



The Regional Greenhouse Gas Initiative
an initiative of Eastern States of the US

**CO₂ Emissions from Electricity Generation and
Imports in the Regional Greenhouse Gas Initiative:
2018 Monitoring Report**

March 11, 2021

The 2018 Monitoring Report on CO₂ Emissions from Electricity Generation and Imports in the Regional Greenhouse Gas Initiative (2018 Electricity Monitoring Report) was prepared on behalf of the states participating in the Regional Greenhouse Gas Initiative (RGGI): Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and Virginia.¹ The opinions expressed in this report do not necessarily reflect those of any of the states participating in RGGI, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it. Further, RGGI, Inc., and the states participating in RGGI make no warranties or representations, expressed or implied, as to the fitness for particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, or other information contained, described, disclosed, or referred to in this report. RGGI, Inc. and the states participating in RGGI make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately owned rights and will assume no liability for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this report.

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort of Eastern states to reduce emissions of carbon dioxide (CO₂), a greenhouse gas that causes global warming.

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

¹ This report summarizes data for the nine states participating in RGGI in 2018: Delaware, Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. New Jersey resumed participation in RGGI in 2020 and Virginia began participation in 2021. Therefore, New Jersey and Virginia data are not included in this report.

Table of Contents

| | |
|--|----|
| Executive Summary | 4 |
| Summary of Results..... | 4 |
| Change in Annual Average Electric Load (Demand for Electricity) and Annual Average Generation..... | 4 |
| Change in Annual Average Non-RGGI Emissions, Non-RGGI Emissions Rate, and Non-RGGI Generation | 7 |
| Change in Annual Average RGGI Emissions, RGGI Emissions Rate, and RGGI Generation..... | 8 |
| Conclusions | 8 |
| I. Background..... | 10 |
| II. Monitoring Approach | 10 |
| III. Evaluation of Monitoring Data..... | 11 |
| Base Period | 11 |
| Key Metrics | 12 |
| General Limitations | 12 |
| IV. Methodology | 13 |
| Data Sources | 13 |
| Monitoring Limitations | 14 |
| V. Monitoring Results | 15 |
| VI. Discussion | 22 |
| VII. Conclusions | 26 |
| Appendix A. Nine-State ISO Monitoring Sources..... | 27 |
| Appendix B. ISO-Specific Monitoring Results..... | 29 |
| ISO-NE | 29 |
| NYISO..... | 36 |
| PJM (RGGI Portion)..... | 43 |
| Appendix C. Monitoring Trends..... | 50 |
| Nine-State RGGI Region..... | 50 |
| ISO-NE | 51 |
| NYISO..... | 52 |
| RGGI PJM | 53 |
| Appendix D. Concept of “Emissions Leakage”..... | 54 |

Executive Summary

The 2018 Electricity Monitoring Report, the tenth report in a series of annual monitoring reports, summarizes data for the period from 2005 through 2018, for electricity generation, net electricity imports, and related carbon dioxide (CO₂) emissions for the nine states² participating in the Regional Greenhouse Gas Initiative (RGGI) in 2018. 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 CO₂ Budget Trading Program to cause CO₂ emissions from generation serving load in the RGGI region to shift towards sources that are not subject to RGGI.³ This potential shift has been referred to as “emissions leakage.”

In the New England and Mid-Atlantic states, CO₂ emissions from the regional electric power sector are a function of highly dynamic wholesale electricity markets. The cost of compliance with the RGGI CO₂ Budget Trading Program is only one of multiple factors that influence the dispatch of electric generation, and resulting CO₂ 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 CO₂ 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 CO₂ emissions leakage.

The 2018 Electricity Monitoring Report tracks electricity generation, net electricity imports, and related CO₂ emissions during the three-year current period of 2016 to 2018 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 decrease in CO₂ emissions from total non-RGGI electric generation serving load in the nine-state RGGI region during the period of 2016 to 2018 and during the 2018 calendar year 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 2016 to 2018 decreased by 26.9 million MWh, or 7.0 percent, compared to the average for 2006 to 2008. (See Figures 1 and 2.)
- The annual average **electric generation** from all sources in the nine-state RGGI region from 2016 to 2018 decreased by 40.7 million MWh, or 12.3 percent, compared to the average for 2006 to 2008. (See Figures 1 and 2.)

² The “nine-state RGGI region” consists of Delaware, Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. New Jersey resumed participation in RGGI in 2020 and Virginia began participation in 2021. Therefore, New Jersey and Virginia are not included in the region for this report.

³ The Memorandum of Understanding called for monitoring electricity imports into the RGGI participating states commencing from the start of the RGGI CO₂ Budget Trading Program and reporting the results of such monitoring on an annual basis beginning in 2010.

- Annual average net imports into the nine-state RGGI region from 2016 to 2018 increased by 21.5 million MWh, or 38.4 percent, compared to the average for 2006 to 2008. (See Figures 1 and 2.)
- For the 2018 calendar year, **electric load** and **electric generation** in the nine-state region show a similar reduction compared to the annual average during the base period from 2006 to 2008.

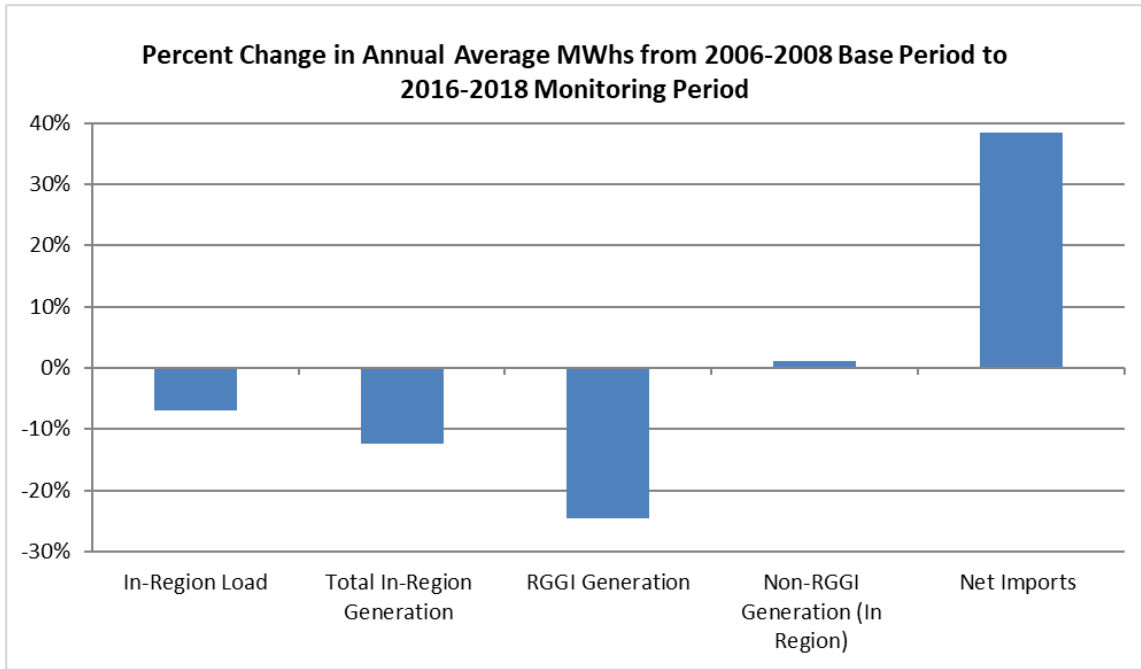


Figure 1. Percentage change in annual average electricity load and generation serving the nine-state RGGI region for 2016 to 2018, relative to the base period of 2006 to 2008.

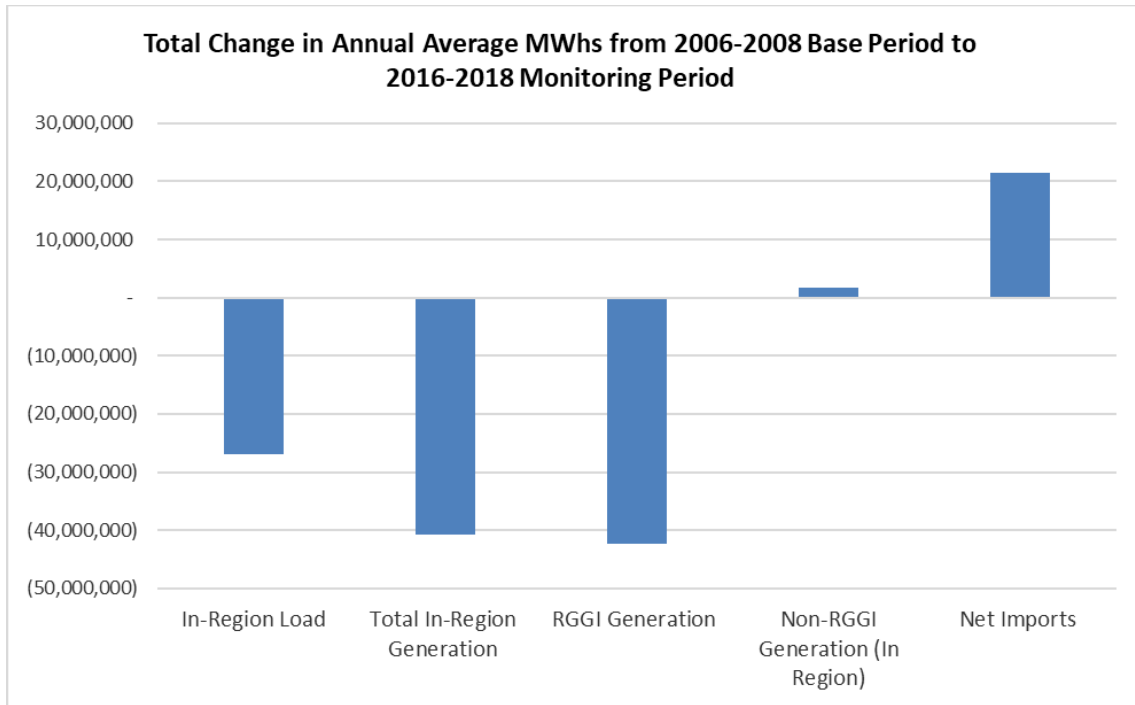


Figure 2. Change in MWhs of annual average electricity load and generation serving the nine-state RGGI Region for 2016 to 2018, relative to the base period of 2006 to 2008.

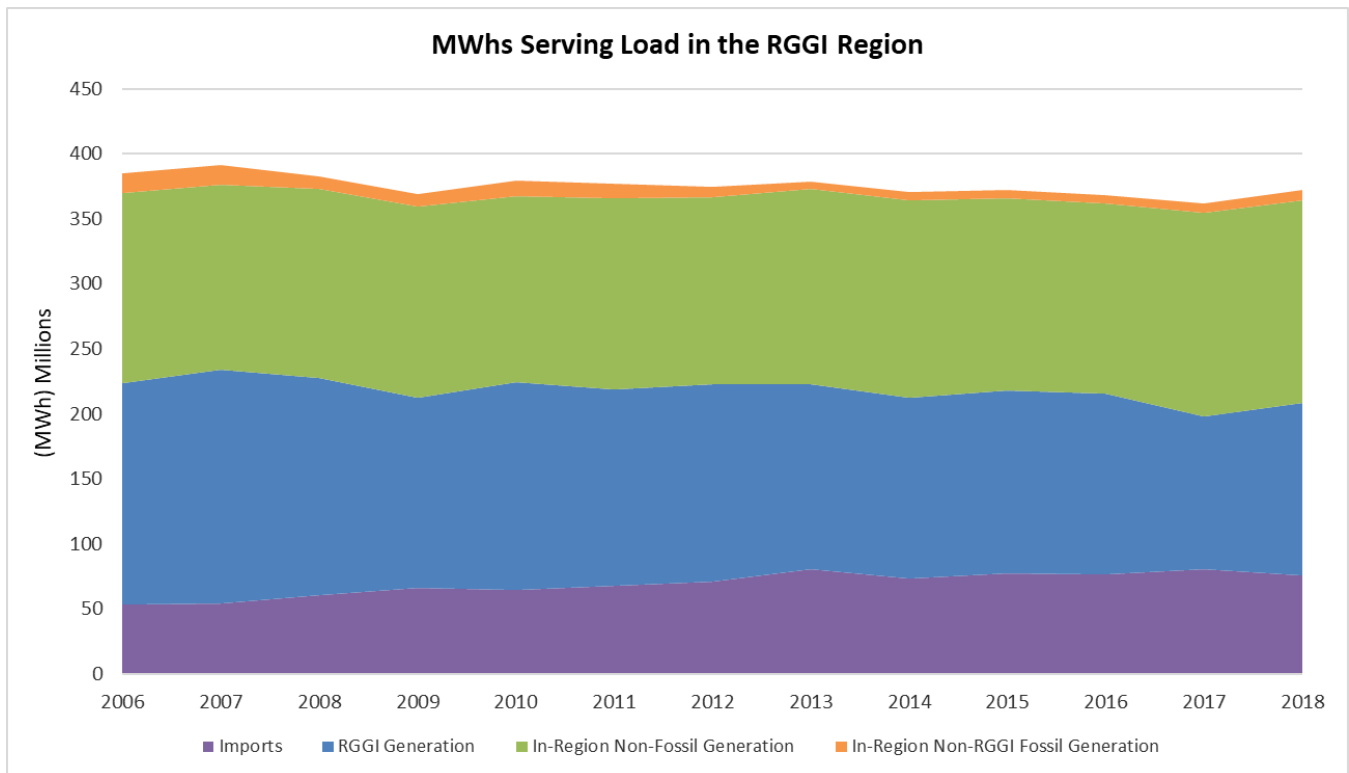


Figure 3. MWhs of generation serving load in the RGGI region from 2006-2018.

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

- The monitoring results indicate there was a decrease of 2.8 million short tons of CO₂, or 6.1 percent, in **CO₂ emissions** from non-RGGI electric generation serving load in the nine-state RGGI region for 2016 to 2018 relative to the base period of 2006 to 2008. The CO₂ emissions from this category for the 2018 calendar year show there has been a similar decrease of 8.5 percent when compared to the base period.⁴
- The annual average **CO₂ emissions rate** from all non-RGGI electric generation sources serving load in the RGGI region for 2016 to 2018 decreased by 64.7 lb CO₂/MWh, or 15.3 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 2016 to 2018 increased by 23.2 million MWh, or 10.9 percent, compared to the base period of 2006 to 2008.

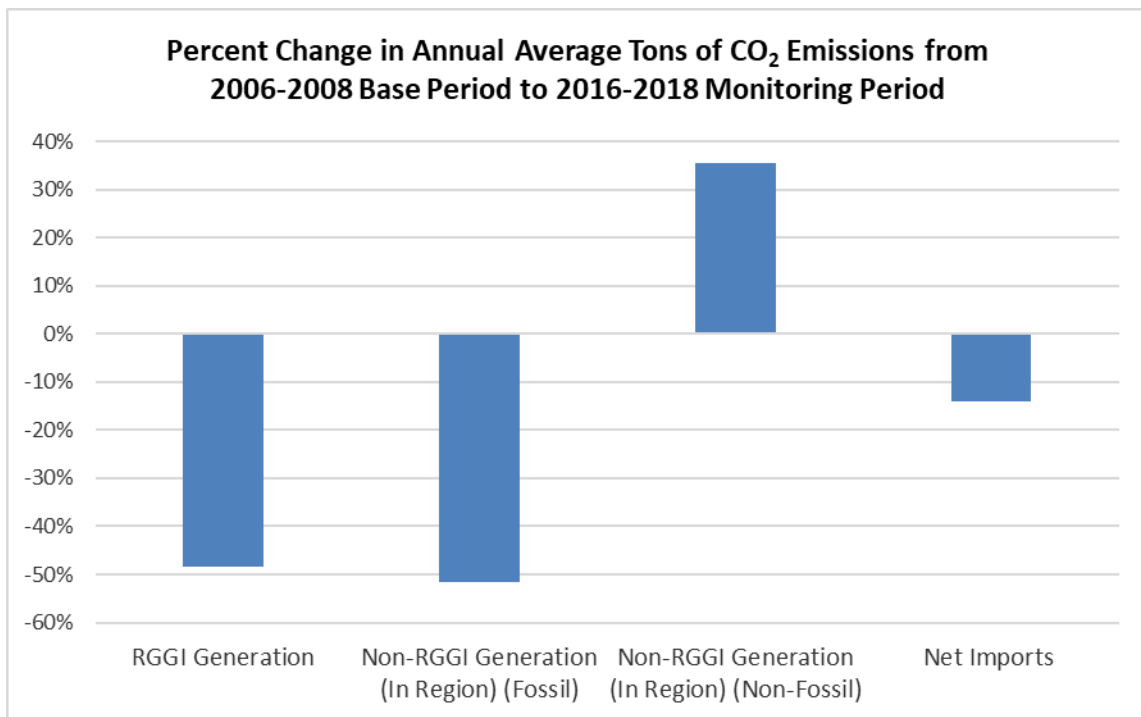


Figure 4. Percent change in annual average CO₂ emissions from generation serving load in the nine-state RGGI region for 2016 to 2018, relative to the base period of 2006 to 2008.

⁴ In the calendar year 2018, non-RGGI electric generation was comprised of 65.2% in-region non-fossil fuel-fired generation, 31.6% net imports, and 3.2% 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.

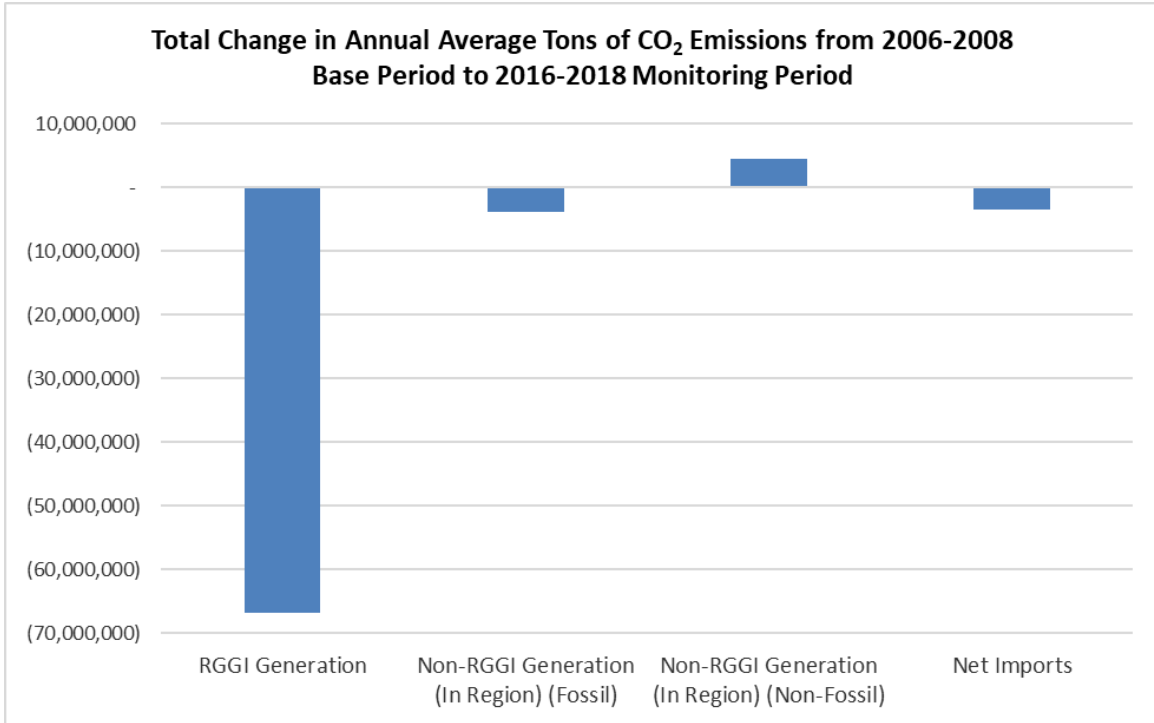


Figure 5. Change in annual average CO₂ emissions from generation serving load in the nine-state RGGI region for 2016 to 2018, relative to the base period of 2006 to 2008.

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

- The annual average **CO₂ emissions** from RGGI electric generation sources from 2016 to 2018 decreased by 66.8 million short tons of CO₂, or 48.3 percent, compared to the base period of 2006 to 2008. (See Figures 4 and 5.)
- The annual average **CO₂ emissions rate** from RGGI electric generation sources from 2016 to 2018 decreased by 504.6 lb CO₂/MWh, or 31.4 percent, compared to the base period of 2006 to 2008.
- The annual average **electric generation** from RGGI electric generation sources from 2016 to 2018 decreased by 42.4 million MWh, or 24.6 percent, compared to the base period of 2006 to 2008. (See Figures 1 and 2.)
- Both **electric generation** and **CO₂ emissions** from RGGI electric generation sources in the 2018 calendar year show a similar reduction compared to the annual average for the base period of 2006 to 2008.

Conclusions

It should be emphasized that this report does not provide indicators of CO₂ emissions leakage, but rather tracks electricity generation and imports, and related CO₂ 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 CO₂ emissions from all non-RGGI electric generation serving electric load in the nine-state region.

Monitoring results show that there has been an increase in the amount of non-RGGI electric generation serving load in the RGGI region as well as a decrease in the CO₂ emissions rate of this generation, which largely offsets the increase in generation. Specifically, there has been a 6.1 percent decrease in average annual CO₂ emissions from non-RGGI electric generation serving load in the RGGI region during the period of 2016 to 2018 when compared to the base period of 2006 to 2008, and a similar decrease for the calendar year 2018 when compared to the base period.

I. Background

The 2018 Electricity Monitoring 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 CO₂ emissions related to these categories of electric generation in the nine-state RGGI region, for the period from 2006 through 2018.⁵ This monitoring was called for in the 2005 RGGI MOU in response to expressed concerns about the potential for the nine RGGI CO₂ Budget Trading Programs⁶ to result in “emissions leakage”.⁷ 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*.⁸

The report should not be used to draw definitive conclusions about whether CO₂ 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 CO₂ 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 CO₂ 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 short tons of CO₂ emissions related to the generation of this electricity, and the associated lb CO₂/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

⁵ This 2018 report is the seventh of the annual monitoring reports to review the data as a nine-state program after New Jersey’s withdrawal from the program at the end of 2011. New Jersey resumed its participation in RGGI on January 1, 2020.

⁶ RGGI is comprised of state CO₂ Budget Trading Programs. Under each of these state programs, a regulated power plant must hold CO₂ allowances equal to its emissions to demonstrate compliance at the end of a three-year control period. Beginning in 2015, a regulated power plant must hold CO₂ allowances equal to 50% of its emissions to demonstrate compliance during each of the first two years of a three-year control period. CO₂ allowances are issued by participating states in a finite amount, or “budget”, resulting in a regional cap on CO₂ 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.

⁷ Specifically, the MOU called for monitoring electricity imports into the RGGI participating states from the start of the RGGI CO₂ Budget Trading Program and reporting the results of such monitoring on an annual basis beginning in 2010.

⁸ 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](#).

and power and solar photovoltaics). The electric generation MWh output that is used on-site is not included in the monitoring results.⁹

For each year 2005 through 2018, the following categories of data are presented for the nine-state RGGI region as well as for each ISO:

- **RGGI Generation**: Electric generation (MWh), CO₂ emissions (short tons), and emission rate (lb CO₂/MWh) for electric generating units subject to a CO₂ allowance compliance obligation under state CO₂ Budget Trading Program regulations.¹⁰
- **Non-RGGI Generation**: Electricity generation (MWh), CO₂ emissions (short tons), and emission rate (lb CO₂/MWh) for all non-RGGI electric generation serving electric load in the nine-state RGGI region. This 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 CO₂ 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).¹¹

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 2016 to 2018 to a base period of 2006 to 2008. The period of 2006 to 2008 represents the three years immediately prior to the start of the program. It was selected as the base period to provide a point of comparison to the three-year control periods of RGGI.

⁹ Behind-the-meter electric generators eligible for credit under state renewable portfolio standards typically voluntarily report electric generation to the ISO-NE Generation Information System (GIS), NY Generation Attribute Tracking System (NYGATS), and PJM Generation Attribute Tracking System (GATS), which are discussed in Section IV. Methodology. These behind-the-meter electric generators that report to ISO-NE GIS, NYGATS, and PJM GATS are included in the monitoring results. CO₂ 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 CO₂/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.

¹⁰ For the purposes of this report, this category does not include electric generators that may be subject to a state CO₂ Budget Trading Program regulation, or portion of such regulation, but that are not subject to a CO₂ allowance compliance obligation that requires the generator to submit CO₂ allowances equivalent to its CO₂ emissions. For example, under Maryland's CO₂ Budget Trading Program regulations, certain industrial cogenerators may be subject to alternative CO₂ compliance obligations under certain conditions in lieu of submission of CO₂ allowances.

¹¹ 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.

In monitoring reports from 2009, 2010, and 2011, data comparisons were made to the base period for the ten-state region. For 2012 through 2018, data comparisons were made to the base period for the nine-state region, reflecting the states participating in RGGI during that time.¹²

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 CO₂ 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 CO₂ allowance compliance obligation under a state CO₂ 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 CO₂ emissions leakage were to occur, it would manifest as an increase in CO₂ emissions from this category of non-RGGI electric generation, assuming all other factors that impact electricity system dispatch and CO₂ emissions (such as electricity demand, relative fossil fuel prices, and wholesale electricity prices) did not change. As a result, an increase in CO₂ 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* CO₂ emissions leakage.

General Limitations

It should be emphasized that this report does not provide indicators of CO₂ emissions leakage, but rather tracks electricity generation and net electricity imports and related CO₂ emissions in the RGGI region for 2016 to 2018, relative to baseline years prior to implementation of the RGGI program. Determining whether CO₂ emissions leakage has occurred requires the evaluation of a hypothetical counterfactual – the amount of CO₂ emissions from non-RGGI electric generation that would occur, assuming there is no shift in electric generation to CO₂-emitting non-RGGI electric generators as a result of the implementation of the RGGI CO₂ Budget Trading Program. In theory, an increase in CO₂ emissions or CO₂ emission rate from non-RGGI electric generation as compared to a historical baseline year could occur in a scenario in which CO₂ emissions leakage does not occur. Conversely, leakage could theoretically occur in a scenario in which CO₂ emissions and CO₂ emission rate for non-RGGI electric generation *decreased* as compared to a historical baseline year, as such emissions could have decreased further under a hypothetical counterfactual in which no CO₂ emissions leakage occurs.

Changes in these data over time may point to *potential* CO₂ emissions leakage as a result of the RGGI CO₂ 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 CO₂ 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

¹² ISO-NE data for years 2005-2015 was adjusted and corrected by the ISO-NE states in the 2016 Electricity Monitoring Report to account for misclassifications of certain generators. New York Control Area (NYCA) data for years 2005-2009 was adjusted and corrected by New York State Department of Public Service (NYSDPS) in the 2011 Electricity Monitoring Report to account for misclassifications of certain generators. The impacts on RGGI and non-RGGI generation and emissions were not significant. All reports available at <https://www.rggi.org/allowance-tracking/emissions>.

emissions of CO₂ and the lb CO₂/MWh emission rates from non-RGGI non-fossil fuel units in this report do not reflect the biomass lifecycle carbon reduction of atmospheric CO₂ levels resulting from uptake of CO₂ from the atmosphere as a result of forest and biomass growth. Likewise, for municipal solid waste combustors, direct emissions of CO₂ are presented with no analysis of the lifecycle of the waste components.

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 CO₂ emissions data for RGGI electric generation from the RGGI CO₂ Allowance Tracking System (RGGI COATS) and emissions statement data reported to state environmental agencies in the RGGI participating states. For non-RGGI electric generation, CO₂ emissions are based on CO₂ emissions for individual electric generation facilities in the NEPOOL 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 for 2005-2015 were compiled by the NYS PSC from NYISO data (MWh generation data) and, beginning in 2016, MWh data were compiled by the NYS PSC from NYISO data (MWh generation data) fed into the New York Generation Attribute Tracking System (NYGATS), which began operation for the 2016 calendar year. NYGATS also captures PJM, NEPOOL, and Hydro Quebec and Ontario data (MWh electricity net import data). This MWh data was supplemented by CO₂ emissions data compiled by the New York State Department of Environmental Conservation (NYSDEC), the EPA, and validated self-reporting in NYGATS. CO₂ emissions data for RGGI electric generation units were compiled from RGGI COATS and from NYSDEC emissions statement program data. CO₂ emissions data for fossil fuel-fired electric generation units that are non-RGGI were taken or extrapolated from reports compiled by NYSDEC, the EPA, and validated self-reporting in NYGATS. A summary of data sources for NYISO is provided in Appendix A.

For each ISO, CO₂ emissions related to net electricity imports from each adjacent control area¹⁴ are the product of a lb CO₂/MWh emission rate and the reported MWh of net imports. The CO₂ emission rate for electricity imports is based on the system average CO₂ 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

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.

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.

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 CO₂ emissions from net imports presented in this report represent net imports from adjacent regions not subject to the RGGI CO₂ 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 CO₂ Budget Trading Program (e.g., from ISO-NE into NYISO and vice versa). To avoid inappropriate double counting of MWh and related CO₂ emissions, the net import subtotals from adjacent ISOs or portion of an ISO subject to the RGGI CO₂ Budget Trading Program were not included when rolling up the individual ISO data into regional summary totals, as the electricity and CO₂ 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.

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.

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 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

¹⁷ 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.

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. 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, which is sometimes referred to as “behind-the-meter” generation.¹⁹

V. Monitoring Results

Monitoring results are provided in this section for the full nine-state RGGI region. These results provide a compilation of data from each ISO fully or partially subject to the RGGI CO₂ Budget Trading Program: ISO-NE, NYISO, and PJM. ISO-NE and NYISO are 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 nine-state RGGI region for 2005 through 2018 are summarized in Table 1.²⁰

¹⁹ See footnote 9.

²⁰ Note that reported regional net electricity imports represent net imports from adjacent control areas or a portion of a control area not subject to the RGGI CO₂ Budget Trading Program. As a result, the net electricity imports and related CO₂ 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 CO₂ 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 CO₂ Budget Trading Program. In order to avoid inappropriate double counting of MWh and related CO₂ emissions, these net import subtotals were not included when rolling up the individual ISO data into regional summary totals, as the electricity and CO₂ emissions represented by these net imports are included in the electric generation subtotals for each ISO.

Table 1. 2005 – 2018 Monitoring Summary for Nine-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 ²¹ | 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 | 182,340,181 | 15,355,763 | 145,831,734 | 161,187,497 | 343,396,401 | 210,926,220 |
| 2006 | 384,993,562 | 3,672,282 | 8,982,749 | 1,047,000 | 8,837,899 | 30,716,157 | 53,256,087 | 170,330,583 | 15,585,075 | 146,057,863 | 161,642,938 | 331,737,475 | 214,899,025 |
| 2007 | 391,243,211 | 2,637,442 | 11,912,292 | 896,000 | 9,452,157 | 28,944,540 | 53,842,431 | 180,079,639 | 15,377,543 | 142,160,325 | 157,537,868 | 337,400,780 | 211,380,299 |
| 2008 | 383,034,165 | 6,162,902 | 15,141,014 | 1,285,000 | 9,917,356 | 28,386,914 | 60,893,186 | 166,479,188 | 10,185,713 | 145,327,318 | 155,513,031 | 322,140,979 | 216,406,217 |
| 2009 | 368,848,273 | 6,463,657 | 17,065,805 | 1,569,000 | 7,760,904 | 33,089,871 | 65,949,237 | 146,453,756 | 10,341,603 | 146,563,495 | 156,905,098 | 302,899,036 | 222,854,335 |
| 2010 | 378,723,230 | 3,872,635 | 13,549,209 | 737,000 | 11,489,286 | 35,142,720 | 64,790,850 | 159,407,982 | 11,890,764 | 143,423,050 | 155,313,814 | 313,931,380 | 220,104,664 |
| 2011 | 375,309,279 | 3,318,681 | 18,681,204 | 846,000 | 10,452,544 | 34,250,993 | 67,549,422 | 151,036,118 | 11,356,368 | 146,908,941 | 158,265,309 | 307,759,857 | 225,814,731 |
| 2012 | 372,082,306 | 5,749,461 | 22,312,689 | 643,000 | 7,926,652 | 34,442,085 | 71,073,887 | 151,793,798 | 8,241,438 | 143,617,952 | 151,859,390 | 301,007,419 | 222,933,277 |
| 2013 | 374,872,244 | 7,593,954 | 24,566,017 | 3,711,000 | 8,700,473 | 35,843,247 | 80,414,691 | 142,194,444 | 5,682,543 | 150,478,150 | 156,160,693 | 294,458,553 | 236,575,384 |
| 2014 | 364,133,729 | 7,180,281 | 22,052,178 | 3,527,050 | 8,239,526 | 32,656,507 | 73,655,542 | 138,677,245 | 6,423,947 | 151,930,514 | 158,354,461 | 292,306,718 | 232,010,003 |
| 2015 | 365,508,854 | 8,302,624 | 22,375,396 | 4,108,000 | 7,144,877 | 35,680,933 | 77,611,830 | 140,574,471 | 6,427,097 | 147,569,738 | 153,996,835 | 289,855,382 | 231,608,665 |
| 2016 | 363,036,567 | 7,668,000 | 21,843,000 | 4,842,000 | 7,936,937 | 33,910,113 | 76,200,050 | 139,176,565 | 6,965,600 | 146,001,202 | 152,966,802 | 286,897,517 | 229,166,852 |
| 2017 | 352,974,095 | 7,720,948 | 25,290,091 | 4,305,000 | 7,551,092 | 35,770,266 | 80,637,398 | 117,676,806 | 7,497,659 | 156,000,097 | 163,497,757 | 273,959,695 | 244,135,154 |
| 2018 | 362,498,067 | 6,586,515 | 24,803,861 | 4,044,000 | 10,145,908 | 30,085,536 | 75,665,820 | 132,757,016 | 7,644,625 | 155,822,346 | 163,466,971 | 288,396,056 | 239,132,791 |

| 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 | 203,397,003 | 460,286 | 30,081 | 714,298 | 4,460,362 | 20,408,108 | 26,073,134 | 159,287,880 | 10,025,160 | 8,010,829 | 18,035,989 | 177,323,869 | 44,109,123 |
| 2006 | 187,356,738 | 769,120 | 39,607 | 547,053 | 5,484,024 | 19,059,750 | 25,899,553 | 139,924,128 | 8,820,383 | 12,712,674 | 21,533,057 | 161,457,185 | 47,432,610 |
| 2007 | 191,288,853 | 604,715 | 39,262 | 455,316 | 5,801,823 | 17,766,431 | 24,667,547 | 145,789,425 | 8,615,550 | 12,216,331 | 20,831,882 | 166,621,306 | 45,499,428 |
| 2008 | 172,528,388 | 1,154,884 | 41,725 | 736,564 | 5,999,390 | 17,172,335 | 25,104,898 | 129,374,761 | 4,650,564 | 13,398,165 | 18,048,729 | 147,423,490 | 43,153,628 |
| 2009 | 147,927,352 | 712,496 | 67,723 | 968,535 | 4,381,845 | 18,682,706 | 24,813,304 | 105,958,243 | 4,812,778 | 12,343,028 | 17,155,806 | 123,114,048 | 41,969,110 |
| 2010 | 163,080,863 | 554,950 | 37,339 | 406,202 | 6,656,944 | 20,361,849 | 28,017,283 | 116,053,938 | 5,405,123 | 13,604,519 | 19,009,642 | 135,063,580 | 47,026,925 |
| 2011 | 147,249,900 | 336,556 | 47,363 | 410,324 | 5,952,203 | 19,504,235 | 26,250,682 | 101,597,445 | 5,148,933 | 14,382,554 | 19,531,487 | 121,128,933 | 45,782,170 |
| 2012 | 135,245,657 | 602,081 | 66,408 | 297,690 | 4,287,069 | 18,627,737 | 23,880,985 | 92,734,116 | 4,037,376 | 14,593,226 | 18,630,601 | 111,364,717 | 42,511,586 |

²¹ See Appendix A, Table 2, Table Note 1.

| | | | | | | | | | | | | | |
|--------------------------------|---|---|---|---|--|---|---|---|---|-----------------------------------|------------------------|-------------|---|
| 2013 | 132,502,742 | 795,236 | 54,159 | 1,186,296 | 4,822,624 | 19,867,713 | 26,726,027 | 86,618,562 | 2,191,307 | 16,967,034 | 19,158,342 | 105,776,903 | 45,884,369 |
| 2014 | 130,934,052 | 603,144 | 34,032 | 1,088,614 | 4,534,250 | 17,971,031 | 24,231,071 | 86,530,517 | 2,613,572 | 17,560,032 | 20,173,603 | 106,703,922 | 44,404,674 |
| 2015 | 126,801,452 | 697,420 | 27,131 | 1,313,206 | 3,602,223 | 17,989,208 | 23,629,188 | 82,987,695 | 3,415,102 | 16,555,084 | 19,970,186 | 102,957,881 | 43,599,373 |
| 2016 | 122,211,267 | 337,392 | 28,893 | 1,761,339 | 3,908,557 | 16,699,087 | 22,735,269 | 79,054,009 | 3,511,705 | 16,736,138 | 20,247,842 | 99,301,852 | 42,983,111 |
| 2017 | 107,727,436 | 298,260 | 33,453 | 1,471,090 | 3,599,881 | 17,052,989 | 22,455,673 | 64,491,131 | 3,601,719 | 17,178,913 | 20,780,632 | 85,271,763 | 43,236,305 |
| 2018 | 112,570,412 | 45,447 | 35,544 | 1,248,169 | 4,692,013 | 13,913,167 | 19,934,339 | 71,057,227 | 3,573,618 | 18,005,228 | 21,578,846 | 92,636,073 | 41,513,186 |
| lb 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 | 1,035 | 485 | 8 | 882 | 1,280 | 1,280 | 1,048 | 1,747 | 1,306 | 110 | 224 | 1,033 | 418 |
| 2006 | 973 | 419 | 9 | 1,045 | 1,241 | 1,241 | 973 | 1,643 | 1,132 | 174 | 266 | 973 | 441 |
| 2007 | 978 | 459 | 7 | 1,016 | 1,228 | 1,228 | 916 | 1,619 | 1,121 | 172 | 264 | 988 | 430 |
| 2008 | 901 | 375 | 6 | 1,146 | 1,210 | 1,210 | 825 | 1,554 | 913 | 184 | 232 | 915 | 399 |
| 2009 | 802 | 220 | 8 | 1,235 | 1,129 | 1,129 | 752 | 1,447 | 931 | 168 | 219 | 813 | 377 |
| 2010 | 861 | 287 | 6 | 1,102 | 1,159 | 1,159 | 865 | 1,456 | 909 | 190 | 245 | 860 | 427 |
| 2011 | 785 | 203 | 5 | 970 | 1,139 | 1,139 | 777 | 1,345 | 907 | 196 | 247 | 787 | 405 |
| 2012 | 727 | 209 | 6 | 926 | 1,082 | 1,082 | 672 | 1,222 | 980 | 203 | 245 | 740 | 381 |
| 2013 | 707 | 209 | 4 | 639 | 1,109 | 1,109 | 665 | 1,218 | 771 | 226 | 245 | 718 | 381 |
| 2014 | 719 | 168 | 3 | 617 | 1,101 | 1,101 | 658 | 1,248 | 814 | 231 | 255 | 730 | 383 |
| 2015 | 694 | 168 | 2 | 639 | 1,008 | 1,008 | 609 | 1,181 | 1,063 | 224 | 259 | 710 | 376 |
| 2016 | 673 | 88 | 3 | 728 | 985 | 985 | 597 | 1,136 | 1,008 | 229 | 265 | 692 | 375 |
| 2017 | 610 | 77 | 3 | 683 | 953 | 953 | 557 | 1,096 | 961 | 220 | 254 | 623 | 354 |
| 2018 | 621 | 14 | 3 | 617 | 925 | 925 | 527 | 1,070 | 935 | 231 | 264 | 642 | 347 |

The monitoring results indicate that the 2016 to 2018 annual average electricity load in the nine-state RGGI region decreased by 26.9 million MWh, or 7.0 percent, compared to the 2006 to 2008 base period. Annual average electric generation from all sources in the nine-state RGGI region decreased by 40.7 million MWh, or 12.3 percent, compared to the base period.

Annual average electric generation from RGGI generation in 2016 to 2018 decreased by 42.4 million MWh, or 24.6 percent, compared to the base period, and annual average CO₂ emissions from RGGI generation decreased by 66.8 million short tons, or 48.3 percent. The annual average CO₂ emission rate of RGGI generation decreased by 504.6 lb CO₂/MWh, a decrease of 31.4 percent. Annual average electric generation from non-RGGI generation sources located in the nine-state RGGI region increased by 1.7 million MWh, or 1.1 percent, during this period, and annual average CO₂ emissions from this category increased by 731,218 short tons. The annual average CO₂ emission rate of non-RGGI electric generation located in the nine-state RGGI region increased by 6.6 lb CO₂/MWh, or 2.6 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 electricity load in the nine-state RGGI region decreased by 23.9 million MWh, or 6.2 percent, and 2018 electric generation from all sources in the nine-state RGGI region decreased by 34.3 million MWh, or 10.4 percent.

For 2016 to 2018, annual average electric generation from all non-RGGI electric generation serving load in the nine-state RGGI region increased by 23.2 million MWh, an increase of 10.9 percent, compared to the annual average generation for the base period. The CO₂ emissions from this category decreased by 2.8 million short tons, a reduction of 6.1 percent, and the CO₂ emission rate decreased by 64.7 lb CO₂/MWh, a reduction of 15.3 percent. (See Figures 6, 7, and 8.) The CO₂ emissions from this category of electric generation for the calendar year 2018 decreased by 3.8 million short tons, or 4.7 percent, when compared to the base period.

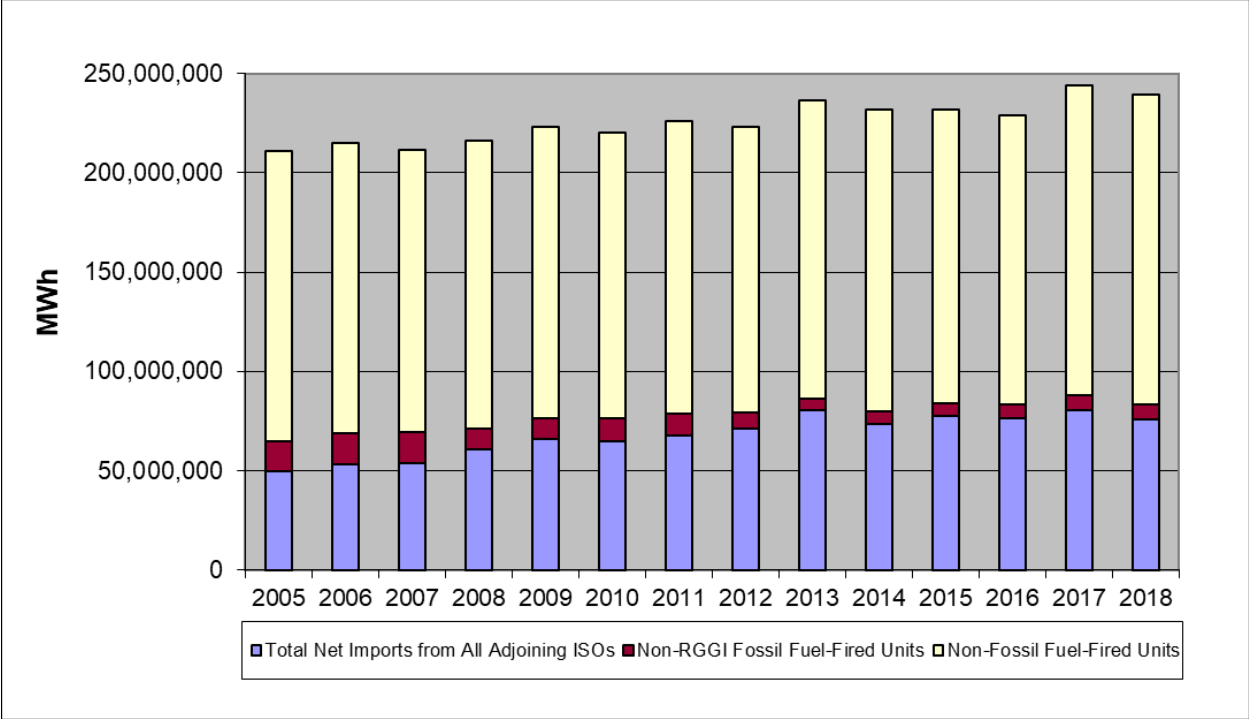


Figure 6. Non-RGGI Generation Serving Load in RGGI Region (MWh)

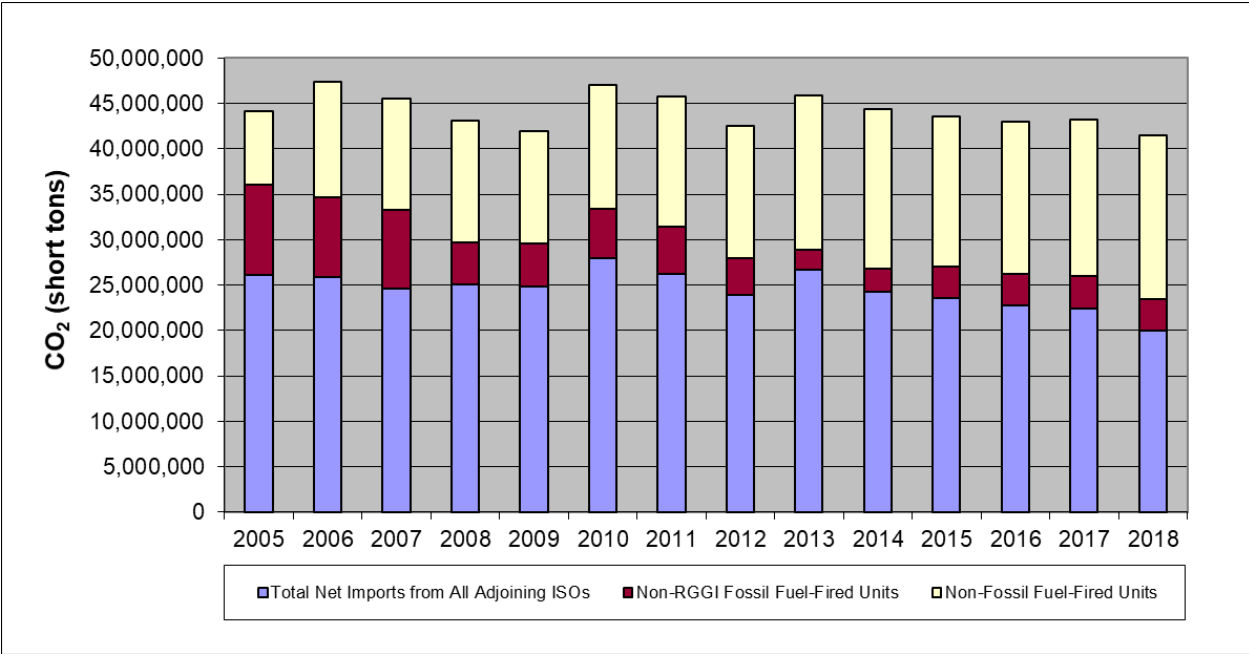


Figure 7. CO₂ Emissions from Non-RGGI Generation Serving Load in RGGI Region (short tons CO₂)

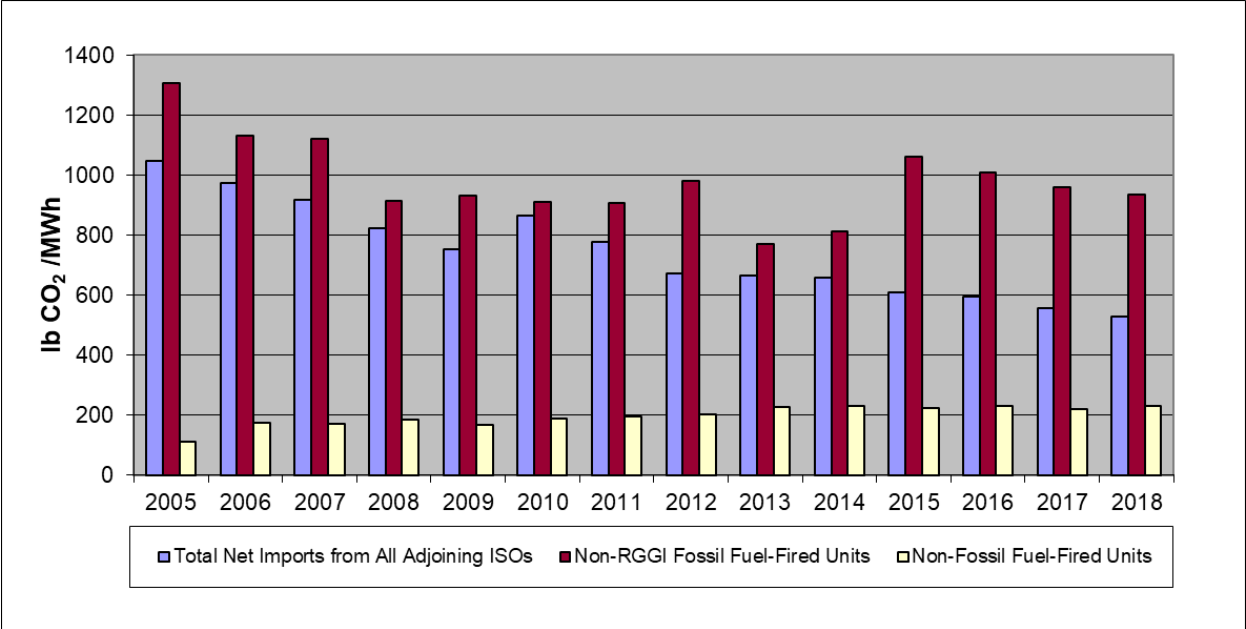


Figure 8. CO₂ Emission Rate for Non-RGGI Generation Serving Load in RGGI Region (lb CO₂/MWh)

Annual average net electricity imports into the nine-state RGGI region increased by 21.5 million MWh, or 38.4 percent, in 2016 to 2018 compared to the 2006 to 2008 base period. CO₂ emissions related to these net electricity imports during this period decreased by 3.5 million short tons, or 13.9 percent, and the average CO₂ emission rate of the electric generation supplying these imports decreased by 344.3 lb CO₂/MWh, a reduction of 38.1 percent. (See Figures 9 and 10.)

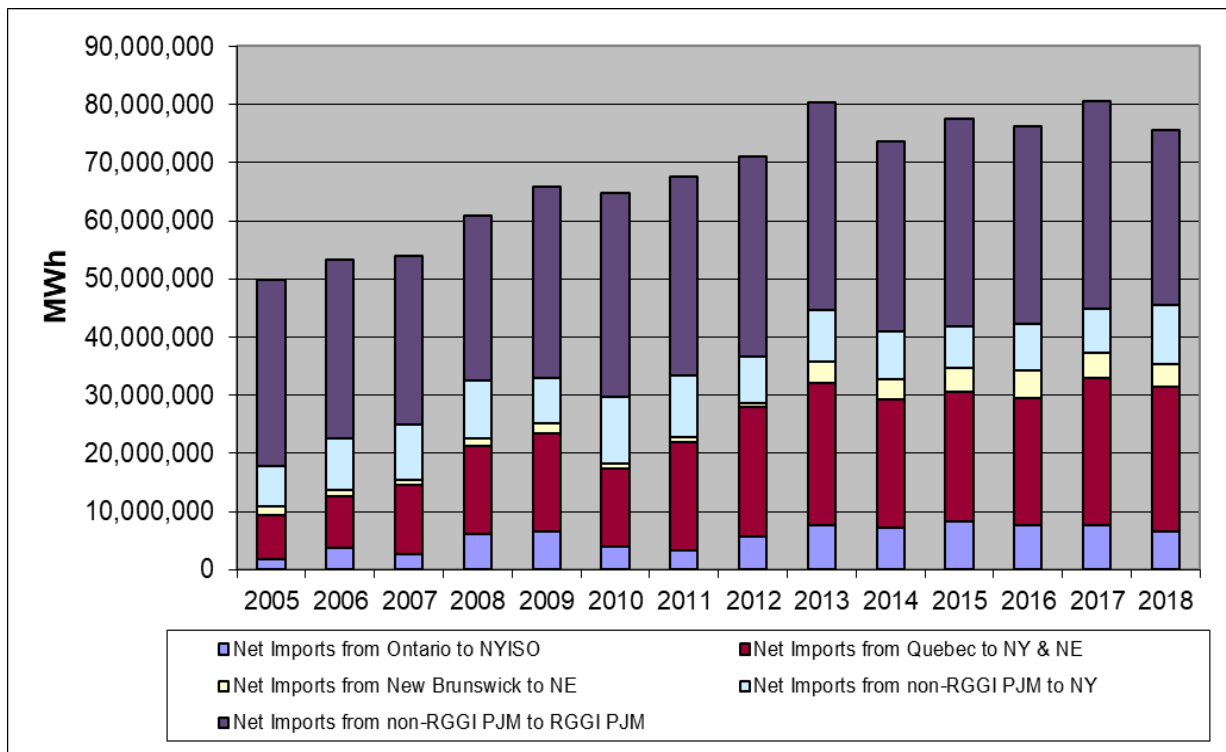


Figure 9. Net Electricity Imports to Nine-State RGGI Region (MWh)

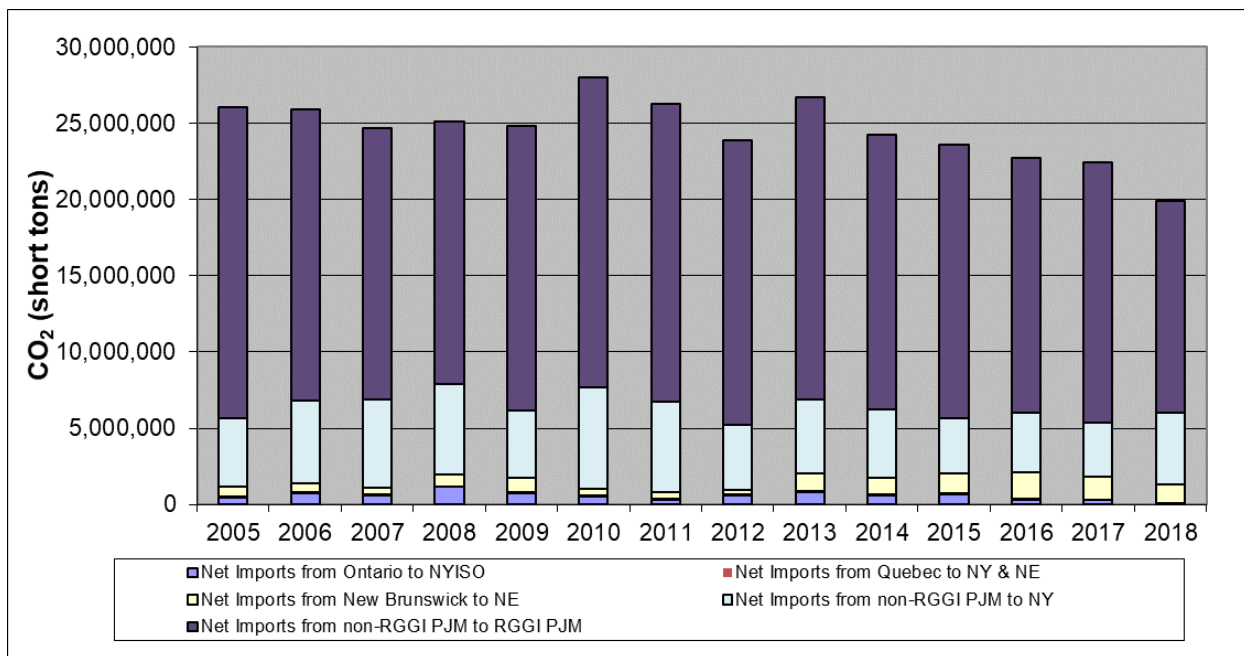


Figure 10. CO₂ Emissions Related to Net Electricity Imports to Nine-State RGGI Region (short tons CO₂)

Compared to the annual average during the 2006 to 2008 base period, 2018 RGGI generation decreased by 39.5 million MWh, or 22.9 percent, and CO₂ emissions from RGGI generation decreased by 67.3 million short tons of CO₂, or 48.6 percent. The CO₂

emission rate of RGGI electric generation in 2018 decreased by 535.0 lb CO₂/MWh compared to the base period, a reduction of 31.7 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 electric generation from non-RGGI generation sources located in the nine-state RGGI region increased by 5.2 million MWh, or 3.3 percent. CO₂ emissions from this category increased by 1.4 million short tons, or 7.2 percent, and the CO₂ emission rate increased by 9.7 lb CO₂/MWh, or 3.8 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 net electricity imports into the nine-state RGGI region increased by 19.7 million MWh, or 35.1 percent. CO₂ emissions related to these net electricity imports decreased by 5.3 million short tons of CO₂, or 21.0 percent, during this period. The average CO₂ emission rate of the electric generation supplying these imports decreased 377.6 lb CO₂/MWh, a reduction of 41.7 percent.

VI. Discussion

As mentioned earlier in this report, multiple market factors interact to influence the dispatch of electric generation. CO₂ 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, CO₂ allowance costs accounted for 2.4 percent of the average all-in wholesale electricity price for ISO-NE, 5.7 percent of the average all-in wholesale electricity price for NYISO, and 0.4 percent of the average all-in locational marginal price on a per MWh basis for PJM in 2018.²² However, the wholesale price is only one of many factors which determine the amount that consumers pay.

When RGGI's benefits are taken into account, independent reports indicate that RGGI is generating net bill savings for consumers. Independent reports from the Analysis Group studied RGGI's first, second, and third three-year control periods, finding that RGGI is reducing consumer energy bills and generating net economic benefits on the order of \$4

²² For 2018, the average all-in wholesale electricity price was \$59.77/MWh for ISO-NE and \$44.92/MWh for NYISO, and the load-weighted average locational marginal price was \$38.24/MWh for PJM (energy only) (see *ISO-NE Monthly Wholesale Load Cost Report*; *NYISO Power Trends 2019*; *2018 State of the Market Report for PJM*). The CO₂ allowance component is based on a 2018 average CO₂ allowance spot price of \$4.41 per CO₂ allowance (See Potomac Economics, *Annual Report on the Market for RGGI CO₂ Allowances: 2018*). For PJM, the CO₂ allowance component of the Locational Marginal Price (LMP) for 2018 was \$0.16 per MWh (See *2018 State of the Market Report for PJM*). ISO-NE and NYISO do not report the CO₂ allowance component of wholesale electricity prices. The New England and New York analyses used a 2018 average CO₂ allowance spot price of \$4.41 as a starting point for deriving a CO₂ allowance wholesale price component. For both ISO-NE and NYISO, the CO₂ emission rate of the assumed marginal unit was used to translate the annual average spot price for CO₂ allowances into a dollar per MWh value. For ISO-NE, this resulted in an average CO₂ allowance wholesale price component of approximately \$1.44 per MWh. For NYISO, this resulted in an average CO₂ allowance wholesale price component of \$2.56 per MWh.

billion.²³ 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. The 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 2011.²⁴ 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 2013.²⁵ 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 2014.²⁶ Wholesale prices fell in 2015 and then reached a low in 2016 due to a warm winter that resulted in less demand for natural gas.²⁷ 2017 saw a slight increase in wholesale prices across the three ISOs. Cold temperatures in early 2018 raised natural gas prices, which further increased average electricity prices in 2018.²⁸

A number of market drivers have changed dramatically during the 2005 through 2018 monitoring timeframe. These changes are due to several factors, including additional investments in energy efficiency and renewable energy (funded in part by RGGI auction proceeds); complementary 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 CO₂ emissions in the 10-state RGGI region from 2005 to 2009, was completed by the New York State Energy Research and Development Authority (NYSERDA).²⁹ 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.³⁰ A 2019 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.³¹

²³ [“The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeastern and Mid-Atlantic States.”](#) Analysis Group. April 2018.

²⁴ [“The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeastern and Mid-Atlantic States.”](#) Analysis Group. July 2015.

²⁵ [“The Economic Impact of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States.”](#) Analysis Group. November 2011.

²⁶ See, for example, Monitoring Analytics, *2011 State of the Market Report for PJM*, Section 1, Introduction.

²⁷ See, for example, *NYISO 2013 Annual Report*, p. 13.

²⁸ See, for example *NYISO 2014 Annual Report*, p. ii.

²⁹ See, for example, *ISO-NE 2018 Annual Markets Report*, p. 4.

³⁰ See, for example, *NYISO Power Trends 2019*, p. 30.

³¹ New York State Energy Research and Development Authority (NYSERDA), *Relative Effects of Various Factors on RGGI Electricity Sector CO₂ Emissions: 2009 Compared to 2005*, November 2010; available at [Retrospective Analysis Draft White Paper.pdf](#).

³² 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.

³³ Congressional Research Service. *The Regional Greenhouse Gas Initiative: Lessons Learned and Issues for Congress*, July 2019, available at <https://fas.org/sqp/crs/misc/R41836.pdf>.

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 CO₂ 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 CO₂ regulation. The extent of this impact is likely to depend, at least in part, on the market value of CO₂ allowances (and the related \$/MWh CO₂ costs incorporated into bids by generators subject to the RGGI CO₂ Budget Trading Program) in relation to other economic factors associated with the generation and delivery of electricity. If the cost of RGGI CO₂ 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 CO₂ allowance price signal³² include:

- **Existing Generator Economics:** Including a CO₂ compliance cost into the generation costs of an individual electric generator may make that generator uneconomic relative to a competitor. Whether this occurs depends on the operating costs of each electric generator, both with and without CO₂ 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 such as nitrogen oxides (NO_x), sulfur dioxide (SO₂), and CO₂. As a result, inclusion of a CO₂ 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 CO₂ allowance cost adder to generation in the RGGI region. 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. LMP is based on the principle that the generation of power has different values at different points in the electric power network. 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.

³² 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 CO₂.

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 can have a large impact on LMPs in a specific region. For example, in 2018, the real-time average LMP by jurisdiction in MD was \$4.13 per MWh higher than the average PJM LMP, indicating the presence of some existing transmission congestion and line losses.³³

- **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 CO₂ 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.³⁴
- **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. In PJM, line losses are accounted for in the calculation of LMP through the application of a line loss “penalty factor.” If the dispatch of an electric generator would result in an increase in system line losses in a certain location, a positive penalty factor is applied to the generator’s bid into the wholesale market, making the unit look less economically attractive to dispatch.³⁵
- **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.

³³ Monitoring Analytics, *2018 State of the Market for PJM*; Volume 2, Energy Market, Table 3-81, p. 188; and Monitoring Analytics, *2018 State of the Market for PJM*; Appendix C, Table C-16, p. 19.

³⁴ For example, the congestion component of the 2018 average day-ahead, load weighted LMP in the Delmarva Power & Light zone (Delaware and Maryland) of PJM was \$2.63 per MWh. For the Baltimore Gas & Electric zone (Maryland), the congestion component was \$4.23 per MWh. Source: Monitoring Analytics, *2018 State of the Market for PJM*; Section 11, Table 11-5, p. 517.

³⁵ For example, the line loss component of the 2018 average day-ahead, load weighted LMP in the Delmarva Power & Light zone (Delaware and Maryland) of PJM was \$1.12 per MWh. Similarly, for the Baltimore Gas & Electric zone (Maryland), the line loss component of LMP was \$1.20 per MWh. Source: Monitoring Analytics, *2018 State of the Market for PJM*; Section 11, Table 11-5, p. 517.

- **Other Factors:** Other relevant factors may include standard transmission pricing, relative fuel prices, natural gas supply and costs that can be influenced by pipeline constraints, and relative heat rates of generation units.³⁶

VII. Conclusions

This report presents data and trends for electricity generation, net electricity imports, and related CO₂ 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 CO₂ emissions rate of this generation. These two trends largely offset one another. Overall, the monitoring results show that there has been a 6.1 percent decrease in average annual CO₂ emissions from non-RGGI electric generation serving load in the RGGI region during the period of 2016 to 2018, compared to the annual average annual CO₂ emissions during the base period of 2006 to 2008.

Emissions leakage may manifest through an increase in CO₂ 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 CO₂ allowance price in 2018 represented approximately 5.7 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 CO₂ allowance prices that result in CO₂ compliance costs on a per MWh basis. The price signal from RGGI allowances prices is likely lower than the aggregate per MWh price signal of mitigating market factors discussed in this report that would counter emissions leakage.

This report is the tenth in a series of annual monitoring reports, as called for in the 2005 RGGI MOU. Ongoing monitoring will further evaluate changes in market and non-market drivers that impact CO₂ emissions related to electricity generation and imports in the RGGI region.

³⁶ Heat rate is a measure of electric generator energy efficiency, represented as Btu of fuel input per kWh of electricity output.

Appendix A. Nine-State ISO Monitoring Sources

Table 2. Summary of Data Sources for ISO-NE

| Code | Electricity Demand (Annual) | | | | | Electricity Generation (Annual) | | | | |
|------------------------------|-------------------------------------|---|--|--|---|---|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| | A-1 | A-2 | A-2 | A-2 | A-3 | B-1 | B-2 | B-3 | B-4 | B-5 |
| Monitoring Category | Total Electricity Use in ISO-NE | Net Electricity Imports - from New York | Net Electricity Imports - from Quebec | Net Electricity Imports - from New Brunswick | Total Net Electricity Imports - from All Adjoining ISOs | RGGI-Affected Units | | | | |
| MWh | ISO-NE ¹ | NYS PSC Calculation (2014-2018) | ISO-NE ¹ | ISO-NE ¹ | Sum of A2s | NEPOOL-GIS ² | NEPOOL-GIS ² | NEPOOL-GIS ² | Sum of B-2 and B-3 | ISO-NE ¹ |
| CO₂ Tons | Sum of A-3 and B-5 | MWh multiplied by CO ₂ /MWh | MWh multiplied by CO ₂ /MWh | MWh multiplied by CO ₂ /MWh | Sum of A-2s | State reported data for 2005-2008; RGGI COATS for 2009 to 2016. 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. | NEPOOL-GIS ² | NEPOOL-GIS ² | Sum of B-2 and B-3 | Sum of B-1 and B-4 |
| CO₂ lb/MWh | CO ₂ tons divided by MWh | NYISO A-2 in Table 3 below | Environment and Climate Change Canada ³ | Environment and Climate Change Canada ³ | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh |

Table Notes:

- ISO-NE, Historical Data Reports, “Net Energy and Peak Load by Source” (Annual Summary). Available at <https://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.
- NEPOOL Generation Information System. Available at <https://www.nepoolgis.com/>.
- National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada, 2020. In Part 3. Available at <https://unfccc.int/documents/224829>. Note that New Brunswick and Quebec emission factors are updated for every year, as compared to the previous year’s report.
- Historical 2005 – 2008 CO₂ emissions data reported by RGGI participating states compiled from CO₂ emissions data reported to U.S. EPA pursuant 40 CFR Part 75 and from CO₂ emissions and fuel use data reported to state emissions statement programs. 2009 through 2018 CO₂ emissions data is from data reported to the RGGI CO₂ Allowance Tracking System (RGGI COATS), available at rggi-coats.org.

Table 3. Summary of Data Sources for NYISO

| Code | Electricity Demand (Annual) | | | | | Electricity Generation (Annual) | | | | | |
|------------------------------|---|---|--|--|--|---|--|--|--|--|-------------------------------------|
| | A-1 | A-2 | A-2 | A-2 | A-3 | B-1 | B-2 | B-3 | B-4 | B-5 | |
| Monitoring Category | Total Electricity Use in NYISO | Net Electricity Imports - from Hydro Quebec | Net Electricity Imports - from ISO-NE | Net Electricity Imports - from Ontario | Net Electricity Imports - from PJM | Total Net Electricity Imports - from All Adjoining ISOs | RGGI-Affected Units | Non-RGGI Units (Fossil Fuel-Fired) | Non-RGGI Units (Non-Fossil Fuel-Fired) | All Non-RGGI Units (Fossil and Non-Fossil) | All Units |
| MWh | NYS PSC Calculation (2005-2015); NYGATS from NYISO data feeds (2016-2018) | Hydro Quebec ¹ (2005-2015); NYGATS from NYISO data feeds (2016-2018) | ISO-NE ² (2005-2015); NYGATS from NYISO/NEPOOL GIS data feeds (2016-2018) | Ontario Independent Electricity System Operator ³ | PJM Annual State of the Market Report ⁴ | Sum of A-2s | NYS PSC Calculation ⁵ (2005-2015); NYGATS from NYISO data feeds (2016-2018) | NYS PSC Calculation ^{5,8} (2005-2015); NYGATS from NYISO data feeds (2016-2018) | NYS PSC Calculation ⁵ (2005-2015); NYGATS from NYISO data feeds (2016-2018) | Sum of B-2 and B-3 | Sum of B-1 and B-4 |
| CO₂ Tons | Sum of A-3 and B-5 | MWh multiplied by CO ₂ /MWh | MWh multiplied by CO ₂ /MWh | MWh multiplied by CO ₂ /MWh | MWh multiplied by CO ₂ /MWh | Sum of A-2s | MWh multiplied by CO ₂ /MWh | MWh multiplied by CO ₂ /MWh | MWh multiplied by CO ₂ /MWh | Sum of B-2 and B-3 | Sum of B-1 and B-4 |
| CO₂ lb/MWh | CO ₂ tons divided by MWh | Environment and Climate Change Canada ⁶ | ISO-NE system average (2005-2015); NY PSC Calculation (2014-2017) | Environment and Climate Change Canada ⁶ | PJM GATS ⁷ | CO ₂ tons divided by MWh | NYS PSC Calculation | NYS PSC Calculation | NYS PSC Calculation | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh |

Table Notes:

- Hydro Quebec response to information request.
- ISO-NE, Historical Data Reports, “Net Energy and Peak Load by Source” (Annual Summary). Available at <https://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/net-ener-peak-load>.
- Ontario IESO response to information request.

4. Monitoring Analytics, *State of the Market for PJM* (2005 through 2018 reports).
5. NYS PSC calculation based on MWh for each generator reported by NYISO and assignment of each generator to appropriate monitoring classification.
6. *National Inventory Report 1990–2018: Greenhouse Gas Sources and Sinks in Canada*, Environment and Climate Change Canada, 2020. In Part 3. Available at <https://unfccc.int/documents/224829>. Note that New Brunswick and Quebec emission factors are updated for every year, as compared to the previous year's report.
7. PJM Generation Attribute Tracking System, accessible at <https://www.pjm-eis.com/>.
8. MWh and CO₂ 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.

Table 4. Summary of Data Sources for RGGI PJM

| Code | Electricity Demand (Annual) | | | | Electricity Generation (Annual) | | | | |
|------------------------------|-------------------------------------|---|--|---|---|-------------------------------------|--|--|-------------------------------------|
| | A-1 | A-2 | A-2 | A-3 | B-1 | B-2 | B-3 | B-4 | B-5 |
| Monitoring Category | Total Electricity Use in RGGI PJM | Net Electricity Imports - from Non-RGGI PJM | Net Electricity Imports - from NYISO | Total Net Electricity Imports - from All Adjoining ISOs | RGGI-Affected Units | Non-RGGI Units (Fossil Fuel-Fired) | Non-RGGI Units (Non-Fossil Fuel-Fired) | All Non-RGGI Units (Fossil and Non-Fossil) | All Units |
| MWh | Sum of A-3 and B-5 | PJM GATS ¹ | PJM GATS ¹ | Sum of A-2s | PJM GATS ¹ | PJM GATS ¹ | PJM GATS ¹ | Sum of B-2 and B-3 | Sum of B-1 and B-4 |
| CO₂ Tons | Sum of A-3 and B-5 | MWh multiplied by CO ₂ /MWh | MWh multiplied by CO ₂ /MWh | Sum of A-2s | State reported data for 2005-2008; RGGI COATS for 2009 through 2018. 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} | PJM GATS ¹ | PJM GATS ¹ | Sum of B-2 and B-3 | Sum of B-1 and B-4 |
| CO₂ lb/MWh | CO ₂ tons divided by MWh | PJM GATS ¹ | B-5 | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh | CO ₂ tons divided by MWh |

Table Notes:

1. PJM Generation Attribute Tracking System, accessible at <https://www.pjm-eis.com/>.
2. Historical 2005 – 2008 CO₂ emissions data reported by RGGI participating states compiled from CO₂ emissions data reported to U.S. EPA pursuant 40 CFR Part 75 and from CO₂ emissions and fuel use data reported to state emissions statement programs. 2009 through 2017 CO₂ emissions data is from data reported to the RGGI CO₂ Allowance Tracking System (RGGI COATS), available at rggi-coats.org.
3. MWh and CO₂ emissions data do not include Maryland Limited Industrial Exemption Set-aside (LIESA) sources. LIESA sources for 2009-2018 include Severstal Sparrows Point LLC, Luke Paper Company, and Cove Point LNG Terminal. LIESA sources refer to certain industrial cogenerators under Maryland's CO₂ Budget Trading Program regulations that are subject to alternative CO₂ compliance obligations under certain conditions in lieu of submission of CO₂ allowances.

Appendix B. ISO-Specific Monitoring Results

Detailed monitoring results for ISO-NE, NYISO, and the RGGI portion of PJM are presented below.³⁷

ISO-NE

Monitoring results for ISO-NE for 2005 through 2018 are summarized below in Table 5 and Figures 11 through 15.

Table 5. 2005 – 2018 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 ³⁸ | 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 | 73,032,078 | 7,932,957 | 51,043,242 | 58,976,199 | 131,877,000 | 65,273,199 |
| 2006 | 134,243,000 | -877,000 | 6,023,000 | 1,047,000 | 6,193,000 | 66,235,352 | 7,994,499 | 54,056,195 | 62,050,694 | 128,050,000 | 68,243,694 |
| 2007 | 136,869,000 | -2,477,000 | 7,727,000 | 896,000 | 6,146,000 | 69,488,412 | 8,430,445 | 53,020,870 | 61,451,315 | 130,723,000 | 67,597,315 |
| 2008 | 134,000,000 | -1,529,000 | 9,495,000 | 1,285,000 | 9,251,000 | 66,518,558 | 5,416,213 | 52,665,469 | 58,081,682 | 124,749,000 | 67,332,682 |
| 2009 | 128,801,000 | -3,031,000 | 10,826,000 | 1,569,000 | 9,363,000 | 60,473,925 | 6,443,028 | 52,979,865 | 59,422,893 | 119,437,000 | 68,785,893 |
| 2010 | 131,956,000 | -4,412,000 | 9,214,000 | 737,000 | 5,539,000 | 65,238,708 | 8,074,341 | 53,893,367 | 61,967,708 | 126,416,000 | 67,506,708 |
| 2011 | 130,752,000 | -2,262,000 | 11,558,000 | 846,000 | 10,142,000 | 62,957,969 | 7,886,924 | 51,306,677 | 59,193,601 | 120,610,000 | 69,335,601 |
| 2012 | 129,590,000 | -1,073,000 | 13,077,000 | 643,000 | 12,648,000 | 62,129,238 | 4,314,475 | 53,144,056 | 57,458,531 | 116,942,000 | 70,106,531 |
| 2013 | 131,001,000 | 1,322,000 | 13,928,000 | 3,711,000 | 18,961,000 | 57,766,430 | 1,637,377 | 56,533,777 | 58,171,154 | 112,041,000 | 77,132,154 |
| 2014 | 127,176,000 | 3,908,078 | 13,212,403 | 3,527,050 | 20,647,531 | 53,539,784 | 1,739,519 | 57,802,685 | 59,542,204 | 108,357,000 | 80,189,735 |
| 2015 | 126,955,000 | 3,911,358 | 12,978,000 | 4,108,000 | 20,997,358 | 58,406,246 | 1,742,545 | 52,483,133 | 54,225,678 | 107,916,000 | 75,223,036 |
| 2016 | 124,416,000 | 1,335,255 | 12,285,000 | 4,842,000 | 18,462,255 | 55,090,362 | 2,024,903 | 53,702,585 | 55,727,488 | 105,572,000 | 74,189,743 |
| 2017 | 121,220,000 | 1,478,998 | 14,495,000 | 4,305,000 | 20,278,998 | 49,456,967 | 2,335,299 | 57,986,601 | 60,321,901 | 102,564,000 | 80,600,898 |
| 2018 | 123,472,000 | 3,285,809 | 13,966,000 | 4,044,000 | 21,295,809 | 52,512,178 | 2,505,743 | 56,550,010 | 59,055,753 | 103,740,000 | 80,351,562 |

³⁷ Short tons of CO₂ emitted and the lb CO₂/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.

³⁸ See Appendix A, Table 2, Table Note 1.

| 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 | 65,211,430 | -56,275 | 19,544 | 714,298 | 677,567 | 54,223,939 | 3,807,116 | 6,502,808 | 10,309,924 | 64,533,863 | 10,987,491 |
| 2006 | 42,202,458 | -404,953 | 26,557 | 547,053 | 168,657 | 47,783,423 | 2,294,218 | 9,049,196 | 11,343,414 | 59,126,837 | 11,512,070 |
| 2007 | 50,079,316 | -1,155,569 | 25,468 | 455,316 | -674,785 | 49,434,978 | 2,963,453 | 8,586,395 | 11,549,849 | 60,984,826 | 10,875,064 |
| 2008 | 54,286,213 | -671,104 | 26,166 | 736,564 | 91,627 | 44,508,400 | 1,820,953 | 8,425,083 | 10,246,036 | 54,754,436 | 10,337,663 |
| 2009 | 44,334,489 | -1,287,840 | 42,961 | 968,535 | -276,344 | 38,815,561 | 2,733,899 | 9,198,068 | 11,931,967 | 50,747,528 | 11,655,623 |
| 2010 | 49,139,981 | -1,932,583 | 25,392 | 406,202 | -1,500,990 | 41,682,538 | 3,331,687 | 10,359,631 | 13,691,318 | 55,373,857 | 12,190,329 |
| 2011 | 43,513,964 | -933,856 | 29,303 | 410,324 | -494,228 | 35,599,032 | 3,294,100 | 11,029,838 | 14,323,938 | 49,793,256 | 13,829,710 |
| 2012 | 38,748,137 | -410,272 | 38,920 | 297,690 | -73,661 | 31,657,173 | 1,815,918 | 11,240,839 | 13,056,757 | 44,713,885 | 12,983,095 |
| 2013 | 45,985,934 | 522,082 | 30,706 | 1,186,296 | 1,739,082 | 30,173,526 | 604,510 | 13,469,005 | 14,073,514 | 44,247,040 | 15,812,597 |
| 2014 | 45,016,852 | 1,054,224 | 20,390 | 1,088,614 | 2,163,233 | 27,665,118 | 584,114 | 14,605,525 | 15,189,639 | 42,854,758 | 17,352,872 |
| 2015 | 45,213,688 | 1,011,086 | 15,736 | 1,313,206 | 2,340,028 | 28,867,519 | 609,582 | 13,155,735 | 13,765,317 | 42,632,836 | 16,105,345 |
| 2016 | 42,138,496 | 414,597 | 16,250 | 1,761,339 | 2,192,186 | 26,013,525 | 635,083 | 13,123,557 | 13,758,641 | 39,772,166 | 15,950,827 |
| 2017 | 40,398,875 | 421,514 | 19,174 | 1,471,090 | 1,911,777 | 23,990,894 | 677,682 | 13,818,521 | 14,496,203 | 38,487,097 | 16,407,980 |
| 2018 | 40,274,183 | 966,028 | 20,013 | 1,248,169 | 2,234,210 | 23,873,039 | 650,362 | 13,516,572 | 14,166,934 | 38,039,973 | 16,401,145 |

| lb 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 | 944 | 979 | 8 | 882 | 215 | 1,485 | 960 | 255 | 350 | 979 | 337 |
| 2006 | 629 | 923 | 9 | 1,045 | 54 | 1,443 | 574 | 335 | 366 | 923 | 337 |
| 2007 | 732 | 933 | 7 | 1,016 | -220 | 1,423 | 703 | 324 | 376 | 933 | 322 |
| 2008 | 810 | 878 | 6 | 1,146 | 20 | 1,338 | 672 | 320 | 353 | 878 | 307 |
| 2009 | 688 | 850 | 8 | 1,235 | -59 | 1,284 | 849 | 347 | 402 | 850 | 339 |
| 2010 | 666 | 876 | 6 | 1,102 | -542 | 1,278 | 825 | 384 | 442 | 876 | 361 |
| 2011 | 666 | 826 | 5 | 970 | -97 | 1,131 | 835 | 430 | 484 | 826 | 399 |

| | | | | | | | | | | | |
|-------------|-----|-----|---|-----|-----|-------|-----|-----|-----|-----|-----|
| 2012 | 598 | 765 | 6 | 926 | -12 | 1,019 | 842 | 423 | 454 | 765 | 370 |
| 2013 | 702 | 790 | 4 | 639 | 183 | 1,045 | 738 | 476 | 484 | 790 | 410 |
| 2014 | 708 | 540 | 3 | 617 | 210 | 1,033 | 672 | 505 | 510 | 791 | 433 |
| 2015 | 712 | 517 | 2 | 639 | 223 | 989 | 700 | 501 | 508 | 790 | 428 |
| 2016 | 677 | 621 | 3 | 728 | 237 | 944 | 627 | 489 | 494 | 753 | 430 |
| 2017 | 667 | 570 | 3 | 683 | 189 | 970 | 580 | 477 | 481 | 750 | 407 |
| 2018 | 652 | 588 | 3 | 617 | 210 | 909 | 519 | 478 | 480 | 733 | 408 |

The monitoring results indicate that the annual average electricity load in ISO-NE for 2016 to 2018 decreased by 12.0 million MWh, or 8.9 percent, compared to the annual average for the baseline period of 2006 to 2008. Electric generation from all sources in ISO-NE decreased by 17.2 million MWh, or 13.5 percent, compared to the base period.

Annual average electric generation from RGGI generation in ISO-NE decreased by 15.1 million MWh during this period, or 22.3 percent, and annual average CO₂ emissions from RGGI electric generation in ISO-NE decreased by 22.6 million short tons of CO₂, or 47.9 percent. The CO₂ emission rate of RGGI electric generation decreased by 460.0 lb CO₂/MWh, or 32.8 percent. Annual average electric generation from non-RGGI electric generation sources located in ISO-NE decreased by 2.2 million MWh, or 3.6 percent, during this period, and CO₂ emissions from this category of electric generation increased by 3.1 million short tons of CO₂, an increase of 28.0 percent. The annual average CO₂ emission rate of non-RGGI electric generation located in ISO-NE increased by 120.0 lb CO₂/MWh, an increase of 32.9 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 total electricity load in ISO-NE decreased by 11.6 million MWh, or 8.6 percent. Compared to the 2006 to 2008 annual average, 2018 total electric generation in ISO-NE decreased by 16.4 million MWh, or 12.8 percent.

When the 2016 to 2018 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 10.7 million MWh, or 15.7 percent. The CO₂ emissions from this category of electric generation increased by 5.3 million short tons of CO₂, or 49.0 percent, and the CO₂ emission rate increased by 93.1 lb CO₂/MWh, or 28.9 percent. (See Figures 11, 12, and 13.)

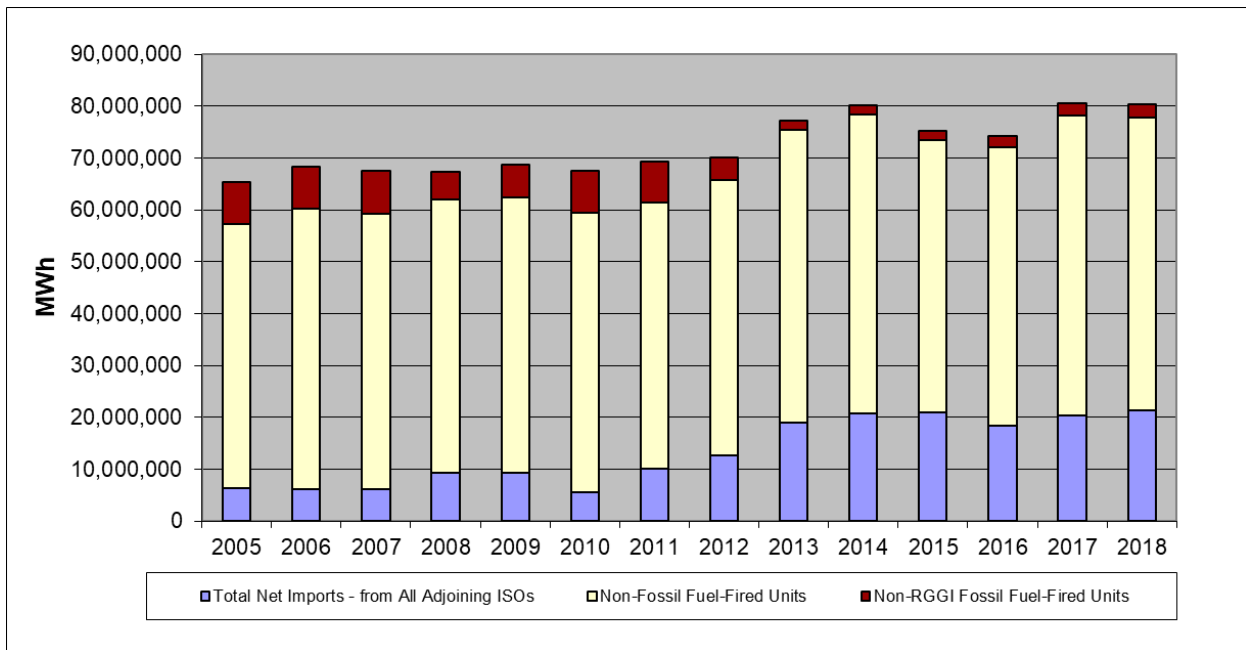


Figure 11. Non-RGGI Generation Serving Load in ISO-NE (MWh)

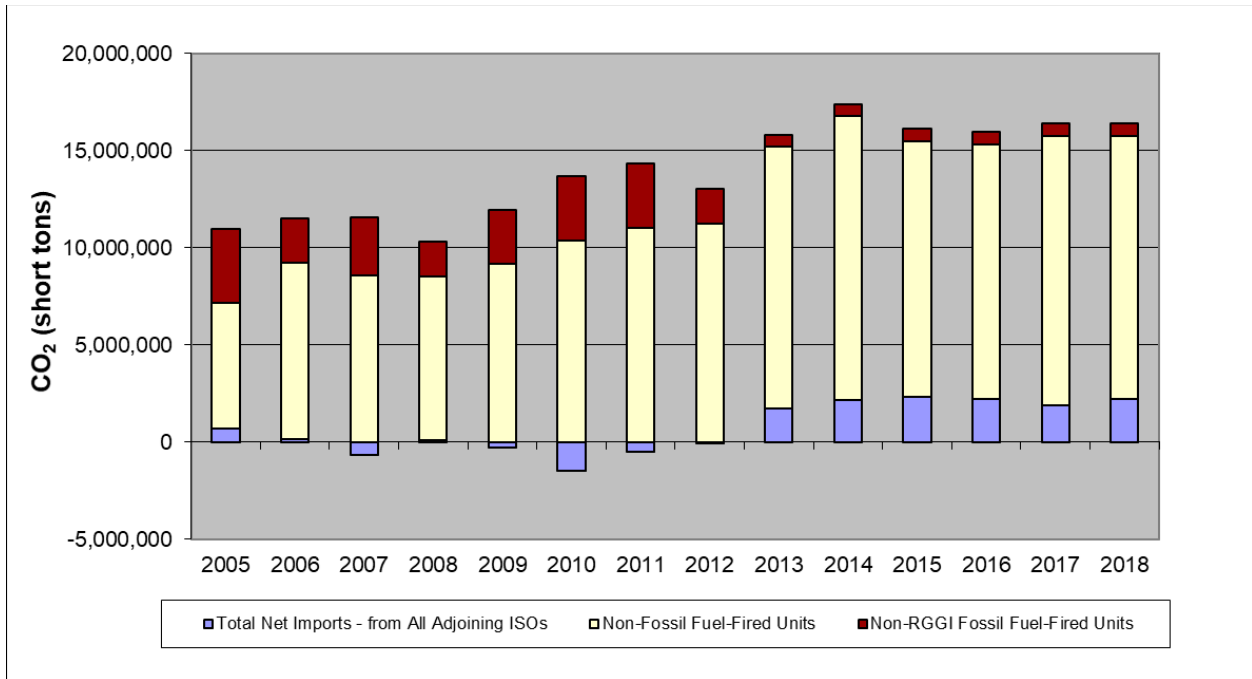


Figure 12. CO₂ Emissions from Non-RGGI Generation Serving Load in ISO-NE (short tons CO₂)

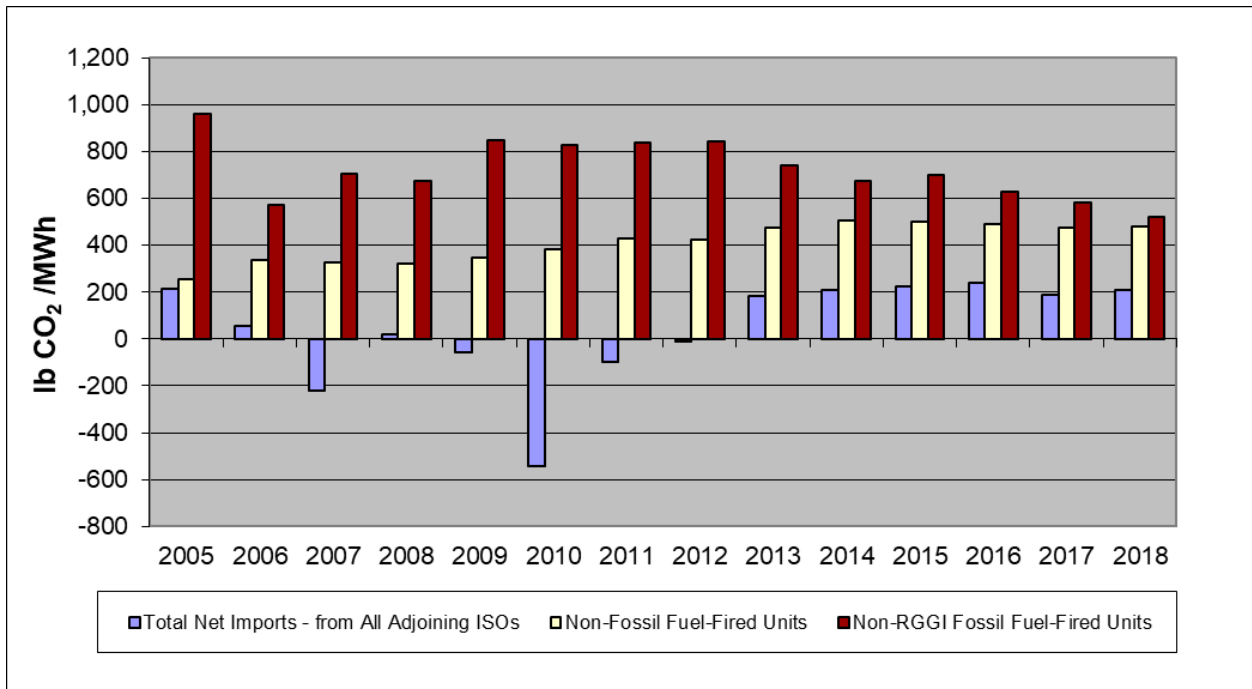


Figure 13. CO₂ Emission Rate for Non-RGGI Generation Serving Load in ISO-NE (lb CO₂/MWh)

Annual average net electricity imports into ISO-NE for 2016 to 2018 increased by 12.8 million MWh compared to the base period annual average for 2006 to 2008. Annual average CO₂ emissions related to these net electricity imports increased by 2.3 million

short tons of CO₂ during this period.³⁹ The annual average CO₂ emission rate of the electric generation supplying these imports increased by 260.4 lb CO₂/MWh.

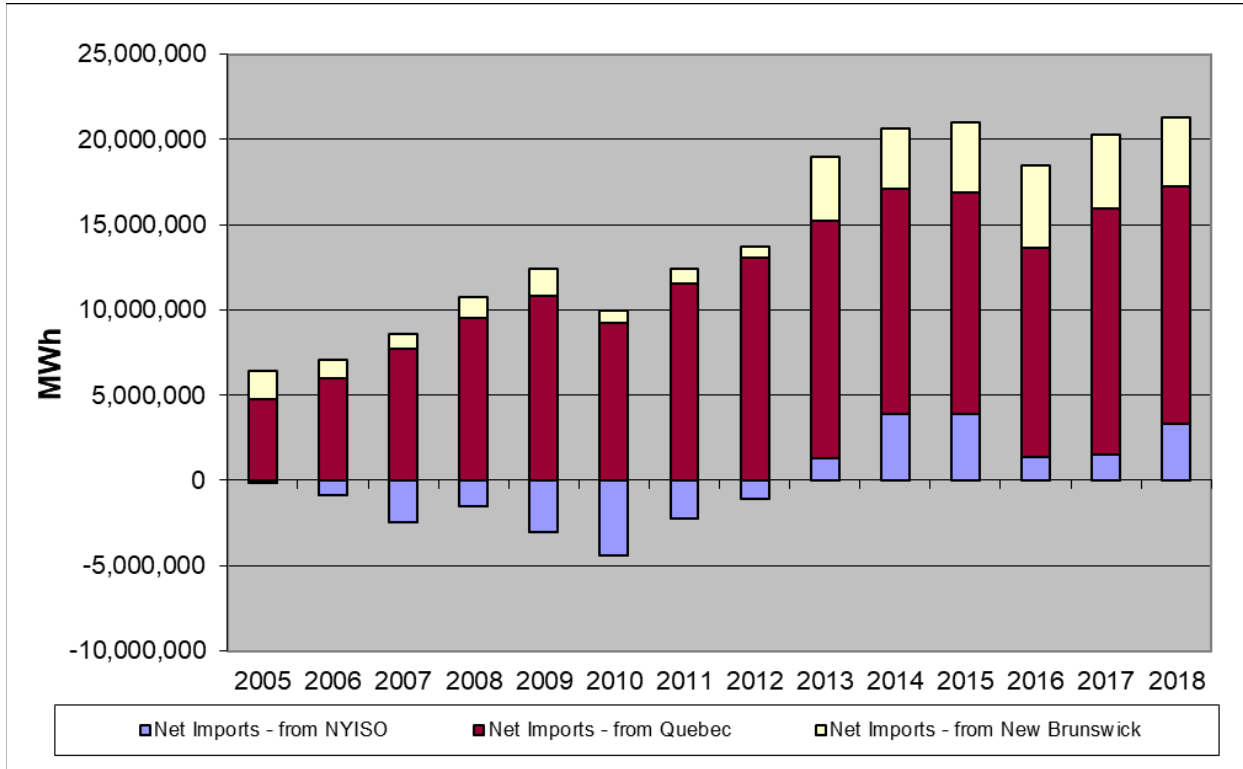


Figure 14. Net Electricity Imports to ISO-NE (MWh)

³⁹ ISO-NE net exports to NYISO doubled from 2008 to 2009 and increased again in 2010. Negative values for MWh and CO₂ 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 CO₂ emissions debited from the ISO-NE net import total, resulting in a negative CO₂ emissions value for total CO₂ 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.

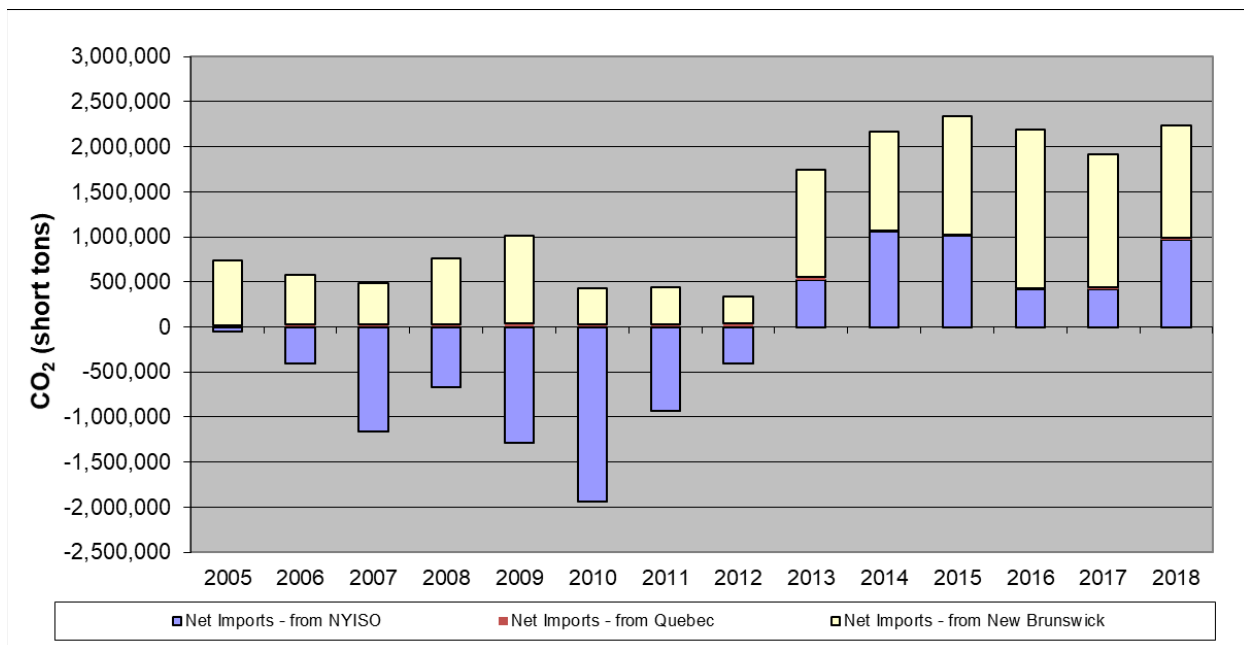


Figure 15. CO₂ Emissions Related to Net Electricity Imports to ISO-NE (short tons CO₂)

Compared to the annual average during the 2006 to 2008 base period, electric generation in 2018 from all non-RGGI electric generation sources serving load in ISO-NE increased by 12.6 million MWh, an increase of 18.6 percent. Compared to the 2006 to 2008 annual average, 2018 CO₂ emissions from this category of electric generation increased by 5.5 million short tons of CO₂, an increase of 50.4 percent, and the CO₂ emission rate increased by 86.2 lb CO₂/MWh, an increase of 26.8 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 RGGI electric generation in ISO-NE decreased by 14.9 million MWh, or 22.1 percent, and CO₂ emissions from RGGI generation in ISO-NE decreased by 23.4 million short tons of CO₂, or 49.5 percent. The CO₂ emission rate of RGGI electric generation decreased by 492.1 lb CO₂/MWh, a reduction of 35.1 percent. Compared to the 2006 to 2008 annual average, 2018 electric generation from non-RGGI generation located in ISO-NE decreased by 1.5 million MWh, or 2.4 percent, and CO₂ emissions from this category increased by 3.1 million short tons of CO₂, an increase of 28.2 percent. The CO₂ emission rate of non-RGGI electric generation located in ISO-NE increased by 115.0 lb CO₂/MWh, an increase of 31.5 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 net electricity imports into ISO-NE increased by 14.1 million MWh. CO₂ emissions related to these net electricity imports increased by 2.4 million short tons of CO₂ during this period. The CO₂ emission rate of the electric generation supplying these imports increased by 258.3 lb CO₂/MWh.

NYISO

Monitoring results for NYISO for 2005 through 2018 are summarized below in Table 6 and Figures 16 through 20.

Table 6. 2005 – 2018 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 | 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 |
| 2016 | 160,798,000 | 9,558,000 | -1,335,255 | 7,668,000 | 8,399,813 | 24,290,558 | 57,581,414 | 4,889,216 | 74,479,557 | 79,368,773 | 136,950,187 | 103,659,331 |
| 2017 | 156,370,000 | 10,795,091 | -1,478,998 | 7,720,948 | 7,948,559 | 24,985,600 | 47,011,708 | 5,134,132 | 79,238,560 | 84,372,692 | 131,384,400 | 109,358,292 |
| 2018 | 161,114,000 | 10,837,861 | -3,285,809 | 6,586,515 | 10,776,410 | 24,914,977 | 51,472,100 | 5,083,318 | 79,643,605 | 84,726,923 | 136,199,023 | 109,641,900 |

| 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 | Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports) |
| 2005 | 74,759,800 | 10,536 | 56,275 | 460,286 | 4,912,184 | 5,439,281 | 62,718,683 | 5,933,822 | 668,014 | 6,601,836 | 69,320,519 | 12,041,117 |
| 2006 | 69,807,908 | 13,050 | 404,953 | 769,120 | 5,983,934 | 7,171,057 | 53,638,129 | 6,319,357 | 2,679,365 | 8,998,722 | 62,636,851 | 16,169,779 |
| 2007 | 71,578,150 | 13,794 | 1,155,569 | 604,715 | 6,349,725 | 8,123,803 | 55,717,151 | 5,430,598 | 2,306,598 | 7,737,196 | 63,454,347 | 15,860,999 |
| 2008 | 63,062,489 | 15,559 | 671,104 | 1,154,884 | 6,520,900 | 8,362,447 | 48,348,177 | 2,676,684 | 3,675,181 | 6,351,865 | 54,700,042 | 14,714,312 |
| 2009 | 48,529,762 | 24,762 | 1,287,840 | 712,496 | 4,736,174 | 6,761,271 | 37,861,408 | 1,931,753 | 1,975,329 | 3,907,082 | 41,768,490 | 10,668,354 |
| 2010 | 55,583,232 | 11,947 | 1,932,583 | 554,950 | 7,179,968 | 9,679,448 | 42,113,171 | 1,944,024 | 1,846,589 | 3,790,613 | 45,903,784 | 13,470,061 |
| 2011 | 48,275,690 | 18,060 | 936,289 | 336,556 | 6,389,108 | 7,677,579 | 37,148,379 | 1,683,269 | 1,764,030 | 3,447,299 | 40,595,678 | 11,127,311 |
| 2012 | 44,898,580 | 27,488 | 410,272 | 602,081 | 4,212,809 | 5,252,649 | 35,640,442 | 2,008,494 | 1,996,995 | 4,005,489 | 39,645,930 | 9,258,138 |
| 2013 | 42,408,932 | 23,453 | -522,082 | 795,236 | 4,871,212 | 5,167,821 | 33,476,561 | 1,485,213 | 2,279,339 | 3,764,552 | 37,241,113 | 8,932,371 |
| 2014 | 42,040,391 | 13,642 | -1,105,986 | 603,144 | 4,827,463 | 4,338,263 | 34,028,752 | 1,946,553 | 1,726,824 | 3,673,376 | 37,702,326 | 8,011,639 |
| 2015 | 40,890,195 | 11,395 | -1,011,086 | 697,420 | 3,831,989 | 3,529,718 | 32,550,962 | 2,745,481 | 2,064,034 | 4,809,515 | 37,334,037 | 8,339,233 |
| 2016 | 39,501,402 | 12,643 | -414,597 | 337,392 | 4,162,107 | 4,097,546 | 30,666,015 | 2,823,920 | 1,913,921 | 4,737,841 | 35,403,858 | 8,835,387 |
| 2017 | 33,305,807 | 14,279 | -421,514 | 298,260 | 3,918,639 | 3,809,665 | 24,577,905 | 2,897,654 | 2,020,583 | 4,918,237 | 29,496,143 | 8,727,902 |
| 2018 | 37,526,044 | 13,602 | -966,028 | 45,477 | 5,188,841 | 4,281,862 | 27,215,742 | 2,870,820 | 3,157,620 | 6,028,440 | 33,244,182 | 10,310,302 |
| lb 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 | Non-RGGI Generation Serving Load in ISO (Non-RGGI Generation within ISO + Net Imports) |
| 2005 | 907 | 8 | 979 | 485 | 1,292 | 892 | 1,849 | 1,688 | 17 | 156 | 909 | 248 |
| 2006 | 838 | 9 | 923 | 419 | 1,252 | 840 | 1,604 | 1,726 | 71 | 218 | 837 | 324 |
| 2007 | 842 | 7 | 933 | 459 | 1,242 | 832 | 1,562 | 1,634 | 64 | 196 | 844 | 322 |

| | | | | | | | | | | | | |
|-------------|-----|---|-----|-----|-------|-----|-------|-------|----|-----|-----|-----|
| 2008 | 748 | 6 | 878 | 375 | 1,220 | 696 | 1,496 | 1,159 | 98 | 159 | 756 | 283 |
| 2009 | 604 | 8 | 850 | 220 | 1,137 | 562 | 1,346 | 1,030 | 52 | 97 | 612 | 205 |
| 2010 | 677 | 6 | 876 | 287 | 1,167 | 777 | 1,347 | 1,055 | 50 | 99 | 659 | 265 |
| 2011 | 589 | 5 | 826 | 203 | 1,146 | 644 | 1,257 | 1,035 | 45 | 85 | 580 | 213 |
| 2012 | 549 | 6 | 765 | 209 | 1,002 | 429 | 1,163 | 1,075 | 54 | 103 | 570 | 181 |
| 2013 | 510 | 4 | 790 | 209 | 1,060 | 396 | 1,122 | 749 | 59 | 93 | 531 | 167 |
| 2014 | 524 | 3 | 566 | 168 | 1,107 | 416 | 1,165 | 844 | 45 | 90 | 540 | 157 |
| 2015 | 509 | 2 | 517 | 168 | 1,014 | 331 | 1,191 | 1,187 | 53 | 117 | 536 | 161 |
| 2016 | 491 | 3 | 621 | 88 | 991 | 337 | 1,108 | 1,155 | 51 | 119 | 517 | 170 |
| 2017 | 426 | 3 | 570 | 77 | 986 | 305 | 1,112 | 1,129 | 51 | 117 | 449 | 160 |
| 2018 | 466 | 3 | 588 | 14 | 963 | 344 | 1,057 | 1,130 | 79 | 142 | 488 | 188 |

The monitoring results indicate that the annual average electricity load in NYISO for 2016 to 2018 decreased by 9.0 million MWh, or 5.3 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 13.4 million MWh, or 9.0 percent, compared to the base period.

Annual average electric generation from RGGI generation in NYISO decreased by 15.6 million MWh during this period, or 23.1 percent, and annual average CO₂ emissions from RGGI electric generation in NYISO decreased by 25.1 million short tons of CO₂, or 47.7 percent. The annual average CO₂ emission rate of RGGI electric generation decreased by 461.7 lb CO₂/MWh, a reduction of 29.7 percent. Annual average electric generation from non-RGGI sources located in NYISO increased by 2.2 million MWh, or 2.8 percent, during this period, and average annual CO₂ emissions from this category decreased by 2.5 million short tons of CO₂, a decrease of 32.1 percent. The annual average CO₂ emission rate of non-RGGI electric generation located in NYISO decreased by 64.6 lb CO₂/MWh, a decrease of 33.9 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 electric load in NYISO decreased by 7.3 million MWh, or 4.3 percent, and electric generation from all sources in NYISO in 2018 decreased by 16.1 million MWh, or 23.9 percent.

The annual average non-RGGI electric generation serving load in NYISO for 2016 to 2018 increased by 6.7 million MWh, or 6.7 percent, compared to the base period of 2006 to 2008. Annual average CO₂ emissions from this category of electric generation decreased by 6.3 million short tons of CO₂, or 40.4 percent, and the annual average CO₂ emission rate decreased by 136.8 lb CO₂/MWh, a decrease of 44.2 percent. (See Figures 16, 17, and 18.)

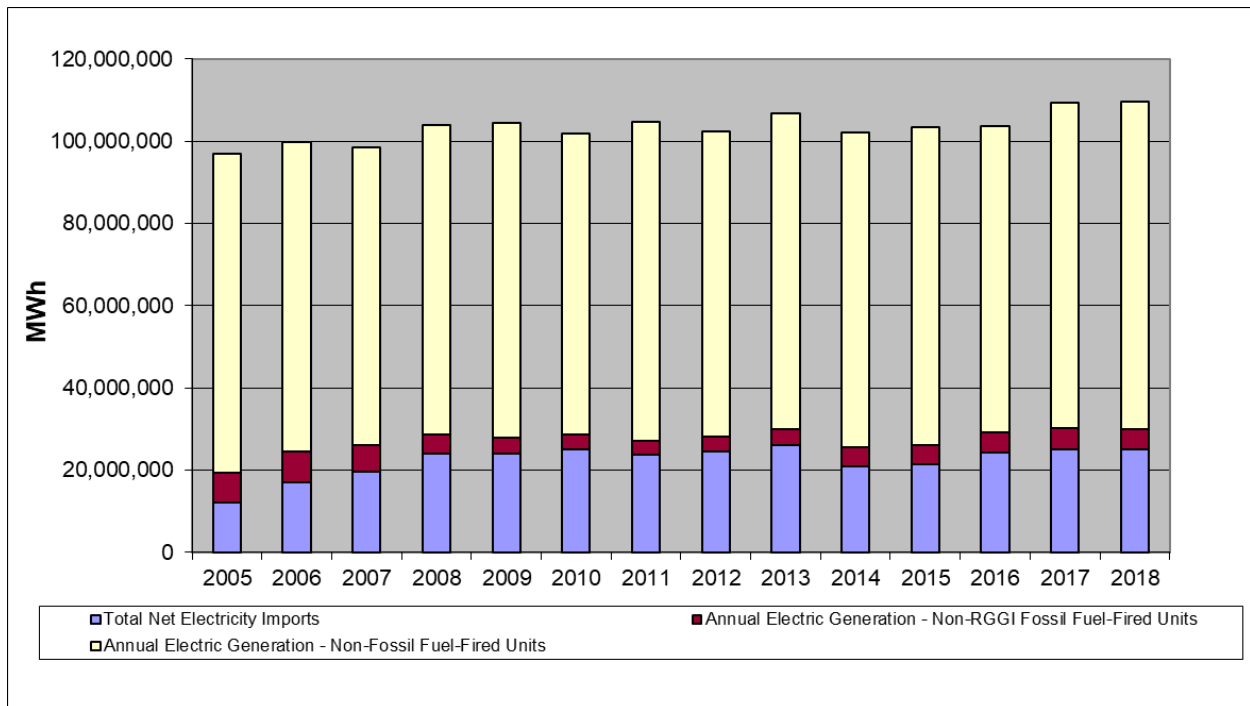


Figure 16. Non-RGGI Generation Serving Load in NYISO (MWh)

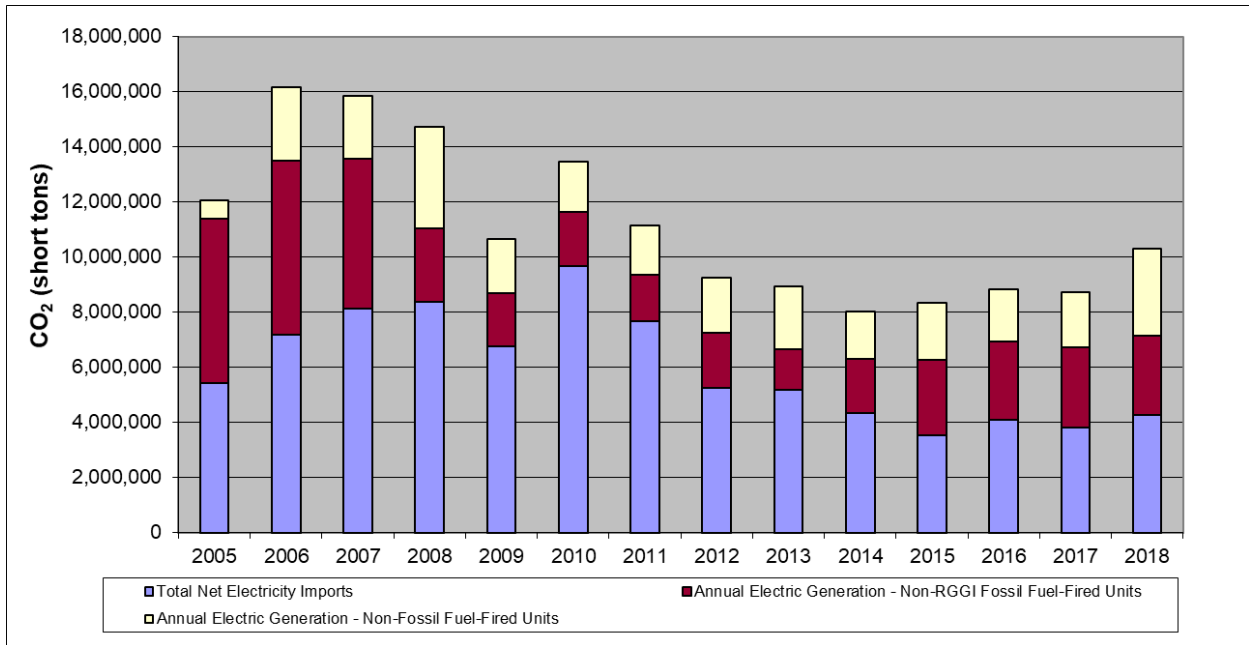


Figure 17. CO₂ Emissions from Non-RGGI Generation Serving Load in NYISO (short tons CO₂)

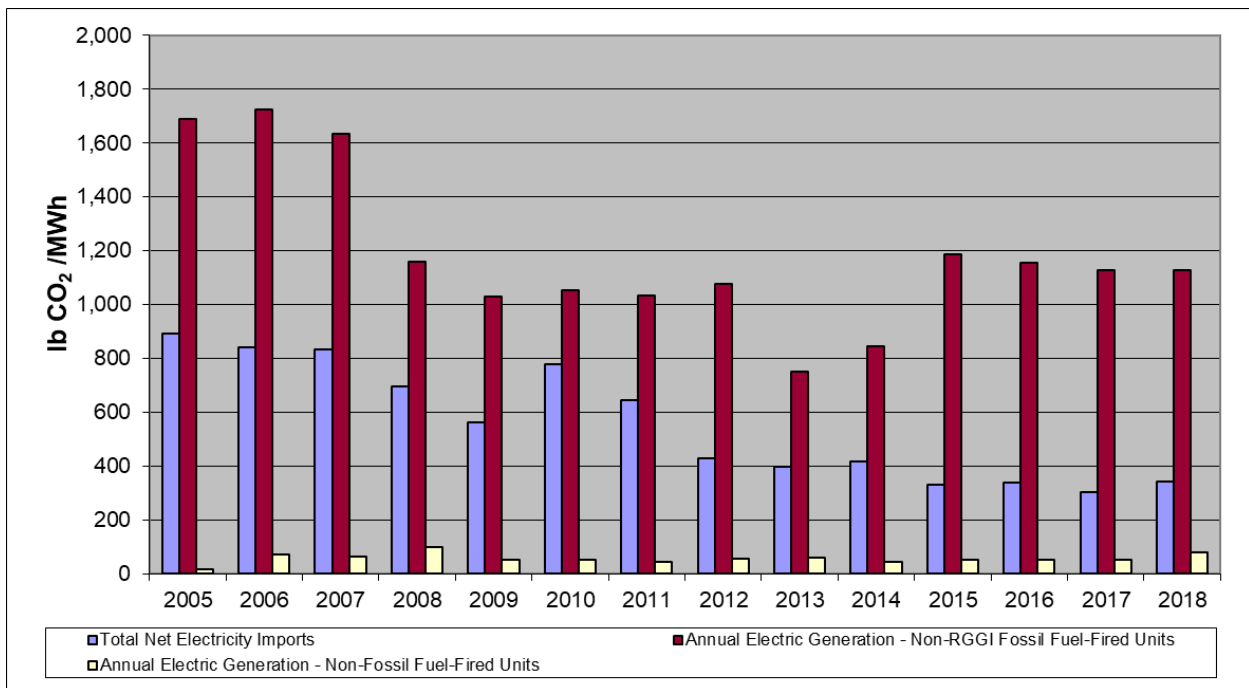


Figure 18. CO₂ Emission Rate for Non-RGGI Generation Serving Load in NYISO (lb CO₂/MWh)

Net electricity imports into NYISO increased by 4.5 million MWh, when comparing the annual average for the base period of 2006 to 2008 to the annual average for 2016 to 2018. Annual average CO₂ emissions related to these net electricity imports decreased by 3.8 million short tons of CO₂, or 48.5 percent, during this period. The annual average

CO₂ emission rate of the electric generation supplying these imports decreased by 460.8 lb CO₂/MWh, a decrease of 58.4 percent. (See Figures 19 and 20.)

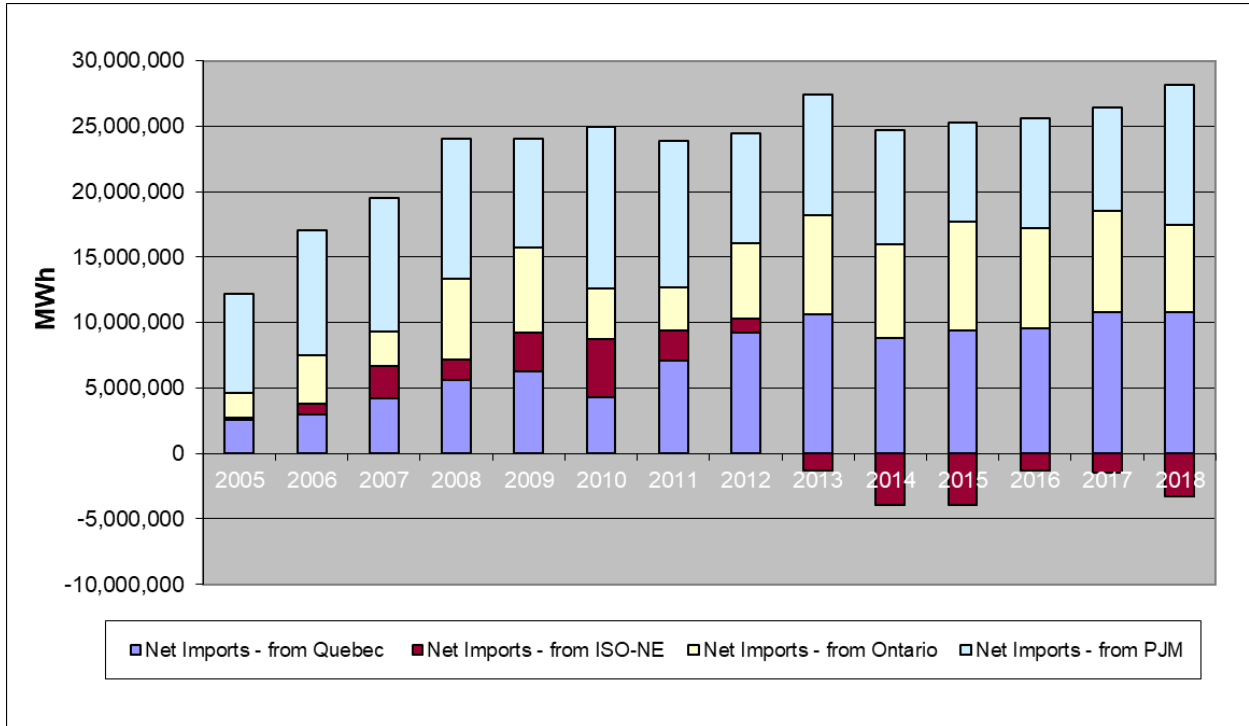


Figure 19. Net Electricity Imports to NYISO (MWh)

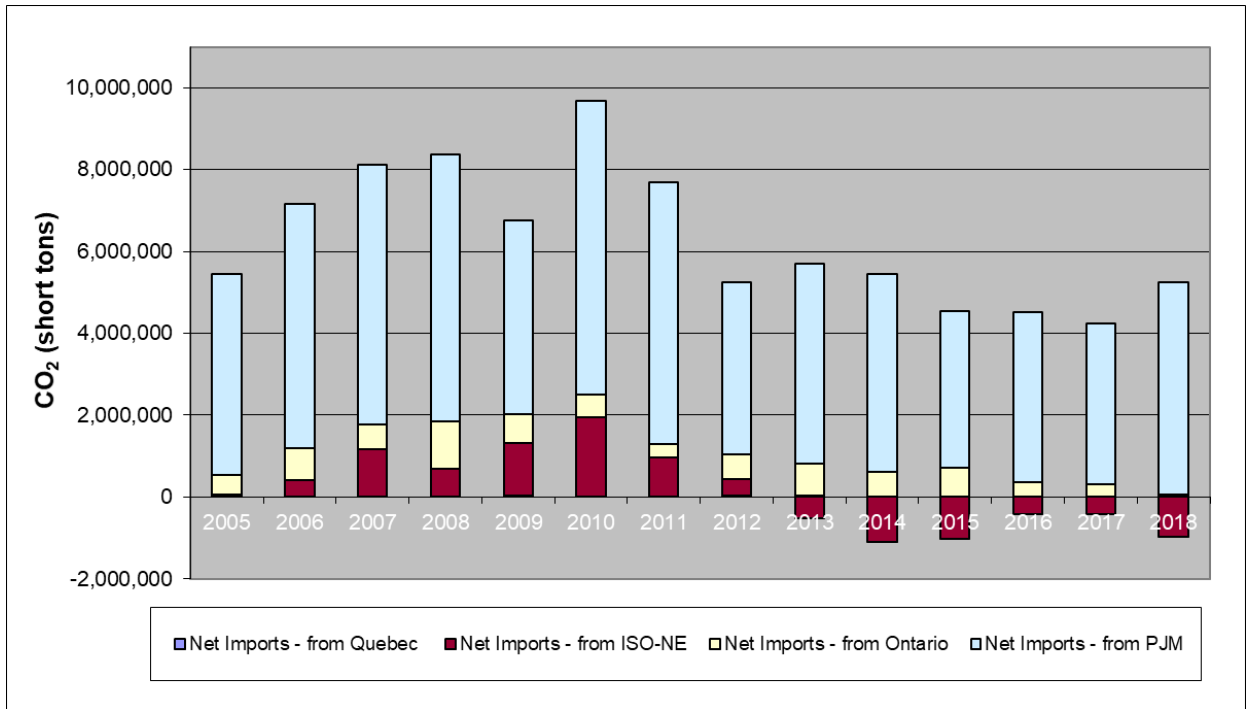


Figure 20. CO₂ Emissions Related to Net Electricity Imports to NYISO (short tons CO₂)

Compared to the annual average during the 2006 to 2008 base period, electric generation in 2018 from all non-RGGI electric generation sources serving load in NYISO increased by 8.8 million MWh, an increase of 8.8 percent. Compared to the base period, 2018 CO₂ emissions from this category of electric generation decreased by 5.2 million short tons of CO₂, a reduction of 33.8 percent, and the CO₂ emission rate decreased by 121.5 lb CO₂/MWh, a reduction of 39.2 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 electric generation from RGGI generation in NYISO decreased by 16.1 million MWh, or 23.9 percent, and CO₂ emissions from RGGI generation in NYISO decreased by 25.4 million short tons of CO₂, a reduction of 48.2 percent. The CO₂ emission rate of RGGI electric generation decreased by 496.8 lb CO₂/MWh, a reduction of 32.0 percent. Compared to the 2006 to 2008 base period, 2018 electric generation from non-RGGI generation located in NYISO increased by 4.1 million MWh, or 5.1 percent, and CO₂ emissions from this category decreased by 1.7 million short tons of CO₂, a reduction of 21.7 percent. The CO₂ emission rate of non-RGGI electric generation located in NYISO decreased by 48.4 lb CO₂/MWh, a reduction of 25.4 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 net electricity imports into NYISO increased by 4.7 million MWh. CO₂ emissions related to these net electricity imports decreased by 3.6 million short tons of CO₂, or 45.7 percent. The CO₂ emission rate of the electric generation supplying these imports decreased by 445.8 lb CO₂/MWh, a reduction of 56.5 percent.

PJM (RGGI Portion)

Monitoring results for PJM for 2005 through 2018 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 (RGGI PJM). Net “imports” represent inferred flows of electricity from the non-RGGI geographic portion of PJM (Non-RGGI PJM) to RGGI PJM to make up for shortfalls in electric generation relative to total electricity load for this subset of PJM.⁴⁰

Table 7. 2005 – 2018 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 | 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 | 51,758,775 |
| 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 | 50,451,424 |
| 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 | 52,683,727 |
| 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 | 49,626,190 |
| 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 | 53,063,238 |
| 2016 | 77,822,567 | 33,910,113 | -462,876 | 33,447,237 | 26,504,789 | 51,481 | 17,819,060 | 17,870,541 | 44,375,330 | 51,317,778 |
| 2017 | 75,384,095 | 35,770,266 | -397,466 | 35,372,800 | 21,208,131 | 28,228 | 18,774,936 | 18,803,164 | 40,011,295 | 54,175,964 |
| 2018 | 77,912,067 | 30,085,536 | -630,502 | 29,455,034 | 28,772,738 | 55,564 | 19,628,731 | 19,684,295 | 48,457,033 | 49,139,329 |

⁴⁰ 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 | 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 | 20,812,028 |
| 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 | 19,905,735 |
| 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 | 20,905,049 |
| 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 | 18,996,287 |
| 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 | 19,161,954 |
| 2016 | 40,573,262 | 16,699,087 | -251,655 | 16,447,433 | 22,374,470 | 52,701 | 1,698,659 | 1,751,360 | 24,125,830 | 18,198,793 |
| 2017 | 34,169,771 | 17,052,989 | -171,742 | 16,881,247 | 15,922,332 | 26,383 | 1,339,809 | 1,366,192 | 17,288,524 | 18,247,439 |
| 2018 | 34,987,263 | 13,913,167 | -277,822 | 13,635,345 | 19,968,446 | 52,436 | 1,331,036 | 1,388,472 | 21,351,918 | 15,018,817 |
| lb 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 | 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 | 804 |
| 2012 | 1,151 | 1,082 | 1,204 | 1,080 | 1,794 | 2,231 | 166 | 190 | 1,204 | 789 |
| 2013 | 1,133 | 1,109 | 1,154 | 1,108 | 1,854 | 2,495 | 141 | 152 | 1,154 | 794 |
| 2014 | 1,148 | 1,101 | 1,184 | 1,099 | 1,858 | 2,311 | 141 | 150 | 1,184 | 766 |
| 2015 | 1,046 | 1,008 | 1,077 | 1,008 | 1,737 | 2,104 | 151 | 157 | 1,077 | 722 |
| 2016 | 1,043 | 985 | 1,087 | 983 | 1,688 | 2,047 | 191 | 196 | 1,087 | 709 |
| 2017 | 907 | 953 | 864 | 954 | 1,502 | 1,869 | 143 | 145 | 864 | 674 |
| 2018 | 898 | 925 | 881 | 926 | 1,388 | 1,887 | 136 | 141 | 881 | 611 |

The monitoring results indicate that the annual average electricity load in RGGI PJM for 2016 to 2018 decreased by 5.9 million MWh, or 7.2 percent, compared to the base period of 2006 to 2008. Annual average electric generation from all sources in RGGI PJM decreased by 10.1 million MWh, or 18.6 percent, compared to the base period.

Annual average electric generation from RGGI generation in RGGI PJM decreased by 11.8 million MWh during this period, or 31.6 percent, and annual average CO₂ emissions from this category decreased by 19.1 million short tons of CO₂, or 49.6 percent. The annual average CO₂ emission rate of RGGI electric generation decreased by 542.5 lb CO₂/MWh, a reduction of 26.2 percent. Annual average electric generation from non-RGGI electric generation sources located in RGGI PJM increased by 1.7 million MWh, or 9.8 percent, during this period, and annual average CO₂ emissions from this category increased by 104,813 short tons of CO₂, an increase of 7.5 percent. The annual average CO₂ emission rate of non-RGGI electric generation located in RGGI PJM increased by 2.4 lb CO₂/MWh, an increase of 1.5 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 electricity load in RGGI PJM decreased by 5.1 million MWh, or 6.1 percent. Compared to the 2006 to 2008 base period, 2018 electric generation from all sources in RGGI PJM decreased by 8.5 million MWh, or 22.8 percent.

The annual average electric generation from all non-RGGI electric generation serving load in RGGI PJM for 2016 to 2018 increased by 5.8 million MWh, or 12.8 percent, compared to the annual average during the 2006 to 2008 base period. Annual average CO₂ emissions from this category decreased by 1.7 million short tons of CO₂, a decrease of 8.9 percent, and the annual average CO₂ emission rate decreased by 159.6 lb CO₂/MWh, a decrease of 19.4 percent. (See Figures 21, 22, and 23.)

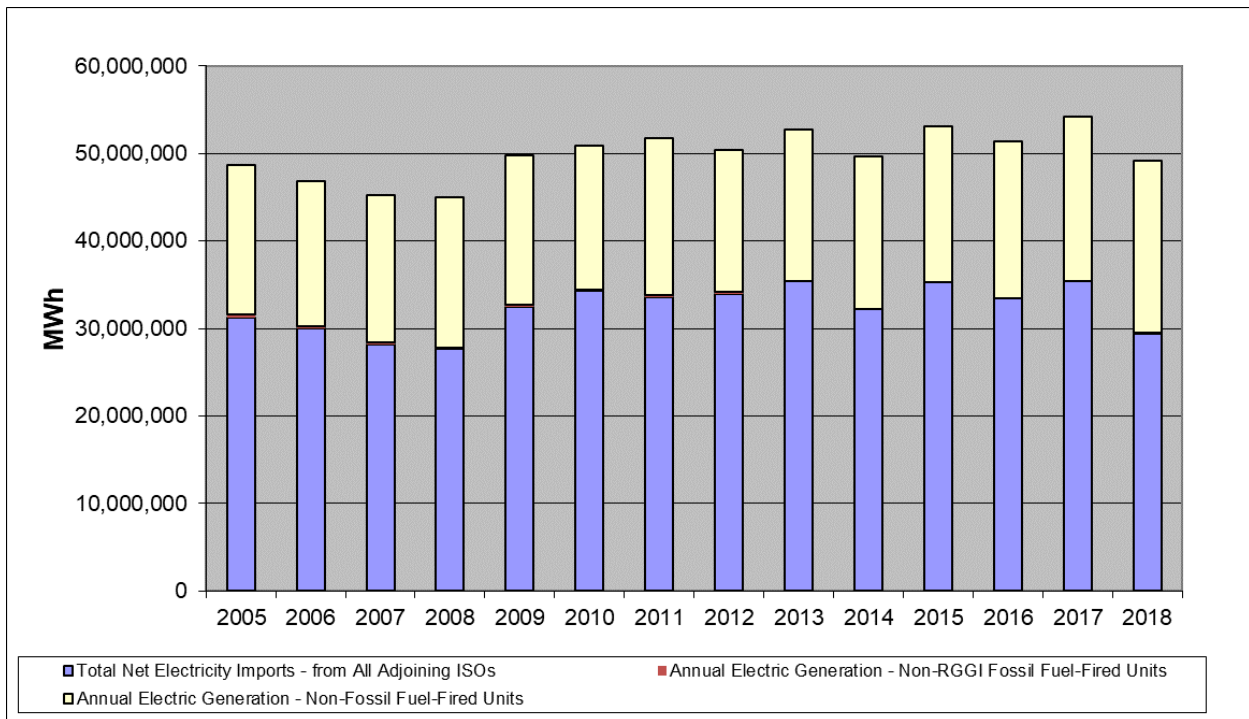


Figure 21. Non-RGGI Generation Serving Load in RGGI PJM (MWh)

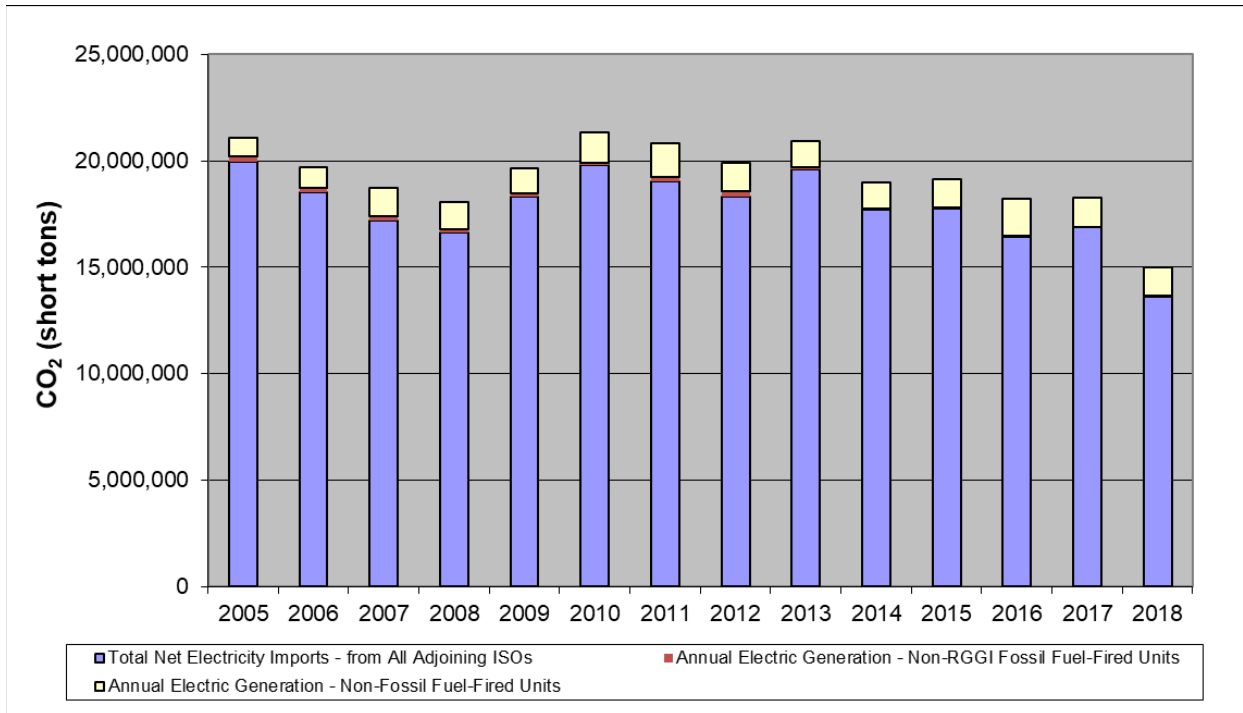


Figure 22. CO₂ Emissions from Non-RGGI Generation Serving Load in RGGI PJM (short tons CO₂)

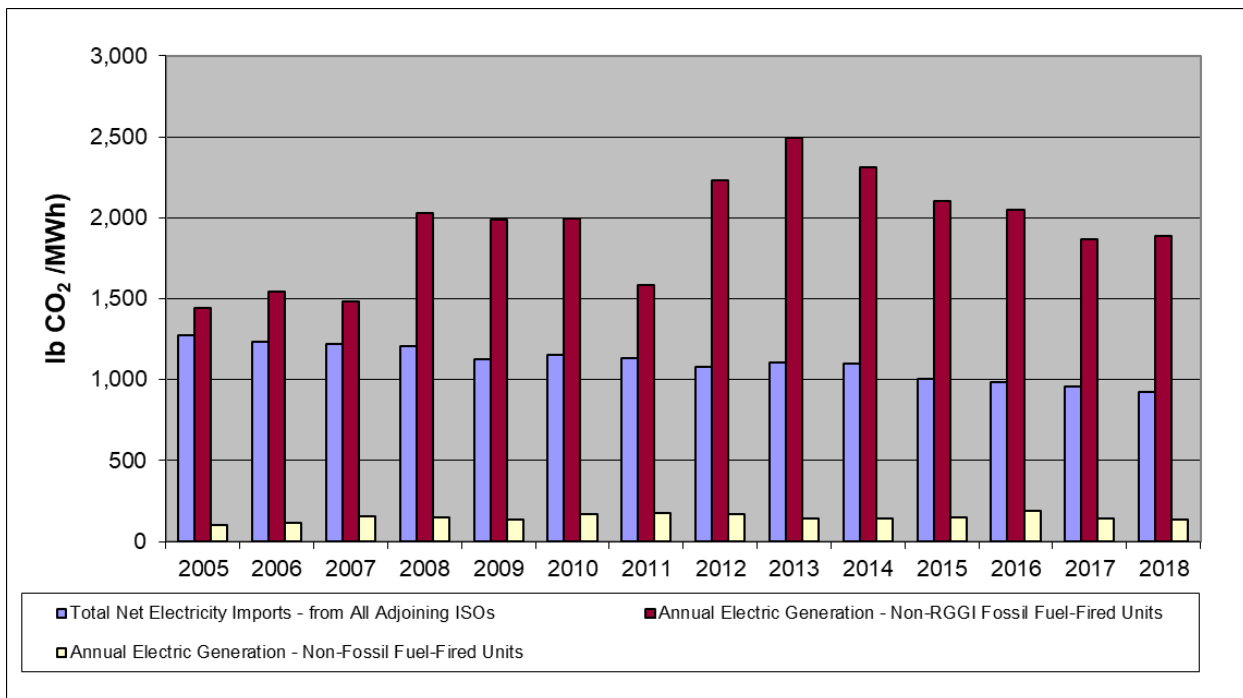


Figure 23. CO₂ Emission Rate for Non-RGGI Generation Serving Load in RGGI PJM (lb CO₂/MWh)

Net electricity imports into RGGI PJM increased by 4.2 million MWh, when comparing the annual average during the base period of 2006 to 2008 to the annual average for

2016 to 2018. Annual average CO₂ emissions related to these net electricity imports decreased by 1.8 million short tons of CO₂, or 10.3 percent, during this period. The annual average CO₂ emission rate of the electric generation supplying these imports decreased by 265.1 lb CO₂/MWh, a decrease of 21.7 percent. (See Figures 24 and 25.)

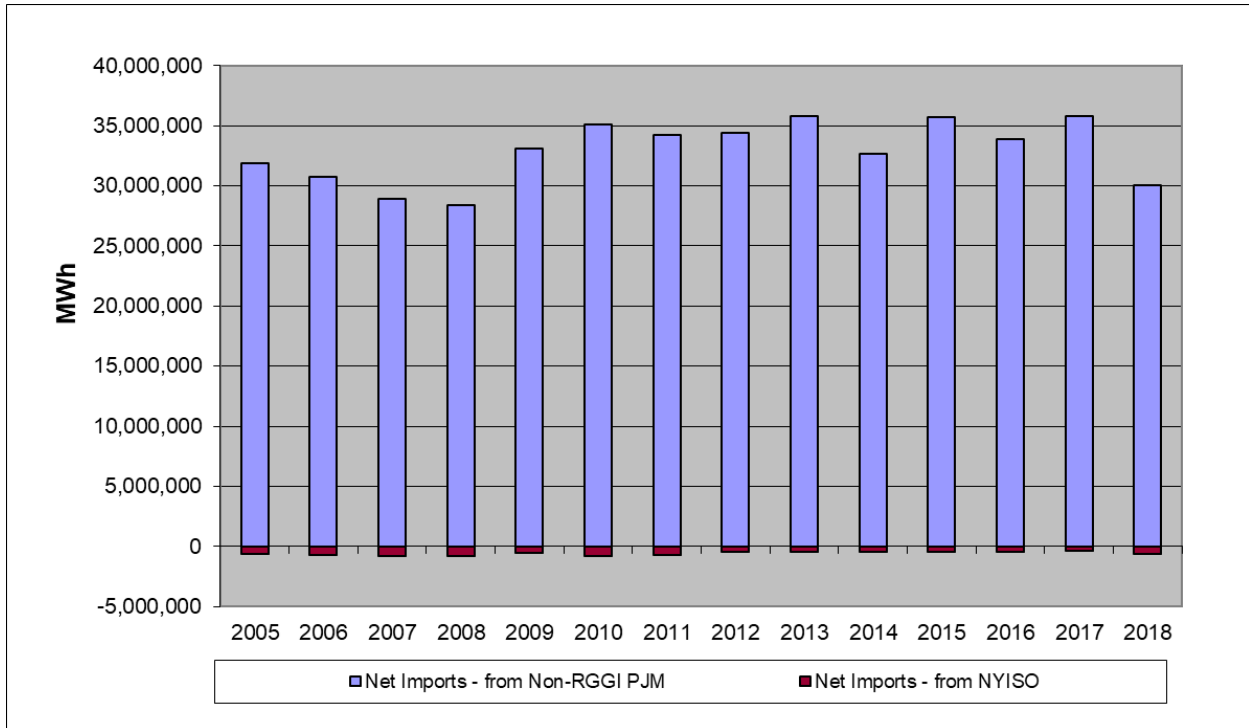


Figure 24. Net Electricity Imports to RGGI PJM (MWh)

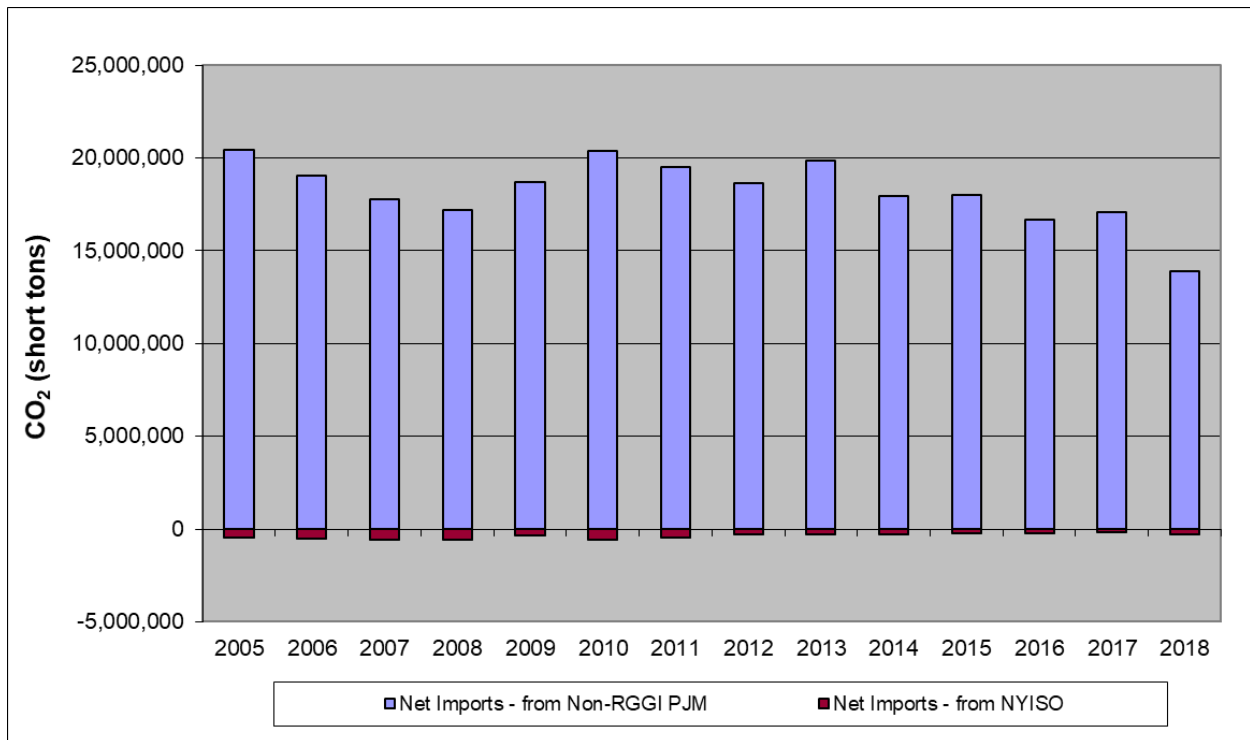


Figure 25. CO₂ Emissions Related to Net Electricity Imports to RGGI PJM (short tons CO₂)

Compared to the annual average during the 2006 to 2008 base period, electric generation in 2018 from all non-RGGI electric generation sources serving load in RGGI PJM increased by 3.4 million MWh, an increase of 7.5 percent. Compared to the base period, 2018 CO₂ emissions from this category of electric generation decreased by 3.8 million short tons of CO₂, a decrease of 20.3 percent, and the CO₂ emission rate decreased by 213.0 lb CO₂/MWh, a reduction of 25.8 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 electric generation from RGGI generation in RGGI PJM decreased by 8.5 million MWh, or 22.8 percent, and CO₂ emissions from RGGI generation in RGGI PJM decreased by 18.6 million short tons of CO₂, or 48.2 percent. The CO₂ emission rate of RGGI electric generation decreased by 680.5 lb CO₂/MWh, a reduction of 32.9 percent. Compared to the 2006 to 2008 annual average, 2018 electric generation from non-RGGI generation located in RGGI PJM increased by 2.6 million MWh, or 15.1 percent, and CO₂ emissions from this category of electric generation decreased by 12,057 short tons of CO₂ a reduction of 0.9 percent. The CO₂ emission rate of non-RGGI electric generation located in RGGI PJM decreased by 22.5 lb CO₂/MWh, a decrease of 13.8 percent.

Compared to the annual average during the 2006 to 2008 base period, 2018 net electricity imports into RGGI PJM increased by 861,360 MWh. CO₂ emissions related to these net electricity imports decreased by 3.8 million short tons of CO₂, or 21.8 percent, during this period. The average CO₂ emission rate of the electric generation supplying these imports decreased by 293.9 lb CO₂/MWh, a reduction of 24.1 percent.

Appendix C. Monitoring Trends

Detailed monitoring trends for the nine-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 three years of program operation, 2016 to 2018.

Nine-State RGGI Region

Table 8. Monitoring Trends for Nine-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) | 158,231,279 | 20,137,889 | 254 | 172,296,470 | 138,362,771 | 1,605 | 55,997,235 | 25,224,000 | 904 |
| Annual average for 2016-2018 | 159,977,177 | 20,869,107 | 261 | 129,870,129 | 71,534,123 | 1,101 | 77,501,089 | 21,708,427 | 560 |
| Difference from base period | 1,745,898 | 731,218 | 7 | -42,426,341 | -66,828,649 | -505 | 21,503,855 | -3,515,573 | -344 |
| % change from base period | 1.1% | 3.6% | 2.6% | -24.6% | -48.3% | -31.4% | 38.4% | -13.9% | -38.1% |
| 2018 | 163,466,971 | 21,578,846 | 264 | 132,757,016 | 71,057,227 | 1,070 | 75,665,820 | 19,934,339 | 527 |
| Difference from base period | 5,235,692 | 1,440,957 | 9.7 | -39,539,454 | -67,305,544 | -535 | 19,668,585 | -5,289,660 | -378 |
| % change from base period | 3.3% | 7.2% | 3.8% | -22.9% | -48.6% | -33.3% | 35.1% | -21.0% | -41.7% |

| | Non-RGGI Generation (Non-RGGI 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) | 214,228,514 | 45,361,889 | 424 | 330,527,749 | 386,423,646 |
| Annual average for 2016-2018 | 237,478,266 | 42,577,534 | 359 | 289,847,306 | 359,502,910 |
| Difference from base period | 23,249,752 | -2,784,355 | -65 | -40,680,443 | -26,920,736 |
| % change from base period | 10.9% | -6.1% | -15.3% | --12.3% | -7.0% |
| 2018 | 239,132,791 | 41,513,186 | 347 | 296,223,987 | 362,498,067 |
| Difference from base period | 24,904,277 | -3,848,703 | -76 | -34,303,762 | -23,920,736 |
| % change from base period | 11.6% | -8.5% | -18.0% | -10.4% | -6.2% |

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) | 60,527,897 | 11,046,433 | 365 | 67,414,107 | 47,242,267 | 1,401 | 7,196,667 | -138,167 | -48 |
| Annual average for 2016-2018 | 58,368,381 | 14,140,593 | 485 | 52,353,169 | 24,625,819 | 941 | 20,012,354 | 2,112,725 | 216 |
| Difference from base period | -2,159,516 | 3,094,160 | 120 | -15,060,938 | 022,616,448 | -460 | 12,815,687 | 2,250,892 | 265 |
| % change from base period | -3.6% | 28.0% | 32.9% | -22.3% | -47.9% | -32.8% | 178.1% | ⁴¹ | ⁴² |
| 2018 | 59,368,381 | 14,166,934 | 480 | 52,512,178 | 23,873,039 | 909 | 21,295,809 | 2,234,210 | 189 |
| Difference from base period | -1,472,144 | 3,120,501 | 115 | -14,901,929 | -23,369,228 | -492 | 14,099,142 | 2,372,378 | 237 |
| % change from base period | -2.4% | 28.2% | 31.5% | -22.1% | -49.5% | -35.1% | 195.9% | ⁴³ | ⁴⁴ |

| | Non-RGGI Generation (Non-RGGI 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) | 67,724,564 | 10,908,266 | 322 | 127,942,004 | 135,037,333 |
| Annual average for 2016-2018 | 78,380,734 | 16,253,317 | 415 | 110,721,550 | 123,036,000 |
| Difference from base period | 10,656,171 | 5,345,052 | 93 | -17,220,455 | -12,001,333 |
| % change from base period | 15.7% | 49.0% | 28.9% | -13.5% | -8.9% |
| 2018 | 80,351,562 | 16,401,145 | 408 | 111,567,931 | 123,472,000 |
| Difference from base period | 12,626,998 | 5,492,879 | 86 | -16,374,073 | -11,565,333 |
| % change from base period | 18.6% | 50.4% | 26.8% | -12.8% | -8.6% |

⁴¹ ISONE changed from a net exporter to a net importer from NY in 2013. This percent change was not reconciled.

⁴² See footnote 41.

⁴³ See footnote 41.

⁴⁴ See footnote 41.⁴⁵ The nine-state RGGI region does not completely align with the geographic footprint of wholesale electricity markets in the greater New England and Mid-Atlantic region, and electric power can flow across multiple wholesale markets in North America.

Table 10. Monitoring Trends for NYISO

| | 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) | 80,597,157 | 7,695,928 | 191 | 67,607,068 | 52,567,819 | 1,554 | 20,206,894 | 7,885,769 | 790 |
| Annual average for 2016-2018 | 82,822,796 | 5,228,173 | 126 | 52,021,741 | 27,486,554 | 1,093 | 24,730,378 | 4,063,024 | 329 |
| Difference from base period | 2,225,639 | -2,467,755 | -65 | -15,585,327 | -25,081,265 | -462 | 4,523,485 | -3,822,745 | -461 |
| % change from base period | 2.8% | -32.1% | -33.9% | -23.1% | -47.7% | -29.7% | 22.4% | -48.5% | -58.4% |
| 2018 | 84,726,923 | 6,028,440 | 142 | 51,472,100 | 27,215,742 | 1,057 | 24,914,977 | 4,281,862 | 344 |
| Difference from base period | 4,129,766 | -1,667,488 | -48 | -16,134,968 | -25,352,077 | -497 | 4,708,083 | -3,603,907 | -446 |
| % change from base period | 5.1% | -21.7% | -25.4% | -23.9% | -48.2% | -32.0% | 23.3% | -45.7% | -56.5% |

| | Non-RGGI Generation (Non-RGGI 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 | 15,581,697 | 309 | 148,204,225 | 168,411,119 |
| Annual average for 2016-2018 | 107,553,174 | 9,291,197 | 173 | 134,844,537 | 159,427,333 |
| Difference from base period | 6,749,123 | -6,290,500 | -137 | -13,359,689 | -8,983,786 |
| % change from base period | 6.7% | -40.4% | -44.2% | -9.0% | -5.3% |
| 2018 | 109,641,900 | 10,310,302 | 188 | 136,199,023 | 161,114,000 |
| Difference from base period | 8,837,849 | -5,271,395 | -122 | -12,005,202 | -7,297,119 |
| % change from base period | 8.8% | -33.8% | -39.2% | -8.1% | -4.3% |

Table 11. Monitoring Trends for RGGI PJM

| | 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) | 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 2016-2018 | 18,786,000 | 1,500,341 | 161 | 25,495,219 | 19,421,749 | 1,526 | 32,758,357 | 15,654,675 | 955 |
| Difference from base period | 1,679,775 | 104,813 | -2 | -11,780,075 | -19,130,936 | -543 | 4,164,683 | -1,790,059 | -265 |
| % change from base period | 9.8% | 7.5% | -1.5% | -31.6% | -49.6% | -26.2% | 14.6% | -10.3% | -21.7% |
| 2018 | 19,684,295 | 1,383,472 | 141 | 28,772,738 | 19,968,446 | 1,388 | 29,455,034 | 13,635,345 | 926 |
| Difference from base period | 2,578,070 | -12,057 | -23 | -8,502,557 | -18,584,239 | -681 | 861,360 | -3,809,389 | -294 |
| % change from base period | 15.1% | -0.9% | -13.8% | -22.8% | -48.2% | -32.9% | 3.0% | -21.8% | -24.1% |

| | Non-RGGI Generation (Non-RGGI 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 | 824 | 54,381,519 | 82,975,194 |
| Annual average for 2018-2018 | 51,544,357 | 17,155,016 | 665 | 44,281,219 | 77,039,576 |
| Difference from base period | 5,844,458 | -1,685,246 | -160 | -10,100,300 | -5,935,617 |
| % change from base period | 12.8% | -8.9% | -19.4% | -18.6% | -7.2% |
| 2018 | 49,139,329 | 15,018,817 | 611 | 48,457,033 | 77,912,067 |
| Difference from base period | 3,439,430 | -3,821,446 | -213 | -5,924,486 | -5,063,127 |
| % change from base period | 7.5% | -20.3% | -25.8% | -10.9% | -6.1% |

Appendix D. Concept of “Emissions Leakage”

“Emissions leakage” is the concept that the RGGI CO₂ compliance obligation and related CO₂ compliance costs for electric generators could result in a shift of electricity generation from CO₂-emitting sources subject to the RGGI CO₂ Budget Trading Program to CO₂-emitting sources not subject to RGGI. Key to this concept is that the cause of such a shift would be due to the RGGI CO₂ Budget Trading Program rather than other factors that influence electric power sector CO₂ emissions. The concept of emissions leakage presumes that an increase in electricity production costs for certain electric generators due to RGGI CO₂ compliance costs would be the driver of changes in the operation of the electric power system that result in an increase in CO₂ emissions from electric generation that is not subject to the RGGI CO₂ Budget Trading Program.

Factors that Influence Electric Generator Dispatch and CO₂ Emissions

In New England and the 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 into 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 CO₂, NO_x, and SO₂ 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 CO₂ emissions, through a highly dynamic wholesale electricity market.

The concept of emissions leakage assumes a scenario in which only a subset of CO₂-emitting electric generators are subject to a CO₂ allowance requirement.⁴⁵ As a result, certain electric generators are subject to an additional production cost – the cost of CO₂ allowances – that is not faced by other CO₂-emitting electric generators. In theory, this could result in a shift in electric generation to emitting units that do not face a CO₂ compliance cost. If such a shift results in an increase in CO₂ emissions from electric generation as a whole, such an increase is referred to as emissions leakage.

⁴⁵ The nine-state RGGI region does not completely align with the geographic footprint of wholesale electricity markets in the greater New England and Mid-Atlantic region, and electric power can flow across multiple wholesale markets in North America.

If emissions leakage were to occur, it would result from an increase in dispatch (and related CO₂ emissions) from: (a) in-region non-RGGI units (i.e., 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.”