Regional Greenhouse Gas Initiative

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

CO_2 Emissions from Electricity Generation and Imports in the Regional Greenhouse Gas Initiative: 2014 Monitoring Report

August 12, 2016

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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_2), 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 sixth report in a series of annual monitoring reports, summarizes data for the period from 2005 through 2014, for electricity generation, net electricity imports, and related carbon dioxide (CO_2) emissions for the nine states[1] participating 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_2 Budget Trading Program to cause CO_2 emissions from generation serving load in the RGGI region to shift towards sources that are not subject to RGGI.[2] This potential shift has been referred to as "emissions leakage."

In the Northeast and Mid-Atlantic states, CO_2 emissions from the regional electric power sector are a function of highly dynamic wholesale electricity markets. The cost of compliance with the RGGI CO_2 Budget Trading Program is only one of multiple factors that influence the dispatch of electric generation, and resulting CO_2 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 or potential indication of emissions leakage, or a lack thereof, is electric generation and related CO_2 emissions from all non-RGGI electric generation serving electricity load in the nine-state RGGI region. Because this report does not establish the causes of observed trends, it should be emphasized that this report does not provide indicators of CO_2 emissions leakage.

This report tracks electricity generation, net electricity imports, and related CO_2 emissions during the three-year current period of 2012 to 2014 relative to 2006 to 2008, a three-year base period prior to the implementation of the RGGI program. The observed trends in electricity demand, electricity generation, and net electricity imports show there has been no significant change in CO_2 emissions or the CO_2 emission rate (pounds of CO_2 per megawatt hour or lb CO_2/MWh) from total non-RGGI electric generation serving load in the nine-state RGGI region during the period of 2012 to 2014 when compared to the base period.

<u>Summary of Results</u>

Change in Annual Average Electric Load (Demand for Electricity) and Annual Average Generation

- The annual average **electric load** in the nine-state RGGI region from 2012 to 2014 decreased by 16.1 million MWh, or 4.2 percent, compared to the average for 2006 to 2008.

[1] The "nine-state RGGI region" consists of Delaware, Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.
[2] The Memorandum of Understanding called for monitoring electricity imports into the RGGI participating states commencing from the start of the RGGI CO_2 Budget Trading Program and reporting the results of such monitoring on an annual basis beginning in 2010.

- The annual average **electric generation** from all sources in the nine-state RGGI region from 2012 to 2014 decreased by 30.1 million MWh, or 9.1 percent, compared to the average for 2006 to 2008.
    - Annual average net imports into the nine-state RGGI region from 2012 to 2014 increased by 19.1 million MWh, or 34.0 percent, compared to the average for 2006 to 2008 (see page 18).
- The reduction in **electric load** and **electric generation** in the nine-state region for the 2014 calendar year show a similar reduction compared to the annual average during the base period from 2006 to 2008.

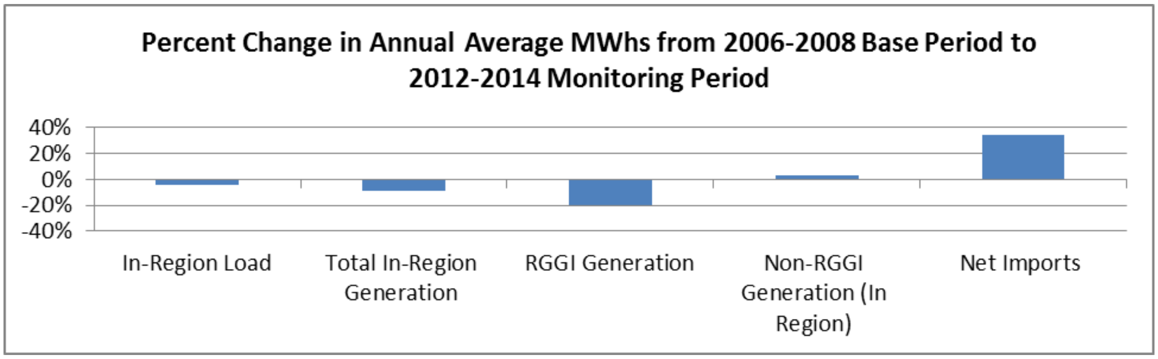

Figure 1. Percentage change in annual average electricity load and generation serving the nine-state RGGI region for 2012 to 2014, relative to the base period of 2006 to 2008.

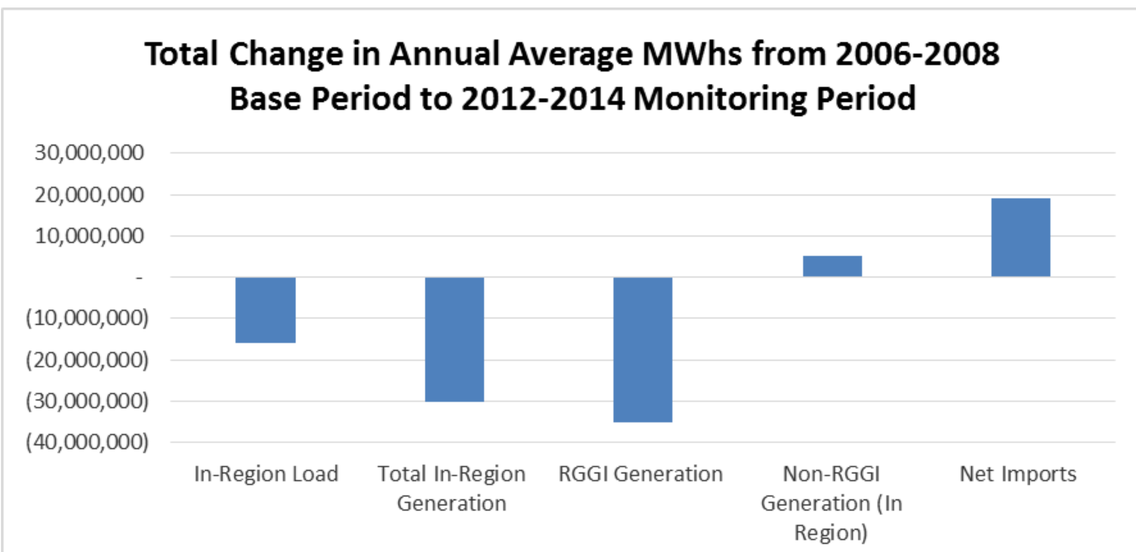

Figure 2. Change in MWhs of annual average electricity load and generation serving the nine-state RGGI Region for 2012 to 2014, relative to the base period of 2006 to 2008.

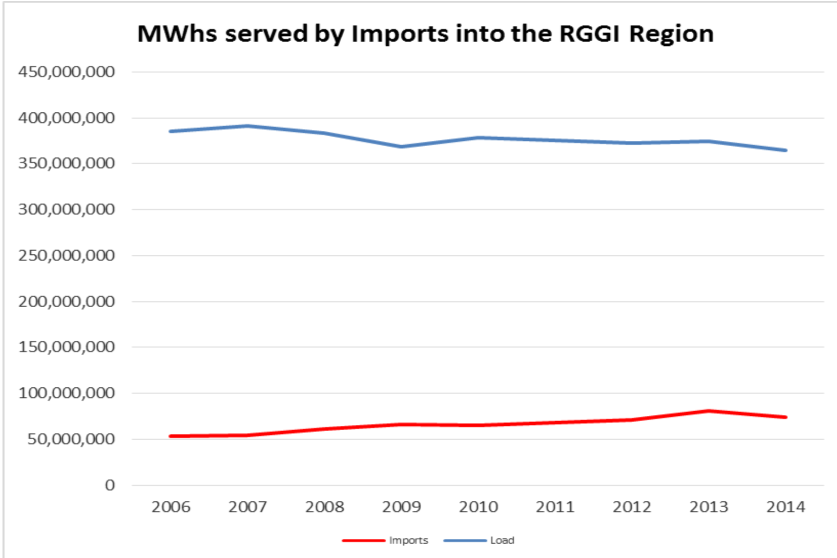

Figure 3. MWhs of load served by imports to the RGGI region from 2006-2014

Change In Annual Average Non-RGGI Emissions, Non-RGGI Emissions Rate, and Non-RGGI Generation

The monitoring results indicate there was no significant change in CO_2 emissions from non-RGGI electric generation serving load in the nine-state RGGI region for 2012 to 2014 relative to the base period of 2006 to 2008. The decrease in emissions related to electric generation from imports into the nine-state RGGI region offsets the slight increase in emissions from non-RGGI in-region electric generation.

- The annual average **CO_2 emissions** from all non-RGGI electric generation sources serving load in the RGGI region for 2012 to 2014 decreased by 216.9 thousand short tons of CO_2, or 0.5 percent, compared to the base period of 2006 to 2008.

- The annual average **CO_2 emissions rate** from all non-RGGI electric generation sources serving load in the RGGI region for 2012 to 2014 decreased by 45.4 lb CO_2/MWh, or 10.8 percent, compared to the base period of 2006 to 2008.

- The annual average **electric generation** from all non-RGGI electric generation sources serving load in the RGGI region for 2012 to 2014 increased by 24.2 million MWh, or 11.6 percent, compared to the base period of 2006 to 2008.

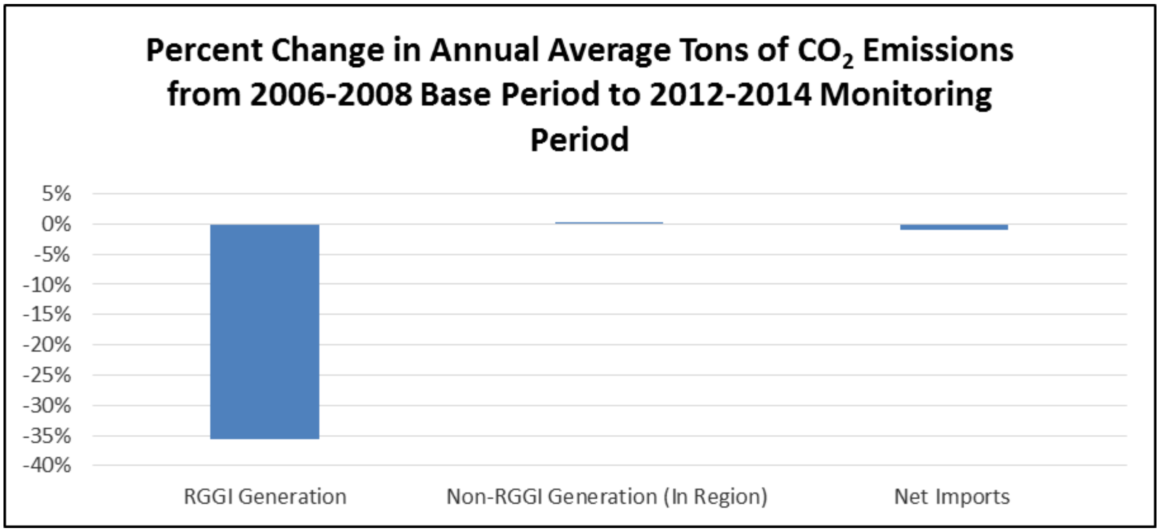

Figure 4. Percent change in annual average CO_2 emissions from generation serving load in the nine-state RGGI region for 2012 to 2014, relative to the base period of 2006 to 2008.

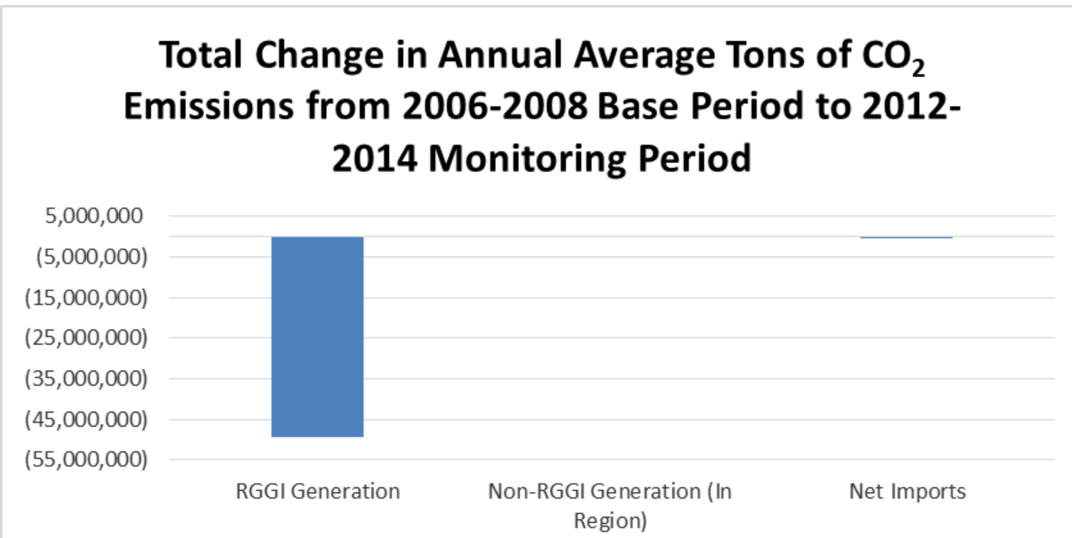

Figure 5. Change in annual average CO_2 emissions from generation serving load in the nine-state RGGI region for 2012 to 2014, relative to the base period of 2006 to 2008.

Change in Annual Average RGGI Emissions, RGGI Emissions Rate, and RGGI Generation

- The annual average **CO_2 emissions** from RGGI electric generation sources from 2012 to 2014 decreased by 49.3 million short tons of CO_2, or 35.7 percent, compared to the base period of 2006 to 2008.

- The annual average **CO_2 emissions rate** from RGGI electric generation sources from 2012 to 2014 decreased by 305 lb CO_2/MWh, or 19.5 percent, compared to the base period of 2006 to 2008.

- The annual average **electric generation** from RGGI electric generation sources from 2012 to 2014 decreased by 35.3 million MWh, or 19.9 percent, compared to the base period of 2006 to 2008.

- Both **electric generation** and **CO_2 emissions** from RGGI electric generation sources in the 2014 calendar year show a similar reduction compared to the annual average for the baseline period from 2006 to 2008.

<u>Conclusions</u>

As mentioned, it should be emphasized that this report does not provide indicators of CO_2 emissions leakage, but merely tracks electricity generation and imports, and related CO_2 emissions, in the RGGI region. A key metric presented in this report that may provide a preliminary or potential indication of emissions leakage, or a lack thereof, is electric generation and related CO_2 emissions from all non-RGGI electric generation serving electric load in the nine-state RGGI region. The monitoring results show that there has been a 0.5% decrease in average annual CO_2 emissions from non-RGGI electric generation for the period from 2012 to 2014, compared to the average annual CO_2 emissions during the base period from 2006 to 2008. The decrease in emissions related to electric generation from imports into the nine-state RGGI region offsets the slight increase in emissions from non-RGGI in-region electric generation.

I. Background

This annual report summarizes monitoring data and tracks trends for electricity demand, net electricity imports, electricity generation from multiple categories of generation sources (including net electricity imports), and the CO_2 emissions related to these categories of electric generation in the nine-state RGGI region, for the period from 2005 through 2014. This monitoring was called for in the 2005 RGGI MOU in response to expressed concerns about the potential for the nine RGGI CO_2 Budget Trading Programs[3] to result in "emissions leakage".[4] 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*.[5,6]

The report should not be used to draw definitive conclusions about whether or not CO_2 emissions leakage has occurred, as it does not address the causes of observed trends among different categories of electric generation serving load in the nine-state RGGI region. This report is an analysis of CO_2 emissions only 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 independent system operator (ISO) regions fully or partially subject to the RGGI CO_2 Budget Trading Program (ISO-New England – "ISO-NE", New York ISO – "NYISO", and PJM). The data track total 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_2 emissions (in short tons of CO_2) related to the generation of this electricity, and the associated lb CO_2/MWh emission rate.

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 known 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). The electric generation MWh output that is used on-site is not included in the monitoring results.[7]

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[3] RGGI is comprised of state CO_2 Budget Trading Programs. Under each of these state programs, a regulated power plant must hold CO_2 allowances equal to its emissions to demonstrate compliance at the end of a three-year control period. CO_2 allowances are issued by participating states in a finite amount, or "budget", resulting in a regional cap on CO_2 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.

[4] Specifically, the Memorandum of Understanding called for monitoring electricity imports into the RGGI participating states commencing from the start of the RGGI CO_2 Budget Trading Program and reporting the results of such monitoring on an annual basis beginning in 2010.

[5] 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

[6] This report for 2014 is the third 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.

[7] 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

For each year 2005 through 2014, the following categories of data are presented for the nine-state RGGI region as well as each for ISO:

- RGGI Generation: Electric generation (MWh), CO_2 emissions (short tons), and emission rate (lb CO_2/MWh) for electric generating units subject to a CO_2 allowance compliance obligation under state CO_2 Budget Trading Program regulations.[8]

- Non-RGGI Generation: Electricity generation (MWh), CO_2 emissions, and emission rate (lb CO_2/MWh) 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).[9] 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 from electric generation units located in the nine-state RGGI region that are not subject to a CO_2 allowance compliance obligation (e.g., generators under 25 megawatts electrical (MWe) capacity and non-fossil fuel-fired electric generators).

  - Net Imports: Electric generation from net electricity imports (MWh) from adjacent control areas (or portion of a control area) outside the nine-state RGGI region (can be fossil or non-fossil generation).[10]

III. 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

This report compares monitoring data for the period from 2012 to 2014 to the base period from 2006 to 2008. The period of 2006 to 2008 represents the three years

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Generation Information System (GIS), which are discussed in Section IV. Methodology. These behind-the-meter electric generators that report to PJM GATS and ISO-NE GIS are included in the monitoring results. CO_2 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_2/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.

[8] For the purposes of this report, this category does not include electric generators that may be subject to a state CO_2 Budget Trading Program regulation, or portion of such regulation, but that are not subject to a CO_2 allowance compliance obligation that requires the generator to submit CO_2 allowances equivalent to its CO_2 emissions. For example, under Maryland's CO_2 Budget Trading Program regulations, certain industrial cogenerators may be subject to alternative CO_2 compliance obligations under certain conditions in lieu of submission of CO_2 allowances.

[9] In practice, this category includes MWh and related CO_2 emissions from all electric generation serving load in the RGGI region, after subtracting out electric generation and related CO_2 emissions from electric generation units subject to a RGGI CO_2 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_2 Budget Trading Program in 2014 (Delaware, and Maryland).

[10] 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.

immediately prior to the start of the program. It was selected for the base period to provide a point of comparison to the three-year control periods of the RGGI program.

In monitoring reports from 2009, 2010, and 2011, data comparisons were made to the base period for the ten-state region; please see the CO_2 Emissions from Electricity Generation and Imports in the 10-State Regional Greenhouse Gas Initiative: 2009, 2010, and 2011 Monitoring Reports.[11] For 2012 and 2013, data comparisons were made to the base period for the nine-state region, reflecting the states participating in RGGI during that time period[12]. 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 the 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 or potential indication of emissions leakage, or a lack thereof, is electric generation and related CO_2 emissions from all non-RGGI-affected electric generation serving 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_2 allowance compliance obligation under a state CO_2 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_2 emissions leakage were to occur, it would manifest as an increase in CO_2 emissions from this category of non-RGGI electric generation, assuming all other factors that impact electricity system dispatch and CO_2 emissions (such as electricity demand, relative fossil fuel prices, and wholesale electricity prices) did not change. As a result, an increase in CO_2 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_2 emissions leakage.

General Limitations

It should be emphasized that this report does not provide indicators of CO_2 emissions leakage, but merely tracks electricity generation and net electricity imports and related CO_2 emissions in the RGGI region for 2012 to 2014, relative to baseline years prior to implementation of the RGGI program. Determining whether CO_2 emissions leakage has occurred requires the evaluation of a hypothetical counterfactual – the amount of CO_2 emissions from non-RGGI electric generation that would occur, assuming there is no shift in electric generation to CO_2-emitting non-RGGI electric generators as a result of the implementation of the RGGI CO_2 Budget Trading Program. In theory, an increase in CO_2 emissions or CO_2 emission rate from non-RGGI electric generation as compared to a historical baseline year could occur in a scenario in which CO_2 emissions leakage does not occur. Conversely, leakage could theoretically occur in a scenario in

[11] 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_12_07_30_Final.pdf, and http://www.rggi.org/docs/Documents/Elec_monitoring_report_2011_13_06_27.pdf.

[12] Reports available at http://www.rggi.org/docs/Documents/Elec_monitoring_report_2012_15_08_11.pdf and http://www.rggi.org/docs/Documents/Elec_Monitoring_Report_2013.pdf

which CO_2 emissions and CO_2 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_2 emissions leakage occurs.

Changes in these data over time may point to *potential* CO_2 emissions leakage as a result of the RGGI CO_2 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 analysis of lifecycle CO_2 emissions or reductions from fuels used in non-RGGI non-fossil-fuel units is also not within the scope of this report. For example, the direct emissions of CO_2 and the lb CO_2/MWh emission rates from non-RGGI non-fossil fuel units in this report do not reflect the biomass lifecycle carbon reduction of atmospheric CO_2 levels resulting from uptake of CO_2 from the atmosphere as a result of forest and biomass growth. Likewise for municipal solid waste combustors, direct emissions of CO_2 are presented with no analysis of the lifecycle of the components of the waste.

IV. 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),[13] supplemented by ISO electricity import/export data, and CO_2 emissions data for RGGI electric generation from the RGGI CO_2 Allowance Tracking System (RGGI COATS) and emissions statement data reported to state environmental agencies in the RGGI participating states. For non-RGGI electric generation, CO_2 emissions are based on CO_2 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_2 emissions data compiled by the New York State Department of Environmental Conservation (NYSDEC). CO_2 emissions data for RGGI electric generation units were compiled from NYSDEC emissions statement program data. CO_2 emissions data for fossil fuel-fired electric generation units that are non-RGGI were taken or extrapolated from reports compiled by NYSDEC. A summary of data sources for NYISO is provided in Appendix A.

[13] 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.) 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).

For each ISO, CO_2 emissions related to net electricity imports from each adjacent control area[14] are the product of a lb CO_2/MWh emission rate and the reported MWh of net imports. The CO_2 emission rate for electricity imports is based on the system average CO_2 emission rate for the respective exporting adjacent control area.[15] For ISO-NE and NYISO, net electricity imports are based on actual flow data for electricity transfers between adjacent control areas.[16] 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.[17]

When aggregating individual ISO net import data, the reported regional net imports of electricity and related CO_2 emissions from net imports presented in this report represent net imports from adjacent regions not subject to the RGGI CO_2 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_2 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_2 emissions, the net import subtotals from adjacent ISOs (or portion of ISO) subject to the RGGI CO_2 Budget Trading Program were not included when rolling up the individual ISO data into regional summary totals, as the electricity and CO_2 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.

For ISO-NE and NYISO, net electricity import data is based on the tracking of actual electricity flows between adjacent control areas.[18] This type of tracking is not possible for the RGGI portion of PJM, as PJM is dispatched as a single control area, and

[14] For PJM, this represents inferred imports from the non-RGGI geographic portion of PJM.
[15] 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.
[16] 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.
[17] For PJM, this category of data does not technically represent an import of electricity, as PJM is dispatched as a single control area.
[18] The exception is net import data from Hydro Quebec into NYISO, which represents net scheduled electricity imports.

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.[19] 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).

[19] This includes most electric generation and electric load typically referred to as “behind the meter” (see footnote 8).

V. 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_2 Budget Trading Program: ISO-NE, NYISO, and PJM. For ISO-NE, the region is fully subject to RGGI. For PJM, monitoring data is compiled for the two-state portion of PJM subject to 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 2014 are summarized below in Table 1.[20]

[20] Note that reported regional net electricity imports represent net imports from adjacent control areas (or portion of a control area) not subject to the RGGI CO_2 Budget Trading Program. As a result, the net electricity imports and related CO_2 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_2 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_2 Budget Trading Program. In order to avoid inappropriate double counting of MWh and related CO_2 emissions, these net import subtotals were not included when rolling up the individual ISO data into regional summary totals, as the electricity and CO_2 emissions represented by these net imports are included in the electric generation subtotals for each ISO.

Table 1. 2005 – 2014 Monitoring Summary for 9-State RGGI Region

	MWh									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
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	364,133,729
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	7,180,281
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	22,052,178
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	3,527,050
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	8,239,526
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	32,656,507
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	73,655,542
Electricity Generation										
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	135,731,651
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	15,902,317
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	147,638,296
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	163,540,613
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	292,306,718
Summary Data										
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	237,196,155
	Tons CO2									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
Total in RGGI	202,257,890	186,429,034	189,347,375	170,936,211	145,619,529	160,228,032	144,442,984	133,558,349	132,601,199	131,904,203
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	603,144
Net Imports - from Quebec to NY & NE	30,081	39,607	39,262	41,725	67,723	37,339	47,363	66,408	54,159	48,617
Net Imports - from New Brunswick to NE	714,298	547,053	455,316	736,564	968,535	406,202	410,324	297,690	1,186,296	1,127,493
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	4,534,250
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	17,971,031
Total Net Imports - from All Adjoining ISOs	26,073,134	25,899,553	24,667,547	25,104,898	24,813,304	28,017,283	26,250,682	23,880,985	26,726,027	24,284,535
Electricity Generation										
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	88,360,436
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	8,974,623
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	10,284,609
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	19,259,231
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	107,619,667
Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	42,970,011	46,504,906	43,557,950	41,561,450	39,661,286	44,174,095	42,986,250	41,346,079	46,083,810	43,543,766
	lb CO2 /MWh									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
Total in RGGI	1,029	968	968	893	790	846	770	718	707	724
Net Imports - from Ontario to NY	485	419	459	375	220	287	203	209	209	168
Net Imports - from Quebec to NY & NE	8	9	7	6	8	6	5	6	4	4
Net Imports - from New Brunswick to NE	882	1,045	1,016	1,146	1,235	1,102	970	926	639	639
Net Imports - from non-RGGI PJM to NY	1,280	1,241	1,228	1,210	1,129	1,159	1,139	1,082	1,109	1,101
Net Imports - from non-RGGI PJM to RGGI PJM	1,280	1,241	1,228	1,210	1,129	1,159	1,139	1,082	1,109	1,101
Total Net Imports - from All Adjoining ISOs	1,048	973	916	825	752	865	777	672	665	659
Electricity Generation										
RGGI-Affected Units	1,706	1,599	1,568	1,517	1,400	1,403	1,288	1,212	1,255	1,302
Non-RGGI Fossil Fuel-Fired Units	1,531	1,574	1,477	1,259	1,288	1,548	1,585	1,240	1,209	1,129
Non-Fossil Fuel-Fired Units	92	145	149	164	146	152	156	156	152	139
All Non-RGGI Units	216	263	249	217	195	217	221	231	241	236
All Units	1,026	968	976	905	798	842	768	729	719	736
Summary Data										
Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	416	442	424	391	364	413	392	372	372	367

The monitoring results indicate that for 2012 to 2014, annual average electric generation from all non-RGGI electric generation serving load in the nine-state RGGI region increased by 24.2 million MWh, an increase of 11.6 percent, compared to the annual average generation for the baseline period of 2006 to 2008. In a comparison of the 2012 to 2014 annual average to the 2006 to 2008 base period, the CO_2 emissions from this category of electric generation decreased by 216.9 thousand short tons of CO_2, a reduction of 0.5 percent, and the CO_2 emission rate decreased by 45.4 lb CO_2/MWh, a reduction of 10.8 percent. (See Figures 6, 7, and 8)

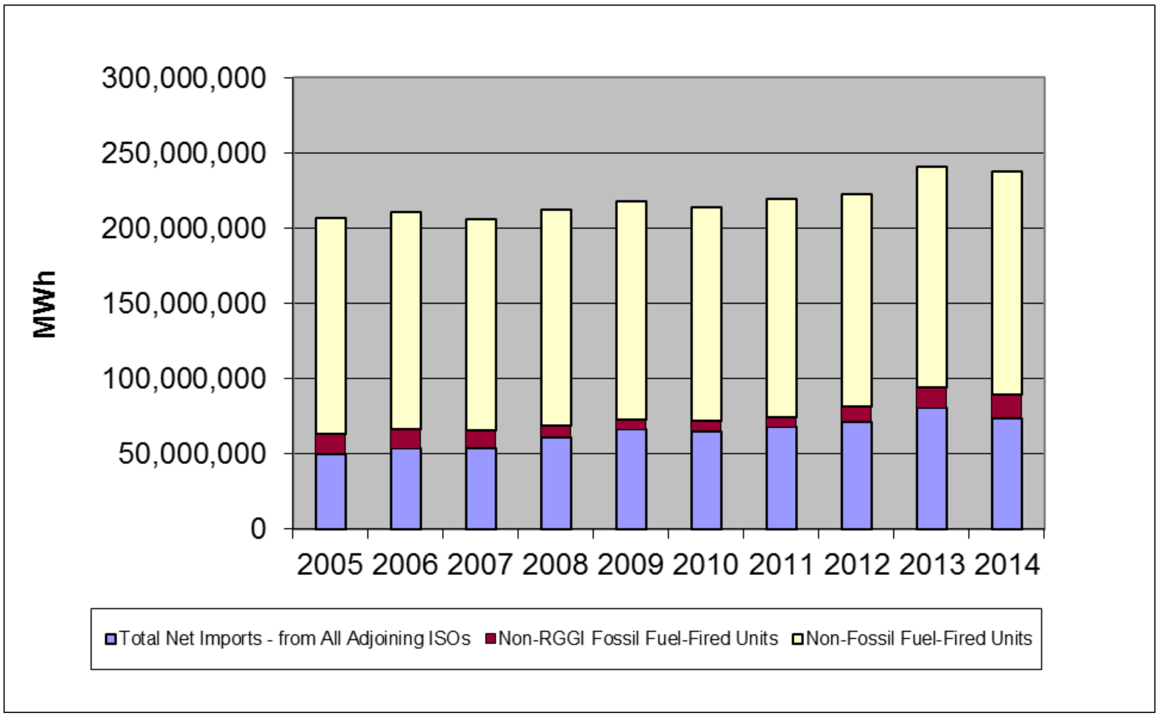

Figure 6. Non-RGGI Generation Serving Load in RGGI Region (MWh)

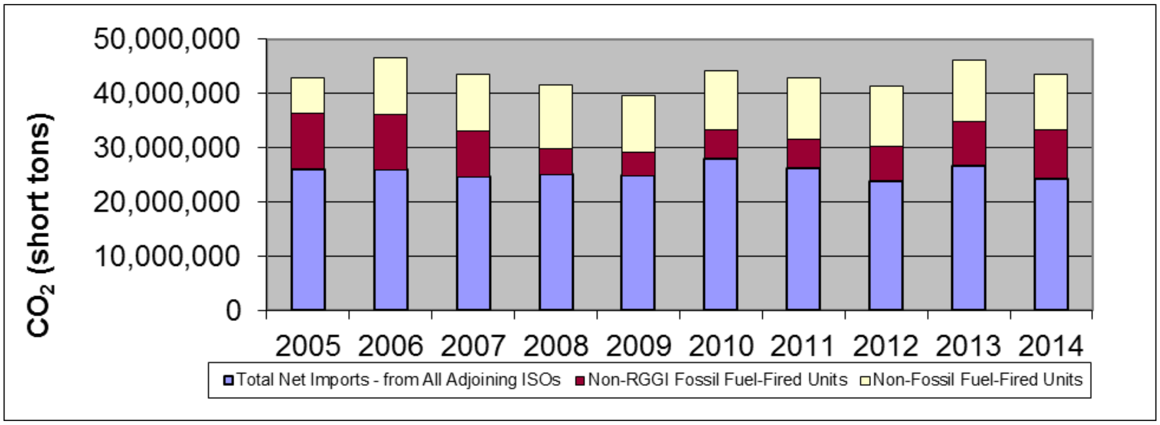

Figure 7. CO_2 Emissions from Non-RGGI Generation Serving Load in RGGI Region (short tons CO_2)

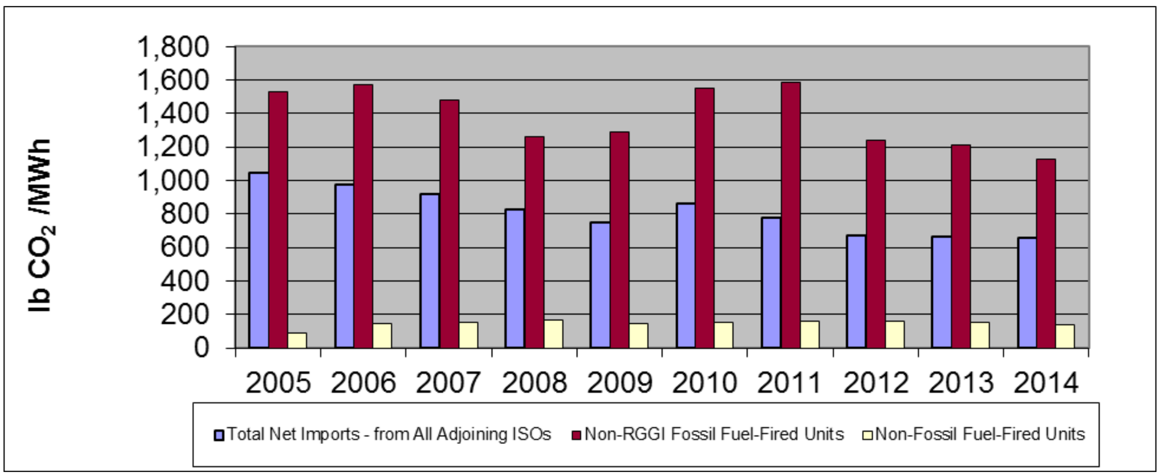

Figure 8. CO_2 Emission Rate for Non-RGGI Generation Serving Load in RGGI Region (lb CO_2/MWh)

The 2012 to 2014 annual average electricity load in the nine-state RGGI region decreased by 16.1 million MWh, or 4.2 percent, compared to the 2006 to 2008 base period. Annual average electric generation from all sources in the nine-state RGGI region decreased by 30.1 million MWh, or 9.1 percent, compared to the base period.

Annual average electric generation from RGGI generation decreased by 35.3 million MWh during this period, or 19.9 percent, and annual average CO_2 emissions from RGGI generation decreased by 49.3 million short tons, or 35.7 percent. The annual average CO_2 emission rate of RGGI generation decreased by 305 lb CO_2/MWh, a decrease of 19.5 percent. Annual average electric generation from non-RGGI generation sources located in the nine-state RGGI region increased by 5.2 million MWh, or 3.4 percent, during this period, and annual average CO_2 emissions from this category of electric generation increased by 43.3 thousand short tons, an increase of 0.2 percent. The annual average CO_2 emission rate of non-RGGI electric generation located in the nine-state RGGI region decreased by 7.2 lb CO_2/MWh, a reduction of 3.0 percent.

Annual average net electricity imports into the nine-state RGGI region increased by 19.1 million MWh, or 34.0 percent, during the 2012 to 2014 annual average compared to the 2006 to 2008 base period. CO_2 emissions related to these net electricity imports decreased by 260.2 thousand short tons, or 1.0 percent, during this period, indicating a reduction in the average CO_2 emission rate of the electric generation supplying these imports of 239.1 lb CO_2/MWh, a reduction of 26.4 percent. (See Figures 9 and 10).

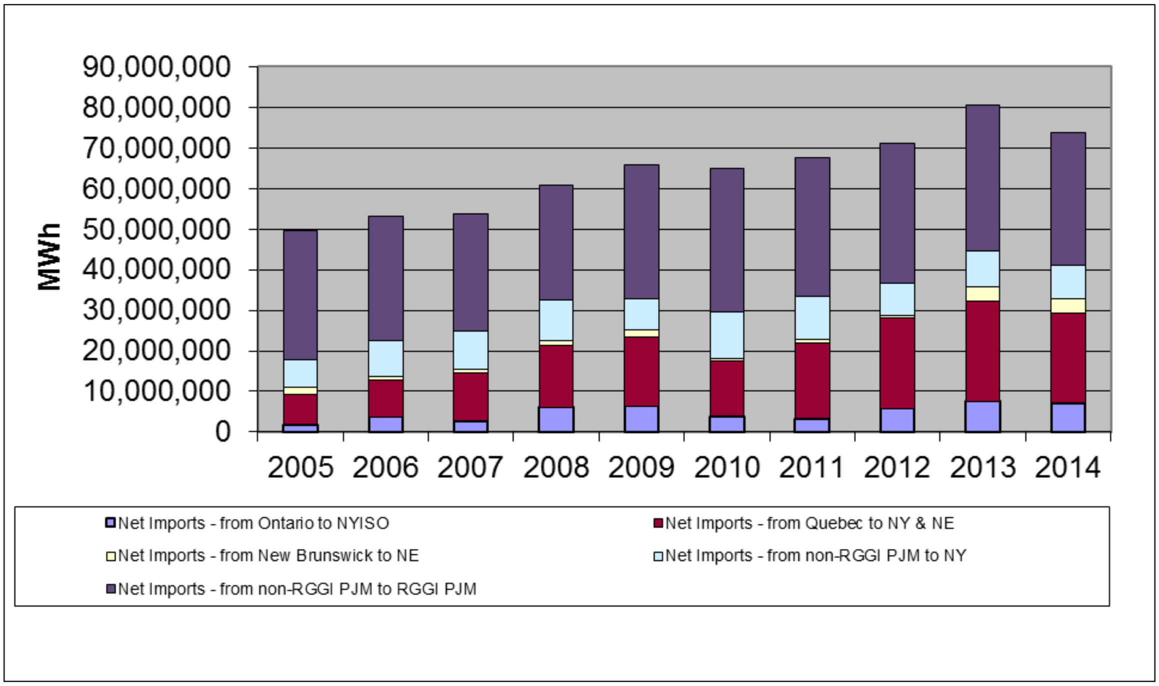

Figure 9. Net Electricity Imports to 9-State RGGI Region (MWh)

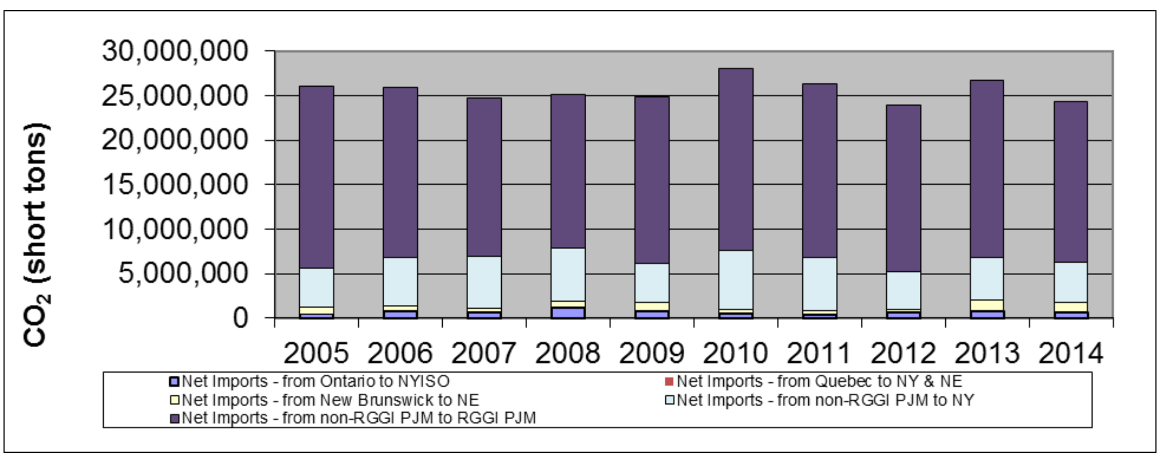

Figure 10. CO_2 Emissions Related to Net Electricity Imports to 9-State RGGI Region (short tons CO_2)

Compared to the annual average during the 2006 to 2008 base period, 2014 electricity load in the nine-state RGGI region decreased by 22.3 million MWh, or 5.8 percent, and 2014 electric generation from all sources in the nine-state RGGI region decreased by 31.3 million MWh, or 9.5 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 electric generation from RGGI generation decreased by 41.4 million MWh, or 23.4 percent, and CO_2 emissions from RGGI generation decreased by 50.0 million short tons of CO_2, or 36.1 percent. The CO_2 emission rate of RGGI electric generation decreased by 259 lb CO_2/MWh, a reduction of 16.6 percent. Compared to the 2006 to 2008 annual average, 2014 electric generation from non-RGGI generation sources located in the nine-state RGGI region increased by 10.2 million MWh, or 6.6 percent, and CO_2 emissions from this category of electric generation increased by 608.5 thousand short tons, an increase of 3.3 percent. The CO_2 emission rate of non-RGGI electric generation located in the nine-state RGGI region decreased by 7.5 lb CO_2/MWh, or 3.1 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 net electricity imports into the nine-state RGGI region increased by 17.7 million MWh, or 31.5 percent. CO_2 emissions related to these net electricity imports decreased by 939.5 thousand short tons of CO_2, or 3.7 percent, during this period. The average CO_2 emission rate of the electric generation supplying these imports of decreased 245.1 lb CO_2/MWh, a reduction of 27.1 percent.

VI. Discussion

As mentioned earlier in this report, multiple market factors interact to influence the dispatch of electric generation. CO_2 allowance costs have been relatively modest compared to other factors that impact wholesale electricity prices.

The wholesale electricity price is paid by market participants such as utilities, who then supply power to end-use retail consumers at retail rates. Retail rates are influenced by the wholesale price, but also include other costs such as delivery charges, administrative costs, and premiums for shielding retail rates from wholesale price volatility. Retail rates vary by state and are approved by state public utility commissions. Finally, consumer energy bills depend not just on the retail rate, but on the amount of power used by the end-use consumer. Improved energy efficiency can cause consumer bills to decline even as wholesale and/or retail rates increase. Without taking any of RGGI's benefits into account, CO_2 allowance costs accounted for 3.1 percent of the average all-in wholesale electricity price for ISO-NE, 4 percent of the average all-in wholesale electricity price for NYISO in 2014, and 0.4 percent of the average all-in locational marginal price on a per MWh basis for PJM in 2014.[21] However, the

[21] For 2014, the average all-in wholesale electricity price $71.69/MWh for ISO-NE and $69.30/MWh for NYISO, and the load-weighted average locational marginal price was $53.14/MWh for PJM (energy only) (See ISO-NE Selectable Wholesale Load Cost Data; NYISO, *Power Trends 2015*, p. 6: Monitoring Analytics, *2014 State of the Market Report for PJM*, p. 18). The CO_2 allowance component is based on a 2014 average CO_2 allowance spot price of $4.72 per CO_2 allowance (See Potomac Economics, *Annual Report on the Market for RGGI CO_2 Allowances: 2014 p. 6*). For PJM, the CO_2 allowance component of the Locational Marginal Price (LMP) for 2014 was $0.23 per MWh (See Monitoring Analytics, *2014 State of the Market Report for PJM*, Section 2 p. 117). ISO-NE and NYISO do not report the CO_2 allowance component of wholesale electricity prices. Both the New England and New York analyses used a 2014 average CO_2 allowance spot price of $4.72 as a starting point for deriving a CO_2 allowance wholesale price component. For both ISO-NE and NYISO, the CO_2 emission rate of the assumed marginal unit was used to translate the annual average spot

wholesale price is only one of many factors which determine the amount that consumers actually pay.

When RGGI's benefits are taken into account, independent reports indicate that RGGI is generating net bill savings for consumers. Two independent reports from the Analysis Group studied RGGI's first and second three-year control periods, finding that RGGI's first control period (2009-2011) is reducing consumer energy bills by $1.3 billion, and RGGI's second control period (2012-2014) is reducing consumer energy bills by $460 million.[22] In particular, the reports found that energy efficiency programs funded by RGGI investments reduce demand for electricity, resulting not only in direct savings for those consumers making the efficiency investments, but also in downward pressure on wholesale prices that reduce costs for all electricity ratepayers. These Analysis Group reports also do not include additional potential economic gains from co-benefits such as public health improvements and avoided climate change impacts.

Wholesale prices fell from 2008 to 2010. In 2010, higher fuel prices, 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.[23] 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.[24] The first quarter of 2014 saw cold weather, with milder weather experienced in the following three quarters, and the net effect was an overall increase in prices in 2014[25].

A number of market drivers have changed dramatically during the 2005 through 2014 monitoring timeframe. These changes are due to a number of factors, including additional investments in energy efficiency and renewable energy (funded in part 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_2 emissions in the 10-state RGGI region from 2005 to 2009, was completed by the New York State Energy Research and Development Authority (NYSERDA).[26] More recently, a 2015 peer-reviewed study in the journal *Energy Economics* examined a similar set of factors and found that RGGI played a significant role in the observed emissions decline in the region.[27] A 2016 research report by the Congressional Research Service cited both studies towards a conclusion

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price for CO_2 allowances ($4.72) into a dollar per MWh value. For ISO-NE, this resulted in an average CO_2 allowance wholesale price component of approximately $2.22 per MWh. For NYISO, this resulted in an average CO_2 allowance wholesale price component of $2.74 per MWh.

[22] "The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeastern and Mid-Atlantic States." Analysis Group. July 2015.
"The Economic Impact of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States." Analysis Group. November 2011.

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

[24] See, for example, *NYISO 2013 Annual Report*, p. 13.

[25] See, for example *NYISO 2014 Annual Report, p. ii.*

[26] New York State Energy Research and Development Authority (NYSERDA), *Relative Effects of Various Factors on RGGI Electricity Sector CO_2 Emissions: 2009 Compared to 2005*, November 2010; available at http://www.rggi.org/docs/Retrospective_Analysis_Draft_White_Paper.pdf.

[27] Murray, Brian C. and Peter T. Maniloff. "Why Have Greenhouse Emissions in RGGI States Declined? An Econometric Attribution to Economic, Energy Market, and Policy Factors." *Energy Economics*. August 2015.

that the RGGI cap, the market signal sent by the allowance price, and the reinvestment of proceeds have worked together to help support a shift towards cleaner generation and regional emissions reductions.[28]

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_2 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.

The dynamics of a competitive wholesale electricity market could drive emissions leakage if there is a sufficient net financial incentive to shift electric generation to units not subject to CO_2 regulation. The extent of this impact is likely to depend, at least in part, on the market value of CO_2 allowances (and the related $/MWh CO_2 costs incorporated into bids by generators subject to the RGGI CO_2 Budget Trading Program) in relation to other economic factors associated with the generation and delivery of electricity (expanded upon below). If the cost of RGGI CO_2 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. Market factors that may impact the economics of importing incremental power in response to a CO_2 allowance price signal include[29]:

> ***Existing Generator Economics****:* Including a CO_2 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_2 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_X), sulfur dioxide (SO_2), and CO_2). As a result, inclusion of a CO_2 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***: Locational Marginal Pricing (LMP) can be expected to affect the market response to the imposition of a CO_2 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. Transmission resources are finite, and transmission “congestion” occurs when available, low-cost electric generation supply cannot be delivered to the demand location due to

[28] Congressional Research Service. *The Regional Greenhouse Gas Initiative: Lessons Learned and Issues for Congress,* April 2016, available at https://www.fas.org/sgp/crs/misc/R41836.pdf.

[29] 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_2.

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.

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 2014 the real-time average LMP by jurisdiction in DE was $4.77 and in MD was $9.15 per MWh above the average PJM LMP, indicating the presence of existing transmission congestion and line losses.[30]

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_2 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.[31]

Line loss charges: The greater the distance that electricity is transmitted, and the more power 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 loses 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.[32]

Long-Term Contracts: Existing long-term power purchase agreements can be expected to mitigate emissions leakage. These agreements mandate the purchase of power from particular sources for pre-set time periods, delaying the response to changes in market conditions.

[30] Monitoring Analytics, *2014 State of the Market for PJM*, 2014; Section 2, Energy Market pp. 114 and Appendix C pp. 392.
[31] As an example, the congestion component of the 2014 average day-ahead, load weighted LMP in the Delmarva Power & Light zone (Delaware and Maryland) zone of PJM was $9.51 per MWh. For the Baltimore Gas & Electric zone (Maryland), the congestion component was $11.97 per MWh. See, Monitoring Analytics, 2014 *State of the Market for PJM*; Section 11, Table 11-4, p. 393.
[32] As an example, the line loss component of the 2014 average day-ahead, load weighted LMP in the Delmarva Power & Light (Delaware and Maryland) zone of PJM was $2.52 per MWh. Similarly, for the Baltimore Gas & Electric zone (Maryland), the line loss component of LMP was $1.90 per MWh. See, Monitoring Analytics, 2014 *State of the Market for PJM*; Section 11, Table 11-4, p. 393.

Reliability Constraints: 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.

Other Factors: Other relevant factors may include 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[33].

VII. Conclusions

This report presents data and trends for electricity generation, net electricity imports, and related CO_2 emissions of electric generation serving load in the nine-state RGGI region, without assigning causality to any one of the factors influencing observed trends. The monitoring results show there has been a 0.5% decrease in in annual average CO_2 emissions from non-RGGI electric generation during the period of 2012 to 2014, compared to the annual average annual CO_2 emissions during the base period of 2006 to 2008. If emissions leakage were to occur, it would manifest through an increase in CO_2 emissions from this aggregate category of non-RGGI electric generation, assuming all other factors that impact electric generator dispatch and CO_2 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 2012 to 2014 show no increase in CO_2 emissions from non-RGGI electric generation serving electricity load in the nine-state RGGI region compared to the base period of 2006 to 2008. When taking only costs into account and not including RGGI's economic benefits, the average CO_2 allowance price in 2012 through 2014 represented approximately 4 percent or less of the average wholesale electricity price and/or average all-in locational marginal price in the three ISOs fully or partially subject to RGGI. The monitoring results are consistent with market dynamics given the CO_2 allowance prices that result in CO_2 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 leakage. Considering these factors, no net market dynamic driving emissions leakage would be expected to occur.

This report is the sixth 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_2 emissions have shifted dramatically from year to year during the 2005 to 2014 time period evaluated in this report. Ongoing monitoring will further evaluate changes in market and non-market drivers that impact CO_2 emissions related to electricity generation and imports in the RGGI region.

[33] Heat rate is a measure of electric generator energy efficiency, represented as Btu of fuel input per kWh of electricity output.

Appendix A. Nine-State ISO Monitoring Sources

Table 2. Summary of Data Sources for ISO-NE

Code	Monitoring Category Associated with Data Elements at Right	MWh	CO_2 lb/MWh	CO_2 Tons
	Electricity Demand (Annual)			
A-1	Total Electricity Use in ISO-NE	ISO-NE[1]	CO_2 tons divided by MWh	Sum of A-3 and B-5
A-2	Net Electricity Imports - from New York	ISO-NE[1]	B-5	MWh multiplied by CO_2/MWh
A-2	Net Electricity Imports - from Quebec	ISO-NE[1]	Environment Canada[3]	MWh multiplied by CO_2/MWh
A-2	Net Electricity Imports - from New Brunswick	ISO-NE[1]	Environment Canada[3]	MWh multiplied by CO_2/MWh
A-3	Total Net Electricity Imports - from All Adjoining ISOs	ISO-NE[1]	CO_2 tons divided by MWh	Sum of A-2s
	Electricity Generation (Annual)			
B-1	RGGI-Affected Units	NEPOOL-GIS[2]	CO_2 tons divided by MWh	State reported data for 2005-2008; RGGI COATS for 2009 to 2014. [4] Includes only sources subject to a state CO_2 Budget Trading Program CO_2 allowance compliance obligation. Does not include biomass-derived CO_2 emissions.
B-2	Non-RGGI Units (Fossil Fuel-Fired; <25MW)	NEPOOL-GIS[2]	CO_2 tons divided by MWh	NEPOOL-GIS[2]
B-3	Non-RGGI Units (Non-Fossil Fuel-Fired)	NEPOOL-GIS[2]	CO_2 tons divided by MWh	NEPOOL-GIS[2]
B-4	All Non-RGGI Units (Fossil and Non-Fossil)	Sum of B-2 and B-3	CO_2 tons divided by MWh	Sum of B-2 and B-3
B-5	All Units	ISO-NE[1]	CO_2 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. Note that B-5 MWh calculated as the sum of the above NEPOOL GIS-based B-1 to B-4 will differ from B-5 MWh from the ISO-NE website, as the website is updated if errors found, while NEPOOL GIS is frozen at time of certificate creation.
2. NEPOOL Generation Information System. Available at http://www.nepoolgis.com.
3. *National Inventory Report 1990–2013: Greenhouse Gas Sources and Sinks in* Canada, Environment Canada, 2015. In Part 3. Available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php#fn5. 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_2 emissions data reported by RGGI participating states compiled from CO_2 emissions data reported to U.S. EPA pursuant 40 CFR Part 75 and from CO_2 emissions and fuel use data reported to state emissions statement programs. 2009 through 2014 CO_2 emissions data is from data reported to the RGGI CO_2 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_2 lb/MWh	CO_2 Tons
	Electricity Demand (Annual)			
A-1	Total Electricity Use in NYISO	Sum of A-3 and B-5	CO_2 tons divided by MWh	Sum of A-3 and B-5
A-2	Net Electricity Imports - from Hydro Quebec	Hydro Quebec[1]	Environment Canada[6]	MWh multiplied by CO_2/MWh
A-2	Net Electricity Imports - from ISO-NE	ISO-NE[2]	ISO-NE system average[7]	MWh multiplied by CO_2/MWh
A-2	Net Electricity Imports - from Ontario	Ontario Independent Electricity System Operator[3]	Environment Canada[6]	MWh multiplied by CO_2/MWh
A-2	Net Electricity Imports - from PJM	PJM Annual State of the Market Report[4]	PJM GATS[8]	MWh multiplied by CO_2/MWh
A-3	Total Net Electricity Imports - from All Adjoining ISOs	Sum of A-2s	CO_2 tons divided by MWh	Sum of A-2s
	Electricity Generation (Annual)			
B-1	RGGI-Affected Units	NYDPS Calculation[5]	CO_2 tons divided by MWh	NYSDEC Emissions Report[10]
B-2	Non-RGGI Units (Fossil Fuel-Fired; < 25 MW)	NYDPS Calculation[5]	CO_2 tons divided by MWh	NYSDEC Emissions Report[9, 10]
B-3	Non-RGGI Units (Non-Fossil Fuel-Fired)	NYDPS Calculation[5]	CO_2 tons divided by MWh	NYSDEC Emissions Report[10]
B-4	All Non-RGGI Units (Fossil and Non-Fossil)	Sum of B-2 and B-3	CO_2 tons divided by MWh	Sum of B-2 and B-3
B-5	All Units	Sum of B-1 and B-4	CO_2 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 2014 reports).

5. NYDPS calculation based on MWh for each generator reported by NYISO and assignment of each generator to appropriate monitoring classification.
6. *National Inventory Report 1990–2013: Greenhouse Gas Sources and Sinks in* Canada, Environment Canada, 2015. In Part 3. Available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php#fn5. 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. MWh and CO_2 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.
10. 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_2 lb/MWh	CO_2 Tons
	Electricity Demand (Annual)			
A-1	Total Electricity Use in RGGI PJM	Sum of A-3 and B-5	CO_2 tons divided by MWh	Sum of A-3 and B-5
A-2	Net Electricity Imports - from Non-RGGI PJM	PJM GATS[1]	PJM GATS[1]	MWh multiplied by CO_2/MWh
A-2	Net Electricity Imports - from NYISO	PJM Annual State of the Market Report[2]	B-5	MWh multiplied by CO_2/MWh
A-3	Total Net Electricity Imports - from All Adjoining ISOs	Sum of A-2s	CO_2 tons divided by MWh	Sum of A-2s
	Electricity Generation (Annual)			
B-1	RGGI-Affected Units	PJM GATS[1]	CO_2 tons divided by MWh	State reported data for 2005-2008; RGGI COATS for 2009 through 2014. Includes only sources subject to a state CO_2 Budget Trading Program CO_2 allowance compliance obligation; does not include Maryland LIESA sources; does not include Linden Cogeneration units 005001-009001.[3, 4]
B-2	Non-RGGI Units (Fossil Fuel-Fired; < 25 MW)	PJM GATS[1]	CO_2 tons divided by MWh	PJM GATS[1]
B-3	Non-RGGI Units (Non-Fossil Fuel-Fired)	PJM GATS[1]	CO_2 tons divided by MWh	PJM GATS[1]
B-4	All Non-RGGI Units (Fossil and Non-Fossil)	Sum of B-2 and B-3	CO_2 tons divided by MWh	Sum of B-2 and B-3
B-5	All Units	Sum of B-1 and B-4	CO_2 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 2014 reports) athttp://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2013.shtml .
3. Historical 2005 – 2008 CO_2 emissions data reported by RGGI participating states compiled from CO_2 emissions data reported to U.S. EPA pursuant 40 CFR Part 75 and from CO_2 emissions and fuel use data reported to state emissions statement programs. 2009 through 2014 CO_2 emissions data is from data reported to the RGGI CO_2 Allowance Tracking System (RGGI COATS), available at <http://www.rggi-coats.org>.
4. MWh and CO_2 emissions data do not include Maryland Limited Industrial Exemption Set-aside (LIESA) sources. LIESA sources for 2009-2014 include Severstal Sparrows Point LLC and Luke Paper Company. LIESA sources refer to certain industrial cogenerators under Maryland's CO_2 Budget Trading Program regulations that are subject to alternative CO_2 compliance obligations under certain conditions in lieu of submission of CO_2 allowances.

Appendix B. ISO-Specific Monitoring Results

Detailed monitoring results for ISO-NE, NYISO, and the RGGI portion of PJM are presented below.[34]

ISO-NE

Monitoring results for ISO-NE for 2005 through 2014 are summarized below in Table 5 and Figures 11 through 15.

Table 5. 2005 – 2014 Monitoring Summary for ISO-NE

	MWh									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
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	127,176,000
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	3,908,078
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	13,212,403
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	3,527,050
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	20,647,531
Electricity Generation										
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	50,594,190
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	1,688,292
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	9,529,597
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	53,510,467
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	64,728,356
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	108,357,000
Summary Data	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	11,217,889
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	85,375,887
	Tons CO2									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
Total in ISO	64,073,310	58,374,143	58,405,351	53,273,400	48,221,927	51,119,602	46,555,544	43,188,897	45,952,769	44,201,297
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	1,105,429
Net Imports - from Quebec	19,544	26,557	25,468	26,166	42,961	25,392	29,303	38,920	30,706	29,128
Net Imports - from New Brunswick	714,298	547,053	455,316	736,564	968,535	406,202	410,324	297,690	1,186,296	1,127,493
Total Net Imports - from All Adjoining ISOs	678,560	175,010	-637,997	111,141	-217,778	-1,401,424	-441,792	-60,221	1,738,695	2,262,051
Electricity Generation										
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	27,663,980
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	713,204
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	6,231,961
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	7,330,102
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	14,275,267
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	41,939,247

[34] The tons of CO_2 emitted and the lb of CO_2/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.

Summary Data	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	6,945,165
Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	9,849,372	10,590,720	8,970,373	8,765,000	9,406,366	9,437,064	11,086,227	11,831,028	16,011,651	16,537,318
	lb CO2 /MWh									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
Total in ISO	927	870	853	795	749	712	712	667	702	695
Net Imports - from NYISO	961	909	903	852	811	831	779	740	789	566
Net Imports - from Quebec	8	9	7	6	8	6	5	6	4	4
Net Imports - from New Brunswick	882	1,045	1,016	1,146	1,235	1,102	970	926	639	639
Total Net Imports - from All Adjoining ISOs	216	57	-208	24	-47	-506	-87	-10	183	219
Electricity Generation								0	0	
RGGI-Affected Units	1,400	1,348	1,312	1,261	1,187	1,169	1,021	1,004	1,121	1,094
Non-RGGI Fossil Fuel-Fired Units <25MW	789	1,129	1,458	1,300	1,193	1,928	1,809	1,609	1,179	845
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	1,308
Non-Fossil Fuel-Fired Units	209	261	267	266	288	286	324	302	289	274
All Non-RGGI Units	336	363	346	320	353	388	438	416	457	441
All Units	961	909	903	852	811	831	779	740	789	774
Summary Data	1,353	1,365	1,245	1,391	1,605	2,115	2,120	1,306	1,390	1,238
Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	324	333	291	277	295	307	353	339	393	387

The monitoring results indicate that when the 2012 to 2014 annual average is compared to the 2006 to 2008 base period annual average, electric generation from all non-RGGI electric generation serving load in ISO-NE increased by 16.0 million MWh, or 25.5 percent. When the 2006 to 2008 base period annual average is compared to the 2012 to 2014 annual average, CO_2 emissions from this category of electric generation increased by 5.4 million short tons of CO_2, or 56.7 percent, and the CO_2 emission rate increased by 72.8 lb CO_2/MWh, or 24.2 percent. (See Figures 11, 12, and 13).

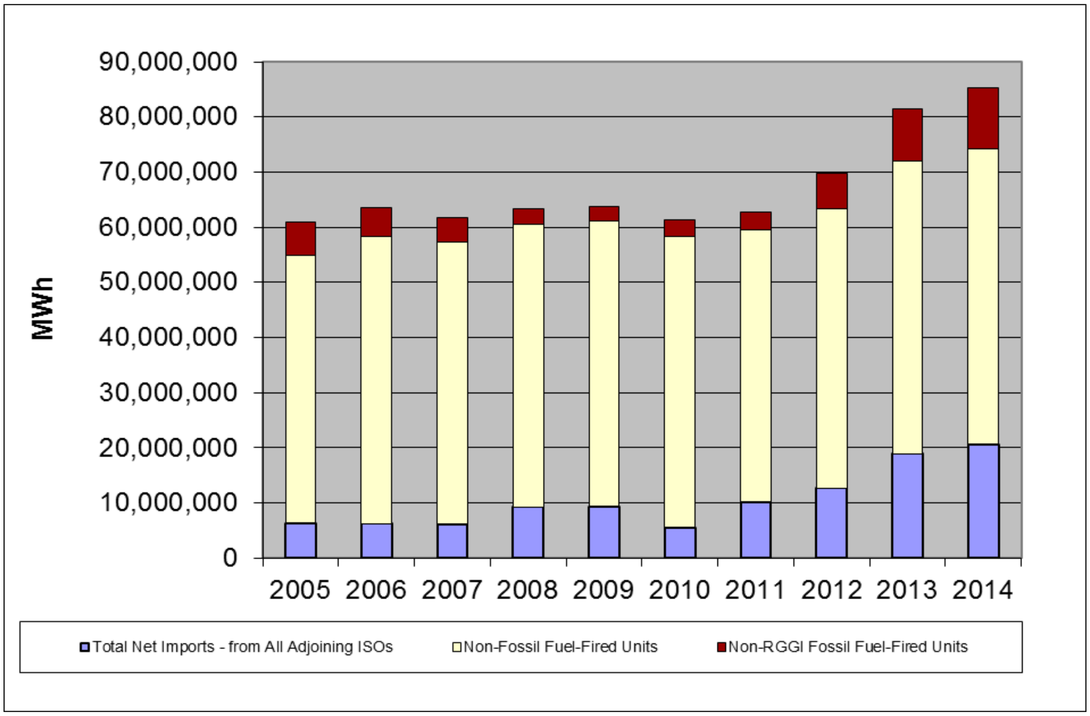

Figure 11. Non-RGGI Generation Serving Load in ISO-NE (MWh)

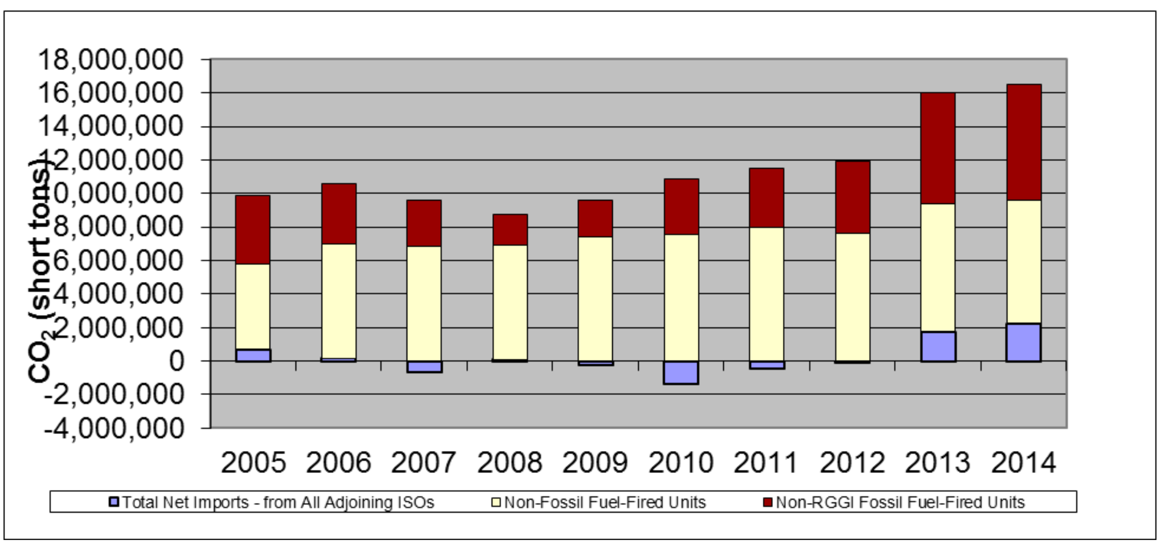

Figure 12. CO_2 Emissions from Non-RGGI Generation Serving Load in ISO-NE (short tons CO_2)

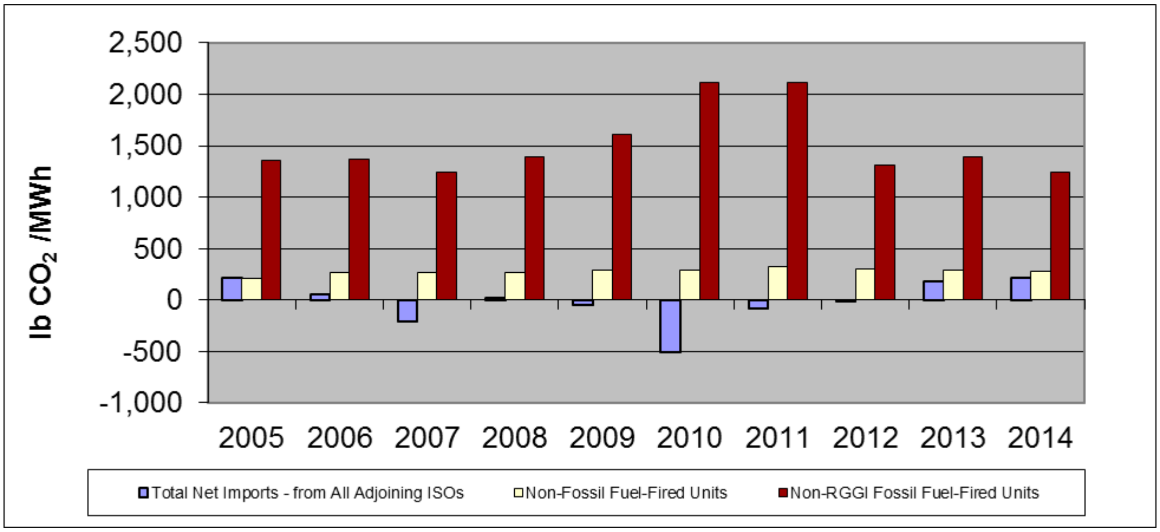

Figure 13. CO_2 Emission Rate for Non-RGGI Generation Serving Load in ISO-NE (lb CO_2/MWh)

The annual average electricity load in ISO-NE for 2012 to 2014 decreased by 5.8 million MWh, or 4.3 percent, compared to the annual average for the baseline period of 2006 to 2008. Electric generation from all sources in ISO-NE decreased by 11.0 million MWh, or 8.6 percent, when comparing the 2006 to 2008 annual average to the 2012 to 2014 annual average.

Annual average electric generation from RGGI generation in ISO-NE decreased by 16.8 million MWh during this period, or 23.2 percent, and annual average CO_2 emissions from RGGI electric generation in ISO-NE decreased by 17.6 million short tons of CO_2, or 37.2 percent. The CO_2 emission rate of RGGI electric generation decreased by 234.3 lb CO_2/MWh, or 17.9 percent. Annual average electric generation from non-RGGI electric generation sources located in ISO-NE increased by 5.8 million MWh, or 10.4 percent, during this period, and CO_2 emissions from this category of electric generation increased by 3.9 million short tons of CO_2, an increase of 41.0 percent. The annual average CO_2 emission rate of non-RGGI electric generation located in ISO-NE increased by 95 lb CO_2/MWh, an increase of 27.7 percent.

Annual average net electricity imports into ISO-NE for 2012 to 2014 increased by 10.2 million MWh, compared to the base period annual average for 2006 to 2008. Annual average CO_2 emissions related to these net electricity imports increased by 1.4 million short tons of CO_2 during this period.[35] The annual average CO_2 emission rate of the electric generation supplying these imports decreased by 173.4 lb CO_2/MWh.

[35] ISO-NE net exports to NYISO doubled from 2008 to 2009, and increased again in 2010. Negative values for MWh and CO_2 tons indicate that more MWh were exported (from New England to New York) than imported. As a result, the increase in net exports to NYISO in 2009 and 2010 increased the amount of CO_2 emissions debited from the ISO-NE net import total, resulting in a negative CO_2 emissions value for total CO_2 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.

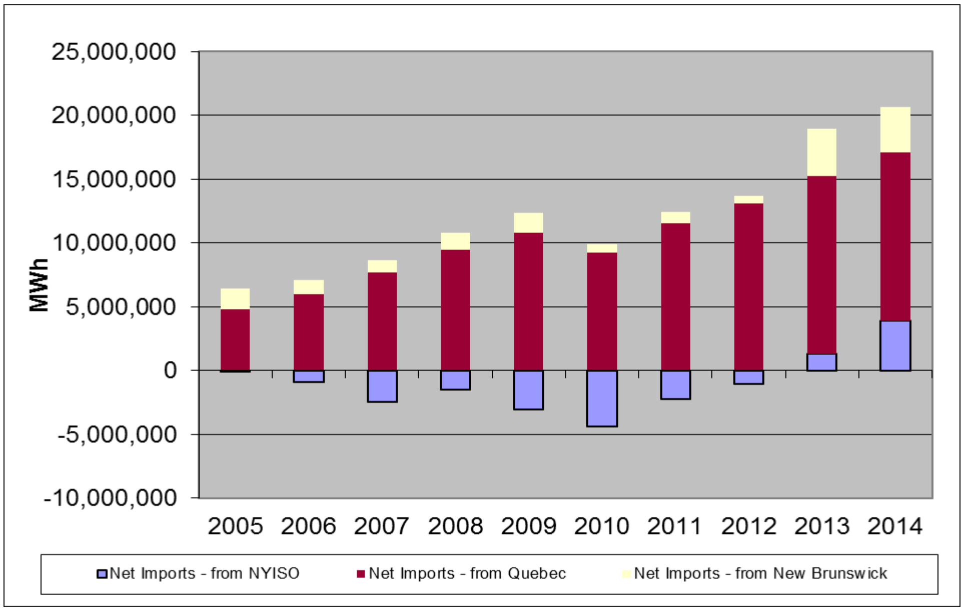

Figure 14. Net Electricity Imports to ISO-NE (MWh)

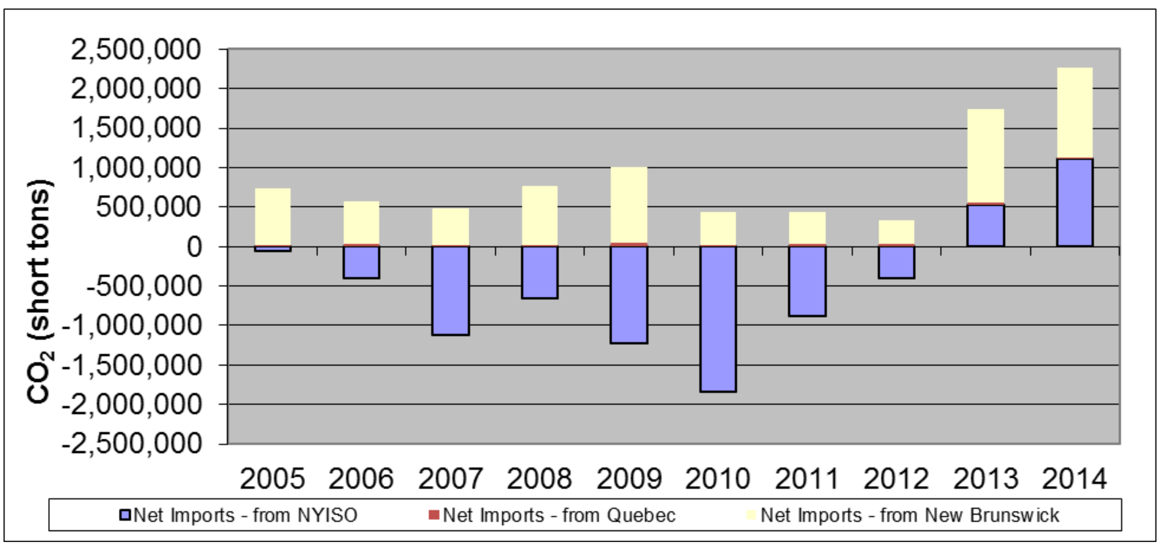

Figure 15. CO_2 Emissions Related to Net Electricity Imports to ISO-NE (short tons CO_2)

Compared to the annual average during the base period of 2006 to 2008, electric generation in 2014 from all non-RGGI electric generation sources serving load in ISO-NE increased by 22.5 million MWh, an increase of 35.8 percent. Compared to the 2006 to 2008 annual average, 2014 CO_2 emissions from this category of electric generation increased by 7.1 million short tons of CO_2, an increase of 75.1 percent, and the CO_2 emission rate increased by 87.0 lb CO_2/MWh, an increase of 28.9 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 total electricity load in ISO-NE decreased by 7.9 million MWh, or 5.8 percent. Compared to the 2006 to 2008 annual average, 2014 total electric generation in ISO-NE decreased by 12.6 million MWh, or 9.9 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 electric generation from RGGI generation in ISO-NE decreased by 21.7 million MWh, or 30.0 percent, and CO_2 emissions from RGGI generation in ISO-NE decreased by 19.6 million short tons of CO_2, or 41.4 percent. The CO_2 emission rate of RGGI electric generation decreased by 213.4 lb CO_2/MWh, a reduction of 16.3 percent. Compared to the 2006 to 2008 annual average, 2014 electric generation from non-RGGI generation located in ISO-NE increased by 9.1 million MWh, or 16.3 percent, and CO_2 emissions from this category of electric generation increased by 4.7 million short tons of CO_2, an increase of 49.3 percent. The CO_2 emission rate of non-RGGI electric generation located in ISO-NE increased by 98.0 lb CO_2/MWh, an increase of 28.6 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 net electricity imports into ISO-NE increased by 13.5 million MWh. CO_2 emissions related to these net electricity imports increased by 2.4 million short tons of CO_2 during this period. The CO_2 emission rate of the electric generation supplying these imports increased by 261.5 lb CO_2/MWh.

NYISO

Monitoring results for NYISO for 2005 through 2014 are summarized below in Table 6 and Figures 16 through 20.

Table 6. 2005 – 2014 Monitoring Summary for NYISO

	MWh									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
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	160,598,000
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	8,839,775
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	-3,908,078
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	7,180,281
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	8,721,704
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	20,833,682
Electricity Generation										
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	58,403,922
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	4,612,684
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	76,747,712
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	81,360,396
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	139,764,318
Summary CO2 Emissions and MWh Data										
Annual CO2 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	102,194,078
	Tons CO2									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
Total Annual Electricity Load in NYISO	74,758,807	69,801,554	71,541,362	63,042,975	48,471,195	55,483,666	48,209,824	44,662,599	42,540,556	43,877,493
Net Imports - from Quebec	10,536	13,050	13,794	15,559	24,762	11,947	18,060	27,488	23,453	19,488
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	-1,105,986
Net Imports - from Ontario	460,286	769,120	604,715	1,154,884	712,496	554,950	336,556	602,081	795,236	603,144
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	4,827,463
Total Net Electricity Imports	5,438,288	7,164,703	8,087,015	8,342,933	6,702,705	9,579,883	7,625,143	5,239,209	5,168,207	4,344,109
Electricity Generation										
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	35,860,008
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	1,946,553
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	1,726,824
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	3,673,376
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	39,533,384
Summary CO2 Emissions and MWh Data										
Annual CO2 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	10,609,787	13,370,495	11,072,442	9,244,698	8,932,760	8,017,485
	lb CO2 /MWh									

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
Total Annual Electricity Load in NYISO	907	838	842	748	604	675	589	546	511	546
Net Imports - from Quebec	8	9	7	6	8	6	5	6	4	4
Net Imports - from ISO-NE	961	909	903	852	811	831	779	740	789	566
Net Imports - from Ontario	485	419	459	375	220	287	203	209	209	168
Net Imports - from PJM	1,292	1,252	1,242	1,220	1,137	1,167	1,146	1,002	1,060	1,107
Total Net Electricity Imports	891	840	828	694	557	769	639	428	396	417
Electricity Generation										
Annual Electric Generation - RGGI-Affected Units	1,849	1,604	1,562	1,496	1,346	1,347	1,257	1,155	1,127	1,228
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	844
Annual Electric Generation - Non-Fossil Fuel-Fired Units	17	71	64	98	52	50	45	54	59	45
Annual Electric Generation - All Non-RGGI Units	156	218	196	159	97	99	85	103	93	90
Total Annual Electric Generation - All Units	909	837	844	756	612	659	580	566	533	566
Summary CO2 Emissions and MWh Data										
Annual CO2 Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)	248	324	321	283	203	263	211	181	167	157

The monitoring results indicate that annual average non-RGGI electric generation serving load in NYISO for 2012 to 2014 increased by 3.0 million MWh, or 2.9 percent, compared to the annual average during the base period of 2006 to 2008. Annual average CO_2 emissions from this category of electric generation decreased by 6.8 million short tons of CO_2, or 43.9 percent, and the annual average CO_2 emission rate decreased by 140.4 lb CO_2/MWh, a decrease of 45.5 percent. (See Figures 16, 17, and 18.)

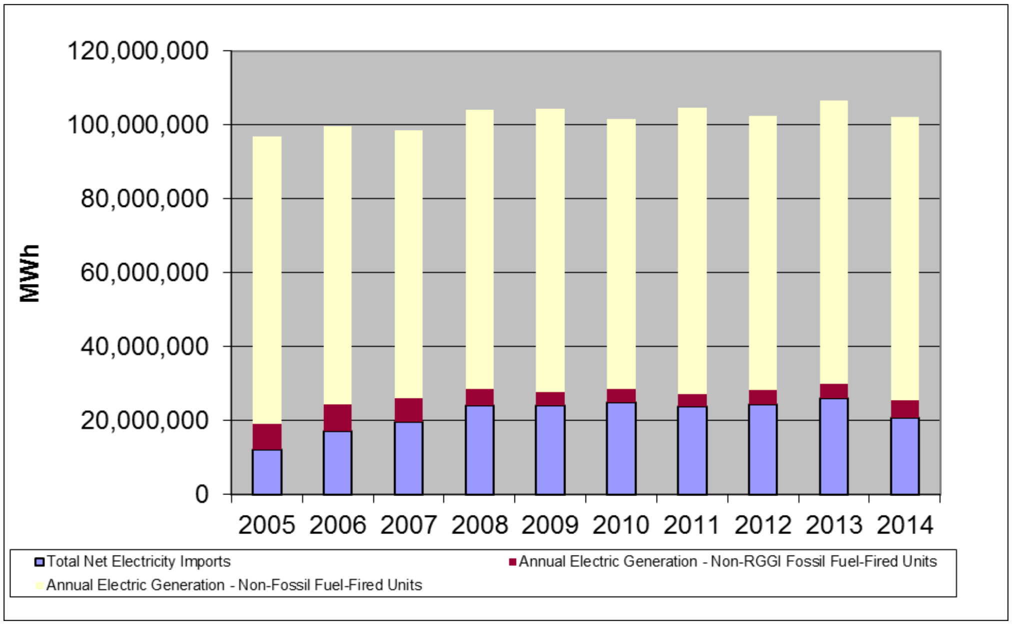

Figure 16. Non-RGGI Generation Serving Load in NYISO (MWh)

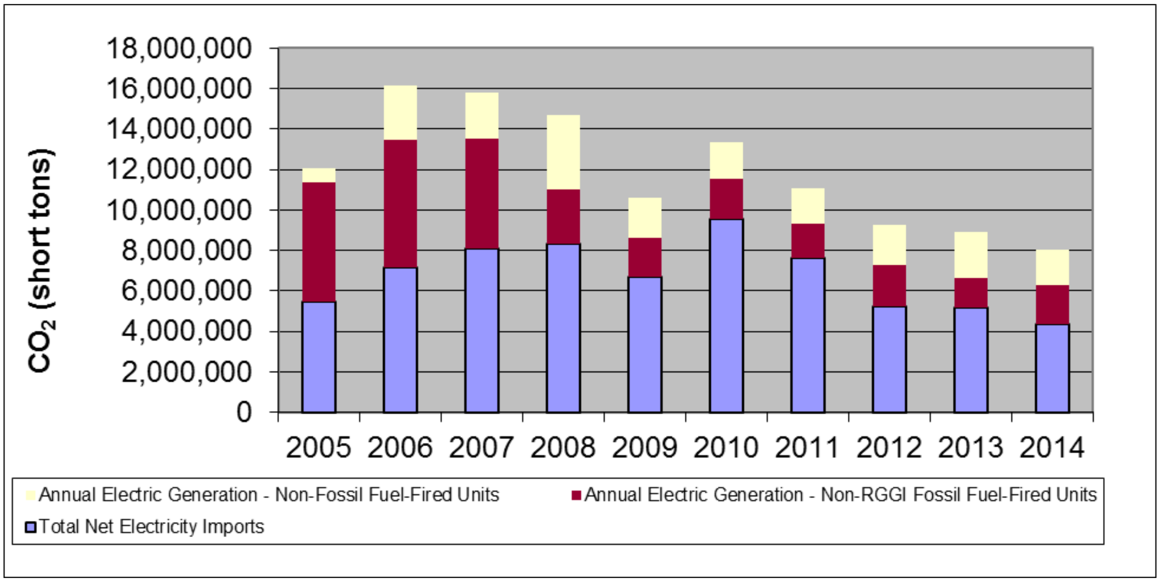

Figure 17. CO_2 Emissions from Non-RGGI Generation Serving Load in NYISO (short tons CO_2)

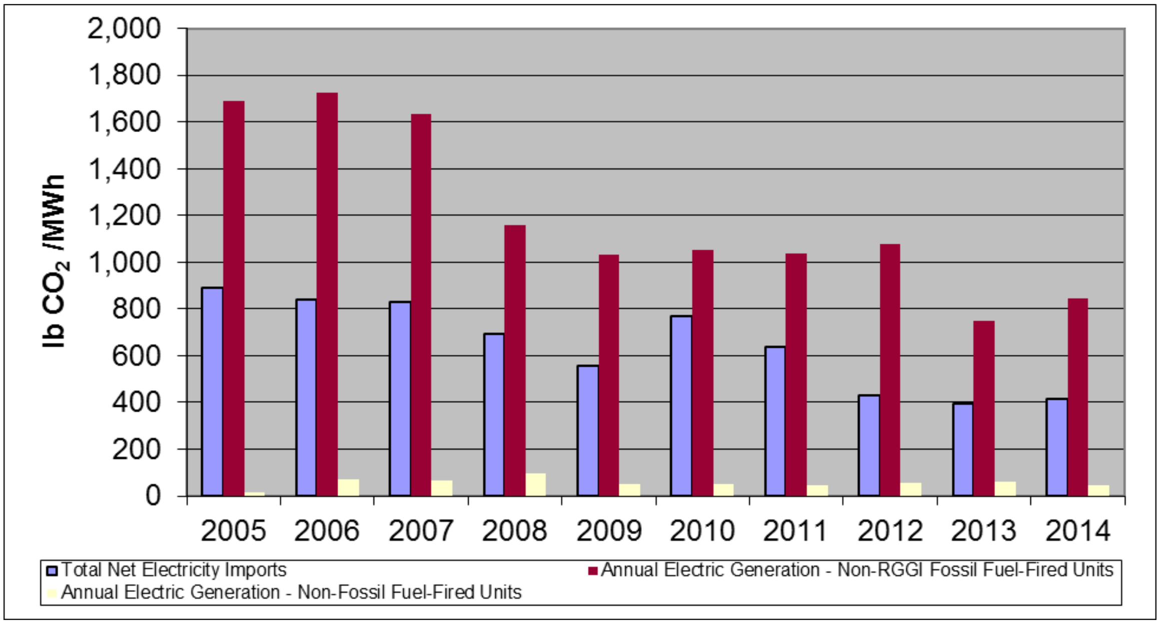

Figure 18. CO_2 Emission Rate for Non-RGGI Generation Serving Load in NYISO (lb CO_2/MWh)

The annual average electricity load in NYISO for 2012 to 2014 decreased by 4.8 million MWh, or 2.9 percent, compared to the annual average for the baseline period of 2006 to 2008. Annual average electric generation from all sources in NYISO decreased by 8.4 million MWh, or 5.7 percent, when comparing the period of 2012 to 2014 with the base period of 2006 to 2008.

Annual average electric generation from RGGI generation in NYISO decreased by 7.8 million MWh during this period, or 11.6 percent, and annual average CO_2 emissions from RGGI electric generation in NYISO decreased by 17.6 million short tons of CO_2, or 33.5 percent. The annual average CO_2 emission rate of RGGI electric generation decreased by 384.3 lb CO_2/MWh, a reduction of 24.7 percent. Annual average electric generation from non-RGGI sources located in NYISO decreased by 621.0 thousand MWh, or 0.8 percent, during this period, and average annual CO_2 emissions from this category of electric generation decreased by 3.9 million short tons of CO_2, a decrease of 50.4 percent. The annual average CO_2 emission rate of non-RGGI electric generation located in NYISO decreased by 95.2 lb CO_2/MWh, a decrease of 49.9 percent.

Net electricity imports into NYISO increased by 3.6 million MWh, when comparing the annual average for the base period of 2006 to 2008 to the annual average for 2012 to 2014. Annual average CO_2 emissions related to these net electricity imports decreased by 2.9 million short tons of CO_2, or 37.5 percent, during this period. The annual average CO_2 emission rate of the electric generation supplying these imports decreased by 373.7 lb CO_2/MWh, a decrease of 47.5 percent. (See figures 19 and 20).

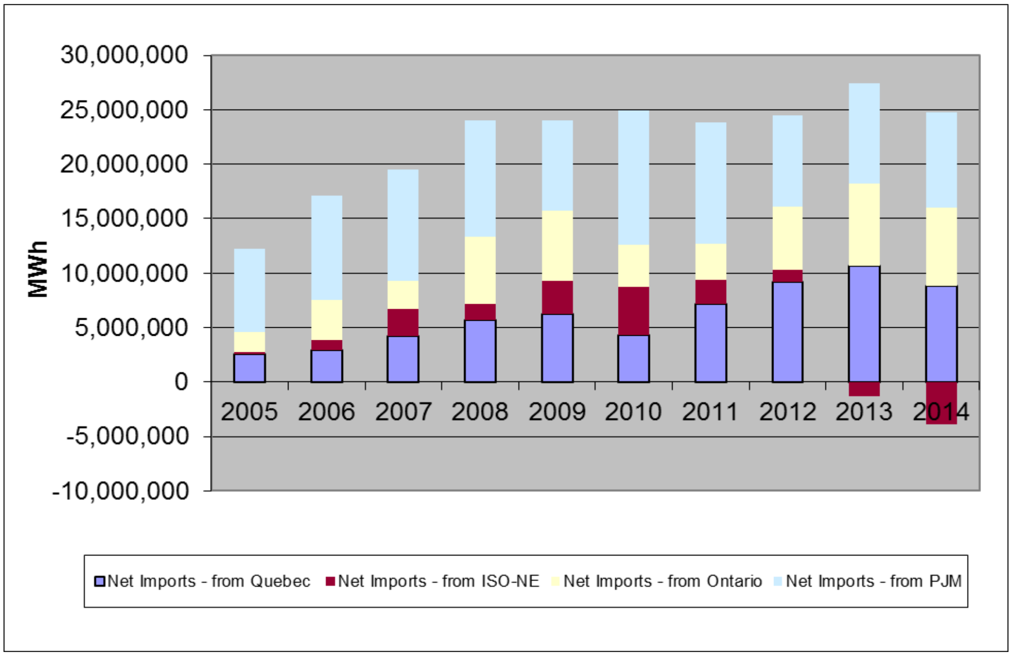

Figure 19. Net Electricity Imports to NYISO (MWh)

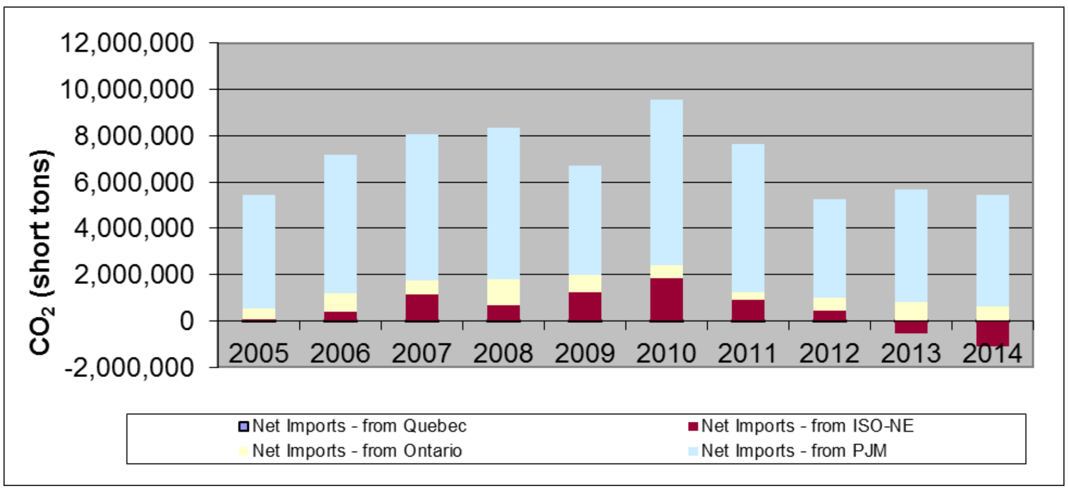

Figure 20. CO_2 Emissions Related to Net Electricity Imports to NYISO (short tons CO_2)

Compared to the annual average during the base period of 2006 to 2008, electric generation in 2014 from all non-RGGI electric generation sources serving load in NYISO increased by 1.4 million MWh, an increase of 1.4 percent. Compared to the annual average for 2006 to 2008, 2014 CO_2 emissions from this category of electric generation decreased by 7.5 million short tons of CO_2, a reduction of 48.5 percent, and the CO_2 emission rate decreased by 151.8 lb CO_2/MWh, a reduction of 49.2 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 electric load in NYISO decreased by 7.8 million MWh, or 4.6 percent, and electric generation from all sources in NYISO in 2014 decreased by 8.4 million MWh, or 5.7 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 electric generation from RGGI generation in NYISO decreased by 9.2 million MWh, or 13.6 percent, and CO_2 emissions from RGGI generation in NYISO decreased by 16.7 million short tons of CO_2, a reduction of 31.8 percent. The CO_2 emission rate of RGGI electric generation decreased by 326.3 lb CO_2MWh, a reduction of 21.0 percent. Compared to the 2006 to 2008 annual average, 2014 electric generation from non-RGGI generation located in NYISO increased by 763.2 thousand MWh, or 0.9 percent, and CO_2 emissions from this category of electric generation decreased by 4.0 million short tons of CO_2, a reduction of 52.3 percent. The CO_2 emission rate of non-RGGI electric generation located in NYISO decreased by 100.4 lb CO_2/MWh, a reduction of 52.6 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 net electricity imports into NYISO increased by 626.8 thousand MWh. CO_2 emissions related to these net electricity imports decreased by 3.5 million short tons of CO_2, or 44.8 percent. The CO_2 emission rate of the electric generation supplying these imports decreased by 370.4 lb CO_2/MWh, a reduction of 47.0 percent.

PJM (RGGI Portion)

Monitoring results for PJM for 2005 through 2014 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.[36]

[36] 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 – 2014 Monitoring Summary for RGGI PJM

	MWh									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
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	76,359,729
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	32,656,507
Net Imports - from NYISO	-636,765	-721,101	-772,843	-772,644	-570,096	-815,714	-697,456	-482,148	-490,493	-482,178
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	32,174,329
Electricity Generation										
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	26,733,539
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	71,744
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	17,380,117
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	17,451,861
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	44,185,400
Summary CO2 Emissions and MWh Data										
Annual CO2 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	26,733,539
	Tons CO2									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
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	43,832,735
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	17,971,031
Net Imports - from NYISO	-469,658	-529,065	-579,349	-555,899	-371,449	-572,275	-452,458	-290,358	-282,938	-285,333
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	17,685,699
Electricity Generation										
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	24,836,448
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	82,905
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	1,227,683
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	1,310,588
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	26,147,036
Summary CO2 Emissions and MWh Data										
Annual CO2 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	24,836,448

	lb CO2 /MWh									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Electricity Demand										
Total Annual Electricity Load in ISO	1,406	1,385	1,406	1,358	1,231	1,299	1,230	1,151	1,133	1,148
Net Imports - from Non-RGGI PJM	1,280	1,241	1,228	1,210	1,129	1,159	1,139	1,082	1,109	1,101
Net Imports - from NYISO	1,475	1,467	1,499	1,439	1,303	1,403	1,297	1,204	1,154	1,184
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	1,099
Electricity Generation										
Annual Electric Generation - RGGI-Affected Units	2,042	2,068	2,070	2,067	1,970	2,039	1,991	1,794	1,854	1,858
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	2,311
Annual Electric Generation - Non-Fossil Fuel-Fired Units	98	119	158	150	137	171	177	166	141	141
Annual Electric Generation - All Non-RGGI Units	129	141	182	166	153	185	193	190	152	150
Total Annual Electric Generation - All Units	1,475	1,467	1,499	1,439	1,303	1,403	1,297	1,204	1,154	1,184
Summary CO2 Emissions and MWh Data										
Annual CO2 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	1,858

The monitoring results indicate that annual average electric generation from all non-RGGI electric generation serving load in PJM for 2012 to 2014 increased by 5.2 million MWh, or 11.4 percent, compared to the annual average during the 2006 to 2008 base period. Annual average CO_2 emissions from this category of electric generation increased by 1.1 million short tons of CO_2, an increase of 5.8 percent, and the annual average CO_2 emission rate decreased by 41.8 lb CO_2/MWh, an decrease of 5.1 percent. (See Figures 21, 22, and 23).

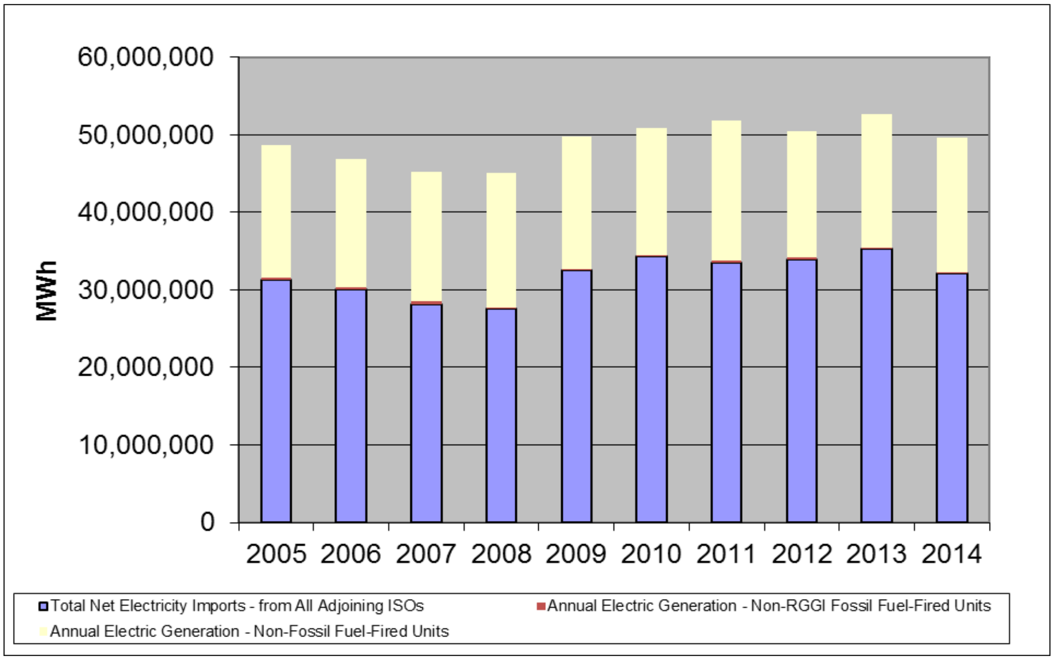

Figure 21. Non-RGGI Generation Serving Load in RGGI PJM (MWh)

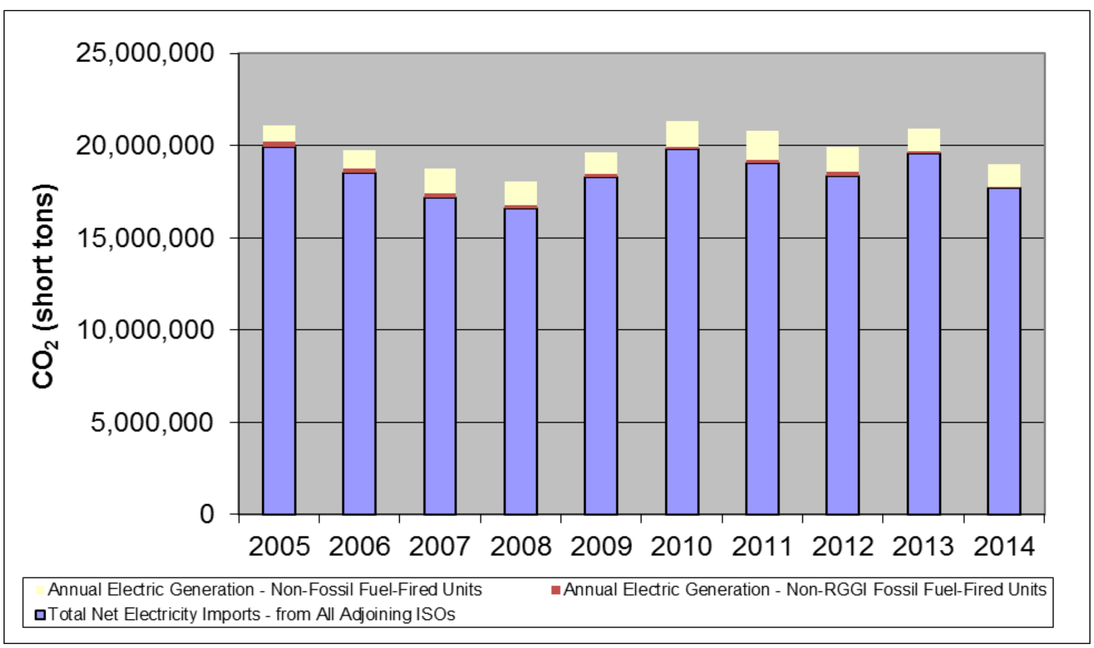

Figure 22. CO_2 Emissions from Non-RGGI Generation Serving Load in RGGI PJM (short tons CO_2)

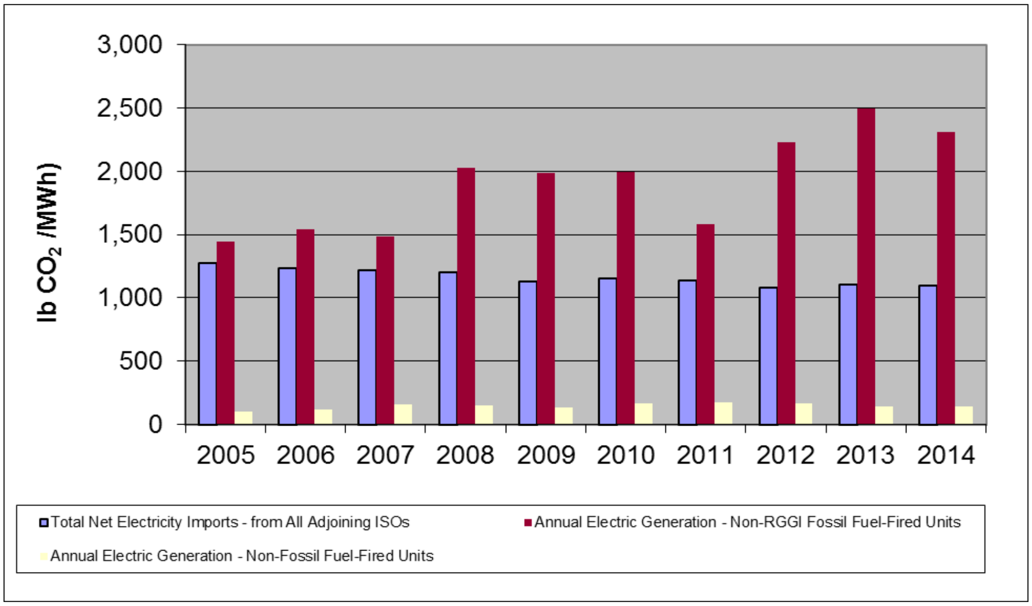

Figure 23. CO_2 Emission Rate for Non-RGGI Generation Serving Load in RGGI PJM (lb CO_2/MWh)

The annual average electricity load in PJM for 2012 to 2014 decreased by 5.4 million MWh, or 6.5 percent, compared to the annual average for the base period of 2006 to 2008. Annual average electric generation from all sources in PJM decreased by 10.7 million MWh, or 19.6 percent, when comparing the 2006 to 2008 annual average to the 2012 to 2014 annual average.

Annual average electric generation from RGGI generation in PJM decreased by 10.7 million MWh during this period, or 28.6 percent, and annual average CO_2 emissions from RGGI electric generation in PJM decreased by 14.1 million short tons of CO_2, or 36.7 percent. The annual average CO_2 emission rate of RGGI electric generation decreased by 232.9 lb CO_2/MWh, a reduction of 11.3 percent. Annual average electric generation from non-RGGI electric generation sources located in PJM decreased by 14.8 thousand MWh, or 0.1 percent, during this period, and annual average CO_2 emissions from this category of electric generation increased by 4.2 thousand short tons of CO_2, an increase of 0.3 percent. The annual average CO_2 emission rate of non-RGGI electric generation located in PJM increased by 1.2 lb CO_2/MWh, an increase of 0.7 percent.

Net electricity imports into PJM increased by 5.2 million MWh, when comparing the annual average during the base period of 2006 to 2008 to the annual average for 2012 to 2014. Annual average CO_2 emissions related to these net electricity imports increased by 1.1 million short tons of CO_2, or 6.3 percent, during this period. The annual average CO_2 emission rate of the electric generation supplying these imports decreased by 124.0 lb CO_2/MWh, a decrease of 10.2 percent. (See Figures 24 and 25).

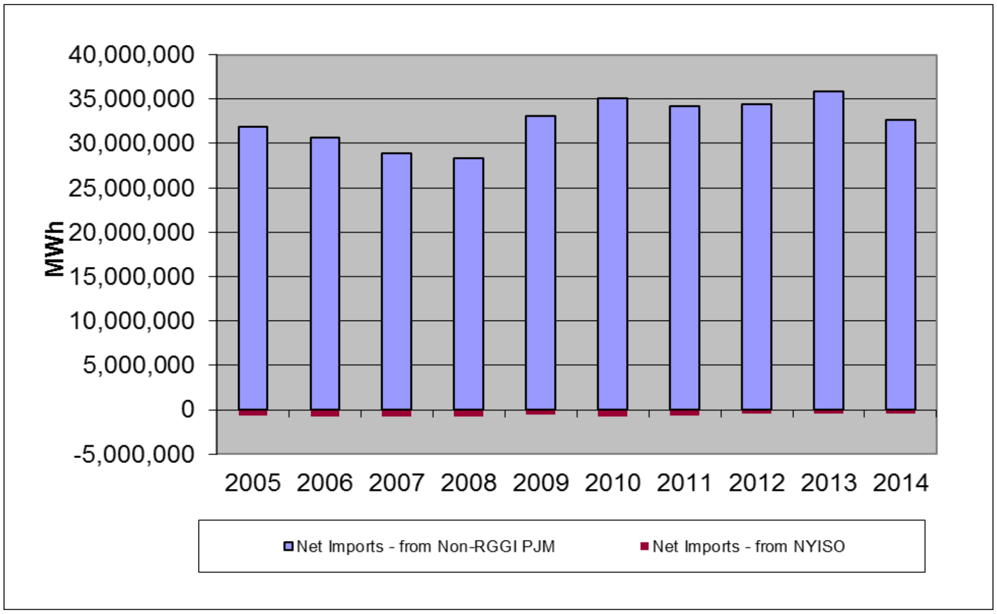

Figure 24. Net Electricity Imports to RGGI PJM (MWh)

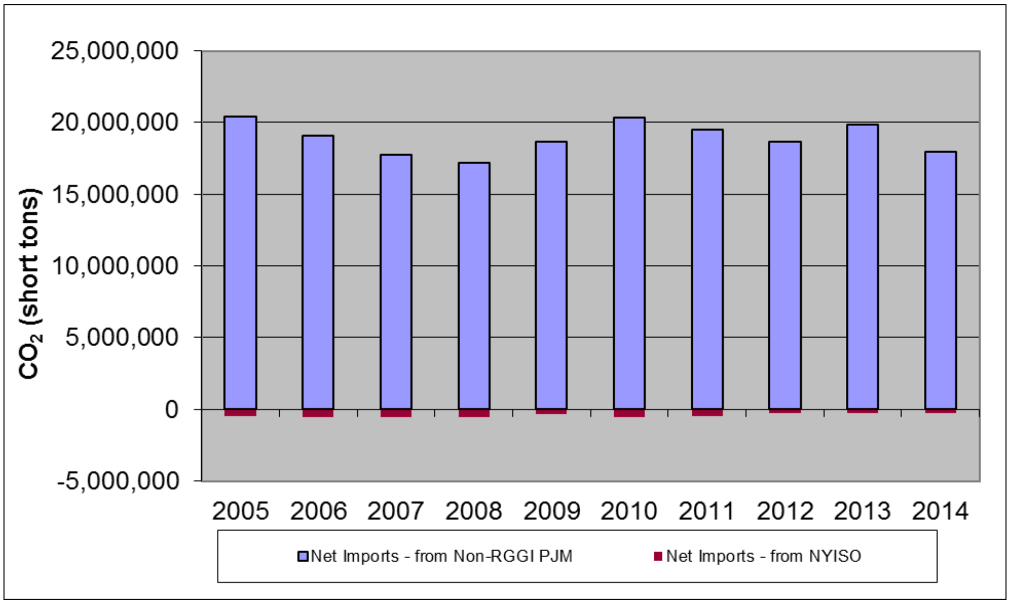

Figure 25. CO_2 Emissions Related to Net Electricity Imports to RGGI PJM (short tons CO_2)

Compared to the annual average during the base period of 2006 to 2008, electric generation in 2014 from all non-RGGI electric generation sources serving load in RGGI PJM increased by 3.9 million MWh, an increase of 8.6 percent. Compared to the 2006 to 2008 annual average, 2014 CO_2 emissions from this category of electric generation increased by 150.0 thousand short tons of CO_2, an increase of 0.8 percent, and the CO_2 emission rate decreased by 58.9 lb CO_2/MWh, a reduction of 7.1 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 electricity load in RGGI PJM decreased by 6.6 million MWh, or 8.0 percent. Compared to the 2006 to 2008 annual average, 2014 electric generation from all sources in RGGI PJM decreased by 10.2 million MWh, or 18.7 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 electric generation from RGGI generation in RGGI PJM decreased by 10.5 million MWh, or 28.3 percent, and CO_2 emissions from RGGI generation in RGGI PJM decreased by 13.7 million short tons of CO_2, or 35.6 percent. The CO_2 emission rate of RGGI electric generation decreased by 210.4 lb CO_2/MWh, a reduction of 10.2 percent. Compared to the 2006 to 2008 annual average, 2014 electric generation from non-RGGI generation located in RGGI PJM increased by 345.6 thousand MWh, or 2.0 percent, and CO_2 emissions from this category of electric generation decreased by 84.9 thousand short tons of CO_2, a decrease of 6.1 percent. The CO_2 emission rate of non-RGGI electric generation located in RGGI PJM decreased by 10.7 lb CO_2/MWh, a decrease of 6.6 percent.

Compared to the annual average during the 2006 to 2008 base period, 2014 net electricity imports into RGGI PJM increased by 3.6 million MWh. CO_2 emissions related to these net electricity imports increased by 241.0 thousand short tons of CO_2, or 1.4 percent, during this period, indicating a reduction in the average CO_2 emission rate of the electric generation supplying these imports of 120.4 lb CO_2/MWh, a reduction of 9.9 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, 2012 to 2014.

9-State RGGI Region

Table 8. Monitoring Trends for 9-State RGGI Region

	Non-RGGI Generation (In-Region)			RGGI Generation			Net Imports		
	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh
Annual average for 2006-2008 (base period)	153,362,597	18,650,769	243	177,165,152	138,362,771	1,561	55,997,235	25,224,000	904
Annual average for 2012-2014	158,513,639	18,694,036	236	141,913,224	89,030,032	1,256	75,048,040	24,963,849	665
Difference from base period	5,151,042	43,267	-7	-35,251,928	-49,332,739	-305	19,050,805	-260,150	-239
% change from base period	3.4%	0.2%	-3.0%	-19.9%	-35.7%	-19.5%	34.0%	-1.0%	-26.4%
2014	163,540,613	19,259,231	236	135,731,651	88,360,436	1,302	73,655,542	24,284,535	659
Difference from base period	10,178,016	608,462	-7	-41,433,501	-50,002,335	-259	17,658,307	-939,465	-245
% change from base period	6.6%	3.3%	-3.1%	-23.4%	-36.1%	-16.6%	31.5%	-3.7%	-27.1%

	Non-RGGI Generation (In-Region + Net Imports)			In-Region Generation	In-Region Load
	MWh	CO2 Emissions	lb CO2/MWh	MWh	MWh
Annual average for 2006-2008 (base period)	209,359,832	43,874,769	419	330,527,749	386,423,646
Annual average for 2012-2014	233,561,679	43,657,885	374	300,426,863	370,362,760
Difference from base period	24,201,847	-216,884	-45	-30,100,886	-16,060,886
% change from base period	11.6%	-0.5%	-10.8%	-9.1%	-4.2%
2014	237,196,155	43,543,766	367	299,272,264	364,133,729
Difference from base period	27,836,323	-331,002	-52	-31,255,485	-22,289,917
% change from base period	13.3%	-0.8%	-12.4%	-9.5%	-5.8%

ISO-NE

Table 9. Monitoring Trends for ISO-NE

	Non-RGGI Generation (In-Region)			RGGI Generation			Net Imports		
	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh
Annual average for 2006-2008 (base period)	55,659,215	9,559,313	343	72,282,789	47,242,267	1,307	7,196,667	-117,282	-42
Annual average for 2012-2014	61,446,088	13,479,824	438	55,503,212	29,654,322	1,073	17,418,844	1,313,508	131
Difference from base period	5,786,872	3,920,511	95	-16,779,577	-17,587,945	-234	10,222,177	1,430,789.91	173.35
% change from base period	10.4%	41.0%	27.7%	-23.2%	-37.2%	-17.9%	142.0%	[37]	[38]
2014	64,728,356	14,275,267	441	50,594,190	27,663,980	1,094	20,647,531	2,262,051	219
Difference from base period	9,069,141	4,715,954	98	-21,688,599	-19,578,287	-213	13,450,864	2,379,332	261
% change from base period	16.3%	49.3%	28.6%	-30.0%	-41.4%	-16.3%	186.9%	[39]	[40]

	Non-RGGI Generation (In-Region + Net Imports)			In-Region Generation	In-Region Load
	MWh	CO2 Emissions	lb CO2/MWh	MWh	MWh
Annual average for 2006-2008 (base period)	62,855,882	9,442,031	300	127,942,004	135,037,333
Annual average for 2012-2014	78,864,931	14,793,332	373	116,949,300	129,255,667
Difference from base period	16,009,049	5,351,301	73	-10,992,705	-5,781,667
% change from base period	25.5%	56.7%	24.2%	-8.6%	-4.3%
2014	85,375,887	16,537,318	387	115,322,546	127,176,000
Difference from base period	22,520,005	7,095,286	87	-12,619,458	-7,861,333
% change from base period	35.8%	75.1%	28.9%	-9.9%	-5.8%

[37] ISONE changed from a net exporter to a net importer from NY in 2013. This percent change was not reconciled.
[38] See footnote 34
[39] See footnote 34
[40] See footnote 34
[41] 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.

NYISO

Table 10. Monitoring Trends for NYISO

	Non-RGGI Generation (In-Region)			RGGI Generation			Net Imports		
	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh
Annual average for 2006-2008 (base period)	80,597,157	7,695,928	191	67,607,068	52,567,819	1,554	20,206,894	7,864,883	787
Annual average for 2012-2014	79,976,111	3,814,472	95	59,790,131	34,961,902	1,170	23,800,523	4,917,175	414
Difference from base period	-621,046	-3,881,455	-95	-7,816,937	-17,605,917	-384	3,593,629	-2,947,708	-374
% change from base period	-0.8%	-50.4%	-49.9%	-11.6%	-33.5%	-24.7%	17.8%	-37.5%	-47.5%
2014	81,360,396	3,673,376	90	58,403,922	35,860,008	1,228	20,833,682	4,344,109	417
Difference from base period	763,239	-4,022,551	-100	-9,203,146	-16,707,811	-326	626,788	-3,520,774.42	-370.43
% change from base period	0.9%	-52.3%	-52.6%	-13.6%	-31.8%	-21.0%	3%	-45%	-47%

	Non-RGGI Generation (In-Region + Net Imports)			In-Region Generation	In-Region Load
	MWh	CO2 Emissions	lb CO2/MWh	MWh	MWh
Annual average for 2006-2008 (base period)	100,804,051	15,560,811	309	148,204,225	168,411,119
Annual average for 2012-2014	103,776,634	8,731,648	168	139,766,242	163,566,765
Difference from base period	2,972,583	-6,829,163	-140	-8,437,983	-4,844,354
% change from base period	2.9%	-43.9%	-45.5%	-5.7%	-2.9%
2014	102,194,078	8,017,485	157	139,764,318	160,598,000
Difference from base period	1,390,027	-7,543,326	-152	-8,439,907.33	-7,813,119
% change from base period	1%	-48%	-49%	-6%	-4.6%

RGGI-PJM

Table 11. Monitoring Trends for RGGI-PJM

	Non-RGGI Generation (In-Region)			RGGI Generation			Net Imports		
	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh	MWh	CO2 Emissions	lb CO2/MWh
Annual average for 2006-2008 (base period)	17,106,225	1,395,529	163	37,275,295	38,552,685	2,068	28,593,674	17,444,734	1,220
Annual average for 2012-2014	17,091,440	1,399,740	164	26,619,881	24,413,808	1,836	33,829,007	18,535,951	1,096
Difference from base period	-14,784	4,211	1	-10,655,414	-14,138,877	-233	5,235,332	1,091,217	-124
% change from base period	-0.1%	0.3%	0.7%	-28.6%	-36.7%	-11.3%	18.3%	6.3%	-10.2%
2014	17,451,861	1,310,588	152	26,733,539	24,836,448	1,858	32,174,329	17,685,699	1,099
Difference from base period	345,636	-84,941	-11	-10,541,756	-13,716,237	-210	3,580,654	240,965	-120
% change from base period	2.0%	-6.1%	-6.6%	-28.3%	-35.6%	-10.2%	12.5%	1.4%	-9.9%

	Non-RGGI Generation (In-Region + Net Imports)			In-Region Generation	In-Region Load
	MWh	CO2 Emissions	lb CO2/MWh	MWh	MWh
Annual average for 2006-2008 (base period)	45,699,899	18,840,263	825	54,381,519	82,975,194
Annual average for 2012-2014	50,920,447	19,935,690	783	43,711,321	77,540,328
Difference from base period	5,220,548	1,095,428	-42	-10,670,198	-5,434,866
% change from base period	11.4%	5.8%	-5.1%	-19.6%	-6.5%
2014	49,626,190	18,996,287	766	43,711,321	76,359,729
Difference from base period	3,926,291	156,024	-58.9	-10,670,198	-6,615,465
% change from base period	8.6%	0.8%	-7.1%	-19.6%	-8.0%

Appendix D. Concept of "Emissions Leakage"

"Emissions leakage" is the concept that the RGGI CO_2 compliance obligation and related CO_2 compliance costs for electric generators could result in a shift of electricity generation from CO_2-emitting sources subject to the RGGI CO_2 Budget Trading Program to CO_2-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_2 Budget Trading Program, rather than other factors that influence electric power sector CO_2 emissions. The concept of emissions leakage presumes that an increase in electricity production costs for certain electric generators due to RGGI CO_2 compliance costs would be the driver of changes in the operation of the electric power system that result in an increase in CO_2 emissions from electric generation that is not subject to the RGGI CO_2 Budget Trading Program.

Factors that Influence Electric Generator Dispatch and CO_2 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_2, NO_X, and SO_2 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_2 emissions, through a highly dynamic wholesale electricity market.

The concept of emissions leakage assumes a scenario in which only a subset of CO_2-emitting electric generators are subject to a CO_2 allowance requirement.[41] As a result, certain electric generators are subject to an additional production cost – the cost of CO_2 allowances – that is not faced by other CO_2-emitting electric generators. In theory, this could result in a shift in electric generation to emitting units that do not face a

[41] 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.

CO_2 compliance cost. If such a shift results in an increase in CO_2 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_2 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”.