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: 2015 Monitoring Report

April 27, 2018

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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.

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Executive Summary

This report, the seventh report in a series of annual monitoring reports, summarizes data for the period from 2005 through 2015, 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) third 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 2013 to 2015 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 a small change in CO_2 emissions from total non-RGGI electric generation serving load in the nine-state RGGI region during the period of 2013 to 2015 when compared to the base period, and the CO_2 emissions from this category for the 2015 calendar year show there has been virtually no change when compared to the base period.

Summary of Results

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 2013 to 2015 decreased by 18.3 million MWh, or 4.7 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 2013 to 2015 decreased by 33.1 million MWh, or 10.0 percent, compared to the average for 2006 to 2008.

    - Annual average net imports into the nine-state RGGI region from 2013 to 2015 increased by 21.2 million MWh, or 37.9 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 2015 calendar year show a similar reduction compared to the annual average during the base period from 2006 to 2008.

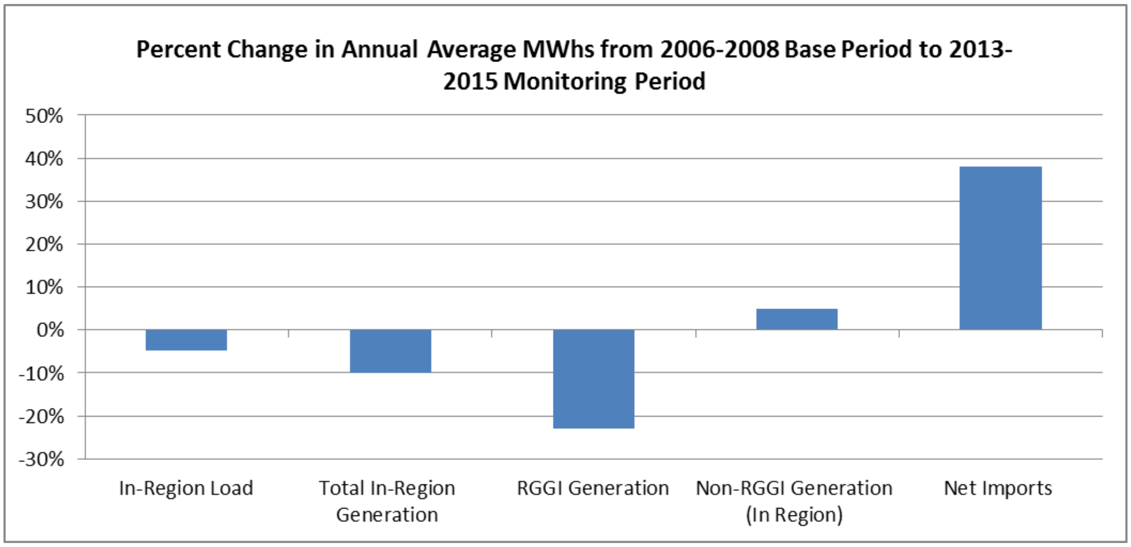

Figure 1. Percentage change in annual average electricity load and generation serving the nine-state RGGI region for 2013 to 2015, relative to the base period of 2006 to 2008.

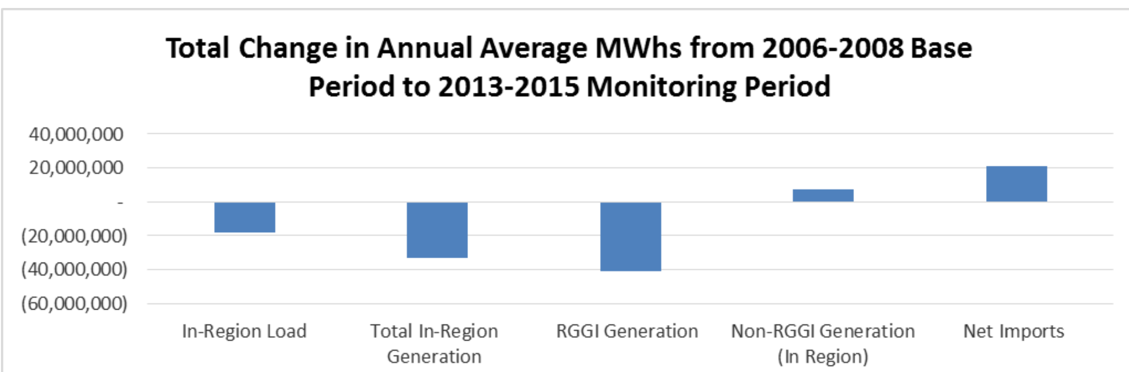

Figure 2. Change in MWhs of annual average electricity load and generation serving the nine-state RGGI Region for 2013 to 2015, relative to the base period of 2006 to 2008.

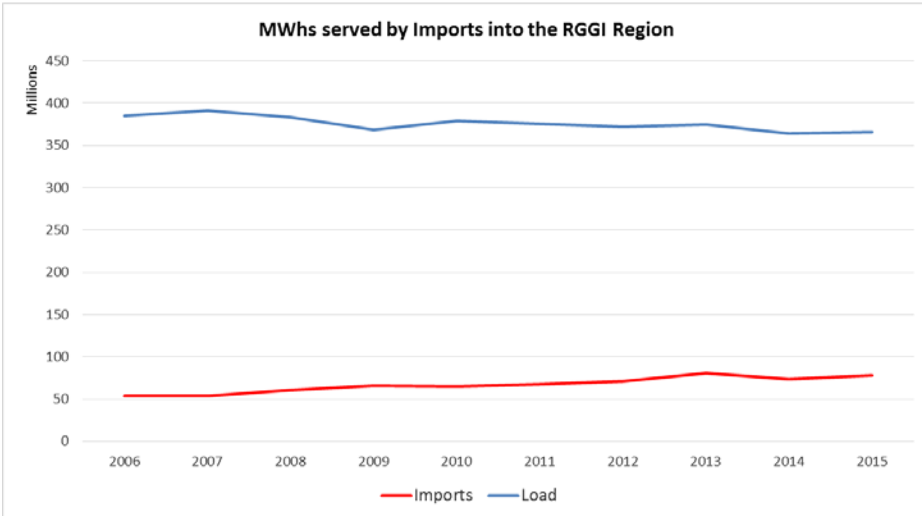

Figure 3. MWhs of load served by imports to the RGGI region from 2006-2015

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

The monitoring results indicate there was a small increase of 603 thousand short tons of CO_2, or 1.4 percent, in **CO_2 emissions** from non-RGGI electric generation serving load in the nine-state RGGI region for 2013 to 2015 relative to the base period of 2006 to 2008. The CO_2 emissions from this category for the 2015 calendar year show there has been a 0.2 percent decrease when compared to the base period.

- The annual average **CO_2 emissions rate** from all non-RGGI electric generation sources serving load in the RGGI region for 2013 to 2015 decreased by 45.6 lb CO_2/MWh, or 10.9 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 2013 to 2015 increased by 28.7 million MWh, or 13.7 percent, compared to the base period of 2006 to 2008.
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    - Of the 28.7 million MWh, 12.2 percent was due to in-region non-fossil fuel-fired generation, 13.9 percent was due to in-region non-RGGI fossil fuel-fired generation, and 73.9 percent was due to net imports.[3]

[3] In the calendar year 2015, non-RGGI electric generation was comprised of 61.1% in-region non-fossil fuel-fired generation, 32.9% net imports, and 6.0% in-region non-RGGI fossil fuel-fired generation. Further details on non-RGGI electric generation sources, including emissions intensity, can be found in Table 1 on pp. 15-16.

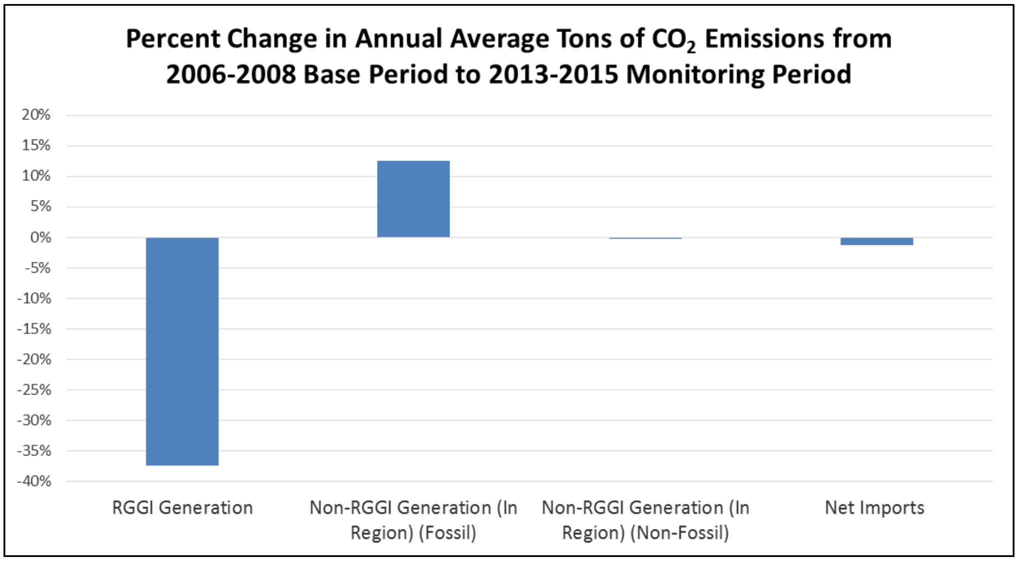

Figure 4. Percent change in annual average CO_2 emissions from generation serving load in the nine-state RGGI region for 2013 to 2015, relative to the base period of 2006 to 2008.

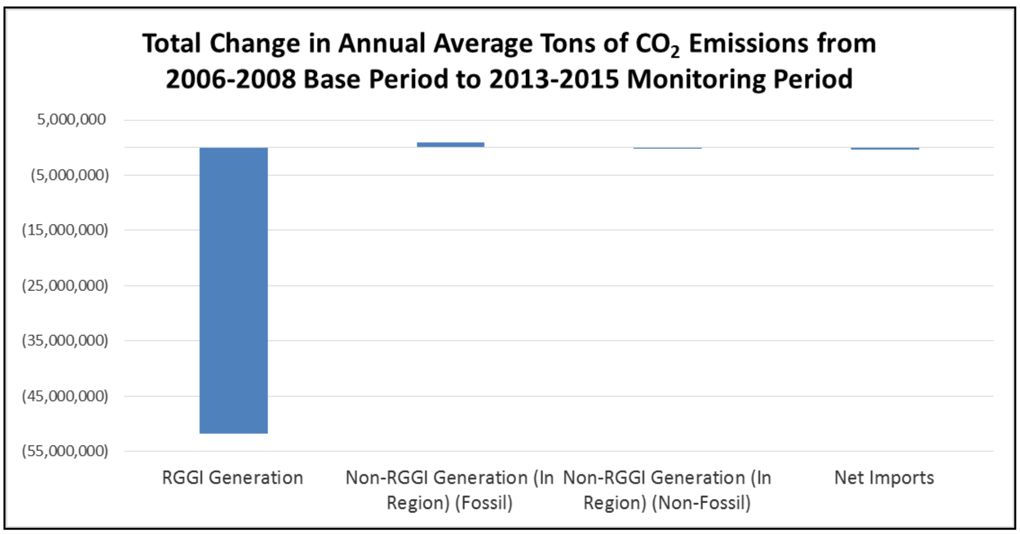

Figure 5. Change in annual average CO_2 emissions from generation serving load in the nine-state RGGI region for 2013 to 2015, relative to the base period of 2006 to 2008.

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

- The annual average **CO_2 emissions** from RGGI electric generation sources from 2013 to 2015 decreased by 51.8 million short tons of CO_2, or 37.4 percent, compared to the base period of 2006 to 2008.

- The annual average **CO_2 emissions rate** from RGGI electric generation sources from 2013 to 2015 decreased by 293.2 lb CO_2/MWh, or 18.8 percent, compared to the base period of 2006 to 2008.

- The annual average **electric generation** from RGGI electric generation sources from 2013 to 2015 decreased by 40.6 million MWh, or 22.9 percent, compared to the base period of 2006 to 2008.

- Both **electric generation** and **CO_2 emissions** from RGGI electric generation sources in the 2015 calendar year show a similar reduction compared to the annual average for the baseline period from 2006 to 2008.

Conclusions

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. Monitoring results show that there has been an increase in the amount of non-RGGI electric generation serving load in the RGGI region, combined with a decrease in the CO_2 emissions rate of this generation. These two trends largely offset one another. Overall, the monitoring results show that there has been a 1.4 percent increase in average annual CO_2 emissions from non-RGGI electric generation serving load in the RGGI region during the period of 2013 to 2015 when compared to the base period, and a 0.2 percent decrease for the calendar year 2015 when compared to the base period.

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 2015. 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[4] to result in "emissions leakage".[5] 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*.[6,7]

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.[8]

[4] 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.

[5] 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.

[6] 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 il_report_final_3_14_07.pdf.

[7] This report for 2015 is the fourth 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.

[8] 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 ISO-NE

For each year 2005 through 2015, the following categories of data are presented for the nine-state RGGI region as well as for each 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.[9]

- 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). 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 2013 to 2015 to the base period from 2006 to 2008. The period of 2006 to 2008 represents the three years 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

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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.

[9] 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.

[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.

Generation and Imports in the 10-State Regional Greenhouse Gas Initiative: 2009, 2010, and 2011 Monitoring Reports.[11] For 2012, 2013, 2014, and 2015, 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 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 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 2013 to 2015, 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 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.

[11] Reports available at https://www.rggi.org/sites/default/files/Uploads/Electricity-Monitoring-Reports/2009_Elec_Monitoring_Report.pdf, https://www.rggi.org/sites/default/files/Uploads/Electricity-Monitoring-Reports/2010_Elec_Monitoring_Report.pdf, and https://www.rggi.org/sites/default/files/Uploads/Electricity-Monitoring-Reports/2011_Elec_Monitoring_Report.pdf.

[12] Reports available at https://www.rggi.org/sites/default/files/Uploads/Electricity-Monitoring-Reports/2012_Elec_Monitoring_Report.pdf, https://www.rggi.org/sites/default/files/Uploads/Electricity-Monitoring-Reports/2013_Elec_Monitoring_Report.pdf, and https://www.rggi.org/sites/default/files/Uploads/Electricity-Monitoring-Reports/2014_Elec_Monitoring_Report.pdf.

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 (RGGI COATS) and 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.

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

[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 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).
[14] For PJM, this represents inferred imports from the non-RGGI geographic portion of PJM.

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 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.

[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.

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 2015 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 may 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 – 2015 Monitoring Summary for 9-State RGGI Region

MWh	Electricity Serving In-Region Demand (MWh)							In-Region Electricity Generation (MWh)					*Summary Data*
	Total in RGGI	**Net Imports - from Ontario to NYISO**	**Net Imports - from Quebec to NY & NE**	**Net Imports - from New Brunswick to NE**	**Net Imports - from non-RGGI PJM to NY**	**Net Imports - from non-RGGI PJM to RGGI PJM**	**Total Net Imports - from All Adjoining ISOs**	**RGGI-Affected Units**	**Non-RGGI Fossil Fuel-Fired Units**	**Non-Fossil Fuel-Fired Units**	**All Non-RGGI Units**	**All Units**	**Non-RGGI Generation (Non-RGGI Generation within RGGI + Net Imports)**
2005	393,135,125	1,898,020	7,375,317	1,620,000	6,967,235	31,878,151	49,738,723	192,701,229	13,470,422	143,309,339	156,779,761	343,396,401	206,518,484
2006	384,993,562	3,672,282	8,982,749	1,047,000	8,837,899	30,716,157	53,256,087	175,006,362	12,878,596	144,088,563	156,967,159	331,737,475	210,223,246
2007	391,243,211	2,637,442	11,912,292	896,000	9,452,157	28,944,540	53,842,431	185,936,729	11,431,101	140,249,677	151,680,778	337,400,780	205,523,209
2008	383,034,165	6,162,902	15,141,014	1,285,000	9,917,356	28,386,914	60,893,186	170,552,364	7,405,729	144,034,126	151,439,855	322,140,979	212,333,041
2009	368,848,273	6,463,657	17,065,805	1,569,000	7,760,904	33,089,871	65,949,237	151,406,757	6,621,598	145,330,499	151,952,097	302,899,036	217,901,334
2010	378,723,230	3,872,635	13,549,209	737,000	11,489,286	35,142,720	64,790,850	165,483,896	6,920,343	142,317,557	149,237,900	313,931,380	214,028,750
2011	375,309,279	3,318,681	18,681,204	846,000	10,452,544	34,250,993	67,549,422	157,544,937	6,815,348	144,941,142	151,756,490	307,759,857	219,305,912
2012	372,082,306	5,749,461	22,312,689	643,000	7,926,652	34,442,085	71,073,887	152,145,642	10,417,967	141,089,579	151,507,546	301,007,419	222,581,433
2013	374,872,244	7,593,954	24,566,017	3,711,000	8,700,473	35,843,247	80,414,691	137,862,378	13,553,456	146,939,303	160,492,759	294,458,553	240,907,450
2014	364,133,729	7,180,281	22,052,178	3,527,050	8,239,526	32,656,507	73,655,542	135,731,651	15,902,317	147,638,296	163,540,613	292,306,718	237,196,155
2015	365,508,854	8,302,624	22,375,396	4,108,000	7,144,877	35,680,933	77,611,830	135,968,708	14,260,710	144,342,651	158,603,360	289,855,382	236,215,190

CO_2	Tons of CO_2 from Electricity Serving In-Region Demand							Tons of CO_2 from in-Region Electricity Generation					*Summary Data*
	Total in RGGI	**Net Imports - from Ontario to NYISO**	**Net Imports - from Quebec to NY & NE**	**Net Imports - from New Brunswick to NE**	**Net Imports - from non-RGGI PJM to NY**	**Net Imports - from non-RGGI PJM to RGGI PJM**	**Total Net Imports - from All Adjoining ISOs**	**RGGI-Affected Units**	**Non-RGGI Fossil Fuel-Fired Units**	**Non-Fossil Fuel-Fired Units**	**All Non-RGGI Units**	**All Units**	**Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)**
2005	202,257,890	460,286	30,081	714,298	4,460,362	20,408,108	26,073,134	159,287,880	10,309,984	6,586,892	16,896,876	176,184,756	42,970,011
2006	186,429,034	769,120	39,607	547,053	5,484,024	19,059,750	25,899,553	139,924,128	10,134,399	10,470,954	20,605,352	160,529,481	46,504,906
2007	189,347,375	604,715	39,262	455,316	5,801,823	17,766,431	24,667,547	145,789,425	8,443,421	10,446,982	18,890,403	164,679,828	43,557,950
2008	170,936,211	1,154,884	41,725	736,564	5,999,390	17,172,335	25,104,898	129,374,761	4,662,824	11,793,728	16,456,552	145,831,312	41,561,450
2009	145,619,529	712,496	67,723	968,535	4,381,845	18,682,706	24,813,304	105,958,243	4,263,698	10,584,284	14,847,982	120,806,225	39,661,286
2010	160,228,032	554,950	37,339	406,202	6,656,944	20,361,849	28,017,283	116,053,938	5,355,842	10,800,970	16,156,812	132,210,749	44,174,095
2011	144,442,984	336,556	47,363	410,324	5,952,203	19,504,235	26,250,682	101,456,734	5,401,761	11,333,807	16,735,567	118,192,302	42,986,250
2012	133,558,349	602,081	66,408	297,690	4,287,069	18,627,737	23,880,985	92,212,271	6,459,299	11,005,795	17,465,094	109,677,364	41,346,079
2013	132,601,199	795,236	54,159	1,186,296	4,822,624	19,867,713	26,726,027	86,517,389	8,193,802	11,163,981	19,357,783	105,875,172	46,083,810
2014	131,904,203	603,144	48,617	1,127,493	4,534,250	17,971,031	24,284,535	88,360,436	8,974,623	10,284,609	19,259,231	107,619,667	43,543,766
2015	128,629,577	697,420	51,796	1,313,206	3,602,223	17,989,208	23,653,852	84,823,838	8,985,467	11,166,421	20,151,887	104,975,725	43,805,740

lbs CO_2/ MWh	Emissions Rate for Electricity Serving In-Region Demand							Emissions Rate for In-Region Electricity Generation					*Summary Data*
	Total in RGGI	**Net Imports - from Ontario to NYISO**	**Net Imports - from Quebec to NY & NE**	**Net Imports - from New Brunswick to NE**	**Net Imports - from non-RGGI PJM to NY**	**Net Imports - from non-RGGI PJM to RGGI PJM**	**Total Net Imports - from All Adjoining ISOs**	**RGGI-Affected Units**	**Non-RGGI Fossil Fuel-Fired Units**	**Non-Fossil Fuel-Fired Units**	**All Non-RGGI Units**	**All Units**	**Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)**
2005	1,029	485	8	882	1,280	1,280	1,048	1,653	1,531	92	216	1,026	416
2006	968	419	9	1,045	1,241	1,241	973	1,599	1,574	145	263	968	442
2007	968	459	7	1,016	1,228	1,228	916	1,568	1,477	149	249	976	424
2008	893	375	6	1,146	1,210	1,210	825	1,517	1,259	164	217	905	391
2009	790	220	8	1,235	1,129	1,129	752	1,400	1,288	146	195	798	364
2010	846	287	6	1,102	1,159	1,159	865	1,403	1,548	152	217	842	413
2011	770	203	5	970	1,139	1,139	777	1,288	1,585	156	221	768	392
2012	718	209	6	926	1,082	1,082	672	1,212	1,240	156	231	729	372
2013	707	209	4	639	1,109	1,109	665	1,255	1,209	152	241	719	372
2014	724	168	4	639	1,101	1,101	659	1,302	1,129	139	236	736	367
2015	704	168	5	639	1,008	1,008	610	1,248	1,260	155	254	724	371

The monitoring results indicate that the 2013 to 2015 annual average electricity load in the nine-state RGGI region decreased by 18.3 million MWh, or 4.7 percent, compared to the 2006 to 2008 base period. Annual average electric generation from all sources in the nine-state RGGI region decreased by 33.1 million MWh, or 10.0 percent, compared to the base period.

Annual average electric generation from RGGI generation decreased by 40.6 million MWh during this period, or 22.9 percent, and annual average CO_2 emissions from RGGI generation decreased by 51.8 million short tons, or 37.4 percent. The annual average CO_2 emission rate of RGGI generation decreased by 293.2 lb CO_2/MWh, a decrease of 18.8 percent. Annual average electric generation from non-RGGI generation sources located in the nine-state RGGI region increased by 7.5 million MWh, or 4.9 percent, during this period, and annual average CO_2 emissions from this category of electric generation increased by 938.9 thousand short tons, an increase of 5.0 percent. The annual average CO_2 emission rate of non-RGGI electric generation located in the nine-state RGGI region increased by 0.6 lb CO_2/MWh, or 0.3 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 electricity load in the nine-state RGGI region decreased by 20.9 million MWh, or 5.4 percent, and 2015 electric generation from all sources in the nine-state RGGI region decreased by 36.0 million MWh, or 10.9 percent.

For 2013 to 2015, annual average electric generation from all non-RGGI electric generation serving load in the nine-state RGGI region increased by 28.7 million MWh, an increase of 13.7 percent, compared to the annual average generation for the baseline period of 2006 to 2008. In a comparison of the 2013 to 2015 annual average to the 2006 to 2008 base period, the CO_2 emissions from this category of electric generation increased by 603 thousand short tons of CO_2, an increase of 1.4 percent, and the CO_2 emission rate decreased by 45.6 lb CO_2/MWh, a reduction of 10.9 percent. (See Figures 6, 7, and 8.) The CO_2 emissions from this category of electric generation decreased by 0.2 percent for the calendar year 2015 when compared to the base period

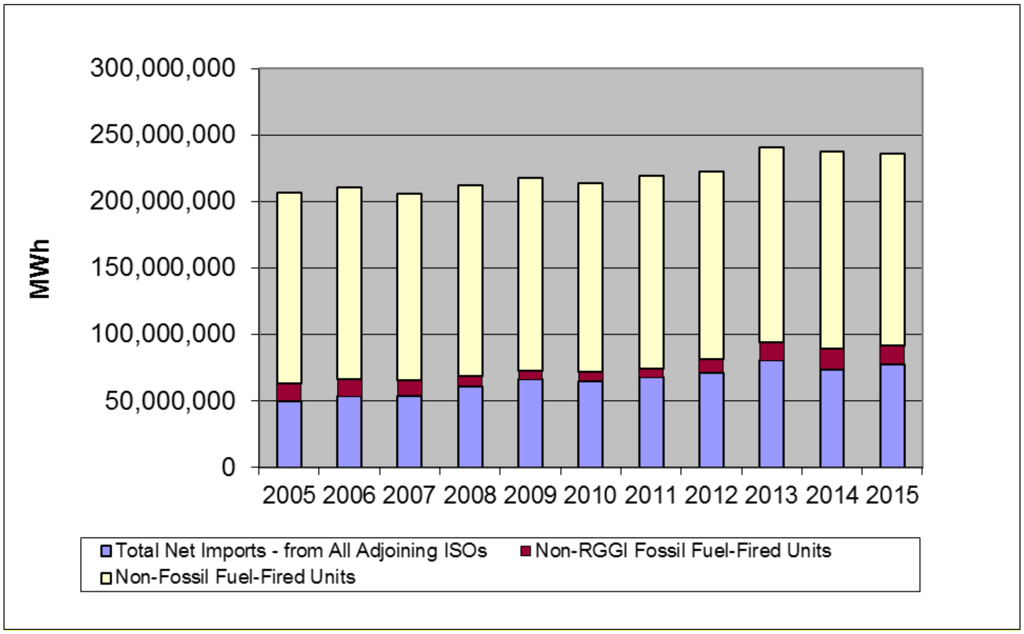

Figure 6. Non-RGGI Generation Serving Load in RGGI Region (MWh)

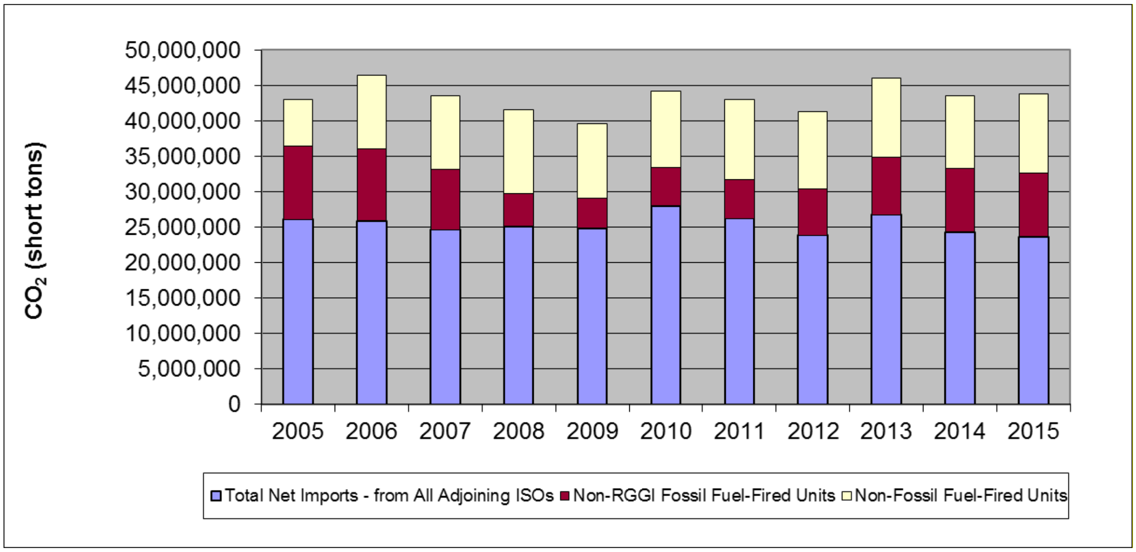

Figure 7. CO_2 Emissions from Non-RGGI Generation Serving Load in RGGI Region (short tons CO_2)

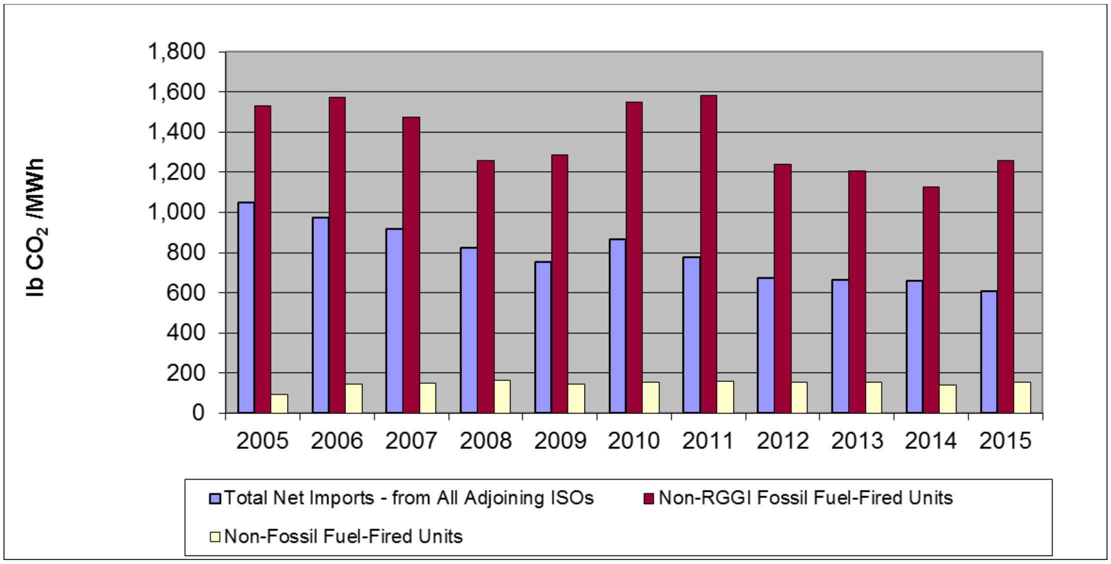

Figure 8. CO_2 Emission Rate for Non-RGGI Generation Serving Load in RGGI Region (lb CO_2/MWh)

Annual average net electricity imports into the nine-state RGGI region increased by 21.2 million MWh, or 37.9 percent, during the 2013 to 2015 annual average compared to the 2006 to 2008 base period. CO_2 emissions related to these net electricity imports decreased by 335.9 thousand short tons, or 1.3 percent, during this period, indicating a reduction in the average CO_2 emission rate of the electric generation supplying these imports of 259.9 lb CO_2/MWh, a reduction of 28.7 percent. (See Figures 9 and 10).

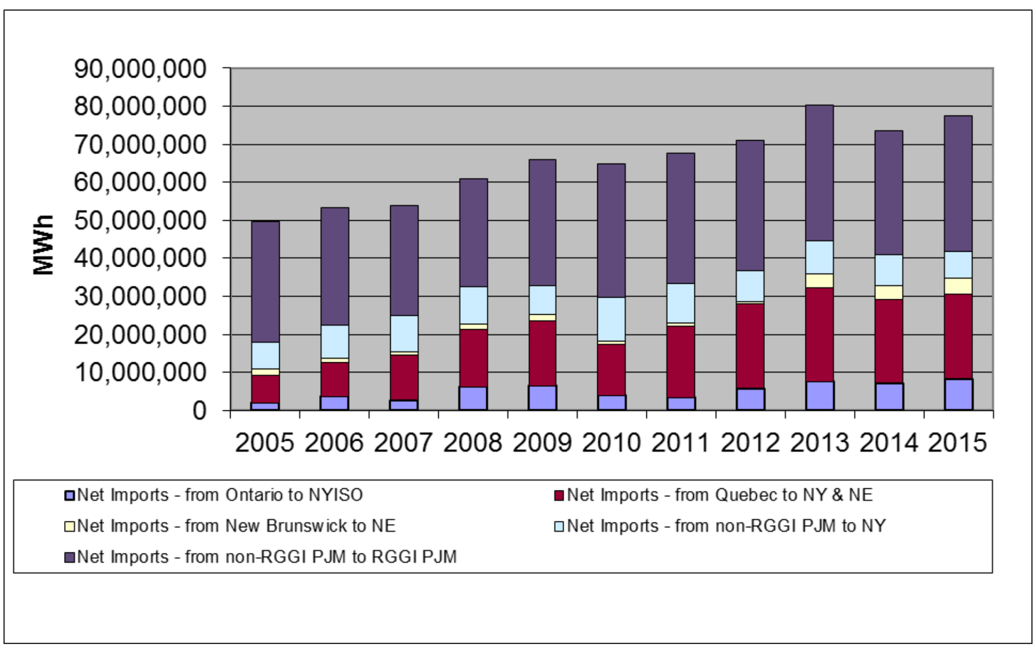

Figure 9. Net Electricity Imports to 9-State RGGI Region (MWh)

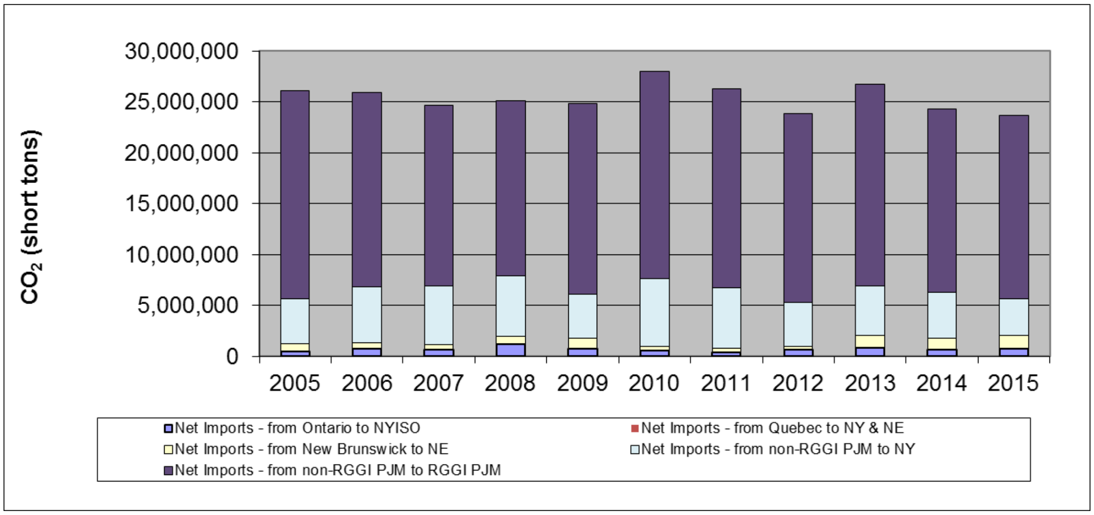

Figure 10. CO_2 Emissions Related to Net Electricity Imports to 9-State RGGI Region (short tons CO_2)

Compared to the annual average during the 2006 to 2008 base period, 2015 electric generation from RGGI generation decreased by 41.2 million MWh, or 23.3 percent, and CO_2 emissions from RGGI generation decreased by 53.5 million short tons of CO_2, or 38.7 percent. The CO_2 emission rate of RGGI electric generation decreased by 313.8 lb CO_2/MWh, a reduction of 20.1 percent. Compared to the 2006 to 2008 annual average, 2015 electric generation from non-RGGI generation sources located in the nine-state RGGI region increased by 5.2 million MWh, or 3.4 percent, and CO_2 emissions from this category of electric generation increased by 1.5 million short tons, an increase of 8.0 percent. The CO_2 emission rate of non-RGGI electric generation located in the nine-state RGGI region increased by 11.1 lb CO_2/MWh, or 4.6 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 net electricity imports into the nine-state RGGI region increased by 21.6 million MWh, or 38.6 percent. CO_2 emissions related to these net electricity imports decreased by 1.6 million short tons of CO_2, or 6.2 percent, during this period. The average CO_2 emission rate of the electric generation supplying these imports decreased 295.0 lb CO_2/MWh, a reduction of 32.6 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 5.3 percent of the average all-in wholesale electricity price for ISO-NE, 8 percent of the average all-in wholesale electricity price for NYISO in 2015, and 0.6 percent of the average all-in locational marginal price on a per MWh basis for PJM in 2015.[21] However, the 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 (2013-2015) 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]. In 2015, we see a decrease in wholesale prices compared to 2014.

A number of market drivers have changed dramatically during the 2005 through 2015 monitoring timeframe. These changes are due to a number of factors, including additional investments in energy efficiency and renewable energy (funded in part by

[21] For 2015, the average all-in wholesale electricity price was $49.54/MWh for ISO-NE and $44.09/MWh for NYISO, and the load-weighted average locational marginal price was $36.16/MWh for PJM (energy only) (See *ISO-NE Monthly Wholesale Load Cost Report; NYISO Power Trends 2016; 2015 State of the Market Report for PJM)*. The CO_2 allowance component is based on a 2015 average CO_2 allowance spot price of $6.10 per CO_2 allowance (See Potomac Economics, *Annual Report on the Market for RGGI CO_2 Allowances: 2015*). For PJM, the CO_2 allowance component of the Locational Marginal Price (LMP) for 2015 was $0.21 per MWh (See *2015 State of the Market Report for PJM*). 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 2015 average CO_2 allowance spot price of $6.10 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 price for CO_2 allowances into a dollar per MWh value. For ISO-NE, this resulted in an average CO_2 allowance wholesale price component of approximately $2.61 per MWh. For NYISO, this resulted in an average CO_2 allowance wholesale price component of $3.54 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.*

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 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),

[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 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.

[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.

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 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 2015 the real-time average LMP by jurisdiction in DE was \$0.42 and in MD was \$7.43 per MWh above the average PJM LMP, indicating the presence of some 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 losses are accounted for in the calculation of LMP through the application of a line loss

[30] Monitoring Analytics, *2015 State of the Market for PJM*, 2015; Section 2, Energy Market pp. 127; and Monitoring Analytics, *2015 State of the Market for PJM*; Appendix C pp. 543.

[31] As an example, the congestion component of the 2015 average day-ahead, load weighted LMP in the Delmarva Power & Light zone (Delaware and Maryland) zone of PJM was \$3.62 per MWh. For the Baltimore Gas & Electric zone (Maryland), the congestion component was \$9.61 per MWh. See, Monitoring Analytics, 2015 *State of the Market for PJM*; Section 11, Table 11-4, p. 419.

"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.

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. Monitoring results show that there has been an increase in the amount of non-RGGI electric generation serving load in the RGGI region, combined with a decrease in the CO_2 emissions rate of this generation. These two trends largely offset one another. Overall, the monitoring results show that there has been a 1.4 percent increase in average annual CO_2 emissions from non-RGGI electric generation serving load in the RGGI region during the period of 2013 to 2015, compared to the annual average annual CO_2 emissions during the base period of 2006 to 2008.

Emissions leakage may manifest through an increase in CO_2 emissions from this aggregate category of non-RGGI electric generation, all other factors being equal. However, given that the monitoring results presented in this report do not address causality, the results should be evaluated in context with market dynamics. Changes in factors such as electricity demand, relative fossil fuel prices, and wholesale electricity prices, can also play a role in changing emissions and generation trends.

When taking only costs into account and not including RGGI's economic benefits, the average CO_2 allowance price in 2015 represented approximately 8 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 price signal from RGGI allowances prices is likely lower

[32] As an example, the line loss component of the 2015 average day-ahead, load weighted LMP in the Delmarva Power & Light (Delaware and Maryland) zone of PJM was $1.44 per MWh. Similarly, for the Baltimore Gas & Electric zone (Maryland), the line loss component of LMP was $1.33 per MWh. See, Monitoring Analytics, 2015 *State of the Market for PJM*; Section 11, Table 11-4, p. 419.

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

than the aggregate per MWh price signal of mitigating market factors discussed in this report that would counter emissions leakage.

This report is the seventh 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 2015 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.

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	NYDPS Calculation	NYISO A-2 in Table 3 below	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	Sum of A2s	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 2015.[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)	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 1990–2014: Greenhouse Gas Sources and Sinks in* Canada, Environment Canada, 2016. In Part 3. Available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/9492.php. Note that New Brunswick and Quebec emission factors were updated for every year, as compared to the previous year's report.
4. Historical 2005 – 2008 CO_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 2015 CO_2 emissions data is from data reported to the RGGI CO_2 Allowance Tracking System (RGGI COATS), available at 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	NYDPS Calculation	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]	NYDPS Calculation	MWh multiplied by CO_2/MWh
B-2	Non-RGGI Units (Fossil Fuel-Fired)	NYDPS Calculation[5,9]	NYDPS Calculation	MWh multiplied by CO_2/MWh
B-3	Non-RGGI Units (Non-Fossil Fuel-Fired)	NYDPS Calculation[5]	NYDPS Calculation	MWh multiplied by CO_2/MWh
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 2015 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 1990–2014: Greenhouse Gas Sources and Sinks in* Canada, Environment Canada, 2016. In Part 3. Available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/9492.php. Note that Ontario and Quebec emission factors were updated for every year, as compared to the previous year's report.
7. Calculated average, based on Row B-5 in Table 2 above.
8. PJM Generation Attribute Tracking System, accessible at http://www.pjm-eis.com.
9. MWh and CO_2 emissions data include Linden Cogeneration, units 005001 – 009001, and 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 GATS[1]	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 2015. 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.[2,3]
B-2	Non-RGGI Units (Fossil Fuel-Fired)	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. 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 2015 CO_2 emissions data is from data reported to the RGGI CO_2 Allowance Tracking System (RGGI COATS), available at rggi-coats.org.
3. MWh and CO_2 emissions data do not include Maryland Limited Industrial Exemption Set-aside (LIESA) sources. LIESA sources for 2009-2015 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 2015 are summarized below in Table 5 and Figures 11 through 15.

Table 5. 2005 – 2015 Monitoring Summary for ISO-NE

MWh	Electricity Demand					Electricity Generation					*Summary Data*
	Total in ISO	Net Imports - from NYISO	Net Imports - from Quebec	Net Imports - from New Brunswick	Total Net Imports - from All Adjoining ISOs	RGGI-Affected Units	Non-RGGI Fossil Fuel-Fired Units	Non-Fossil Fuel-Fired Units	All Non-RGGI Units	All Units	Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)
2005	138,174,000	-115,000	4,792,000	1,620,000	6,297,000	83,393,126	6,047,616	48,520,847	54,568,463	131,877,000	60,865,463
2006	134,243,000	-877,000	6,023,000	1,047,000	6,193,000	70,911,131	5,288,020	52,086,895	57,374,915	128,050,000	63,567,915
2007	136,869,000	-2,477,000	7,727,000	896,000	6,146,000	75,345,502	4,484,003	51,110,222	55,594,225	130,723,000	61,740,225
2008	134,000,000	-1,529,000	9,495,000	1,285,000	9,251,000	70,591,734	2,636,229	51,372,277	54,008,506	124,749,000	63,259,506
2009	128,801,000	-3,031,000	10,826,000	1,569,000	9,363,000	65,426,926	2,723,023	51,746,869	54,469,892	119,437,000	63,832,892
2010	131,956,000	-4,412,000	9,214,000	737,000	5,539,000	71,314,622	3,103,920	52,787,874	55,891,794	126,416,000	61,430,794
2011	130,752,000	-2,262,000	11,558,000	846,000	10,142,000	69,466,788	3,345,904	49,338,878	52,684,782	120,610,000	62,826,782
2012	129,590,000	-1,073,000	13,077,000	643,000	12,648,000	62,481,082	6,491,004	50,615,683	57,106,687	116,942,000	69,754,687
2013	131,001,000	1,322,000	13,928,000	3,711,000	18,961,000	53,434,364	9,508,290	52,994,930	62,503,220	112,041,000	81,464,220
2014	127,176,000	3,908,078	13,212,403	3,527,050	20,647,531	50,594,190	11,217,889	53,510,467	64,728,356	108,357,000	85,375,887
2015	126,955,000	3,911,358	12,978,000	4,108,000	20,997,358	53,800,483	9,576,158	49,256,046	58,832,203	107,916,000	79,829,561

[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.

CO_2	Electricity Demand					Electricity Generation					Summary Data
	Total in ISO	Net Imports - from NYISO	Net Imports - from Quebec	Net Imports - from New Brunswick	Total Net Imports - from All Adjoining ISOs	RGGI-Affected Units	Non-RGGI Fossil Fuel-Fired Units	Non-Fossil Fuel-Fired Units	All Non-RGGI Units	All Units	Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)
2005	64,073,310	-55,282	19,544	714,298	678,560	54,223,939	4,091,940	5,078,871	9,170,811	63,394,750	9,849,372
2006	42,202,458	-398,599	26,557	547,053	175,010	47,783,423	3,608,234	6,807,476	10,415,709	58,199,133	10,590,720
2007	50,079,316	-1,118,781	25,468	455,316	-637,997	49,434,978	2,791,324	6,817,046	9,608,370	59,043,348	8,970,373
2008	54,286,213	-651,589	26,166	736,564	111,141	44,508,400	1,833,213	6,820,646	8,653,859	53,162,258	8,765,000
2009	44,334,489	-1,229,274	42,961	968,535	-217,778	38,815,561	2,184,820	7,439,324	9,624,143	48,439,704	9,406,366
2010	49,139,981	-1,833,018	25,392	406,202	-1,401,424	41,682,538	3,282,406	7,556,082	10,838,488	52,521,026	9,437,064
2011	43,513,964	-881,419	29,303	410,324	-441,792	35,469,318	3,546,928	7,981,091	11,528,018	46,997,336	11,086,227
2012	38,748,137	-396,832	38,920	297,690	-60,221	31,357,869	4,237,841	7,653,408	11,891,249	43,249,118	11,831,028
2013	45,952,769	521,693	30,706	1,186,296	1,738,695	29,941,118	6,607,005	7,665,951	14,272,956	44,214,074	16,011,651
2014	44,201,297	1,105,429	29,128	1,127,493	2,262,051	27,663,980	6,945,165	7,330,102	14,275,267	41,939,247	16,537,318
2015	45,409,522	1,011,086	30,042	1,313,206	2,354,334	29,108,169	6,179,947	7,767,072	13,947,019	43,055,188	16,301,353

lbs CO_2/ MWh	Electricity Demand					Electricity Generation					Summary Data
	Total in ISO	Net Imports - from NYISO	Net Imports - from Quebec	Net Imports - from New Brunswick	Total Net Imports - from All Adjoining ISOs	RGGI-Affected Units	Non-RGGI Fossil Fuel-Fired Units	Non-Fossil Fuel-Fired Units	All Non-RGGI Units	All Units	Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)
2005	927	961	8	882	216	1,300	1,353	209	336	961	324
2006	629	909	9	1,045	57	1,348	1,365	261	363	909	333
2007	732	903	7	1,016	-208	1,312	1,245	267	346	903	291
2008	810	852	6	1,146	24	1,261	1,391	266	320	852	277
2009	688	811	8	1,235	-47	1,187	1,605	288	353	811	295
2010	666	831	6	1,102	-506	1,169	2,115	286	388	831	307
2011	666	779	5	970	-87	1,021	2,120	324	438	779	353
2012	598	740	6	926	-10	1,004	1,306	302	416	740	339
2013	702	789	4	639	183	1,121	1,390	289	457	789	393
2014	695	566	4	639	219	1,094	1,238	274	441	774	387
2015	715	517	5	639	224	1,082	1,291	315	474	798	408

The monitoring results indicate that the annual average electricity load in ISO-NE for 2013 to 2015 decreased by 6.7 million MWh, or 4.9 percent, compared to the annual average for the baseline period of 2006 to 2008. Electric generation from all sources in ISO-NE decreased by 13.3 million MWh, or 10.4 percent, when comparing the 2006 to 2008 annual average to the 2013 to 2015 annual average.

Annual average electric generation from RGGI generation in ISO-NE decreased by 19.7 million MWh during this period, or 27.2 percent, and annual average CO_2 emissions from RGGI electric generation in ISO-NE decreased by 18.3 million short tons of CO_2, or 38.8 percent. The CO_2 emission rate of RGGI electric generation decreased by 208.2 lb CO_2/MWh, or 15.9 percent. Annual average electric generation from non-RGGI electric generation sources located in ISO-NE increased by 6.4 million MWh, or 11.4 percent, during this period, and CO_2 emissions from this category of electric generation increased by 4.6 million short tons of CO_2, an increase of 48.2 percent. The annual average CO_2 emission rate of non-RGGI electric generation located in ISO-NE increased by 114.2 lb CO_2/MWh, an increase of 33.3 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 total electricity load in ISO-NE decreased by 8.1 million MWh, or 6.0 percent. Compared to the 2006 to 2008 annual average, 2015 total electric generation in ISO-NE decreased by 15.3 million MWh, or 12.0 percent.

When the 2013 to 2015 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 19.4 million MWh, or 30.8 percent. When the 2006 to 2008 base period annual average is compared to the 2013 to 2015 annual average, CO_2 emissions from this category of electric generation increased by 6.8 million short tons of CO_2, or 72.5 percent, and the CO_2 emission rate increased by 95.9 lb CO_2/MWh, or 31.9 percent. (See Figures 11, 12, and 13).

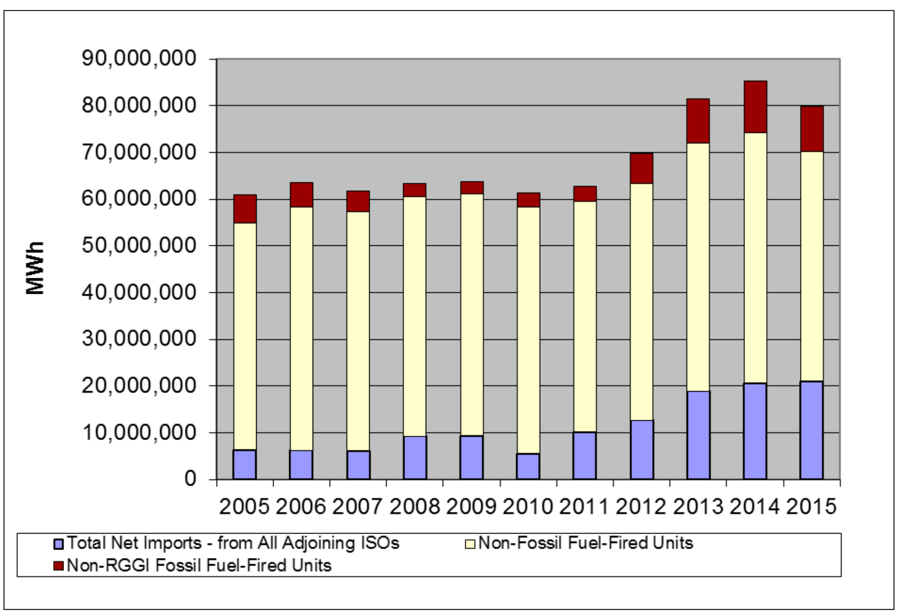

Figure 11. Non-RGGI Generation Serving Load in ISO-NE (MWh)

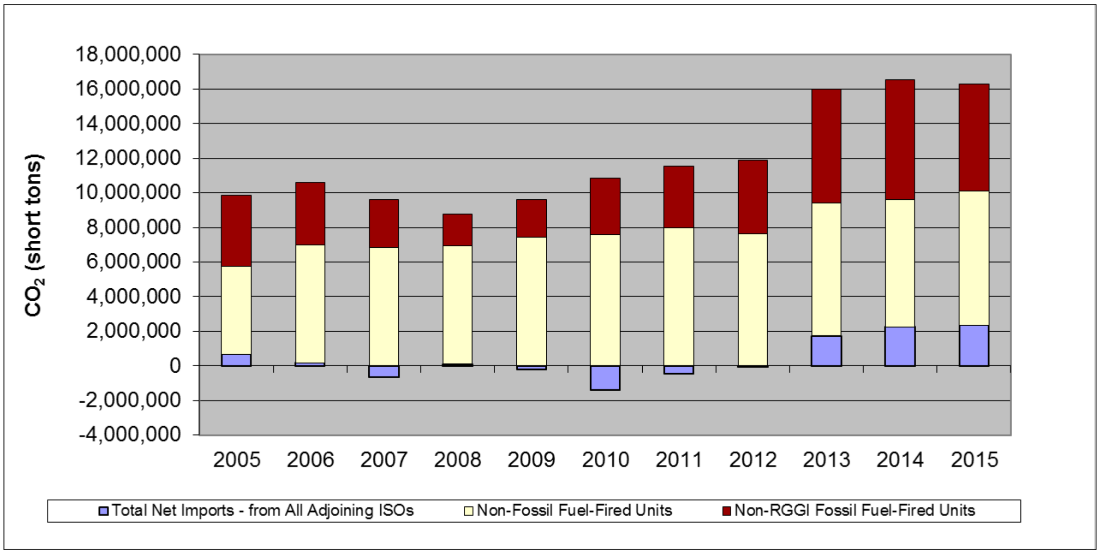

Figure 12. CO_2 Emissions from Non-RGGI Generation Serving Load in ISO-NE (short tons CO_2)

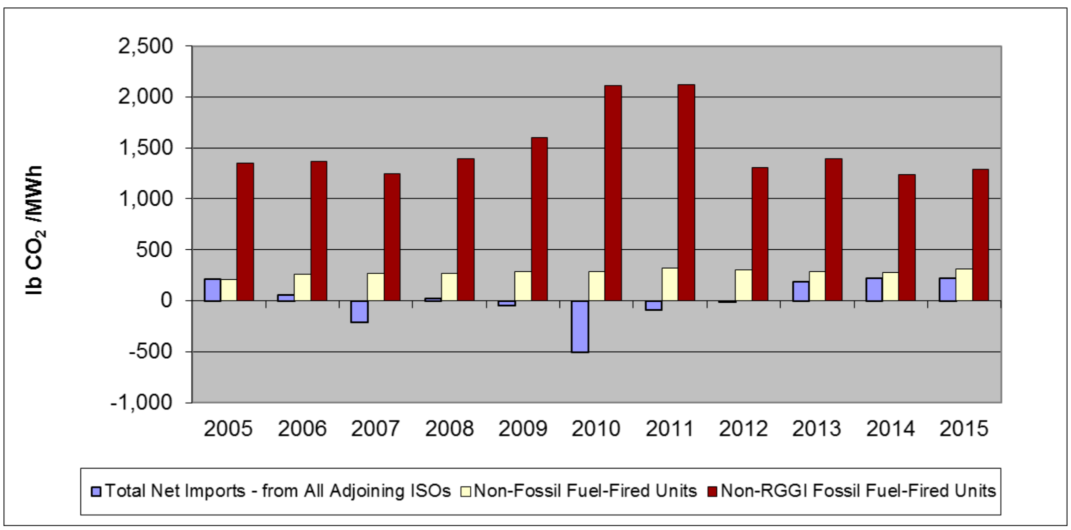

Figure 13. CO_2 Emission Rate for Non-RGGI Generation Serving Load in ISO-NE (lb CO_2/MWh)

Annual average net electricity imports into ISO-NE for 2013 to 2015 increased by 13.0 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 2.2 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.

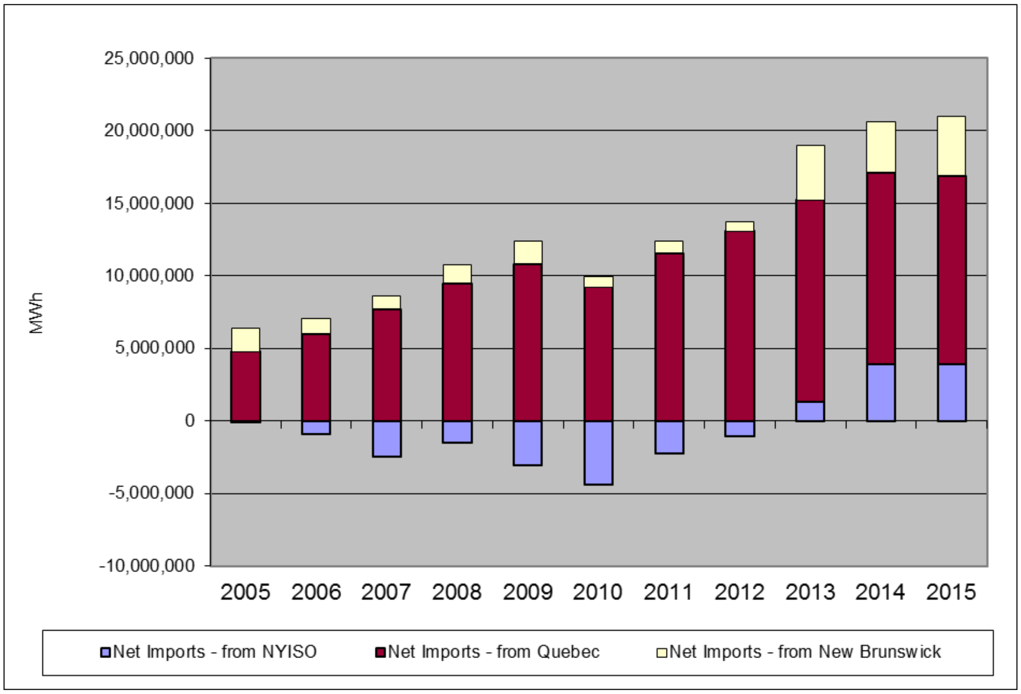

Figure 14. Net Electricity Imports to ISO-NE (MWh)

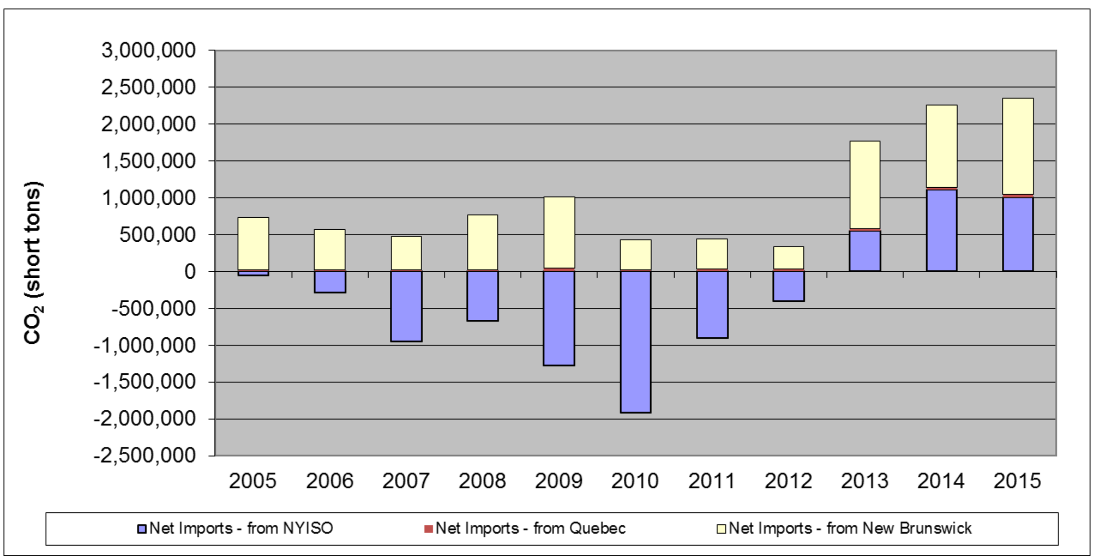

Figure 15. CO_2 Emissions Related to Net Electricity Imports to ISO-NE (short tons CO_2)

Compared to the annual average during the base period of 2006 to 2008, electric generation in 2015 from all non-RGGI electric generation sources serving load in ISO-NE increased by 17.0 million MWh, an increase of 27.0 percent. Compared to the 2006 to 2008 annual average, 2015 CO_2 emissions from this category of electric generation increased by 6.9 million short tons of CO_2, an increase of 72.6 percent, and the CO_2 emission rate increased by 108.0 lb CO_2/MWh, an increase of 35.9 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 electric generation from RGGI generation in ISO-NE decreased by 18.5 million MWh, or 25.6 percent, and CO_2 emissions from RGGI generation in ISO-NE decreased by 18.1 million short tons of CO_2, or 38.4 percent. The CO_2 emission rate of RGGI electric generation decreased by 224.9 lb CO_2/MWh, a reduction of 17.2 percent. Compared to the 2006 to 2008 annual average, 2015 electric generation from non-RGGI generation located in ISO-NE increased by 3.2 million MWh, or 5.7 percent, and CO_2 emissions from this category of electric generation increased by 4.4 million short tons of CO_2, an increase of 45.9 percent. The CO_2 emission rate of non-RGGI electric generation located in ISO-NE increased by 131.1 lb CO_2/MWh, an increase of 38.2 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 net electricity imports into ISO-NE increased by 13.8 million MWh. CO_2 emissions related to these net electricity imports increased by 2.5 million short tons of CO_2 during this period. The CO_2 emission rate of the electric generation supplying these imports increased by 266.6 lb CO_2/MWh.

NYISO

Monitoring results for NYISO for 2005 through 2015 are summarized below in Table 6 and Figures 16 through 20.

Table 6. 2005 – 2015 Monitoring Summary for NYISO

MWh	Electricity Demand						Electricity Generation					*Summary Data*
	Total Annual Electricity Load in NYISO	Net Imports - from Quebec	Net Imports - from ISO-NE	Net Imports - from Ontario	Net Imports - from PJM	Total Net Electricity Imports	Annual Electric Generation - RGGI-Affected Units	Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units	Annual Electric Generation - Non-Fossil Fuel-Fired Units	Annual Electric Generation - All Non-RGGI Units	Total Annual Electric Generation - All Units	Annual CO_2 Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)
2005	164,783,642	2,583,317	115,000	1,898,020	7,604,000	12,200,337	67,835,907	7,029,219	77,718,179	84,747,398	152,583,305	96,947,735
2006	166,654,413	2,959,749	877,000	3,672,282	9,559,000	17,068,031	66,864,341	7,322,844	75,399,197	82,722,041	149,586,382	99,790,072
2007	169,932,177	4,185,292	2,477,000	2,637,442	10,225,000	19,524,734	71,336,352	6,648,463	72,422,628	79,071,091	150,407,443	98,595,825
2008	168,646,767	5,646,014	1,529,000	6,162,902	10,690,000	24,027,916	64,620,511	4,618,782	75,379,558	79,998,340	144,618,851	104,026,256
2009	160,565,962	6,239,805	3,031,000	6,463,657	8,331,000	24,065,462	56,246,945	3,750,738	76,502,817	80,253,555	136,500,500	104,319,017
2010	164,282,144	4,335,209	4,412,000	3,872,635	12,305,000	24,924,844	62,527,452	3,686,768	73,143,080	76,829,848	139,357,300	101,754,692
2011	163,818,485	7,123,204	2,262,000	3,318,681	11,150,000	23,853,885	59,098,130	3,252,477	77,613,993	80,866,470	139,964,600	104,720,355
2012	163,689,994	9,235,689	1,073,000	5,749,461	8,408,800	24,466,950	61,313,672	3,736,023	74,173,349	77,909,372	139,223,044	102,376,322
2013	166,412,302	10,638,017	-1,322,000	7,593,954	9,190,966	26,100,937	59,652,799	3,963,738	76,694,828	80,658,566	140,311,365	106,759,503
2014	160,598,000	8,839,775	-3,908,078	7,180,281	8,721,704	20,833,682	58,403,922	4,612,684	76,747,712	81,360,396	139,764,318	102,194,078
2015	160,650,689	9,397,396	-3,911,358	8,302,624	7,558,163	21,346,825	57,328,298	4,627,476	77,348,090	81,975,566	139,303,864	103,322,391

CO_2	Electricity Demand						Electricity Generation					*Summary Data*
	Total Annual Electricity Load in NYISO	Net Imports - from Quebec	Net Imports - from ISO-NE	Net Imports - from Ontario	Net Imports - from PJM	Total Net Electricity Imports	Annual Electric Generation - RGGI-Affected Units	Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units	Annual Electric Generation - Non-Fossil Fuel-Fired Units	Annual Electric Generation - All Non-RGGI Units	Total Annual Electric Generation - All Units	Annual CO_2 Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)
2005	74,755,271	10,536	51,746	460,286	4,912,184	5,434,752	62,718,683	5,933,822	668,014	6,601,836	69,320,519	12,036,588
2006	69,691,995	13,050	289,040	769,120	5,983,934	7,055,144	53,638,129	6,319,357	2,679,365	8,998,722	62,636,851	16,053,866
2007	71,371,507	13,794	948,926	604,715	6,349,725	7,917,160	55,717,151	5,430,598	2,306,598	7,737,196	63,454,347	15,654,356
2008	63,056,750	15,559	665,365	1,154,884	6,520,900	8,356,708	48,348,177	2,676,684	3,675,181	6,351,865	54,700,042	14,708,573
2009	48,425,248	24,762	1,183,327	712,496	4,736,174	6,656,758	37,861,408	1,931,753	1,975,329	3,907,082	41,768,490	10,563,840
2010	55,399,675	11,947	1,749,027	554,950	7,179,968	9,495,892	42,113,171	1,944,024	1,846,589	3,790,613	45,903,784	13,286,504
2011	48,162,627	18,060	834,222	336,556	6,389,108	7,577,946	37,137,382	1,683,269	1,764,030	3,447,299	40,584,681	11,025,245
2012	44,634,115	27,488	368,348	602,081	4,212,809	5,210,726	35,417,901	2,008,494	1,996,995	4,005,489	39,423,389	9,216,215
2013	42,511,394	23,453	-550,855	795,236	4,871,212	5,139,045	33,607,796	1,485,213	2,279,339	3,764,552	37,372,349	8,903,597
2014	43,877,493	19,488	-1,105,986	603,144	4,827,463	4,344,109	35,860,008	1,946,553	1,726,824	3,673,376	39,533,384	8,017,485
2015	42,496,046	21,754	-1,011,086	697,420	3,831,989	3,540,077	34,146,454	2,745,481	2,064,034	4,809,515	38,955,969	8,349,592

lbs CO_2/MWh	Electricity Demand						Electricity Generation					*Summary Data*
	Total Annual Electricity Load in NYISO	Net Imports - from Quebec	Net Imports - from ISO-NE	Net Imports - from Ontario	Net Imports - from PJM	Total Net Electricity Imports	Annual Electric Generation - RGGI-Affected Units	Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units	Annual Electric Generation - Non-Fossil Fuel-Fired Units	Annual Electric Generation - All Non-RGGI Units	Total Annual Electric Generation - All Units	Annual CO_2 Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)
2005	907	8	900	485	1,292	891	1,849	1,688	17	156	909	248
2006	836	9	659	419	1,252	827	1,604	1,726	71	218	837	322
2007	840	7	766	459	1,242	811	1,562	1,634	64	196	844	318
2008	748	6	870	375	1,220	696	1,496	1,159	98	159	756	283
2009	603	8	781	220	1,137	553	1,346	1,030	52	97	612	203
2010	674	6	793	287	1,167	762	1,347	1,055	50	99	659	261
2011	588	5	738	203	1,146	635	1,257	1,035	45	85	580	211
2012	545	6	687	209	1,002	426	1,155	1,075	54	103	566	180
2013	511	4	833	209	1,060	394	1,127	749	59	93	533	167
2014	546	4	566	168	1,107	417	1,228	844	45	90	566	157
2015	529	5	517	168	1,014	332	1,191	1,187	53	117	559	162

The monitoring results indicate that the annual average electricity load in NYISO for 2013 to 2015 decreased by 5.9 million MWh, or 3.5 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 2013 to 2015 with the base period of 2006 to 2008.

Annual average electric generation from RGGI generation in NYISO decreased by 9.1 million MWh during this period, or 13.5 percent, and annual average CO_2 emissions from RGGI electric generation in NYISO decreased by 18.0 million short tons of CO_2, or 34.3 percent. The annual average CO_2 emission rate of RGGI electric generation decreased by 372.3 lb CO_2/MWh, a reduction of 24.0 percent. Annual average electric generation from non-RGGI sources located in NYISO increased by 734.4 thousand MWh, or 0.9 percent, during this period, and average annual CO_2 emissions from this category of electric generation decreased by 3.6 million short tons of CO_2, a decrease of 47.0 percent. The annual average CO_2 emission rate of non-RGGI electric generation located in NYISO decreased by 90.4 lb CO_2/MWh, a decrease of 47.4 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 electric load in NYISO decreased by 7.8 million MWh, or 4.6 percent, and electric generation from all sources in NYISO in 2015 decreased by 8.9 million MWh, or 6.0 percent.

The annual average non-RGGI electric generation serving load in NYISO for 2013 to 2015 increased by 3.3 million MWh, or 3.3 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 7.0 million short tons of CO_2, or 45.6 percent, and the annual average CO_2 emission rate decreased by 145.2 lb CO_2/MWh, a decrease of 47.3 percent. (See Figures 16, 17, and 18.)

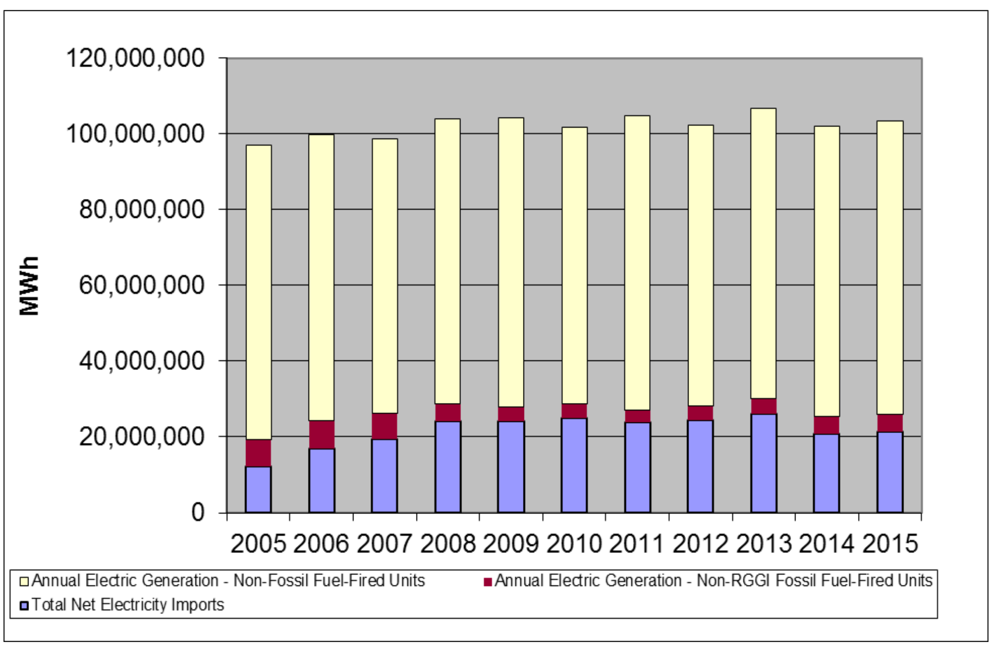

Figure 16. Non-RGGI Generation Serving Load in NYISO (MWh)

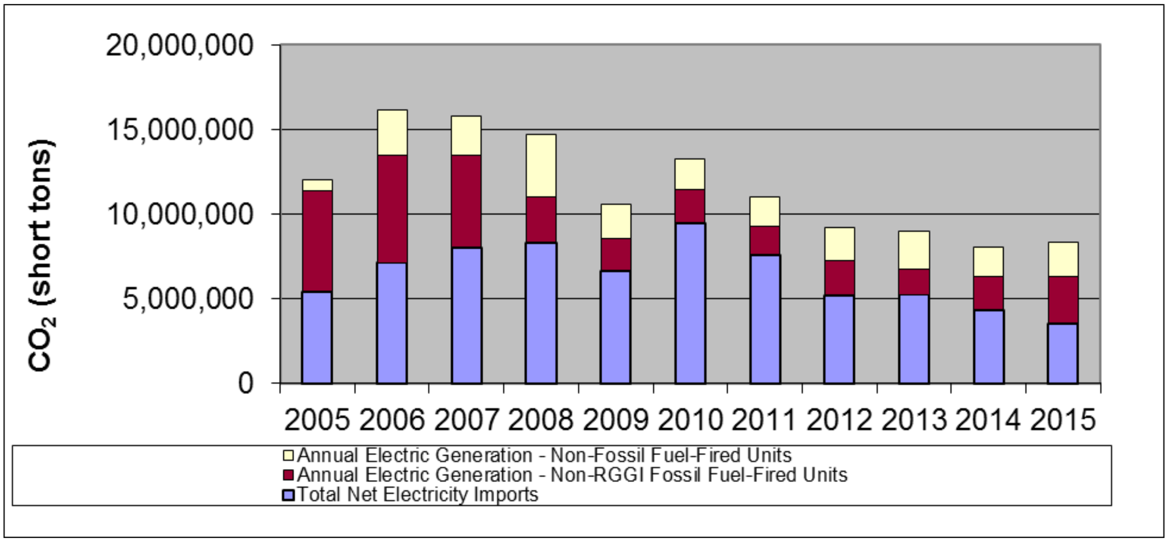

Figure 17. CO_2 Emissions from Non-RGGI Generation Serving Load in NYISO (short tons CO_2)

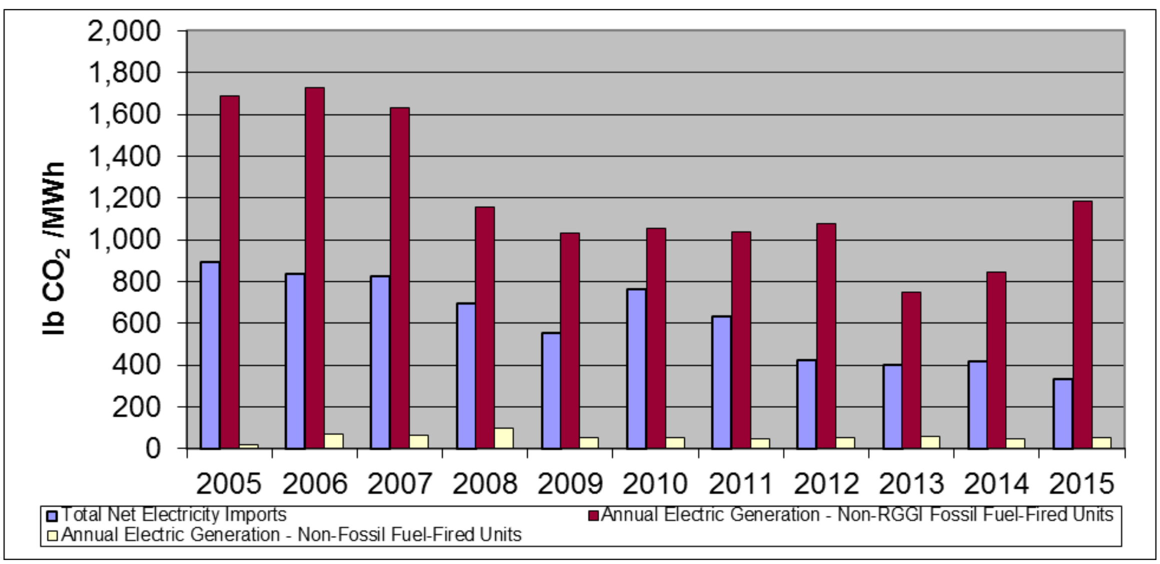

Figure 18. CO_2 Emission Rate for Non-RGGI Generation Serving Load in NYISO (lb CO_2/MWh)

Net electricity imports into NYISO increased by 2.6 million MWh, when comparing the annual average for the base period of 2006 to 2008 to the annual average for 2013 to 2015. Annual average CO_2 emissions related to these net electricity imports decreased by 3.5 million short tons of CO_2, or 44.2 percent, during this period. The annual average CO_2 emission rate of the electric generation supplying these imports decreased by 396.9 lb CO_2/MWh, a decrease of 51.0 percent. (See figures 19 and 20).

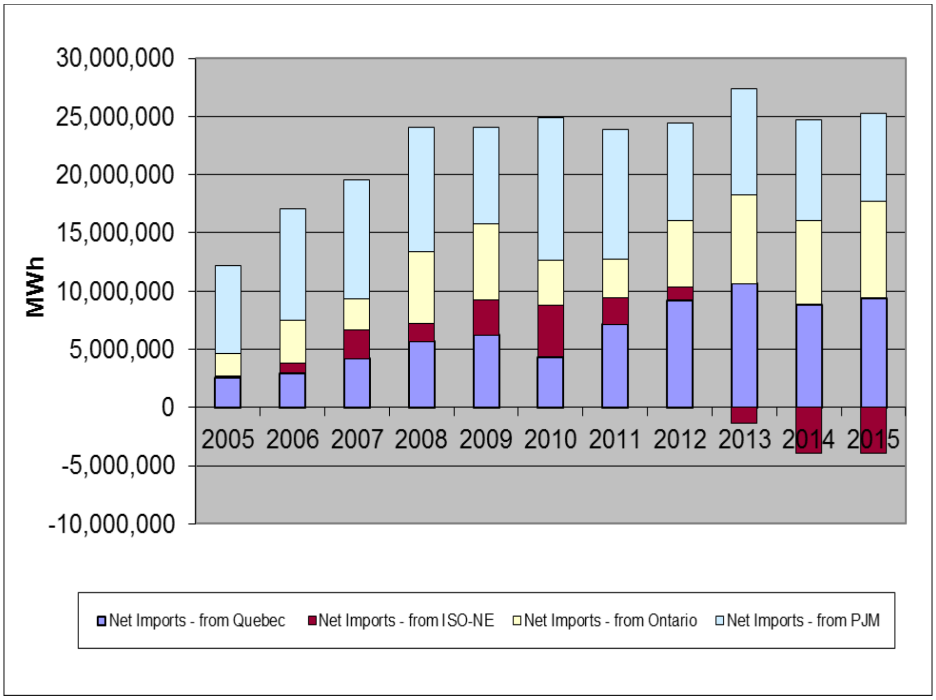

Figure 19. Net Electricity Imports to NYISO (MWh)

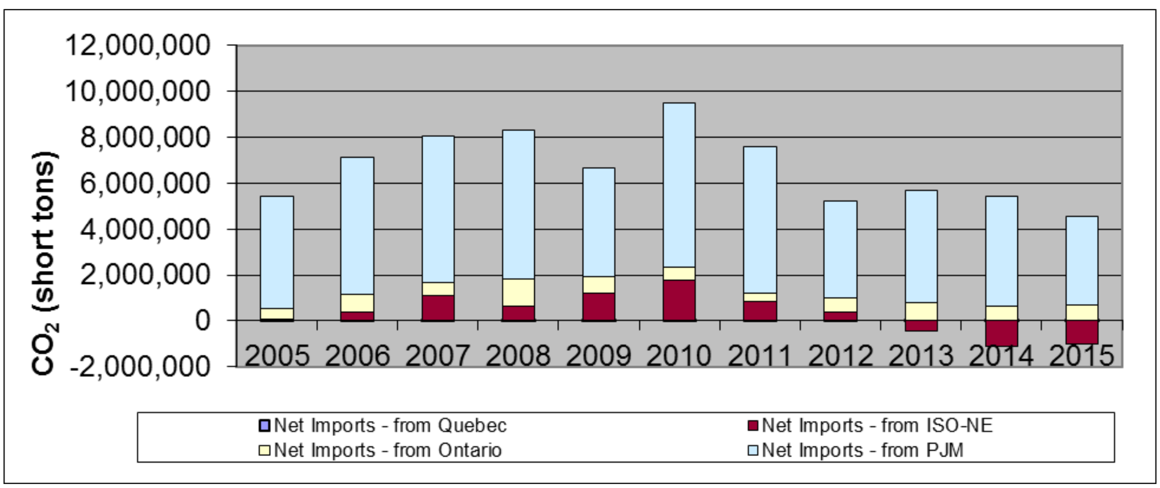

Figure 20. CO_2 Emissions Related to Net Electricity Imports to NYISO (short tons CO_2)

Compared to the annual average during the base period of 2006 to 2008, electric generation in 2015 from all non-RGGI electric generation sources serving load in NYISO increased by 2.5 million MWh, an increase of 2.5 percent. Compared to the annual average for 2006 to 2008, 2015 CO_2 emissions from this category of electric generation decreased by 7.1 million short tons of CO_2, a reduction of 46.0 percent, and the CO_2 emission rate decreased by 145.4 lb CO_2/MWh, a reduction of 47.4 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 electric generation from RGGI generation in NYISO decreased by 10.3 million MWh, or 15.2 percent, and CO_2 emissions from RGGI generation in NYISO decreased by 18.4 million short tons of CO_2, a reduction of 35.0 percent. The CO_2 emission rate of RGGI electric generation decreased by 363.0 lb CO_2MWh, a reduction of 23.4 percent. Compared to the 2006 to 2008 annual average, 2015 electric generation from non-RGGI generation located in NYISO increased by 1.4 million MWh, or 1.7 percent, and CO_2 emissions from this category of electric generation decreased by 2.9 million short tons of CO_2, a reduction of 37.5 percent. The CO_2 emission rate of non-RGGI electric generation located in NYISO decreased by 73.3 lb CO_2/MWh, a reduction of 38.5 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 net electricity imports into NYISO increased by 1.1 million MWh. CO_2 emissions related to these net electricity imports decreased by 4.2 million short tons of CO_2, or 54.5 percent. The CO_2 emission rate of the electric generation supplying these imports decreased by 446.1 lb CO_2/MWh, a reduction of 57.4 percent.

PJM (RGGI Portion)

Monitoring results for PJM for 2005 through 2015 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]

Table 7. 2005 – 2015 Monitoring Summary for RGGI PJM

MWh	Electricity Demand				Electricity Generation					*Summary Data*
	Total Annual Electricity Load in ISO	Net Imports - from Non-RGGI PJM	Net Imports - from NYISO	Total Net Electricity Imports - from All Adjoining ISOs	Annual Electric Generation - RGGI-Affected Units	Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units	Annual Electric Generation - Non-Fossil Fuel-Fired Units	Annual Electric Generation - All Non-RGGI Units	Total Annual Electric Generation - All Units	Annual CO_2 Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)
2005	90,177,482	31,878,151	-636,765	31,241,386	41,472,196	393,587	17,070,313	17,463,900	58,936,096	48,705,286
2006	84,096,149	30,716,157	-721,101	29,995,056	37,230,890	267,732	16,602,471	16,870,203	54,101,093	46,865,259
2007	84,442,034	28,944,540	-772,843	28,171,697	39,254,875	298,635	16,716,827	17,015,462	56,270,337	45,187,159
2008	80,387,398	28,386,914	-772,644	27,614,270	35,340,119	150,718	17,282,291	17,433,009	52,773,128	45,047,279
2009	79,481,311	33,089,871	-570,096	32,519,775	29,732,886	147,837	17,080,813	17,228,650	46,961,536	49,748,425
2010	82,485,086	35,142,720	-815,714	34,327,006	31,641,822	129,655	16,386,603	16,516,258	48,158,080	50,843,264
2011	80,738,794	34,250,993	-697,456	33,553,537	28,980,019	216,967	17,988,271	18,205,238	47,185,257	28,980,019
2012	78,802,312	34,442,085	-482,148	33,959,937	28,350,888	190,940	16,300,547	16,491,487	44,842,375	28,350,888
2013	77,458,942	35,843,247	-490,493	35,352,754	24,775,215	81,428	17,249,545	17,330,973	42,106,188	24,775,215
2014	76,359,729	32,656,507	-482,178	32,174,329	26,733,539	71,744	17,380,117	17,451,861	44,185,400	26,733,539
2015	77,903,165	35,680,933	-413,286	35,267,647	24,839,927	57,076	17,738,515	17,795,591	42,635,518	24,839,927

[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.

CO_2	Electricity Demand				Electricity Generation					*Summary Data*
	Total Annual Electricity Load in ISO	**Net Imports - from Non-RGGI PJM**	**Net Imports - from NYISO**	**Total Net Electricity Imports - from All Adjoining ISOs**	**Annual Electric Generation - RGGI-Affected Units**	**Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units**	**Annual Electric Generation - Non-Fossil Fuel-Fired Units**	**Annual Electric Generation - All Non-RGGI Units**	**Total Annual Electric Generation - All Units**	**Annual CO_2 Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)**
2005	63,407,937	20,408,108	-469,658	19,938,450	42,345,258	284,222	840,007	1,124,229	43,469,487	21,062,679
2006	58,224,181	19,059,750	-529,065	18,530,684	38,502,576	206,808	984,113	1,190,921	39,693,497	19,721,605
2007	59,369,215	17,766,431	-579,349	17,187,082	40,637,296	221,499	1,323,338	1,544,837	42,182,133	18,731,919
2008	54,585,448	17,172,335	-555,899	16,616,436	36,518,184	152,927	1,297,901	1,450,828	37,969,012	18,067,264
2009	48,909,286	18,682,706	-371,449	18,311,256	29,281,274	147,125	1,169,631	1,316,756	30,598,030	19,628,012
2010	53,575,513	20,361,849	-572,275	19,789,574	32,258,228	129,412	1,398,299	1,527,711	33,785,939	21,317,285
2011	49,662,062	19,504,235	-452,458	19,051,778	28,850,034	171,564	1,588,686	1,760,250	30,610,284	28,850,034
2012	45,342,236	18,627,737	-290,358	18,337,379	25,436,501	212,964	1,355,392	1,568,356	27,004,857	25,436,501
2013	43,873,524	19,867,713	-282,938	19,584,774	22,968,475	101,584	1,218,691	1,320,275	24,288,750	22,968,475
2014	43,832,735	17,971,031	-285,333	17,685,699	24,836,448	82,905	1,227,683	1,310,588	26,147,036	24,836,448
2015	40,731,169	17,989,208	-222,606	17,766,601	21,569,214	60,038	1,335,315	1,395,353	22,964,567	21,569,214

lbs CO_2/ MWh	Electricity Demand				Electricity Generation					*Summary Data*
	Total Annual Electricity Load in ISO	**Net Imports - from Non-RGGI PJM**	**Net Imports - from NYISO**	**Total Net Electricity Imports - from All Adjoining ISOs**	**Annual Electric Generation - RGGI-Affected Units**	**Annual Electric Generation - Non-RGGI Fossil Fuel-Fired Units**	**Annual Electric Generation - Non-Fossil Fuel-Fired Units**	**Annual Electric Generation - All Non-RGGI Units**	**Total Annual Electric Generation - All Units**	**Annual CO_2 Emissions from Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports)**
2005	1,406	1,280	1,475	1,276	2,042	1,444	98	129	1,475	865
2006	1,385	1,241	1,467	1,236	2,068	1,545	119	141	1,467	842
2007	1,406	1,228	1,499	1,220	2,070	1,483	158	182	1,499	829
2008	1,358	1,210	1,439	1,203	2,067	2,029	150	166	1,439	802
2009	1,231	1,129	1,303	1,126	1,970	1,990	137	153	1,303	789
2010	1,299	1,159	1,403	1,153	2,039	1,996	171	185	1,403	839
2011	1,230	1,139	1,297	1,136	1,991	1,581	177	193	1,297	1,991
2012	1,151	1,082	1,204	1,080	1,794	2,231	166	190	1,204	1,794
2013	1,133	1,109	1,154	1,108	1,854	2,495	141	152	1,154	1,854
2014	1,148	1,101	1,184	1,099	1,858	2,311	141	150	1,184	1,858
2015	1,046	1,008	1,077	1,008	1,737	2,104	151	157	1,077	1,737

The monitoring results indicate that the annual average electricity load in PJM for 2013 to 2015 decreased by 5.7 million MWh, or 6.9 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 11.4 million MWh, or 21.0 percent, when comparing the 2006 to 2008 annual average to the 2013 to 2015 annual average.

Annual average electric generation from RGGI generation in PJM decreased by 11.8 million MWh during this period, or 31.7 percent, and annual average CO_2 emissions from RGGI electric generation in PJM decreased by 15.4 million short tons of CO_2, or 40.0 percent. The annual average CO_2 emission rate of RGGI electric generation decreased by 252.2 lb CO_2/MWh, a reduction of 12.2 percent. Annual average electric generation from non-RGGI electric generation sources located in PJM increased by 420.0 thousand MWh, or 2.5 percent, during this period, and annual average CO_2 emissions from this category of electric generation decreased by 53.5 thousand short tons of CO_2, a decrease of 3.8 percent. The annual average CO_2 emission rate of non-RGGI electric generation located in PJM decreased by 9.9 lb CO_2/MWh, a decrease of 6.1 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 electricity load in RGGI PJM decreased by 5.1 million MWh, or 6.1 percent. Compared to the 2006 to 2008 annual average, 2015 electric generation from all sources in RGGI PJM decreased by 11.7 million MWh, or 21.6 percent.

The annual average electric generation from all non-RGGI electric generation serving load in PJM for 2013 to 2015 increased by 6.1 million MWh, or 13.3 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 847.5 thousand short tons of CO_2, an increase of 4.5 percent, and the annual average CO_2 emission rate decreased by 64.1 lb CO_2/MWh, an decrease of 7.8 percent. (See Figures 21, 22, and 23).

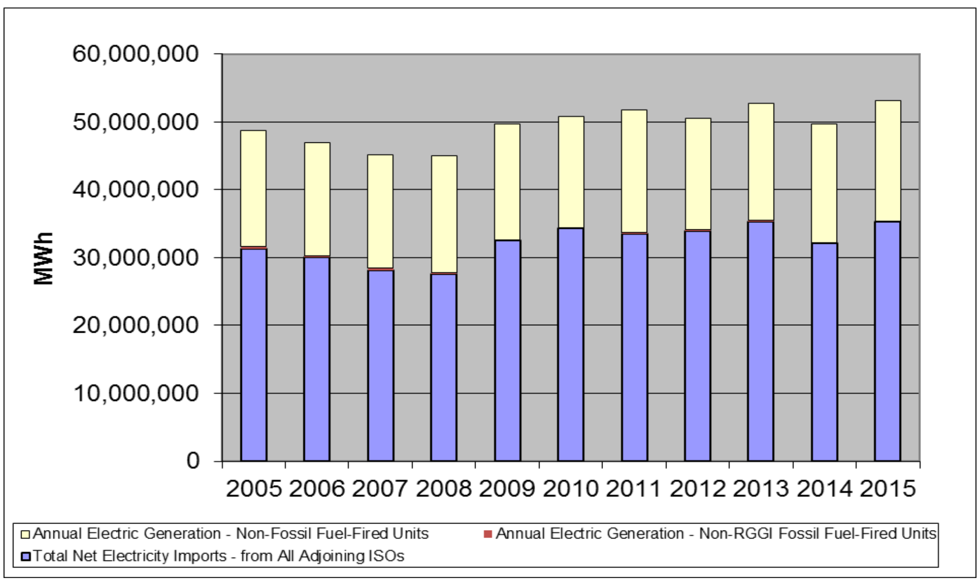

Figure 21. Non-RGGI Generation Serving Load in RGGI PJM (MWh)

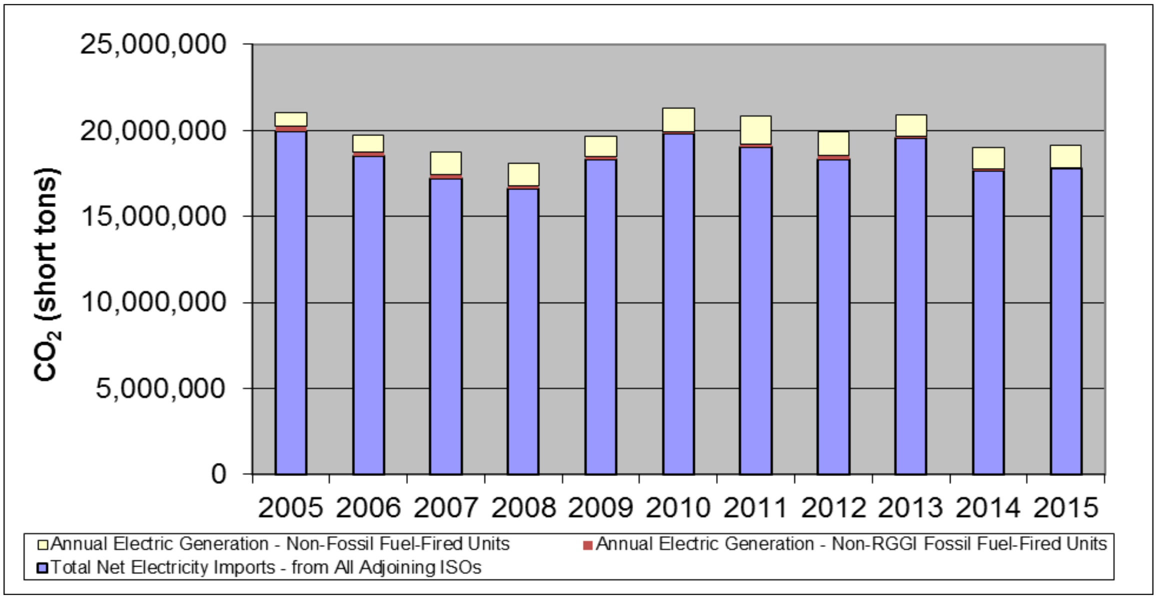

Figure 22. CO_2 Emissions from Non-RGGI Generation Serving Load in RGGI PJM (short tons CO_2)

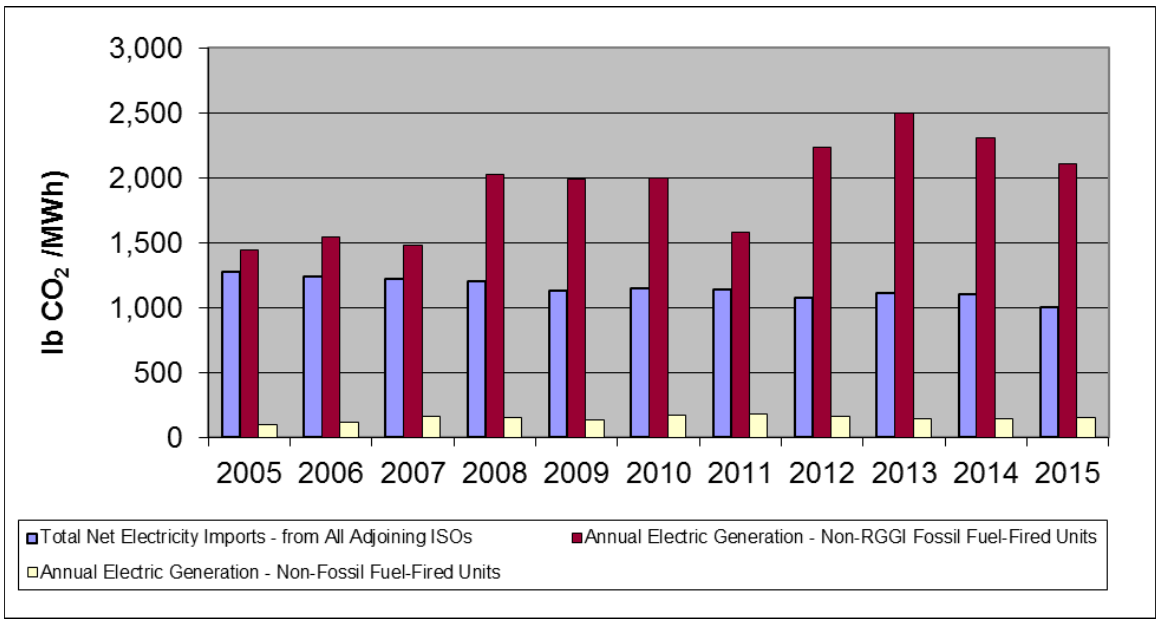

Figure 23. CO_2 Emission Rate for Non-RGGI Generation Serving Load in RGGI PJM (lb CO_2/MWh)

Net electricity imports into PJM increased by 5.7 million MWh, when comparing the annual average during the base period of 2006 to 2008 to the annual average for 2013 to 2015. Annual average CO_2 emissions related to these net electricity imports increased by 901.0 thousand short tons of CO_2, or 5.2 percent, during this period. The annual average CO_2 emission rate of the electric generation supplying these imports decreased by 148.1 lb CO_2/MWh, a decrease of 12.1 percent. (See Figures 24 and 25).

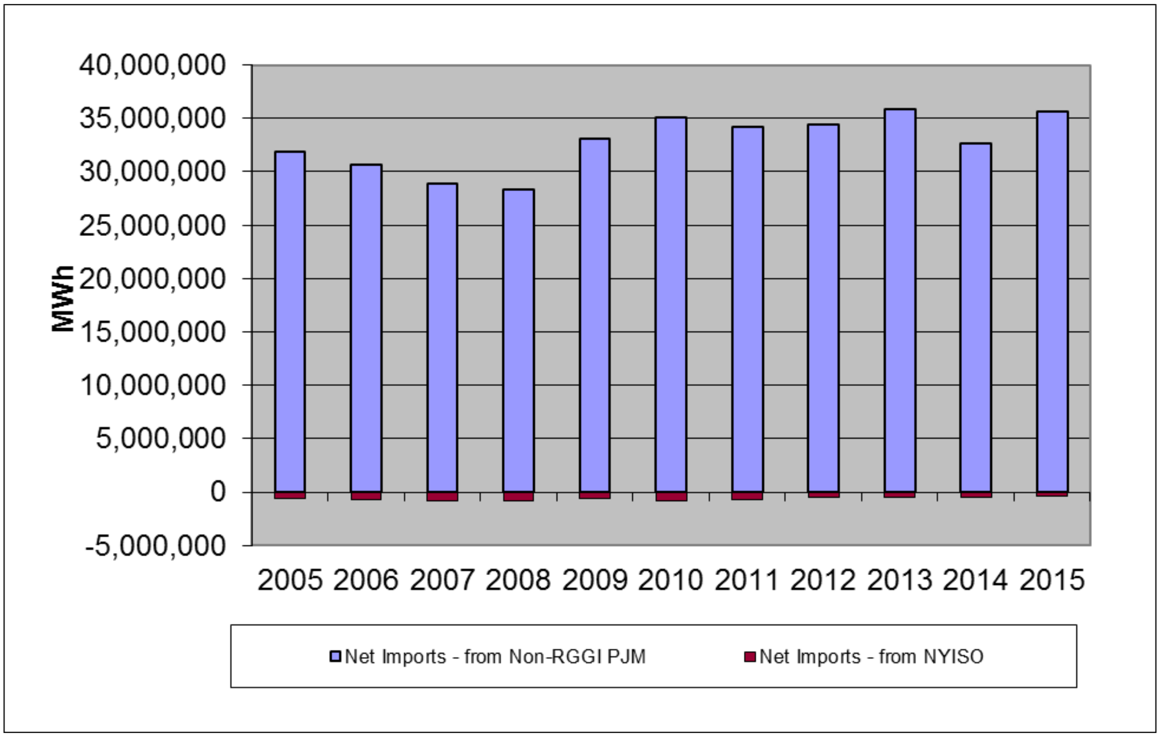

Figure 24. Net Electricity Imports to RGGI PJM (MWh)

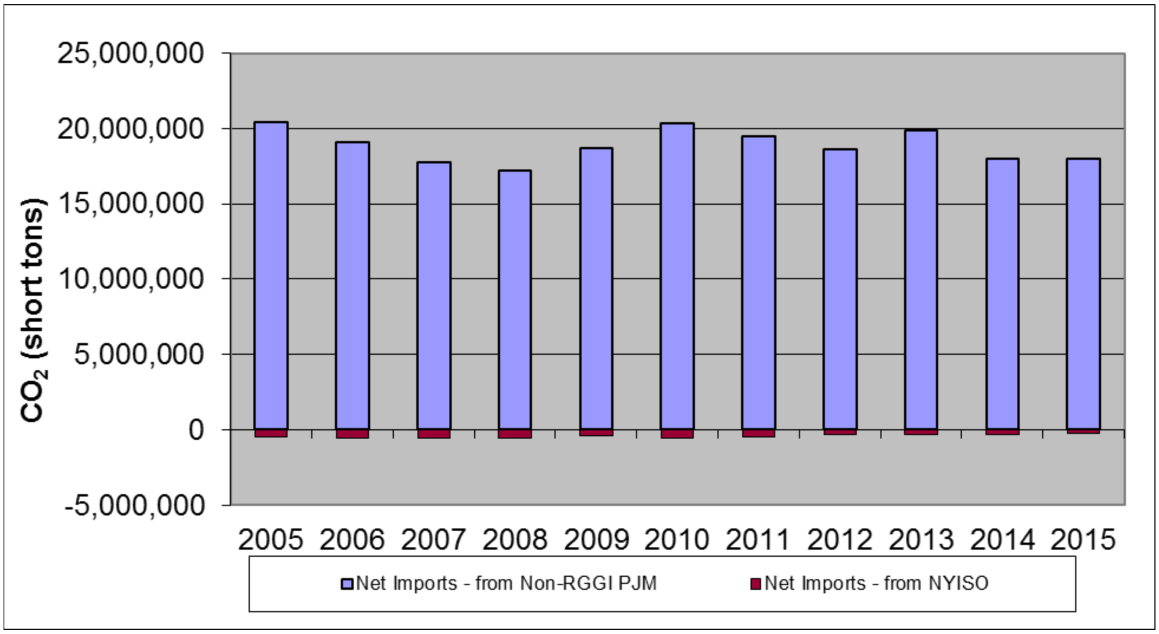

Figure 25. CO_2 Emissions Related to Net Electricity Imports to RGGI PJM (short tons CO_2)

Compared to the annual average during the base period of 2006 to 2008, electric generation in 2015 from all non-RGGI electric generation sources serving load in RGGI PJM increased by 7.4 million MWh, an increase of 16.1 percent. Compared to the 2006 to 2008 annual average, 2015 CO_2 emissions from this category of electric generation increased by 321.7 thousand short tons of CO_2, an increase of 1.7 percent, and the CO_2 emission rate decreased by 102.3 lb CO_2/MWh, a reduction of 12.4 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 electric generation from RGGI generation in RGGI PJM decreased by 12.4 million MWh, or 33.4 percent, and CO_2 emissions from RGGI generation in RGGI PJM decreased by 17.0 million short tons of CO_2, or 44.1 percent. The CO_2 emission rate of RGGI electric generation decreased by 331.8 lb CO_2/MWh, a reduction of 16.0 percent. Compared to the 2006 to 2008 annual average, 2015 electric generation from non-RGGI generation located in RGGI PJM increased by 689.4 thousand MWh, or 4.0 percent, and CO_2 emissions from this category of electric generation decreased by 176 short tons of CO_2. The CO_2 emission rate of non-RGGI electric generation located in RGGI PJM decreased by 6.3 lb CO_2/MWh, a decrease of 3.8 percent.

Compared to the annual average during the 2006 to 2008 base period, 2015 net electricity imports into RGGI PJM increased by 6.7 million MWh. CO_2 emissions related to these net electricity imports increased by 321.9 thousand short tons of CO_2, or 1.8 percent, during this period, indicating a reduction in the average CO_2 emission rate of the electric generation supplying these imports of 212.2 lb CO_2/MWh, a reduction of 17.4 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, 2013 to 2015.

9-State RGGI Region

Table 8. Monitoring Trends for 9-State RGGI Region

	Non-RGGI Generation (In-Region)			RGGI Generation			Net Imports		
	MWh	CO_2 Emissions	lb CO_2/MWh	MWh	CO_2 Emissions	lb CO_2/MWh	MWh	CO_2 Emissions	lb CO_2/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 2013-2015	160,878,911	19,589,634	244	136,520,912	86,567,221	1,268	77,227,354	24,888,138	645
Difference from base period	7,516,313	938,865	1	-40,644,239	-51,795,550	-293	21,230,120	-335,861	-260
% change from base period	4.9%	5.0%	0.3%	-22.9%	-37.4%	-18.8%	37.9%	-1.3%	-28.7%
2015	158,603,360	20,151,887	254	135,968,708	84,823,838	1,248	77,611,830	23,653,852	610
Difference from base period	5,240,763	1,501,118	11	-41,196,444	-53,538,934	-314	21,614,596	-1,570,147	-295
% change from base period	3.4%	8.0%	4.6%	-23.3%	-38.7%	-20.1%	38.6%	-6.2%	-32.6%

	Non-RGGI Generation (In-Region + Net Imports)			In-Region Generation	In-Region Load
	MWh	CO_2 Emissions	lb CO_2/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 2013-2015	238,106,265	44,477,772	374	297,399,823	368,171,609
Difference from base period	28,746,433	603,003	-46	-33,127,926	-18,252,037
% change from base period	13.7%	1.4%	-10.9%	-10.0%	-4.7%
2015	236,215,190	43,805,740	371	294,572,068	365,508,854
Difference from base period	26,855,358	-69,029	-48	-35,955,681	-20,914,792
% change from base period	12.8%	-0.2%	-11.5%	-10.9%	-5.4%

ISO-NE

Table 9. Monitoring Trends for ISO-NE

	Non-RGGI Generation (In-Region)			RGGI Generation			Net Imports		
	MWh	CO_2 Emissions	lb CO_2/MWh	MWh	CO_2 Emissions	lb CO_2/MWh	MWh	CO_2 Emissions	lb CO_2/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 2013-2015	62,021,260	14,165,081	457	52,609,679	28,904,422	1,099	20,201,963	2,118,360	131
Difference from base period	6,362,044	4,605,768	114	-19,673,110	-18,337,845	-208	13,005,296	2,235,642	173
% change from base period	11.4%	48.2%	33.3%	-27.2%	-38.8%	-15.9%	180.7%	[37]	[38]
2015	58,832,203	13,947,019	474	53,800,483	29,108,169	1,082	20,997,358	2,354,334	224
Difference from base period	3,172,988	4,387,706	131	-18,482,306	-18,134,098	-225	13,800,691	2,471,615	267
% change from base period	5.7%	45.9%	38.2%	-25.6%	-38.4%	-17.2%	191.8%	[39]	[40]

	Non-RGGI Generation (In-Region + Net Imports)			In-Region Generation	In-Region Load
	MWh	CO_2 Emissions	lb CO_2/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 2013-2015	82,223,223	16,283,441	396	114,630,939	128,377,333
Difference from base period	19,367,341	6,841,409	96	-13,311,066	-6,660,000
% change from base period	30.8%	72.5%	31.9%	-10.4%	-4.9%
2015	79,829,561	16,301,353	408	112,632,686	126,955,000
Difference from base period	16,973,679	6,859,322	108	-15,309,318	-8,082,333
% change from base period	27.0%	72.6%	35.9%	-12.0%	-6.0%

[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	CO_2 Emissions	lb CO2/MWh	MWh	CO_2 Emissions	lb CO2/MWh	MWh	CO_2 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 2013-2015	81,331,509	4,082,481	100	58,461,673	34,538,086	1,182	22,760,481	4,350,798	382
Difference from base period	734,352	-3,613,446	-90	-9,145,395	-18,029,733	-372	2,553,588	-3,514,086	-406
% change from base period	0.9%	-47.0%	-47.4%	-13.5%	-34.3%	-24.0%	12.6%	-44.7%	-51.5%
2015	81,975,566	4,809,515	117	57,328,298	34,146,454	1,191	21,346,825	3,540,077	332
Difference from base period	1,378,409	-2,886,412	-73	-10,278,770	-18,421,365	-363	1,139,931	-4,324,807	-456
% change from base period	1.7%	-37.5%	-38.5%	-15.2%	-35.0%	-23.4%	5.6%	-55.0%	-57.9%

	Non-RGGI Generation (In-Region + Net Imports)			In-Region Generation	In-Region Load
	MWh	CO_2 Emissions	lb CO_2/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 2013-2015	104,091,991	8,433,279	162	139,793,182	162,553,664
Difference from base period	3,287,940	-7,127,532	-147	-8,411,043	-5,857,455
% change from base period	3.3%	-45.8%	-47.5%	-5.7%	-3.5%
2015	103,322,391	8,349,592	162	139,303,864	160,650,689
Difference from base period	2,518,340	-7,211,219	-147	-8,900,361	-7,760,430
% change from base period	2.5%	-46.3%	-47.7%	-6.0%	-4.6%

RGGI-PJM

Table 11. Monitoring Trends for RGGI-PJM

	Non-RGGI Generation (In-Region)			RGGI Generation			Net Imports		
	MWh	CO_2 Emissions	lb CO2/MWh	MWh	CO_2 Emissions	lb CO2/MWh	MWh	CO_2 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 2013-2015	17,526,142	1,342,072	153	25,449,560	23,124,713	1,816	34,264,910	18,345,691	1,072
Difference from base period	419,917	-53,457	-10	-11,825,734	-15,427,973	-252	5,671,236	900,957	-148
% change from base period	2.5%	-3.8%	-6.1%	-31.7%	-40.0%	-12.2%	19.8%	5.2%	-12.1%
2015	17,795,591	1,395,353	157	24,839,927	21,569,214	1,737	35,267,647	17,766,601	1,008
Difference from base period	689,366	-176	-6	-12,435,368	-16,983,471	-332	6,673,973	321,867	-212
% change from base period	4.0%	0.0%	-3.8%	-33.4%	-44.1%	-16.0%	23.3%	1.8%	-17.4%

	Non-RGGI Generation (In-Region + Net Imports)			In-Region Generation	In-Region Load
	MWh	CO_2 Emissions	lb CO_2/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 2013-2015	51,791,052	19,687,763	760	42,975,702	77,240,612
Difference from base period	6,091,153	847,501	-64	-11,405,817	-5,734,582
% change from base period	13.3%	4.5%	-7.8%	-21.0%	-6.9%
2015	53,063,238	19,161,954	722	42,635,518	77,903,165
Difference from base period	7,363,339	321,692	-102.3	-11,746,001	-5,072,028
% change from base period	16.1%	1.7%	-12.4%	-21.6%	-6.1%

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”.