissions statement programs. 2009 through 2012 CO<sub>2</sub> emissions data is from data reported to the RGGI CO<sub>2</sub> Allowance Tracking System (RGGI COATS), available at <<http://www.rggi-coats.org>>.
4. MWh and CO<sub>2</sub> emissions data do not include Maryland Limited Industrial Exemption Set-aside (LIESA) sources. LIESA sources for 2009-2013 include Severstal Sparrows Point LLC and Luke Paper Company. LIESA sources refer to certain industrial cogenerators under Maryland’s CO<sub>2</sub> Budget Trading Program regulations that are subject to alternative CO<sub>2</sub> compliance obligations under certain conditions in lieu of submission of CO<sub>2</sub> allowances.

## Appendix B. ISO-Specific Monitoring Results

Detailed monitoring results for ISO-NE, NYISO, and the RGGI portion of PJM are presented below.<sup>31</sup>

### ISO-NE

Monitoring results for ISO-NE for 2005 through 2013 are summarized below in Table 5 and Figures 11 through 15.

**Table 5. 2005 – 2011 Monitoring Summary for ISO-NE**

	MWh									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	
<b>Electricity Demand</b>										
Total in ISO	138,174,000	134,243,000	136,869,000	134,000,000	128,801,000	131,956,000	130,752,000	129,590,000	131,001,000	
Net Imports - from NYISO	-115,000	-877,000	-2,477,000	-1,529,000	-3,031,000	-4,412,000	-2,262,000	-1,073,000	1,322,000	
Net Imports - from Quebec	4,792,000	6,023,000	7,727,000	9,495,000	10,826,000	9,214,000	11,558,000	13,077,000	13,928,000	
Net Imports - from New Brunswick	1,620,000	1,047,000	896,000	1,285,000	1,569,000	737,000	846,000	643,000	3,711,000	
Total Net Imports - from All Adjoining ISOs	6,297,000	6,193,000	6,146,000	9,251,000	9,363,000	5,539,000	10,142,000	12,648,000	18,961,000	
<b>Electricity Generation</b>										
RGGI-Affected Units	77,439,814	70,911,131	75,345,502	70,591,734	65,426,926	71,314,622	69,466,788	62,481,082	53,434,364	
Non-RGGI Fossil Fuel-Fired Units <25MW	94,304	75,137	64,598	152,110	627,311	908,731	1,139,223	1,408,663	1,590,958	
Non-RGGI Fossil Fuel-Fired Units >=25MW	5,953,312	5,212,883	4,419,405	2,484,119	2,095,712	2,195,189	2,206,681	5,082,341	7,917,332	
Non-Fossil Fuel-Fired Units	48,520,847	52,086,895	51,110,222	51,372,277	51,746,869	52,787,874	49,338,878	50,615,683	52,994,930	
All Non-RGGI Units	54,568,463	57,374,915	55,594,225	54,008,506	54,469,892	55,891,794	52,684,782	57,106,687	62,503,220	
All Units	131,877,000	128,050,000	130,723,000	124,749,000	119,437,000	126,416,000	120,610,000	116,942,000	112,041,000	
<b>Summary Data</b>	6,047,616	5,288,020	4,484,003	2,636,229	2,723,023	3,103,920	3,345,904	6,491,004	9,508,290	
Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	60,865,463	63,567,915	61,740,225	63,259,506	63,832,892	61,430,794	62,826,782	69,754,687	81,464,220	
<b>Tons CO2</b>										
<b>Electricity Demand</b>										
Total in ISO	63,359,709	58,374,143	58,405,351	53,273,400	48,220,733	51,119,602	46,544,945	43,184,692	46,457,468	
Net Imports - from NYISO	-55,282	-398,599	-1,118,781	-651,589	-1,229,274	-1,833,018	-881,419	-396,832	521,693	
Net Imports - from Quebec	19,544	26,557	25,468	26,166	41,768	25,392	28,029	41,803	44,524	
Net Imports - from New Brunswick	696	547,053	455,316	736,564	968,535	406,202	400,999	290,602	1,677,178	
Total Net Imports - from All Adjoining ISOs	-35,041	175,010	-637,997	111,141	-218,971	-1,401,424	-452,391	-64,426	2,243,394	
<b>Electricity Generation</b>										
RGGI-Affected Units	54,223,939	47,783,423	49,434,978	44,508,400	38,815,561	41,682,538	35,469,318	31,357,869	29,941,118	
Non-RGGI Fossil Fuel-Fired Units <25MW	37,197	42,415	47,105	98,880	374,282	875,835	1,030,383	1,133,530	938,145	
Non-RGGI Fossil Fuel-Fired Units >=25MW	4,054,743	3,565,819	2,744,219	1,734,332	1,810,538	2,406,571	2,516,545	3,104,311	5,668,860	
Non-Fossil Fuel-Fired Units	5,078,871	6,807,476	6,817,046	6,820,646	7,439,324	7,556,082	7,981,091	7,653,408	7,665,951	
All Non-RGGI Units	9,170,811	10,415,709	9,608,370	8,653,859	9,624,143	10,838,488	11,528,018	11,891,249	14,272,956	
All Units	63,394,750	58,199,133	59,043,348	53,162,258	48,439,704	52,521,026	46,997,336	43,249,118	44,214,074	
<b>Summary Data</b>	4,091,940	3,608,234	2,791,324	1,833,213	2,184,820	3,282,406	3,546,928	4,237,841	6,607,005	
Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	9,135,770	10,590,720	8,970,373	8,765,000	9,405,172	9,437,064	11,075,627	11,826,823	16,516,350	
<b>Lb CO2 /MWh</b>										
<b>Electricity Demand</b>										
Total in ISO	917	870	853	795	749	712	712	666	709	
Net Imports - from NYISO	961	909	903	852	811	831	779	740	789	
Net Imports - from Quebec	8	9	7	6	8	6	5	6	6	
Net Imports - from New Brunswick	1	1,045	1,016	1,146	1,235	1,102	948	904	904	
Total Net Imports - from All Adjoining ISOs	-11	57	-208	24	-47	-506	-89	-10	237	
<b>Electricity Generation</b>										
RGGI-Affected Units	1,400	1,348	1,312	1,261	1,187	1,169	1,021	1,004	1,121	
Non-RGGI Fossil Fuel-Fired Units <25MW	789	1,129	1,458	1,300	1,193	1,928	1,809	1,609	1,179	
Non-RGGI Fossil Fuel-Fired Units >=25MW	1,362	1,368	1,242	1,396	1,728	2,193	2,281	1,222	1,432	
Non-Fossil Fuel-Fired Units	209	261	267	266	288	286	324	302	289	
All Non-RGGI Units	336	363	346	320	353	388	438	416	457	
All Units	961	909	903	852	811	831	779	740	789	
<b>Summary Data</b>	1,353	1,365	1,245	1,391	1,605	2,115	2,120	1,306	1,390	
Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Import)	300	333	291	277	295	307	353	339	405	

<sup>31</sup> The tons of CO<sub>2</sub> emitted and the lb of CO<sub>2</sub>/MWh emission rates in this report do not represent total lifecycle reductions or contributions of greenhouse gases. Such analysis is outside the scope of this report.

The monitoring results indicate that when the 2011 to 2013 annual average is compared to the 2006 to 2008 base period annual average, total electric generation from all non-RGGI electric generation serving load in ISO-NE increased by 8.5 million MWh, an increase of 13.5 percent. When the 2006 to 2008 base period annual average is compared to the 2011 to 2013 annual average, CO<sub>2</sub> emissions from this category of electric generation increased by 3.7 million short tons of CO<sub>2</sub>, an increase of 39.2 percent, and the CO<sub>2</sub> emission rate increased by 65 lb CO<sub>2</sub>/MWh, an increase of 21.7 percent. (See Figures 11, 12, and 13).

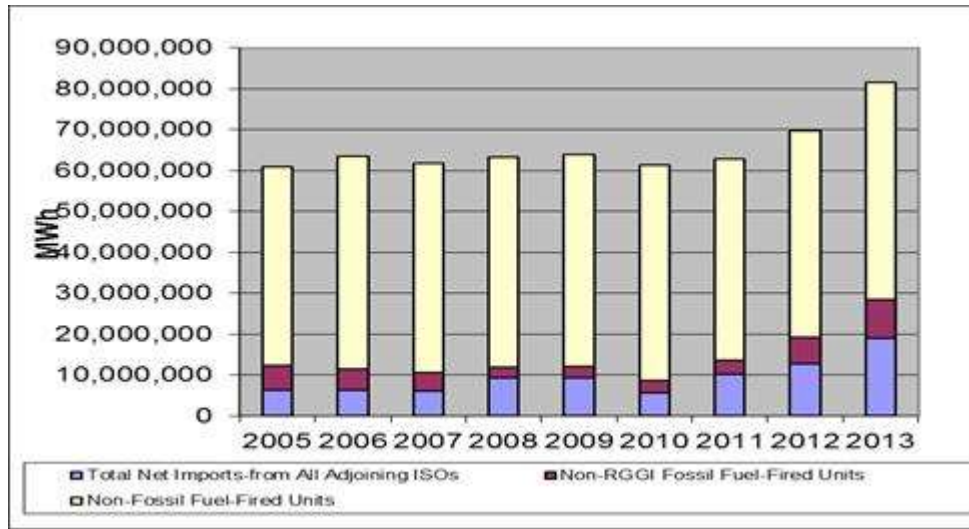


Figure 11. Non-RGGI Generation Serving Load in ISO-NE (MWh)

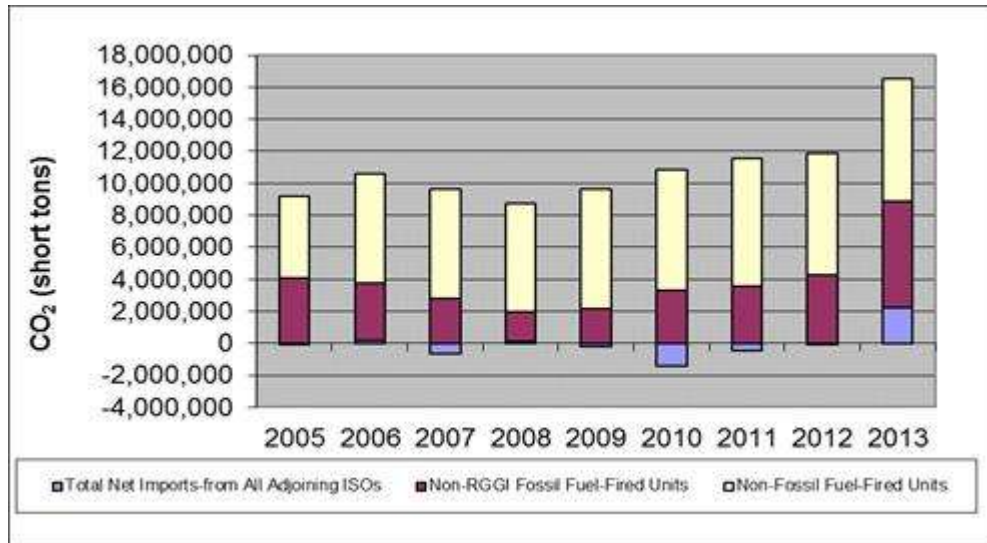
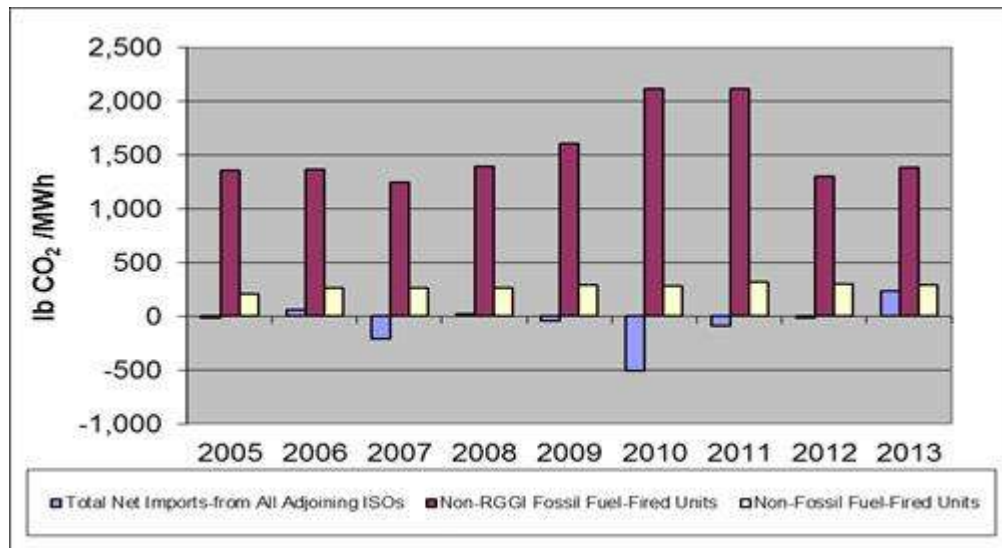


Figure 12. CO<sub>2</sub> Emissions from Non-RGGI Generation Serving Load in ISO-NE (short tons CO<sub>2</sub>)





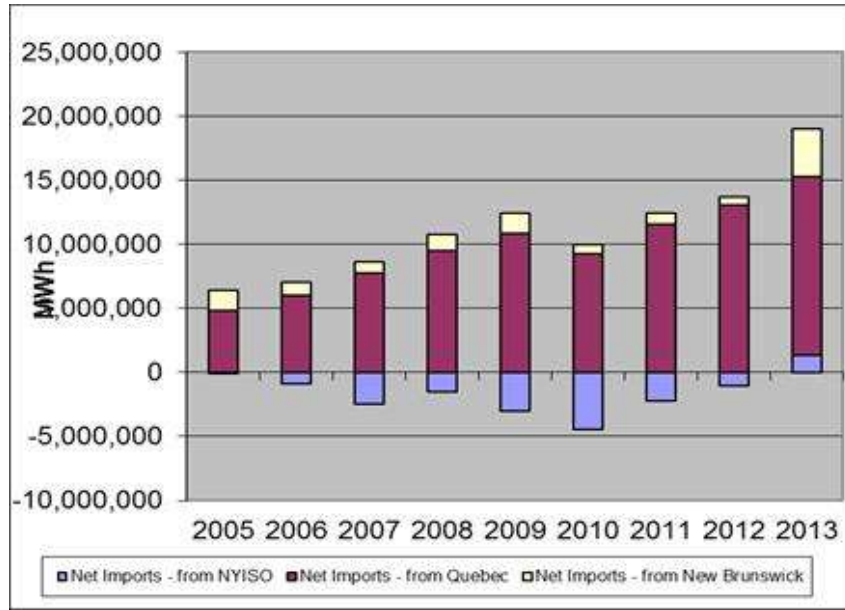
**Figure 13. CO<sub>2</sub> Emission Rate for Non-RGGI Generation Serving Load in ISO-NE (lb CO<sub>2</sub>/MWh)**

The annual average electricity load in ISO-NE decreased by 4.6 million MWh, or 3.4 percent for 2011 to 2013 as compared to the annual average from the baseline period of 2006 to 2008. In total, electric generation (fossil and non-fossil) in ISO-NE decreased by 8.7 million MWh, or 6.8 percent, when comparing the 2006 to 2008 annual average to the 2011 to 2013 annual average.

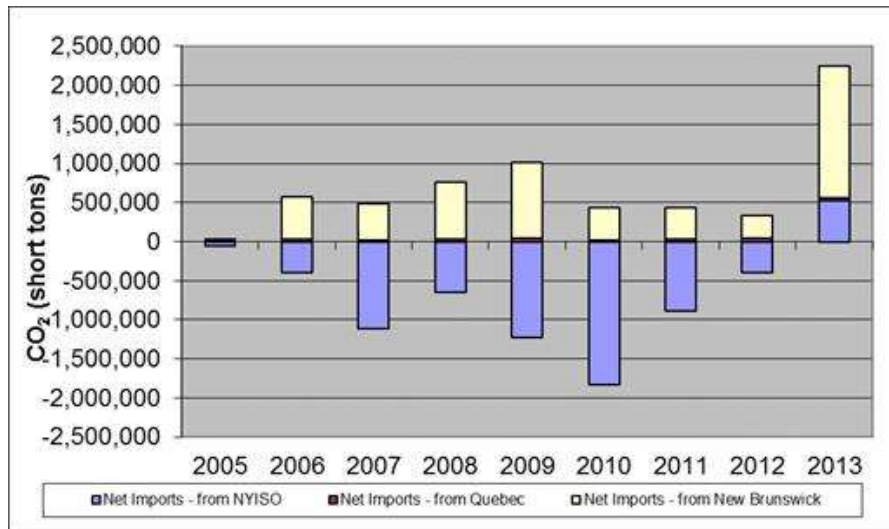
Electric generation from RGGI-affected generation in ISO-NE decreased by 10.5 million MWh during this period, or 14.5 percent, and CO<sub>2</sub> emissions from RGGI-affected electric generation in ISO-NE decreased by 15.0 million short tons of CO<sub>2</sub>, or 31.7 percent. The CO<sub>2</sub> emission rate of RGGI-affected electric generation decreased by 258 lb CO<sub>2</sub>/MWh, a reduction of 19.8 percent. Electric generation from non-RGGI electric generation sources located in ISO-NE increased by 1.8 million MWh, or 3.2 percent, during this period, and CO<sub>2</sub> emissions from this category of electric generation increased by 3.0 million short tons of CO<sub>2</sub>, an increase of 31.4 percent. The CO<sub>2</sub> emission rate of non-RGGI electric generation located in ISO-NE increased by 94 lb CO<sub>2</sub>/MWh, an increase of 27.4 percent.

Net electricity imports into ISO-NE increased by 6.7 million MWh, or 93.4 percent, when comparing the base period annual average from 2006 to 2008 to the annual average from 2011 to 2013. CO<sub>2</sub> emissions related to these net electricity imports increased by 692.8 thousand short tons of CO<sub>2</sub> during this period.<sup>32</sup> The CO<sub>2</sub> emission rate of the electric generation supplying these imports decreased by 88.1 thousand lb CO<sub>2</sub>/MWh.

<sup>32</sup> ISO-NE net exports to NYISO doubled from 2008 to 2009, and increased again in 2010. Negative values for MWh and CO<sub>2</sub> tons indicate that more MWh were exported (from New England to New York) than imported. As a result, the



**Figure 14. Net Electricity Imports to ISO-NE (MWh)**



**Figure 15. CO<sub>2</sub> Emissions Related to Net Electricity Imports to ISO-NE (short tons CO<sub>2</sub>)**

increase in net exports to NYISO in 2009 and 2010 increased the amount of CO<sub>2</sub> emissions debited from the ISO-NE net import total, resulting in a negative CO<sub>2</sub> emissions value for total CO<sub>2</sub> emissions related to total net electricity imports in 2009, 2010, 2011, and 2012 for ISO-NE. In 2013, the trend was reversed as NE imported more than was exported to NY. In 2008, CO<sub>2</sub> emissions related to net imports of electricity to ISO-NE were 651,589 short tons of CO<sub>2</sub>; in 2009, 2010, 2011, and 2012 CO<sub>2</sub> emissions related to net imports of electricity to ISO-NE were -1,229,274, -1,833,018, 881,419, and 396,832 short tons of CO<sub>2</sub>, respectively, representing the assignment of an increased amount of CO<sub>2</sub> emissions to NYISO for tracking purposes. For 2013, CO<sub>2</sub> emissions related to net imports of electricity to ISO-NE were 2,346,770 as ISO-NE was a net importer of electricity from NYISO in that year.

Compared to the annual average during a multi-year base period of 2006 to 2008, electric generation in 2013 from all non-RGGI electric generation sources serving load in ISO-NE increased by 18.6 million MWh, an increase of 29.6 percent. Compared to the 2006 to 2008 annual average, 2013 CO<sub>2</sub> emissions from this category of electric generation increased by 7.1 million short tons of CO<sub>2</sub>, an increase of 74.9 percent, and the CO<sub>2</sub> emission rate increased by 105 lb CO<sub>2</sub>/MWh, an increase of 35.0 percent.

Compared to the annual average during a multi-year 2006 to 2008 base period, 2013 total electricity load in ISO-NE decreased by 4.0 million MWh, or 3.0 percent. Compared to the 2006 to 2008 annual average, 2013 total electric generation in ISO-NE decreased by 12.0 million MWh, or 9.4 percent.

Compared to the annual average during a multi-year 2006 to 2008 base period, 2013 electric generation from RGGI-affected generation in ISO-NE decreased by 18.8 million MWh, or 26.1 percent, and CO<sub>2</sub> emissions from RGGI-affected generation in ISO-NE decreased by 17.3 million short tons of CO<sub>2</sub>, or 36.6 percent. The CO<sub>2</sub> emission rate of RGGI-affected electric generation decreased by 186 lb CO<sub>2</sub>/MWh, a reduction of 14.3 percent. Compared to the 2006 to 2008 annual average, 2013 electric generation from non-RGGI generation located in ISO-NE increased by 6.8 million MWh, or 12.3 percent, and CO<sub>2</sub> emissions from this category of electric generation increased by 4.7 million short tons of CO<sub>2</sub>, an increase of 49.3 percent. The CO<sub>2</sub> emission rate of non-RGGI electric generation located in ISO-NE increased by 114 lb CO<sub>2</sub>/MWh, an increase of 33.1 percent.

Compared to the annual average during a multi-year 2006 to 2008 base period, 2013 net electricity imports into ISO-NE increased by 11.8 million MWh, or 163.5 percent. CO<sub>2</sub> emissions related to these net electricity imports increased by 2.4 million short tons of CO<sub>2</sub> during this period. The CO<sub>2</sub> emission rate of the electric generation supplying these imports increased by 279 lb CO<sub>2</sub>/MWh.

# NYISO

Monitoring results for NYISO for 2005 through 2013 are summarized below in Table 6 and Figures 16 through 20.

**Table 6. 2005 – 2013 Monitoring Summary for NYISO**

	MWh								
	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Electricity Demand</b>									
Total Annual Electricity Load in NYISO	164,783,642	166,654,413	169,932,177	168,646,767	160,565,962	164,282,144	163,818,485	163,689,994	166,412,302
Net Imports - from Quebec	2,583,317	2,959,749	4,185,292	5,646,014	6,239,805	4,335,209	7,123,204	9,235,689	10,638,017
Net Imports - from ISO-NE	115,000	877,000	2,477,000	1,529,000	3,031,000	4,412,000	2,262,000	1,073,000	-1,322,000
Net Imports - from Ontario	1,898,020	3,672,282	2,637,442	6,162,902	6,463,657	3,872,635	3,318,681	5,749,461	7,593,954
Net Imports - from PJM	7,604,000	9,559,000	10,225,000	10,690,000	8,331,000	12,305,000	11,150,000	8,408,800	9,190,966
Total Net Electricity Imports	12,200,337	17,068,031	19,524,734	24,027,916	24,065,462	24,924,844	23,853,885	24,466,950	26,100,937
<b>Electricity Generation</b>									
Annual Electric Generation - RGGI-Affected Units	67,835,907	66,864,341	71,336,352	64,620,511	56,246,945	62,527,452	59,098,130	61,313,672	59,652,799
Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units	7,029,219	7,322,844	6,648,463	4,618,782	3,750,738	3,686,768	3,252,477	3,736,023	3,963,738
Annual Electric Generation - Non-Fossil Fuel-Fired Units	77,718,179	75,399,197	72,422,628	75,379,558	76,502,817	73,143,080	77,613,993	74,173,349	76,694,828
Annual Electric Generation - All Non-RGGI Units	84,747,398	82,722,041	79,071,091	79,998,340	80,253,555	76,829,848	80,866,470	77,909,372	80,658,566
Total Annual Electric Generation - All Units	152,583,305	149,586,382	150,407,443	144,618,851	136,500,500	139,357,300	139,964,600	139,223,044	140,311,365
<b>Summary CO<sub>2</sub> Emissions and MWh Data</b>									
Annual CO <sub>2</sub> Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	96,947,735	99,790,072	98,595,825	104,026,256	104,319,017	101,754,692	104,720,355	102,376,322	106,759,503
	Tons CO <sub>2</sub>								
	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Electricity Demand</b>									
Total Annual Electricity Load in NYISO	74,758,807	69,801,554	71,541,362	63,042,975	48,470,507	55,483,666	48,209,039	44,664,635	42,551,110
Net Imports - from Quebec	10,536	13,050	13,794	15,559	24,074	11,947	17,274	29,524	34,007
Net Imports - from ISO-NE	55,282	398,599	1,118,781	651,589	1,229,274	1,833,018	881,419	396,832	-521,693
Net Imports - from Ontario	460,286	769,120	604,715	1,154,884	712,496	554,950	336,556	602,081	795,236
Net Imports - from PJM	4,912,184	5,983,934	6,349,725	6,520,900	4,736,174	7,179,968	6,389,108	4,212,809	4,871,212
Total Net Electricity Imports	5,438,288	7,164,703	8,087,015	8,342,933	6,702,017	9,579,883	7,624,358	5,241,245	5,178,761
<b>Electricity Generation</b>									
Annual Electric Generation - RGGI-Affected Units	62,718,683	53,638,129	55,717,151	48,348,177	37,861,408	42,113,171	37,137,382	35,417,901	33,607,796
Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units	5,933,822	6,319,357	5,430,598	2,676,684	1,931,753	1,944,024	1,683,269	2,008,494	1,485,213
Annual Electric Generation - Non-Fossil Fuel-Fired Units	668,014	2,679,365	2,306,598	3,675,181	1,975,329	1,846,589	1,764,030	1,996,995	2,279,339
Annual Electric Generation - All Non-RGGI Units	6,601,836	8,998,722	7,737,196	6,351,865	3,907,082	3,790,613	3,447,299	4,005,489	3,764,552
Total Annual Electric Generation - All Units	69,320,519	62,636,851	63,454,347	54,700,042	41,768,490	45,903,784	40,584,681	39,423,389	37,372,349
<b>Summary CO<sub>2</sub> Emissions and MWh Data</b>									
Annual CO <sub>2</sub> Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	12,040,124	16,163,425	15,824,211	14,694,798	10,609,099	13,370,495	11,071,657	9,246,734	8,943,313
	Lb CO <sub>2</sub> /MWh								
	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Electricity Demand</b>									
Total Annual Electricity Load in NYISO	907	838	842	748	604	675	589	546	511
Net Imports - from Quebec	8	9	7	6	8	6	5	6	6
Net Imports - from ISO-NE	961	909	903	852	811	831	779	740	789
Net Imports - from Ontario	485	419	459	375	220	287	203	209	209
Net Imports - from PJM	1,292	1,252	1,242	1,220	1,137	1,167	1,146	1,002	1,060
Total Net Electricity Imports	891	840	828	694	557	769	639	428	397
<b>Electricity Generation</b>									
Annual Electric Generation - RGGI-Affected Units	1,849	1,604	1,562	1,496	1,346	1,347	1,257	1,155	1,127
Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units	1,688	1,726	1,634	1,159	1,030	1,055	1,035	1,075	749
Annual Electric Generation - Non-Fossil Fuel-Fired Units	17	71	64	98	52	50	45	54	59
Annual Electric Generation - All Non-RGGI Units	156	218	196	159	97	99	85	103	93
Total Annual Electric Generation - All Units	909	837	844	756	612	659	580	566	533
<b>Summary CO<sub>2</sub> Emissions and MWh Data</b>									
Annual CO <sub>2</sub> Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	248	324	321	283	203	263	211	181	168

The monitoring results indicate that the 2011 to 2013 annual average compared to the 2006 to 2008 base period annual average, total electric generation from all non-RGGI electric generation serving load in NYISO increased by 3.8 million

MWh, an increase of 3.8 percent. From the 2006 to 2008 base period annual average to the 2011 to 2013 annual average, CO<sub>2</sub> emissions from this category of electric generation decreased by 5.8 million short tons of CO<sub>2</sub>, a decrease of 37.3 percent, and the CO<sub>2</sub> emission rate decreased by 122 lb CO<sub>2</sub>/MWh, a decrease of 39.6 percent. (See Figures 16, 17, and 18.)

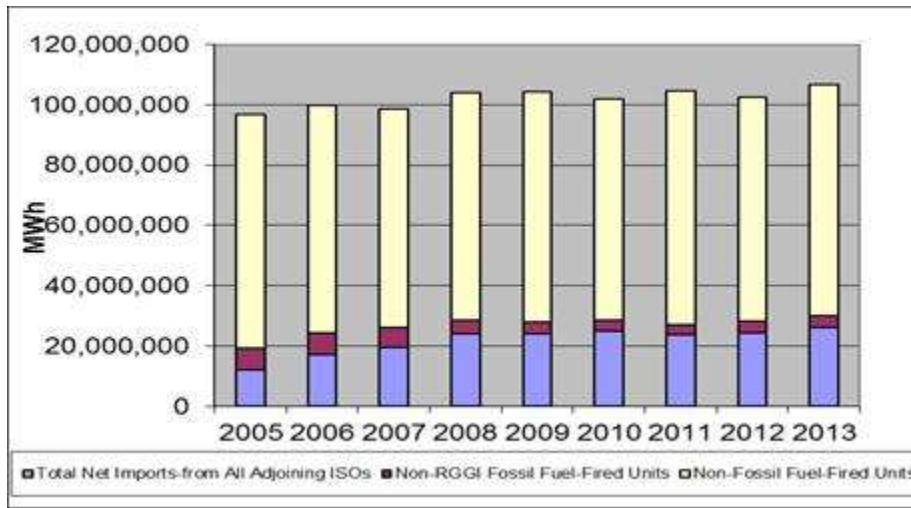


Figure 16. Non-RGGI Generation Serving Load in NYISO (MWh)

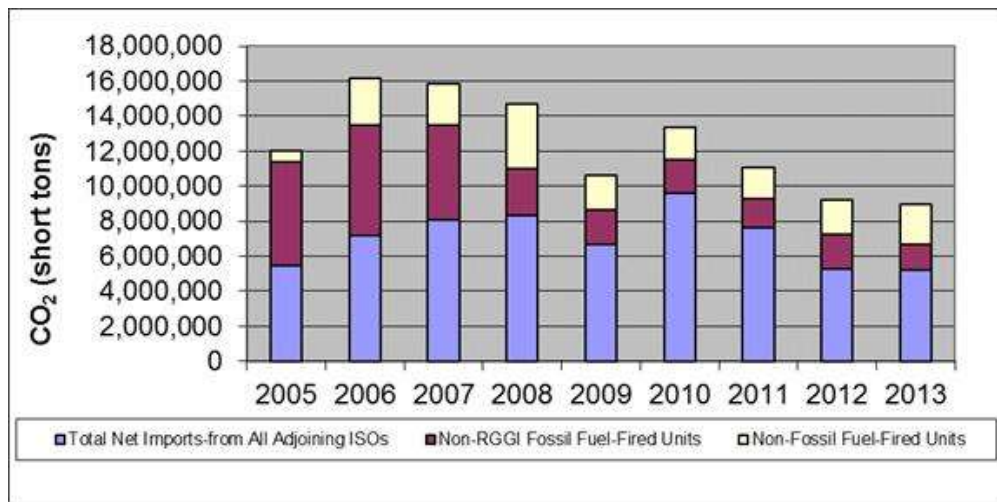
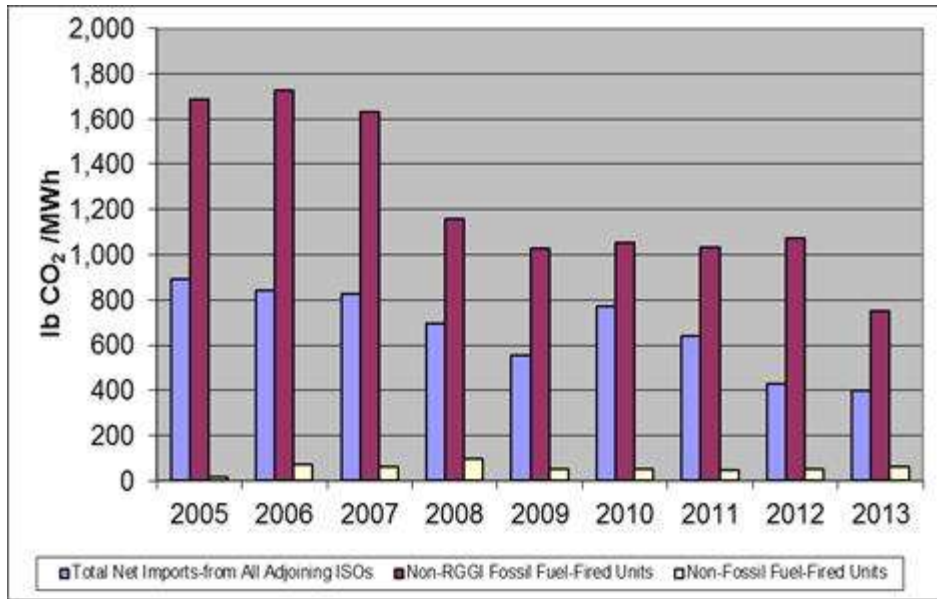


Figure 17. CO<sub>2</sub> Emissions from Non-RGGI Generation Serving Load in NYISO (short tons CO<sub>2</sub>)

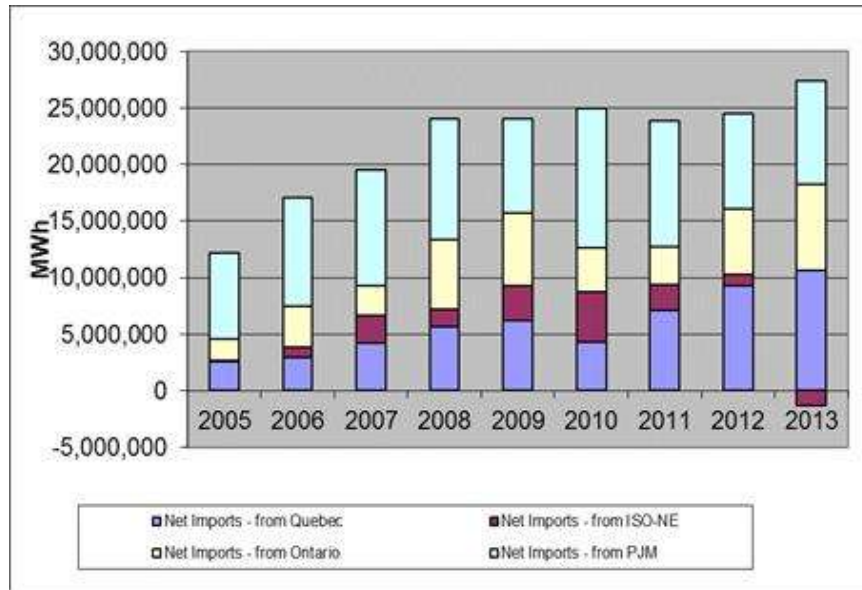


**Figure 18. CO<sub>2</sub> Emission Rate for Non-RGGI Generation Serving Load in NYISO (lb CO<sub>2</sub>/MWh)**

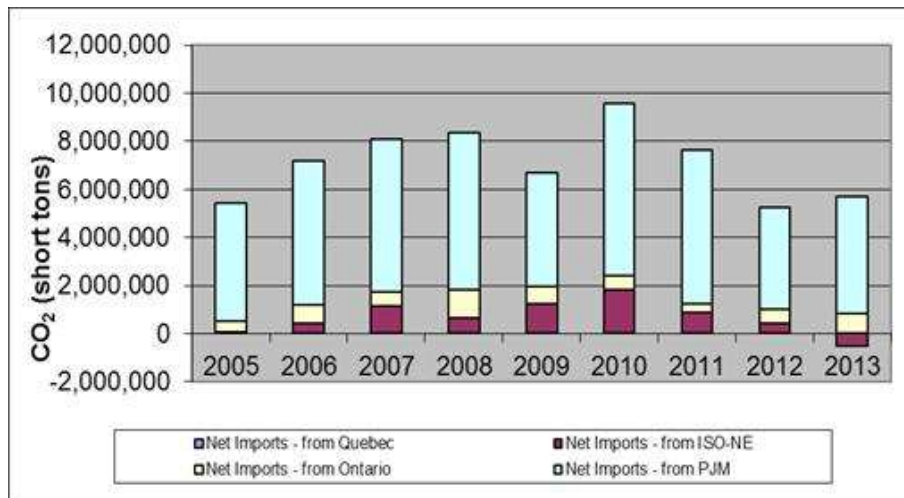
The annual average electricity load in NYISO decreased by 3.8 million MWh, or 2.2 percent for 2011 to 2013 as compared to the annual average from the baseline period of 2006 to 2008. In total, electric generation (fossil and non-fossil) in NYISO decreased by 8.4 million MWh, or 5.6 percent, when comparing the 2006 to 2008 annual average to the 2011 to 2013 annual average.

Electric generation from RGGI-affected generation in NYISO decreased by 7.6 million MWh during this period, or 11.2 percent, and CO<sub>2</sub> emissions from RGGI-affected electric generation in NYISO decreased by 17.2 million short tons of CO<sub>2</sub>, or 32.7 percent. The CO<sub>2</sub> emission rate of RGGI-affected electric generation decreased by 375 lb CO<sub>2</sub>/MWh, a reduction of 24.1 percent. Electric generation from non-RGGI electric generation sources located in NYISO decreased by 785.7 thousand MWh, or 1.0 percent, during this period, and CO<sub>2</sub> emissions from this category of electric generation decreased by 4.0 million short tons of CO<sub>2</sub>, a decrease of 51.4 percent. The CO<sub>2</sub> emission rate of non-RGGI electric generation located in NYISO decreased by 97 lb CO<sub>2</sub>/MWh, a decrease of 50.8 percent.

Net electricity imports into NYISO increased by 4.6 million MWh, or 22.8 percent, when comparing the base period annual average from 2006 to 2008 to the annual average from 2011 to 2013. CO<sub>2</sub> emissions related to these net electricity imports decreased by 3.4 million short tons of CO<sub>2</sub>, or 42.6 percent, during this period. The CO<sub>2</sub> emission rate of the electric generation supplying these imports decreased by 299 lb CO<sub>2</sub>/MWh, a decrease of 38.0 percent. (See figures 19 and 20).



**Figure 19. Net Electricity Imports to NYISO (MWh)**



**Figure 20. CO<sub>2</sub> Emissions Related to Net Electricity Imports to NYISO (short tons CO<sub>2</sub>)**

Compared to the annual average during a multi-year base period of 2006 to 2008, electric generation in 2013 from all non-RGGI electric generation sources serving load in NYISO increased by 6.0 million MWh, an increase of 5.9 percent. Compared to the 2006 to 2008 annual average, 2013 CO<sub>2</sub> emissions from this category of electric generation decreased by 6.6 million short tons of CO<sub>2</sub>, a reduction of 42.5 percent, and the CO<sub>2</sub> emission rate decreased by 141.2 lb CO<sub>2</sub>/MWh, a reduction of 45.7 percent.

Compared to the annual average during a multi-year 2006 to 2008 base period, 2013 total electricity load in NYISO decreased by 2.0 million MWh, or 1.2



percent. Compared to the 2006 to 2008 annual average, total electric generation in 2013 in NYISO decreased by 7.9 million MWh, or 5.3 percent.

Compared to the annual average during a multi-year 2006 to 2008 base period, 2013 electric generation from RGGI-affected generation in NYISO decreased by 8.0 million MWh, or 11.8 percent, and CO<sub>2</sub> emissions from RGGI-affected generation in NYISO decreased by 19.0 million short tons of CO<sub>2</sub>, a reduction of 36.1 percent. The CO<sub>2</sub> emission rate of RGGI-affected electric generation decreased by 428 lb CO<sub>2</sub>/MWh, a reduction of 27.5 percent. Compared to the 2006 to 2008 annual average, 2013 electric generation from non-RGGI generation located in NYISO increased by 61.4 thousand MWh, or 0.1 percent, and CO<sub>2</sub> emissions from this category of electric generation decreased by 3.9 million short tons of CO<sub>2</sub>, a reduction of 51.1 percent. The CO<sub>2</sub> emission rate of non-RGGI electric generation located in NYISO decreased by 97 lb CO<sub>2</sub>/MWh, a reduction of 50.8 percent.

Compared to the annual average during a multi-year 2006 to 2008 base period, 2013 net electricity imports into NYISO increased by 5.9 million MWh, or 29.2 percent. CO<sub>2</sub> emissions related to these net electricity imports decreased by 2.7 million short tons of CO<sub>2</sub>, or 34.2 percent. The CO<sub>2</sub> emission rate of the electric generation supplying these imports decreased by 391 lb CO<sub>2</sub>/MWh, a reduction of 49.6 percent.



### **PJM (RGGI Portion)**

Monitoring results for PJM for 2005 through 2013 are summarized below in Table 7 and Figures 18 through 22. Note that for PJM, the data presented below is for the RGGI geographic portion of PJM (Delaware and Maryland referred to below as “RGGI PJM”). Net “imports” represent inferred flows of electricity from the non-RGGI geographic portion of PJM (Non-RGGI PJM) to the RGGI geographic portion of PJM (RGGI PJM) to make up for shortfalls in electric generation relative to total electricity load for this subset of PJM.<sup>33</sup>

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<sup>33</sup> This data is compiled from PJM GATS, which reports data for both the non-RGGI and RGGI geographic portions of PJM. Inferred net imports are based on total MWh load in the RGGI geographic portion of PJM minus total electric generation in the RGGI geographic portion of PJM. Any shortfall in generation relative to load is assumed to be met through an inferred “import” of electricity from the non-RGGI geographic portion of PJM into the RGGI geographic portion of PJM.

**Table 7. 2005 – 2013 Monitoring Summary for RGGI PJM**

	MWh								
	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Electricity Demand</b>									
Total Annual Electricity Load in ISO	90,177,482	84,096,149	84,442,034	80,387,398	79,481,311	82,485,086	80,738,794	78,802,312	77,458,942
Net Imports - from Non-RGGI PJM	31,878,151	30,716,157	28,944,540	28,386,914	33,089,871	35,142,720	34,250,993	34,442,085	35,843,247
Net Imports - from NYISO	-636,765	-721,101	-772,843	-772,644	-570,096	-815,714	-697,456	-482,148	-490,493
Total Net Electricity Imports - from All Adjoining ISOs	31,241,386	29,995,056	28,171,697	27,614,270	32,519,775	34,327,006	33,553,537	33,959,937	35,352,754
<b>Electricity Generation</b>									
Annual Electric Generation - RGGI-Affected Units	41,472,196	37,230,890	39,254,875	35,340,119	29,732,886	31,641,822	28,980,019	28,350,888	24,775,215
Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units	393,587	267,732	298,635	150,718	147,837	129,655	216,967	190,940	81,428
Annual Electric Generation - Non-Fossil Fuel-Fired Units	17,070,313	16,602,471	16,716,827	17,282,291	17,080,813	16,386,603	17,988,271	16,300,547	17,249,545
Annual Electric Generation - All Non-RGGI Units	17,463,900	16,870,203	17,015,462	17,433,009	17,228,650	16,516,258	18,205,238	16,491,487	17,330,973
Total Annual Electric Generation - All Units	58,936,096	54,101,093	56,270,337	52,773,128	46,961,536	48,158,080	47,185,257	44,842,375	42,106,188
<b>Summary CO<sub>2</sub> Emissions and MWh Data</b>									
Annual CO <sub>2</sub> Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	48,705,286	46,865,259	45,187,159	45,047,279	49,748,425	50,843,264	28,980,019	28,350,888	24,775,215
	Tons CO <sub>2</sub>								
	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Electricity Demand</b>									
Total Annual Electricity Load in ISO	63,407,937	58,224,181	59,369,215	54,585,448	48,909,286	53,575,513	49,662,062	45,342,236	43,873,524
Net Imports - from Non-RGGI PJM	20,408,108	19,059,750	17,766,431	17,172,335	18,682,706	20,361,849	19,504,235	18,627,737	19,867,713
Net Imports - from NYISO	-469,658	-529,065	-579,349	-555,899	-371,449	-572,275	-452,458	-290,358	-282,938
Total Net Electricity Imports - from All Adjoining ISOs	19,938,450	18,530,684	17,187,082	16,616,436	18,311,256	19,789,574	19,051,778	18,337,379	19,584,774
<b>Electricity Generation</b>									
Annual Electric Generation - RGGI-Affected Units	42,345,258	38,502,576	40,637,296	36,518,184	29,281,274	32,258,228	28,850,034	25,436,501	22,968,475
Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units	284,222	206,808	221,499	152,927	147,125	129,412	171,564	212,964	101,584
Annual Electric Generation - Non-Fossil Fuel-Fired Units	840,007	984,113	1,323,338	1,297,901	1,169,631	1,398,299	1,588,686	1,355,392	1,218,691
Annual Electric Generation - All Non-RGGI Units	1,124,229	1,190,921	1,544,837	1,450,828	1,316,756	1,527,711	1,760,250	1,568,356	1,320,275
Total Annual Electric Generation - All Units	43,469,487	39,693,497	42,182,133	37,969,012	30,598,030	33,785,939	30,610,284	27,004,857	24,288,750
<b>Summary CO<sub>2</sub> Emissions and MWh Data</b>									
Annual CO <sub>2</sub> Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	21,062,679	19,721,605	18,731,919	18,067,264	19,628,012	21,317,285	28,850,034	25,436,501	22,968,475
	Lb CO <sub>2</sub> /MWh								
	2005	2006	2007	2008	2009	2010	2011	2012	2013
<b>Electricity Demand</b>									
Total Annual Electricity Load in ISO	1,406	1,385	1,406	1,358	1,231	1,299	1,230	1,151	1,133
Net Imports - from Non-RGGI PJM	1,280	1,241	1,228	1,210	1,129	1,159	1,139	1,082	1,109
Net Imports - from NYISO	1,475	1,467	1,499	1,439	1,303	1,403	1,297	1,204	1,154
Total Net Electricity Imports - from All Adjoining ISOs	1,276	1,236	1,220	1,203	1,126	1,153	1,136	1,080	1,108
<b>Electricity Generation</b>									
Annual Electric Generation - RGGI-Affected Units	2,042	2,068	2,070	2,067	1,970	2,039	1,991	1,794	1,854
Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units	1,444	1,545	1,483	2,029	1,990	1,996	1,581	2,231	2,495
Annual Electric Generation - Non-Fossil Fuel-Fired Units	98	119	158	150	137	171	177	166	141
Annual Electric Generation - All Non-RGGI Units	129	141	182	166	153	185	193	190	152
Total Annual Electric Generation - All Units	1,475	1,467	1,499	1,439	1,303	1,403	1,297	1,204	1,154
<b>Summary CO<sub>2</sub> Emissions and MWh Data</b>									
Annual CO <sub>2</sub> Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	865	842	829	802	789	839	1,991	1,794	1,854

The monitoring results indicate that the 2011 to 2013 annual average compared to the 2006 to 2008 base period annual average, total electric generation from all non-RGGI electric generation serving load in PJM increased by 5.9 million MWh, an increase of 13.0 percent. From the 2006 to 2008 base period annual average to the 2011 to 2013 annual average, CO<sub>2</sub> emissions from this category of electric

generation increased by 1.7 million short tons of CO<sub>2</sub>, an increase of 9.0 percent, and the CO<sub>2</sub> emission rate decreased by 28.9 lb CO<sub>2</sub>/MWh, an decrease of 3.5 percent. (See Figures 21, 22, and 23).

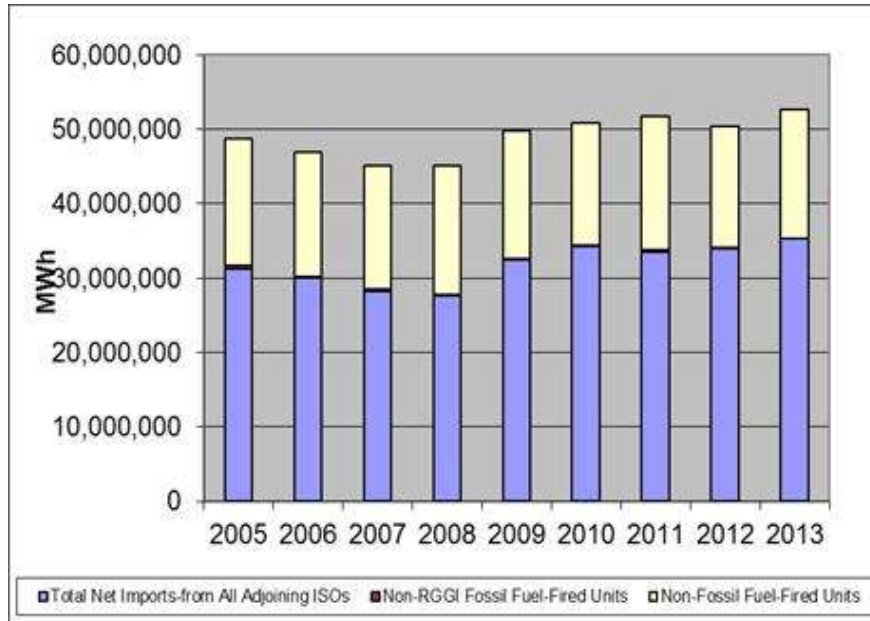


Figure 21. Non-RGGI Generation Serving Load in RGGI PJM (MWh)

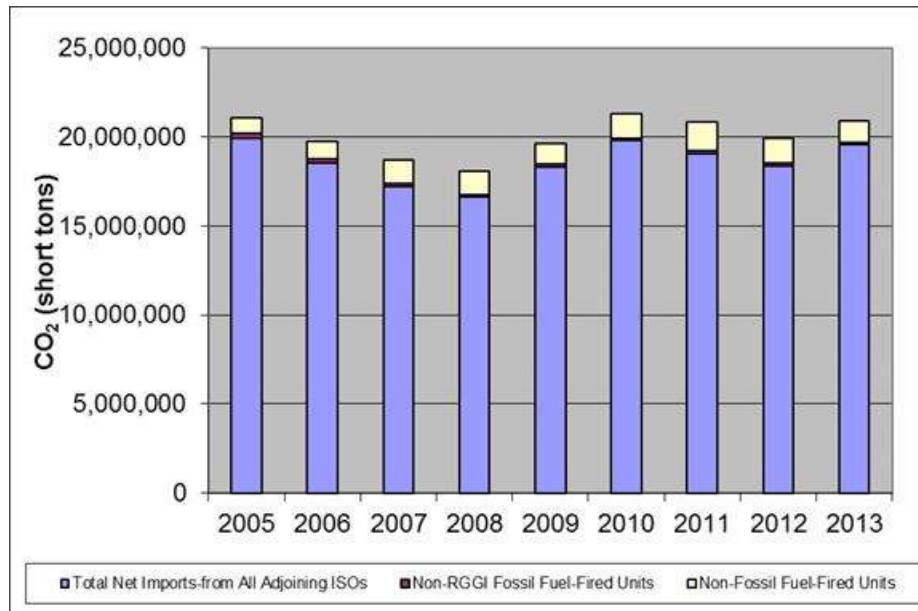
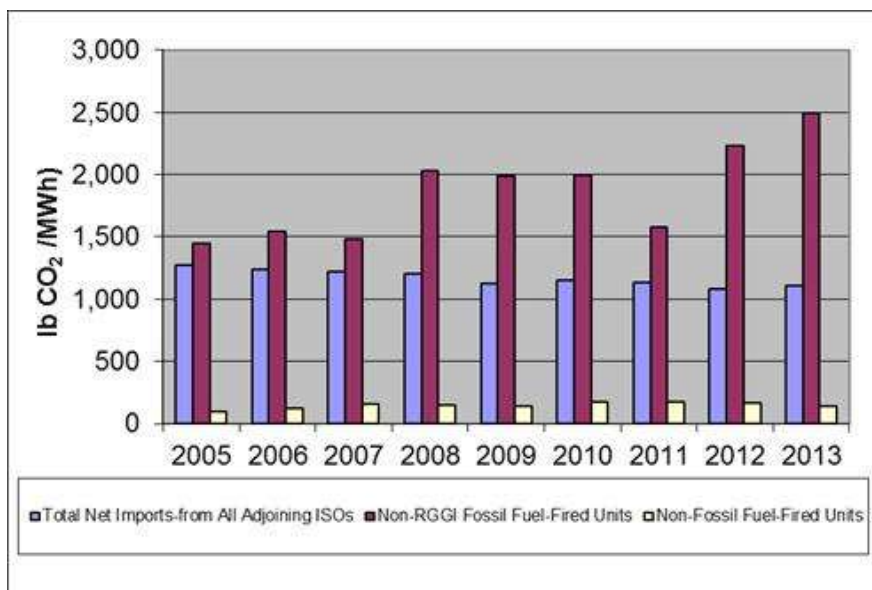


Figure 22. CO<sub>2</sub> Emissions from Non-RGGI Generation Serving Load in RGGI PJM (short tons CO<sub>2</sub>)

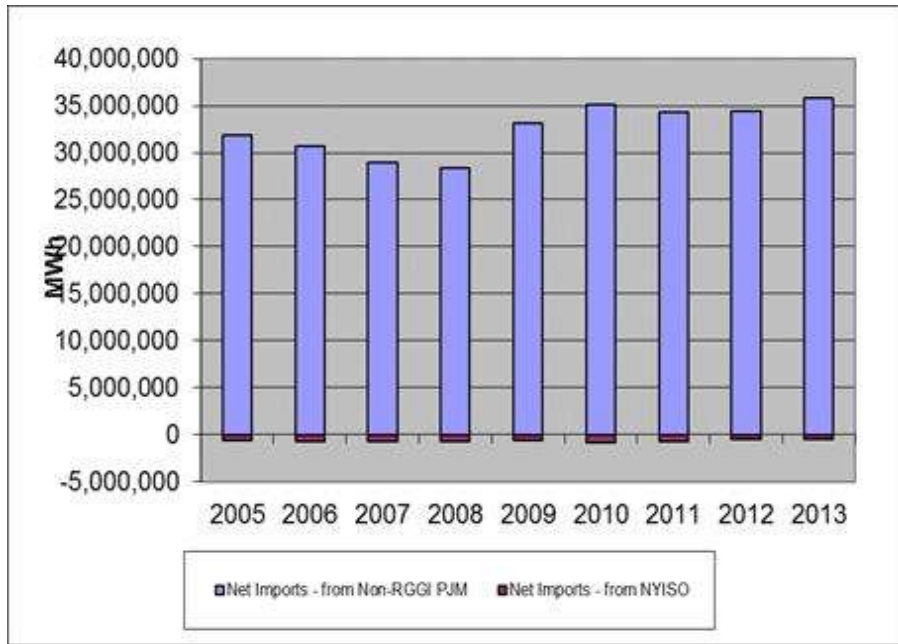


**Figure 23. CO<sub>2</sub> Emission Rate for Non-RGGI Generation Serving Load in RGGI PJM (lb CO<sub>2</sub>/MWh)**

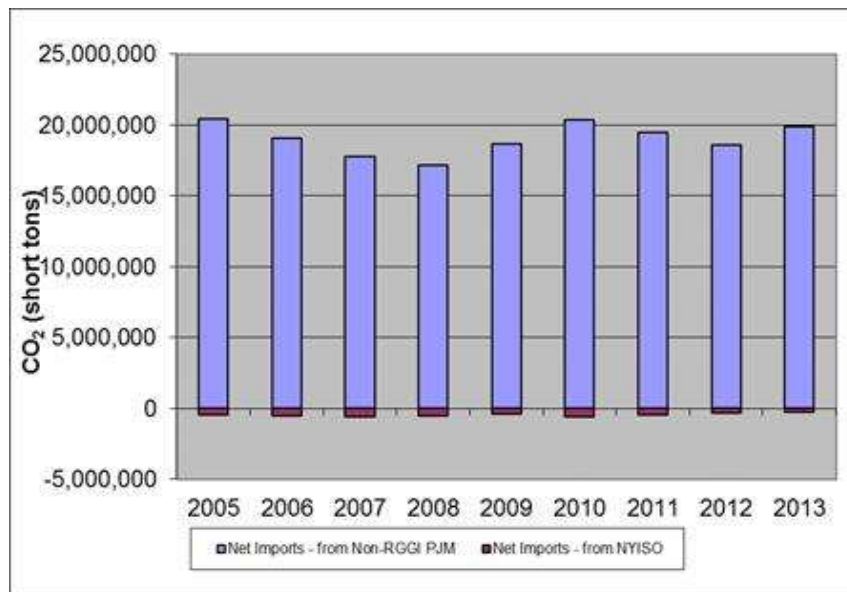
The annual average electricity load in PJM decreased by 4.0 million MWh, or 4.8 percent for 2011 to 2013 as compared to the annual average from the baseline period of 2006 to 2008. In total, electric generation (fossil and non-fossil) in PJM decreased by 9.7 million MWh, or 17.8 percent, when comparing the 2006 to 2008 annual average to the 2011 to 2013 annual average.

Electric generation from RGGI-affected generation in PJM decreased by 9.9 million MWh during this period, or 26.6 percent, and CO<sub>2</sub> emissions from RGGI-affected electric generation in PJM decreased by 12.8 million short tons of CO<sub>2</sub>, or 33.2 percent. The CO<sub>2</sub> emission rate of RGGI-affected electric generation decreased by 189 lb CO<sub>2</sub>/MWh, a reduction of 9.1 percent. Electric generation from non-RGGI electric generation sources located in PJM increased by 236.3 thousand MWh, or 1.4 percent, during this period, and CO<sub>2</sub> emissions from this category of electric generation increased by 154.1 thousand short tons of CO<sub>2</sub>, an increase of 11.0 percent. The CO<sub>2</sub> emission rate of non-RGGI electric generation located in PJM increased by 16 lb CO<sub>2</sub>/MWh, an increase of 9.6 percent.

Net electricity imports into PJM increased by 5.7 million MWh, or 19.9 percent, when comparing the base period annual average from 2006 to 2008 to the annual average from 2011 to 2013. CO<sub>2</sub> emissions related to these net electricity imports increased by 1.5 million short tons of CO<sub>2</sub>, or 8.9 percent, during this period. The CO<sub>2</sub> emission rate of the electric generation supplying these imports decreased by 112 lb CO<sub>2</sub>/MWh, a decrease of 9.2 percent. (See Figures 24 and 25).



**Figure 24. Net Electricity Imports to RGGI PJM (MWh)**



**Figure 25. CO<sub>2</sub> Emissions Related to Net Electricity Imports to RGGI PJM (short tons CO<sub>2</sub>)**

Compared to the annual average during a multi-year base period of 2006 to 2008, electric generation in 2013 from all non-RGGI electric generation sources serving load in RGGI PJM increased by 7.0 million MWh, an increase of

15.3 percent. Compared to the 2006 to 2008 annual average, 2013 CO<sub>2</sub> emissions from this category of electric generation increased by 2.1 million short tons of CO<sub>2</sub>, an increase of 11.0 percent, and the CO<sub>2</sub> emission rate decreased by 30.9 lb CO<sub>2</sub>/MWh, a reduction of 3.7 percent.

Compared to the annual average during a multi-year 2006 to 2008 base period, 2013 total electricity load in RGGI PJM decreased by 5.5 million MWh, or 6.6 percent. Compared to the 2006 to 2008 annual average, total electric generation in RGGI PJM decreased by 12.3 million MWh, or 22.6 percent.

Compared to the annual average during a multi-year 2006 to 2008 base period, 2013 electric generation from RGGI-affected generation in RGGI PJM decreased by 12.5 million MWh, or 33.5 percent, and CO<sub>2</sub> emissions from RGGI-affected generation in RGGI PJM decreased by 15.6 million short tons of CO<sub>2</sub>, or 40.4 percent. The CO<sub>2</sub> emission rate of RGGI-affected electric generation decreased by 214 lb CO<sub>2</sub>/MWh, a reduction of 10.4 percent. Compared to the 2006 to 2008 annual average, 2013 electric generation from non-RGGI generation located in RGGI PJM increased by 224.7 thousand MWh, or 1.3 percent, and CO<sub>2</sub> emissions from this category of electric generation decreased by 75.3 thousand short tons of CO<sub>2</sub>, a decrease of 5.4 percent. The CO<sub>2</sub> emission rate of non-RGGI electric generation located in RGGI PJM decreased by 11 lb CO<sub>2</sub>/MWh, a decrease of 6.6 percent.

Compared to the annual average during a multi-year 2006 to 2008 base period, 2013 net electricity imports into RGGI PJM increased by 6.8 million MWh, or 23.6 percent. CO<sub>2</sub> emissions related to these net electricity imports increased by 2.1 million short tons of CO<sub>2</sub>, or 12.3 percent, during this period, indicating a reduction in the average CO<sub>2</sub> emission rate of the electric generation supplying these imports of 112 lb CO<sub>2</sub>/MWh, a reduction of 9.2 percent.

## Appendix C. Monitoring Trends

Detailed monitoring trends for the 9-State RGGI Region, ISO-NE, NYISO, and the RGGI portion of PJM are presented in Tables 8 through 11. The tables summarize the comparison between the 2006 to 2008 base period and the three years of program operation, 2011 to 2013.

### 9-State RGGI Region

**Table 8. Monitoring Trends for 9-State RGGI Region**

	Non-RGGI Generation			RGGI Generation			Imports			Total Non-RGGI Generation (ISO + Net Imports)		
	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh
2006-2008	153,362,597	18,650,769	243	177,165,152	138,362,771	1,561	55,997,235	25,224,000	904	209,359,832	43,874,769	419
2011-2013	154,585,598	17,852,815	231	149,184,319	93,395,465	1,252	73,012,667	25,786,464	709	227,598,265	43,639,279	383
<b>Difference</b>	1,223,001	-797,954	-12	-27,980,833	-44,967,307	-310	17,015,432	562,465	-196	18,238,433	-235,489	-35.7
<b>% change</b>	0.8%	-4.3%	-5.0%	-15.8%	-32.5%	-19.8%	30.4%	2.2%	-21.6%	8.7%	-0.5%	-8.5%
	<b>In-Region Generation (MWh)</b>		<b>Total In-Region Load (MWh)</b>									
2006-2008	330,527,749		386,423,646									
2011-2013	303,769,917		374,087,943									
<b>Difference</b>	-26,757,832		-12,335,703									
<b>% change</b>	-8.1%		-3.2%									

	Non-RGGI Generation			RGGI Generation			Imports			Total Non-RGGI Generation (ISO + Net Imports)		
	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh
2006-2008	153,362,597	18,650,769	243	177,165,152	138,362,771	1,561	55,997,235	25,224,000	904	209,359,832	43,874,769	419
2013	160,492,759	19,357,783	231	137,862,378	86,517,389	1,255	80,414,691	27,241,280	678	240,907,450	46,599,063	387
<b>Difference</b>	7,130,162	707,014	-2	-39,302,774	-51,845,382	-306	24,417,457	2,017,281	-227	31,547,618	2,724,294	-32
<b>change</b>	4.6%	3.8%	-0.7%	-22.2%	-37.5%	-19.6%	43.6%	8.0%	-25.1%	15.1%	6.2%	-7.7%
	<b>In-Region Generation (MWh)</b>		<b>Total In-Region Load (MWh)</b>									
2006-2008	330,527,749		386,423,646									
2013	298,355,137		374,872,244									
<b>Difference</b>	-32,172,612		-11,551,402									
<b>% change</b>	-9.7%		-3.0%									

**ISO-NE**

**Table 9. Monitoring Trends for ISO-NE**

	Non-RGGI Generation			RGGI Generation			Imports			Total Non-RGGI Generation (ISO + Net Imports)		
	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh
2006-2008	55,659,215	9,559,313	343	72,282,789	47,242,267	1,307	7,196,667	-117,282	-42	62,855,882	9,442,031	300
2011-2013	57,431,563	12,564,074	437	61,794,078	32,256,102	1,049	13,917,000	575,526	46	71,348,563	13,139,600	366
<b>Difference</b>	-1,772,348	3,004,762	94	-10,488,711	-14,986,165	-258	6,720,333	692,807	88.10	8,492,681	3,697,569	65
<b>% change</b>	-3.2%	31.4%	27.4%	-14.5%	-31.7%	-19.8%	93.4%	<sup>34</sup>	<sup>35</sup>	13.5%	39.2%	21.7%
	<b>In-Region Generation (MWh)</b>		<b>Total In-Region Load (MWh)</b>									
2006-2008	127,942,004		135,037,333									
2011-2013	119,225,641		130,447,667									
<b>Difference</b>	-8,716,363		-4,589,667									
<b>% change</b>	-6.8%		-3.4%									

	Non-RGGI Generation			RGGI Generation			Imports			Total Non-RGGI Generation (ISO + Net Imports)		
	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh
2006-2008	55,659,215	9,559,313	343	72,282,789	47,242,267	1,307	7,196,667	-117,282	-42	62,855,882	9,442,031	300
2013	62,503,220	14,272,956	457	53,434,364	29,941,118	1,121	18,961,000	2,243,394	237	81,464,220	16,516,350	405
<b>Difference</b>	6,844,005	4,713,643	114	-18,848,425	-17,307,149	-186	11,764,333	2,360,676	279	18,608,338	7,074,319	105
<b>% change</b>	12.3%	49.3%	33.1%	-26.1%	-36.6%	-14.3%	163.5%	<sup>36</sup>	<sup>37</sup>	29.6%	74.9%	35.0%
	<b>In-Region Generation (MWh)</b>		<b>Total In-Region Load (MWh)</b>									
2006-2008	127,942,004		135,037,333									
2013	115,937,584		131,001,000									
<b>Difference</b>	-12,004,420		-4,036,333									
<b>% change</b>	-9.4%		-3.0%									

<sup>34</sup> ISONE changed from a net exporter to a net importer from NY during the 2011-2013 time period. This percent change was not reconciled.

<sup>35</sup> See footnote 34

<sup>36</sup> See footnote 34

<sup>37</sup> See footnote 34



**NYISO**

**Table 10. Monitoring Trends for NYISO**

	Non-RGGI Generation			RGGI Generation			Imports			Total Non-RGGI Generation (ISO + Net Imports)		
	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh
2006-2008	80,597,157	7,695,928	191	67,607,068	52,567,819	1,554	20,206,894	7,864,883	787	100,804,051	15,560,811	309
2011-2013	79,811,469	3,739,113	94	60,021,534	35,387,693	1,180	24,807,257	4,511,091	488	104,618,727	9,753,901	187
<b>Difference</b>	-785,688	-3,956,814	-97	-7,585,534	-17,180,126	-375	4,600,364	-3,353,792	-299	3,814,676	-5,806,910	122
<b>% change</b>	-1.0%	-51.4%	-50.8%	-11.2%	-32.7%	-24.1%	22.8%	-42.6%	-38.0%	3.8%	-37.3%	-39.6%
	<b>In-Region Generation (MWh)</b>		<b>Total In-Region Load (MWh)</b>									
2006-2008	148,204,225		168,411,119									
2011-2013	139,833,003		164,640,260									
<b>Difference</b>	-8,371,222		-3,770,859									
<b>% change</b>	-5.6%		-2.2%									

	Non-RGGI Generation			RGGI Generation			Imports			Total Non-RGGI Generation (ISO + Net Imports)		
	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh
2006-2008	80,597,157	7,695,928	191	67,607,068	52,567,819	1,554	20,206,894	7,864,883	787	100,804,051	15,560,811	309
2013	80,658,566	3,764,552	93	59,652,799	33,607,796	1,127	26,100,937	5,178,761	397	106,759,503	8,943,313	168
<b>Difference</b>	61,409	-3,931,375	-97	-7,954,269	-18,960,023	-428	5,894,043	-2,686,122	-391	5,955,452	-6,617,498	-141.2
<b>% change</b>	0.1%	-51.1%	-51.0%	-11.8%	-36.1%	-27.5%	29.2%	-34.2%	-49.6%	5.9%	-42.5%	-45.7%
	<b>In-Region Generation (MWh)</b>		<b>Total In-Region Load (MWh)</b>									
2006-2008	148,204,225		168,411,119									
2013	140,311,365		166,412,302									
<b>Difference</b>	-7,892,860		-1,998,817									
<b>% change</b>	-5.3%		-1.2%									

**RGGI-PJM**

**Table 11. Monitoring Trends for RGGI-PJM**

	Non-RGGI Generation			RGGI Generation			Imports			Total Non-RGGI Generation (ISO + Net Imports)		
	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh
2006-2008	17,106,225	1,395,529	163	37,275,295	38,552,685	2,068	28,593,674	17,444,734	1,220	45,699,899	18,840,263	825
2011-2013	17,342,566	1,549,627	179	27,368,707	25,751,670	1,880	34,288,743	18,991,310	1,108	51,631,309	20,540,937	796
<b>Difference</b>	236,341	154,098	16	-9,906,587	-12,801,015	-189	5,695,068	1,546,576	-112	5,931,410	1,700,675	-28.9
<b>% change</b>	1.4%	11.0%	9.6%	-26.6%	-33.2%	-9.1%	19.9%	8.9%	-9.2%	13.0%	9.0%	-3.5%
	<b>In-Region Generation (MWh)</b>		<b>Total In-Region Load (MWh)</b>									
2006-2008	54,381,519		82,975,194									
2011-2013	44,711,273		79,000,016									
<b>Difference</b>	-9,670,246		-3,975,178									
<b>% change</b>	-17.8%		-4.8%									

	Non-RGGI Generation			RGGI Generation			Imports			Total Non-RGGI Generation (ISO + Net Imports)		
	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh	MWh	CO <sub>2</sub> Emissions	lb CO <sub>2</sub> /MWh
2006-2008	17,106,225	1,395,529	163	37,275,295	38,552,685	2,068	28,593,674	17,444,734	1,220	45,699,899	18,840,263	825
2013	17,330,973	1,320,275	152	24,775,215	22,968,475	1,854	35,352,754	19,584,774	1,108	52,683,727	20,905,049	794
<b>Difference</b>	224,748	-75,254	-11	-12,500,080	-15,584,211	-214	6,759,080	2,140,040	-112	6,983,828	2,064,786	-31
<b>% change</b>	1.3%	-5.4%	-6.6%	-33.5%	-40.4%	-10.4%	23.6%	12.3%	-9.2%	15.3%	11.0%	-3.7%
	<b>In-Region Generation (MWh)</b>		<b>Total In-Region Load (MWh)</b>									
2006-2008	54,381,519		82,975,194									
2013	42,106,188		77,458,942									
<b>Difference</b>	-12,275,331		-5,516,251									
<b>% change</b>	-22.6%		-6.6%									

## **Appendix D. Concept of “Emissions Leakage”**

“Emissions leakage” is the concept that the RGGI CO<sub>2</sub> compliance obligation and related CO<sub>2</sub> compliance costs for electric generators could result in a shift of electricity generation from CO<sub>2</sub>-emitting sources subject to the RGGI CO<sub>2</sub> Budget Trading Program to CO<sub>2</sub>-emitting sources not subject to RGGI. Key to this concept is that the cause of such a shift would be due to the RGGI CO<sub>2</sub> Budget Trading Program, rather than other factors that influence electric power sector CO<sub>2</sub> emissions. The concept of emissions leakage presumes that an increase in electricity production costs for certain electric generators due to RGGI CO<sub>2</sub> compliance costs would be the driver of changes in the operation of the electric power system that result in an increase in CO<sub>2</sub> emissions from electric generation that is not subject to the RGGI CO<sub>2</sub> Budget Trading Program.

### **Factors that Influence Electric Generator Dispatch and CO<sub>2</sub> Emissions**

In the Northeast and Mid-Atlantic, electric generation is deregulated and subject to competitive wholesale electricity markets. In the simplest terms, wholesale electricity markets are used to determine which power plants run to meet electricity demand and determine the wholesale price of electricity. Electric generators bid into day-ahead and real-time auctions for generation supply, in which the lowest priced plants are selected one by one until electricity demand is met. The last plant selected, or “dispatched,” to meet demand is referred to as the marginal unit, and sets the wholesale clearing price. A number of elements factor in to the bid offers made by individual electric generators, including fuel prices, operation and maintenance costs, and environmental compliance costs. For this latter category, certain environmental compliance costs are represented by the market value of emissions allowances, such as CO<sub>2</sub>, NO<sub>x</sub>, and SO<sub>2</sub> allowances. The market value of these emission allowances influences the production costs of individual electric generators in a similar manner as fuel costs, and therefore play a role in influencing the dispatch of electric generators and the wholesale market clearing price of electricity.

In addition to the production costs of electric generators, such as natural gas supply and costs which can be influenced by pipeline constraints, the dispatch of electric generators and wholesale electricity prices are also influenced by electricity demand and electricity transmission constraints. Since electricity cannot be stored, it must be delivered instantaneously to where it is needed. In locations where electric demand is high, transmission capability may be constrained, meaning that electric generation has different values in different areas – because the lowest cost electric generation cannot always be delivered to where it is needed based on transmission limitations. As a result, wholesale electricity prices also differ by location, a concept referred to as locational marginal pricing.

All of the above, including production costs, market factors, and physical limitations, impact the dispatch of electric generation, and related CO<sub>2</sub> emissions, through a highly dynamic wholesale electricity market.

The concept of emissions leakage assumes a scenario in which only a subset of CO<sub>2</sub>-emitting electric generators are subject to a CO<sub>2</sub> allowance requirement.<sup>38</sup> As a result, certain electric generators are subject to an additional

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<sup>38</sup> The nine-state RGGI region does not completely align with the geographic footprint of wholesale electricity markets in the greater Northeast and Mid-Atlantic region, and electric power can flow across multiple wholesale markets in North America.

production cost – the cost of CO<sub>2</sub> allowances – that is not faced by other CO<sub>2</sub>-emitting electric generators. In theory, this could result in a shift in electric generation to emitting units that do not face a CO<sub>2</sub> compliance cost. If such a shift results in an increase in CO<sub>2</sub> emissions from electric generation as a whole, such an increase is referred to as emissions leakage.

If emissions leakage were to occur, it would result from an increase in dispatch (and related CO<sub>2</sub> emissions) from: (a) in-region non-RGGI units (i.e., small fossil fuel-fired units in the nine-state RGGI region with a capacity less than 25 MWe, which are not subject to RGGI); (b) electric generation outside the nine-state RGGI region (represented as electricity imports); or (c) a combination of the two, both of which are referred to in this report as “non-RGGI generation”.