Clean Power Plan Assessment

Final Report

December 2016

Figures

Tables

Executive Summary

New environmental regulations, technological advances, and market trends are transforming the methods, locations, and characteristics of the resources used to generate and deliver electricity. The promulgation of the United States Environmental Protection Agency (EPA) Clean Power Plan (CPP) calls for tomorrow's electricity to be generated with fewer carbon dioxide (CO_2) emissions. The CPP will have a complementary relationship with the outcome of the on-going review of the Regional Greenhouse Gas Initiative (RGGI). The RGGI states are considering additional reductions in CO_2 emissions from the power industry in the Northeast. The RGGI program options currently under consideration prescribe lower CO_2 emission caps than those called for in the CPP. Both programs provide for a trajectory to lower emissions over the planning horizon to 2030.

In 2016, the NYISO conducted a study of the potential operational impacts and related compliance options for the CPP and RGGI at the request of its stakeholders. The judicial review of the CPP has contributed to delaying CPP implementation. In the interim, New York State regulators have directed their attention to the Clean Energy Standard (CES). The CPP and RGGI are designed to cap emissions or emission rates, whereas the "chief focus of the CES" is "building new renewable power generation facilities".[1] This assessment examines the effects of the potential emission caps set forth in the CPP and the RGGI Program Review. The assessment does not evaluate the impacts from the additional renewable resources called for by the CES.

Major findings of this assessment include:

1. **Compliance with the CPP and RGGI is attainable in New York under the assumptions examined.** Various combinations of additional renewable resources and fossil fuel-fired peaking generators can provide adequate supplies of energy while meeting emission caps or rates prescribed by CPP and caps being considered by RGGI.

2. **Trading between states is an essential element for complying with evolving environmental program requirements.** This assessment finds that New York's compliance with the CPP, RGGI, and the new Cross-State Air Pollution Rule (CSAPR) ozone season limits will depend on an adequate supply of emission allowances or emission rate credits from other affected states. Beyond efforts to reduce CO_2 emissions, the EPA has also promulgated regulations aimed at further reducing nitrogen oxides (NO_X), an ozone precursor, in the ozone season (OS).

3. **Additional resources beyond those considered in this assessment will be necessary to satisfy resource adequacy criteria.** Significant additional resources comprised of various combinations of renewable resources and peaking fossil fuel-fired

[1] PSC Case 15-E-0302, *Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard*, Order Adopting a Clean Energy Standard (Aug. 1, 2016) ("CES Order"), p. 78.

units will be necessary to comply with the possible emission limits while also satisfying the Resource Adequacy Criterion. The bulk power transmission system must be designed to have sufficient resources such that the probability of an unplanned loss of load is no greater than one occurrence in ten years. This assessment did not analyze the impact of emissions from additional resources needed to maintain resource adequacy on the achievement of the CPP emission limits. Additional analyses can be considered when CPP implementation progresses and after the RGGI program review is completed.

Figure ES-1 shows the relationship between the CO_2 emission reduction programs applicable to New York that were examined in this assessment.

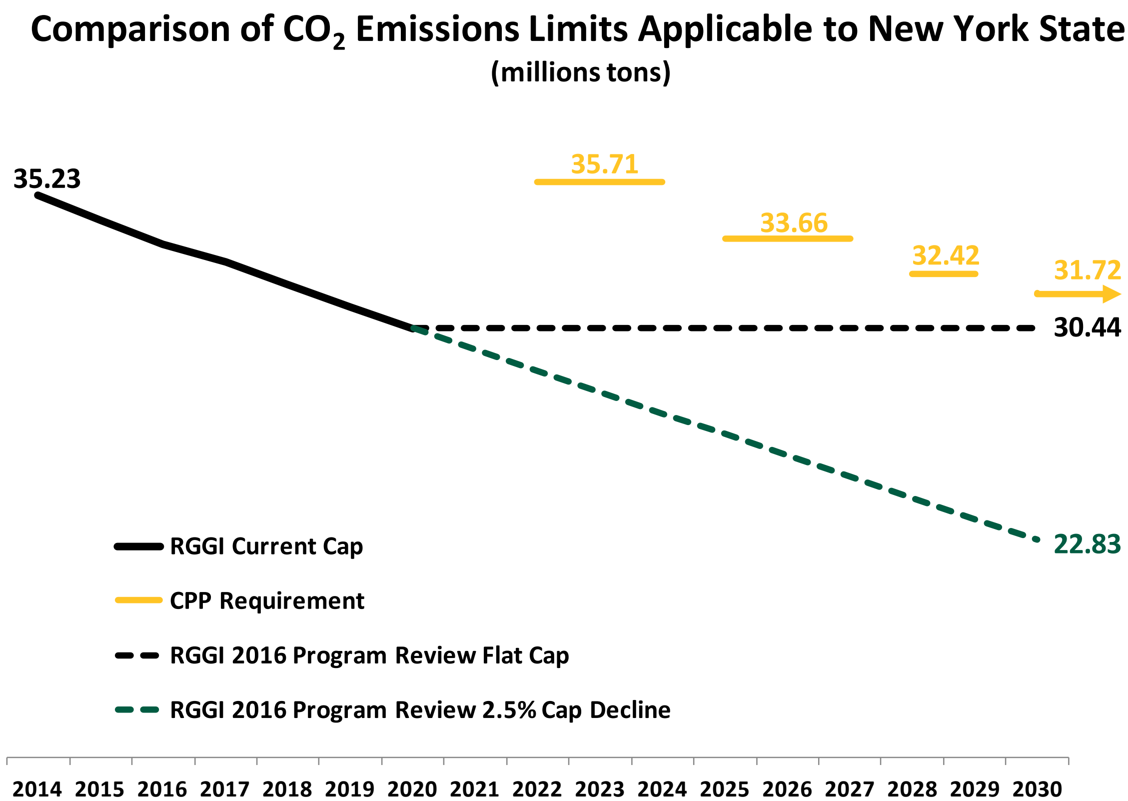


Figure ES-1 Comparison of CPP and Potential RGGI Mass-Based Limits

To achieve the prescribed emission reductions, the composition and operation of the New York Control Area (NYCA) generation fleet will need to adjust their equipment and operations while meeting reliability criteria at a reasonable cost. This assessment is designed to provide the New York State Department of Environmental Conservation (DEC), other policymakers, market participants, and interested stakeholders important information about the ability of the NYCA generation fleet to achieve compliance with these new environmental regulations, changes in emission patterns, and cost impacts.

This assessment has been designed in two stages—first, to build upon existing work at the New York Independent System Operator, Inc. (NYISO) and, second, to perform additional work over a longer planning horizon. This assessment has looked at various CO_2 caps, changes in the resource mix, and the impacts of these changes on resource adequacy.

The initial study plan was based on schedule assumptions for implementation of the CPP and the RGGI Program Review. The judicial review process for the CPP has influenced and delayed completion of New York State's initial state plan submittal beyond September 6, 2016 and the RGGI Program Review results initially planned for in summer of 2016. Accordingly, the scope of this assessment was modified to consider potential scenarios rather than provide a detailed analysis of the State's initial plan submittal and any RGGI Program Review recommended changes. This Report, *Clean Power Plan Assessment- Final Report*, provides the findings for the horizon year 2030 for the CPP.

Clean Power Plan Assessment

Final Report

1. Introduction and Background

The United States Environmental Protection Agency (EPA) Clean Power Plan (CPP) has established a national program to reduce carbon dioxide (CO_2) emissions from existing fossil fuel-fired steam and combined cycle generators by 32% by 2030 as compared to the 2005 emission levels. The plan is novel in its approach to regulating emissions at the state level by providing options for the states to design compliance programs. The CPP schedule called for states to submit an Initial Submittal, in lieu of a final State Plan, by September 6, 2016, and a final State Plan by September 6, 2018. States that do not make a timely submission of an approvable State Plan will be subject to a Federal Plan created by the EPA.

The CPP has attracted a number of legal challenges and is currently under a stay issued by the Supreme Court of the United States. During the pendency of the stay and resolution of the legal challenges, states are not required to comply with the CPP, including submitting their Initial Submittal. Future compliance action dates may be subject to tolling as directed by the courts. However, the Governor of New York has directed the New York State Department of Environmental Conservation (DEC) and other agency staff to continue with planning for implementation of the CPP.

The New York Independent System Operator, Inc. (NYISO)'s *Clean Power Plan Assessment* has four purposes.

1. Provide input to the New York State's planning process on issues relating to bulk electric system reliability, as well as, bulk electric system efficiency and emissions.

2. Examine the impacts of potential CO_2 caps, as well as the retirement of nuclear resources, to provide input to the Regional Greenhouse Gas Initiative (RGGI) 2016 Program Review that is currently underway. The objectives of the 2016 RGGI Program Review are: (i) an identification of modifications potentially desirable to satisfy CPP criteria; (ii) establishment of a CO_2 cap post-2020; (iii) review of flexibility mechanisms and regulated sources; (iv) consideration of criteria for additional partners; and (v) consideration of other program design elements.

3. Analyze the impacts of the EPA Cross-State Air Pollution Rule (CSAPR) Update Rule and associated ozone season (OS) nitrogen oxides (NO_x) limits.

4. Examine the operational characteristics and resource adequacy of the generating fleet as intermittent resources are added to the system and older, controllable resources leave the system.

This assessment evaluates scenarios that approximate compliance with the CPP and the RGGI when the standards of comparison are based on the mass-based limits prescribed by the CPP and RGGI. Understanding that the CPP provides alternative approaches for states to use in their State Plans, such as rate-based approaches that are defined in terms of lb CO_2/net-MWh, this Report also details the mass-based scenario results in terms of rate-based outcomes to compare compliance margins of the rate-and mass-based compliance methods.

The *Clean Power Plan Assessment – Interim Report,* reviewed work completed in the first half of 2016.[2] Findings in the Interim Report suggested that the New York Control Area (NYCA) will be able to comply with the requirements of the CPP in the scenarios studied for 2024 with consideration of future potential RGGI caps and ozone season NO_x limits. The Interim Report found that New York will be able to comply with the RGGI requirements, understanding that in some of the cases studied, out-of-state allowances will be required to offset emissions in excess of New York's proportional share of allowances provided under the RGGI caps. The proposed ozone season NO_x budgets, examined in the Interim Report, were exceeded in all cases, which suggested that the NYCA may need to procure out-of-state allowances for those emissions above the budget to achieve compliance. If emissions are above the trading limit, allowances will need to be surrendered at a rate of three to one for emission quantities greater than the budget.

1.1. Objectives

The primary objective of this assessment is to examine potential changes to the composition of the NYCA generation resources to meet increasingly stringent limits on emissions (*i.e.*, the CPP, RGGI, and CSAPR Update Rule) and to maintain the reliability of the New York State bulk power system under a variety of possible scenarios. The scenarios selected for this assessment are intended to approximate compliance with the CPP, RGGI, and the CSAPR Phase 2 ozone season NO_x limits. The scenarios, however, are not forecasts and are not intended to predict the future states of NYCA's transmission system.

1.2. Scope

This assessment is designed as a two-step analysis. The initial examination determines how environmental limits may impact operations in the year 2024. To perform this analysis, the assessment uses five scenarios. The "Business As Usual" (BAU) case is built on an updated *2015 Congestion Assessment and Resource Integration Study* (CARIS) model. In the second step, two additional scenarios evaluate the potential impacts of two variations of the RGGI program post-2020. Two other scenarios are designed to examine two contrasting approaches to the replacement of various amounts of capacity from nuclear generation—one of which weighted towards renewable resources and the other is weighted towards the use of natural gas-fueled combustion turbines. The study assumptions focus on New York by adjusting model inputs to achieve net imports that are approximately equivalent to existing net imports with adjustments for nuclear retirements. Assumptions for fleet changes outside New York are generally limited to those included in the CARIS model. The Final Report extends the analysis out to the 2030 horizon year for the CPP and includes additional studies of resource adequacy.

The results are reported in terms of CARIS metrics for New York, including net production cost, and emissions across RGGI and CSAPR affected states. This assessment examines

[2] http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Special_Studies/Special_Studies_Documents/Clean_Power_Plan_Assessment-Interim_Report-July_2016.pdf

resource adequacy in the 2030 horizon year for two scenarios, one weighted towards renewable resources and the base case.

The assessment employed GridView, a production cost simulation model,[3] to capture the effects of increased intermittent renewable resources in the NYCA generation fleet.

1.2.1. Regulatory Process

This assessment examines the emission limitations established by three regulations: the CPP, RGGI, and the CSAPR Update Rule. Each of these regulations is designed to limit emissions from fossil fuel-fired Electric Generating Units (EGUs). When implemented, these regulations can impose limits on production from affected facilities. Further, scenarios pose changes in the resource mix available to meet load. These resource changes along with the new limits on production give rise to the question of whether or not the bulk power system can be operated in a manner that still satisfies reliability criteria. Additional questions arise about the economic and environmental impacts of the new regulations.

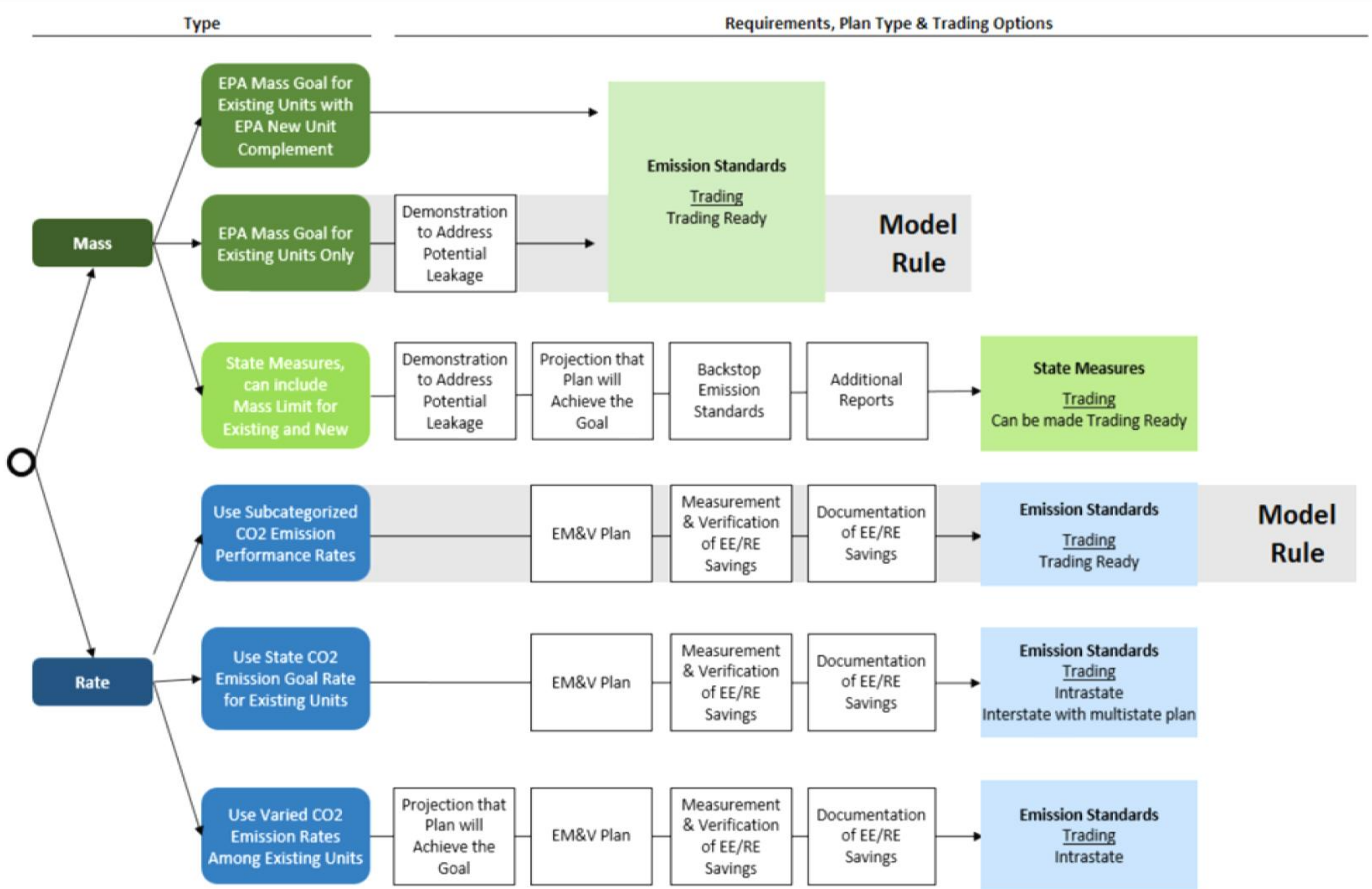
Clean Power Plan (CPP)

The CPP establishes technology-specific emission rates measured as lb CO_2/net-MWh for EGUs in 47 continental states.[4] The affected EGUs include existing fossil fuel-fired Steam Turbine (ST) and natural gas Combined Cycle (CC) generators.[5] The CPP, among other things, requires states to implement plans that meet the interim CO_2 performance rates between 2022 and 2029 and the final emission performance target beginning in 2030. The rule also provides a four-step schedule of reductions state programs will be compared to. The CPP allows states to select among various plan design options, most broadly mass- or rate-based plans, each having several subtypes. Depending on plan design, states can also allow regulated interstate trading of environmental compliance attributes. The possible State Plan/Federal Plan pathways are shown in Figure 1-1.[6]

---

[3] Additional information on GridView is available at http://new.abb.com/enterprise-software/energy-portfolio-management/market-analysis/gridview.
[4] *See* 80 Fed. Reg. 64661, 40 C.F.R. part 60.
[5] *See* 80 Fed. Reg. 64959, 40 C.F.R. §60.5880.
[6] https://www.epa.gov/sites/production/files/2015-08/documents/flow_chart_v6_aug5.pdf

Figure 1–1 EPA State Plan Pathways Decision Tree



States that do not submit an approvable State Plan will be subject to a Federal Plan created by the EPA. The EPA plans to release the final Model Trading Rule for trading CO_2 emission allowances or clean energy attributes in late 2016 or early 2017, which will inform the Federal Plan design.

The identified emission rate-based approaches, that may serve as alternatives to the technology-specific rate-based approach, include:

- a state rate program in which states can choose to implement a program that blends the technology-specific emission rates, while providing credit for new renewable generation, and
- a state program that assigns specific emission rates to specific units.

The CPP converts the specified state emission rate goals into mass-based caps, which states may choose to implement.

The specified mass-based limits and allowance options that states can use in their proposed plans include:

- existing affected units only,
- existing units plus an allowance of new sources, and
- plans that are based on unique state measures such as energy efficiency or non-electric sector programs.

All state plans are required to assign the ultimate responsibility for compliance to specific entities and must consider the reliability of the bulk power system in developing their plan with input from regional power grid operators such as the NYISO.[7]

The CPP allows trading of CO_2 allowances and Emission Rate Credits (ERCs)[8] within a state and among states that have suitable and approved trading arrangements including a "trading ready"[9] option allowing states the potential opportunity to join a multi-state program. States trading with each other generally are required to select similar compliance approaches.

New York has experience with both mass- and rate-based compliance approaches through RGGI and the state Renewable Portfolio Standard (RPS). RGGI allowances are required to be held in source accounts by the transfer deadline in excess of the emissions (in tons) that occurred during the applicable compliance period. The use of allowances for CPP mass-based compliance could be similar. On the other hand, for rate-based CPP compliance approaches, EGUs emission intensity measured in lb CO_2/MWh may be offset by the procurement of ERCs, which may be applied to a source's compliance obligation, reducing the effective emission rate by including zero emission energy in the compliance rate. Currently, in New York, RPS goal achievement is demonstrated by purchase of sufficient Renewable Energy Credits (RECs) to achieve the required proportion of served load in a given calendar

[7] *See* 80 Fed. Reg. 64946, 40 C.F.R. § 60.5745(a)(7).
[8] One ERC is produced for each MWh produced by a qualifying renewable energy generation resource. ERCs can also be produced by certain fossil fuel-fired generators that operate below specified emission rate levels. Similarly, RECs under New York's RPS program represent one MWh of renewable energy generation by a qualified RPS resource.
[9] *See* 80 Fed. Reg. 64827.

year. The relationship between mass emissions, generation, ERCs, and rate is shown in Equation 1.

$$Rate = \frac{Emissions\ (lb)}{Generation\ (MWh) +\ ERCs} \qquad (1)$$

Figure 1-2, Figure 1-3, and Figure 1-4 display the combination of the mass- and rate-based CPP goals and compares them to the historic RGGI emissions and limits applicable to New York EGUs.

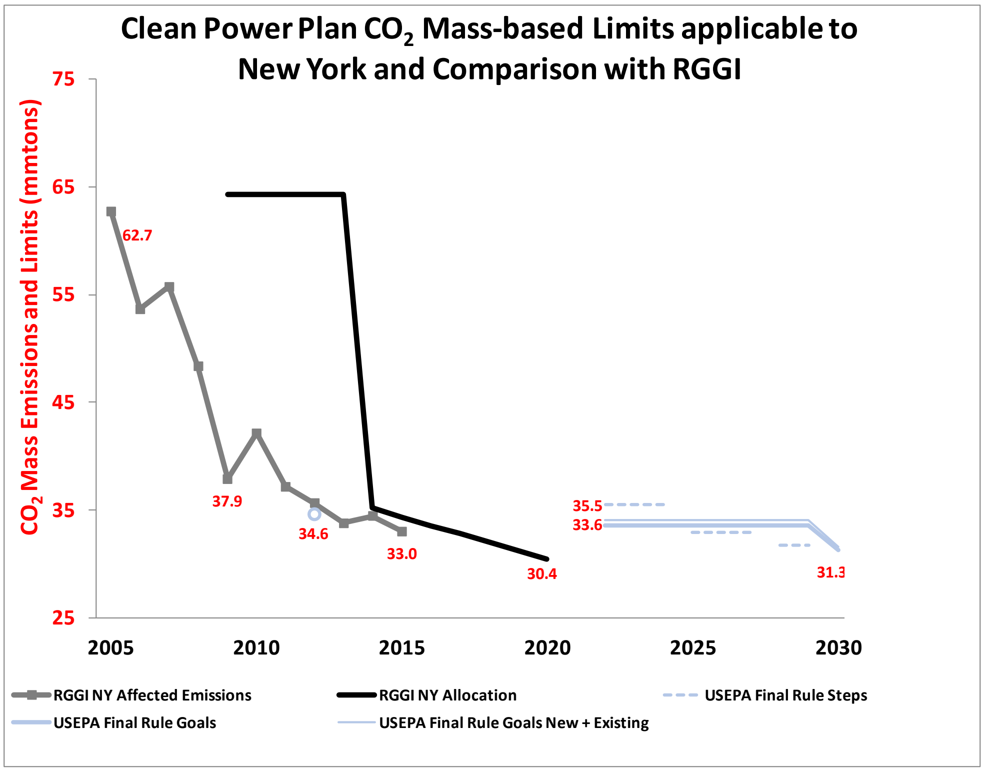


Figure 1-2 Comparison of CPP and RGGI Mass-Based Goals to Historic RGGI Emissions

Figure 1-2 shows significant mass emission reductions during the period of the RGGI program. Until 2020, the RGGI Program Caps are defined to reduce CO_2 emissions by 2.5% year-on-year, which for New York is the equivalent of a reduction from 34.4 million tons to 30.4 million tons of annual emissions between 2015 and 2020. As shown in Figure 1-2, the annualized CPP mass-based compliance goal for existing units in New York, declines from 35.5 million tons (in 2022-24)[10] to 31.3 million tons (beginning in 2030).

In the alternative, states may consider rate-based compliance options as a means of achieving emission reductions, based on either nation-wide, technology-specific (CC and ST) emission rates for CCs and for STs, or a state rate determined by the proportional utilization of the state's EGU fleets' production levels in 2012. In Figure 1-3, the upper (brown for ST) and

[10] Interim Step 1 Goal is the first time period (*i.e.*, 2022-2024) of compliance during the Interim Period (2022-2029). *See* 80 Fed. Reg. 64960, 40 C.F.R. § 60.5880.

lower (green for CC) circles show the estimated retroactive fleet emission rates in 2005 and 2014 in addition to values provided by EPA in 2012. The corresponding bold lines display the technology-specific rate goals for ST and CC EGUs. New York's "blended" rate (blue line) reflects the proportion of the 2012 generation share among the CC (73%) and ST (27%) fleets applied to the applicable technology-specific goals. The values for 2005 and 2014 reflect the actual operational shares estimated based upon reported EPA Air Market Program Data (AMPD)[11] and annual energy by generator from the NYISO Load & Capacity Data Reports (Gold Book).[12] Under rate-based approaches ERCs are issued to qualifying new renewable resources[13] and affected EGUs that operate below emission rate targets.[14] ERCs may be used to achieve the rate-based standards by including zero emission MWh generation credits in the computation of the applicable affected EGU compliance obligation, as shown in Equation 1, above.

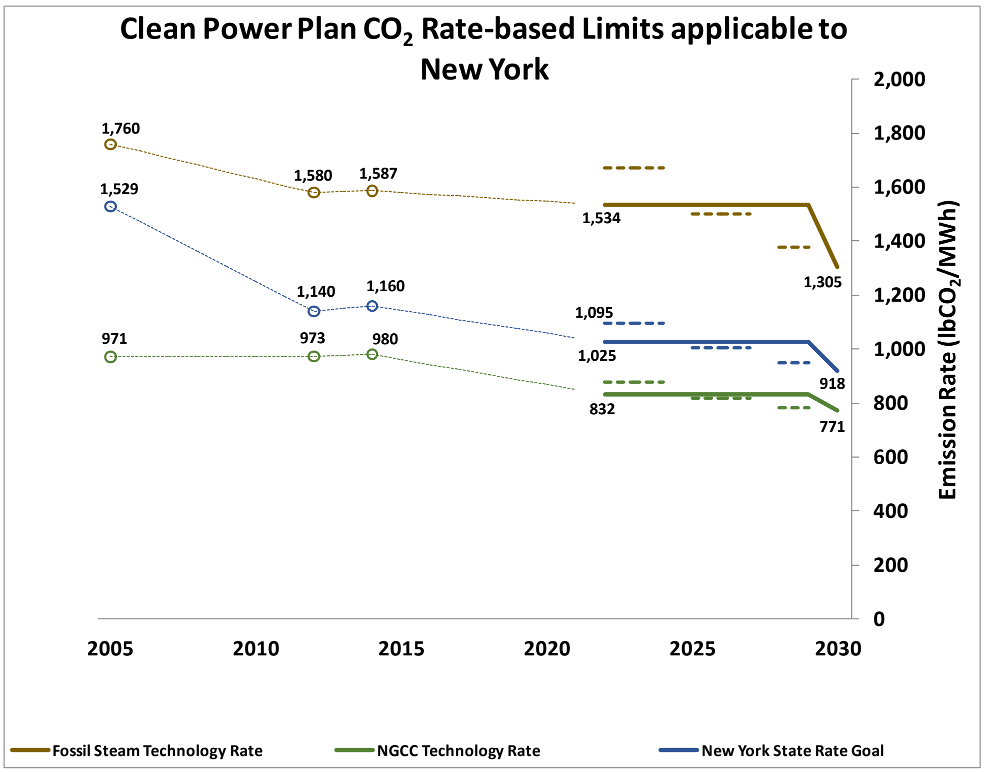


Figure 1-3 Comparison of CPP Rate-Based Goals to Historic Emission Rates

Figure 1-4 compares CPP mass-based compliance options shown in red numbers on the left axis, and CPP rate-based compliance options shown in black numbers on the right axis,

---

[11] Air Market Program Data (AMPD), *available at* https://ampd.epa.gov/ampd/ ("The Air Markets Program Data tool allows users to search EPA data to answer scientific, general, policy, and regulatory questions about industry emissions.").
[12] NYISO Load & Capacity Data Reports are available at: http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2006_NYCA_Generators.xls and http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2015_NYCA_Generators_Revised.xls
[13] *See* 80 Fed. Reg. 64950, 40 C.F.R. § 60.5800(a).
[14] *See* 80 Fed. Reg. 64950, 40 C.F.R. § 60.5795.

together with the RGGI Program Cap applicable to New York (NY Allocation) and the historic RGGI Affected Emissions.[15] Both the mass- and rate-based goals are shown as blue lines in the figure.

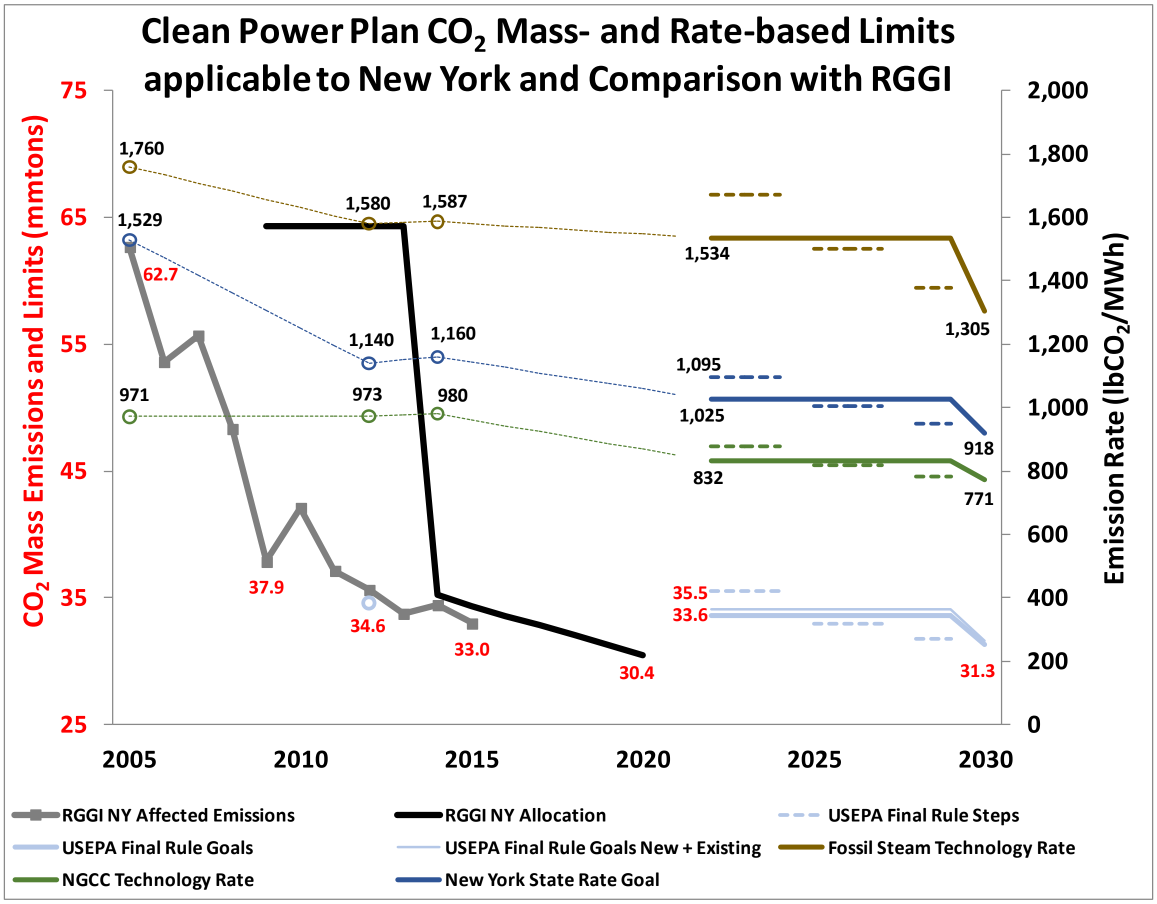


Figure 1-4 Comparison of CPP and RGGI Goals to Historic Emissions and Rates

In February 2016, the Supreme Court of the United States stayed the implementation of the CPP pending disposition of petitions in the Court of Appeals for the District of Columbia Circuit (D.C. Circuit) and a subsequent appeal to the Supreme Court, if sought. The stay put on hold all further compliance obligations under the CPP for the states. The D.C. Circuit held oral argument on September 27, 2016, and a decision is pending. The Governor of New York State has directed state agencies to continue planning for implementation while the CPP remains under judicial review.

Regional Greenhouse Gas Initiative (RGGI)

The RGGI is a multi-state[16] market-based power sector cap-and-trade approach among Northeastern and Mid-Atlantic states to reduce emissions of CO_2. RGGI has required the

---

[15] The affected units under the CPP and RGGI contain differences. Both the CPP and RGGI regulate EGUs above 25 MW nameplate capacity; however, the CPP generally does not regulate simple-cycle gas turbine configurations or new units, unless a state decides to address leakage in that fashion in their State Plan.

surrender of allowances to cover CO_2 emissions since 2009. The program has a model rule and states share agreements that are generally adopted by the member states. The program affects all fossil fuel-fired units greater than 25 MW (*i.e.*, ST, CC, and simple cycle gas turbine (GT) EGUs), which differs from the CPP that only applies to existing fossil fuel-fired steam and natural gas fired combined cycles. Allowances are auctioned quarterly and are generally available to generators and the public. In 2012, the RGGI states completed a program review, agreeing to decrease the program caps and to set other program parameters. The current RGGI program caps limit emissions to 91 million tons in 2014 with an annual reduction of 2.5% year-over-year arriving at a final target of 78,175,215 tons annually for the RGGI states in 2020. The actual quantities of allowances available for auction are reduced to compensate for the banked allowances available through 2014.

Currently, the member states are engaged in a RGGI 2016 Program Review[17] to assess program design decisions post-2020 and to begin planning for compliance with the CPP. Specifically the review focuses on: (i) potential adjustments to the nine-state emissions cap; (ii) affected EGU determination; and (iii) adjustments that may be necessary to comply with the CPP. The program review is considering various potential designs for reductions. Figure 1-5, below, shows CO_2 emission limits applicable to New York that are under consideration in the ongoing RGGI Program Review reviewed in this assessment.[18] In addition the CPP mass (step) goals applicable to new and existing EGUs are also shown for comparison. As shown in Figure 1-5, even a flat RGGI cap, which affects a broader set of units than the CPP, would impose a more binding CO_2 emission reduction requirement than the CPP.

[16] RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap and reduce CO_2 emissions from the power sector. Further information is available at https://www.rggi.org/.
[17] https://www.rggi.org/design/2016-program-review
[18] Recently, RGGI released updated modeling results in which 2.5% (0.76 mmtons/yr in New York and 1.94 mmtons/yr RGGI-wide) and 3.5% (1.07 mmtons/yr in New York and 2.74 mmtons/yr RGGI-wide) annual reductions were examined. http://www.rggi.org/docs/ProgramReview/2016/11-21-16/2016_Nov_21_IPM_Modeling_Draft_Results.pdf

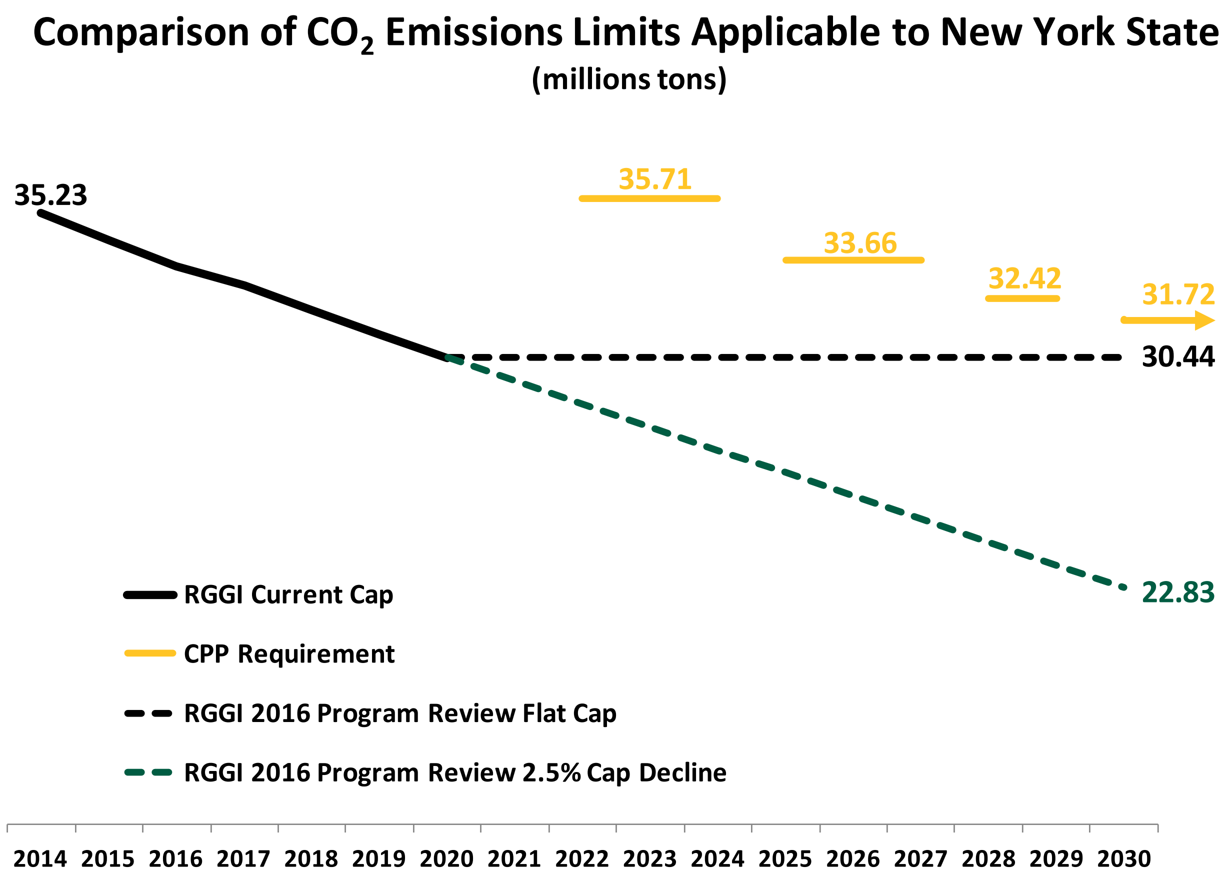


Figure 1-5 New York RGGI Emission Limits Comparison

The RGGI 2016 Program Review has not yet reached a conclusion as anticipated when this assessment was initiated. Since a specific endorsed program design is not available, this assessment examined two potential RGGI Cap scenarios in 2030—the 2020 flat cap and post-2020 modified declining cap at 2.5%. The details of these scenarios are discussed in Section 2.3 of this Report.

The RGGI 2016 Program Review is being conducted by the member states for the purpose of evaluating the effectiveness of the existing program, examining potential modifications for the RGGI program design, and identifying changes that may be necessary for the program to meet the design criteria of the CPP. The current program is designed to continue annual reductions of 2.5% year-on-year until 2020. Proposals to continue cap reductions, as well as to maintain the 2020 cap, are being studied as part of the program review. Between 2014 and 2020, an annual decrease of 2.5% year-over-year defined the reduction. For the post-2020 program review, RGGI has instead modeled a constant reduction of the annual emission cap based upon 2.5% of the 2020 cap. The revised definition provides a steeper rate of emission reductions, particularly in the out years.

The RGGI program has several design features that are intended to avoid price spikes and to avoid situations where the CO_2 reduction requirement could interfere with electric system reliability. These include a Cost Containment Reserve and emission offsets. Other program features under investigation are: (i) the continued inclusion of gas turbines that are not subject to the CPP; (ii) participation in the CPP Clean Energy Incentive Program; and (iii) participation in broader emission attribute markets. The ongoing RGGI 2016 Program Review report was scheduled to be released in mid 2016, however deliberations continue.

Cross-State Air Pollution Rule (CSAPR) Update Rule NO_x Reductions

The CSAPR limits SO_2 and NO_x from fossil fuel-fired EGUs greater than 25 MW in 28 eastern states by establishing annual or seasonal emission budgets and limited allowance trading caps. The trading limit is established at 121% of the ozone season budget. The Final CSAPR Update Rule, as published in the Federal Register on October 26, 2016,[19] addresses interstate transport under the 2008 Ozone National Ambient Air Quality Standard (NAAQS) of 75 parts per billion (ppb). Significant ozone season reductions in 22 affected states, shown green in Figure 1-6 below, were finalized. New York's ozone season NO_x budget was reduced by 50% from the original budget, while neighboring states such as New Jersey and Pennsylvania face reductions of similar stringency. Historic New York EGU operations are close to the 2017 interstate trading limit of 6,213 tons,[20] which is 21% above the ozone season budget of 5,135 tons. Should the sum of emissions from all affected units in New York exceed the trading limit, all emissions above the budget will require three allowances to be surrendered for each ton emitted above the budget by units that exceed their respective budgets, as displayed in Figure 1-7. Future operations below the trading limits are highly sensitive to the continued operation of the NYCA nuclear generation fleet.

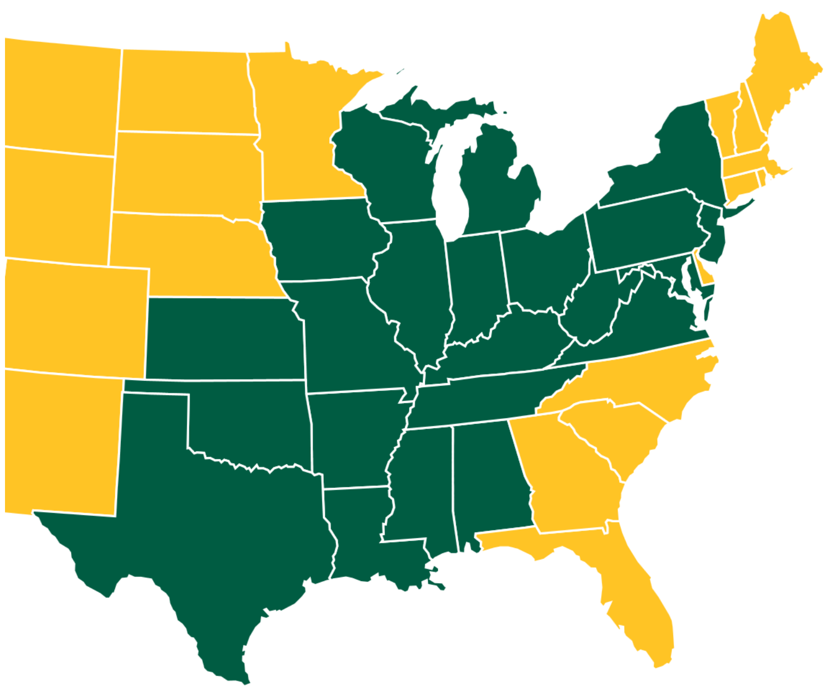


Figure 1-6 State Applicability in the CSAPR Update Rule

[19] 81 Fed. Reg. 74504 (to be codified at 40 C.F.R. parts 52, 78, and 97).

[20] NO_X emissions for CSAPR affected units in NY were reported to USEPA to be 6,521 tons for the 2016 ozone season.

The final CSAPR Update Rule is scheduled to take effect May 2017.[21] The aggregate budget amongst the 22 affected states is in excess of 310,000 tons, which is more than 60 times the New York ozone season budget. In addition the EPA will administer a one-time conversion of the aggregated banked vintage 2015 and 2016 (Phase 1) allowances to 2017 (Phase 2) vintage allowances of approximately 99,700 allowances.[22] Given the large volume of allowances in the market, the NYISO does not anticipate a reliability impact from the final CSAPR Update. Nevertheless, there may be an economic impact for some generators and there will be some uncertainty whether bids from affected generators should be based on one allowance or three allowances being required for each ton of actual NO_X emissions.

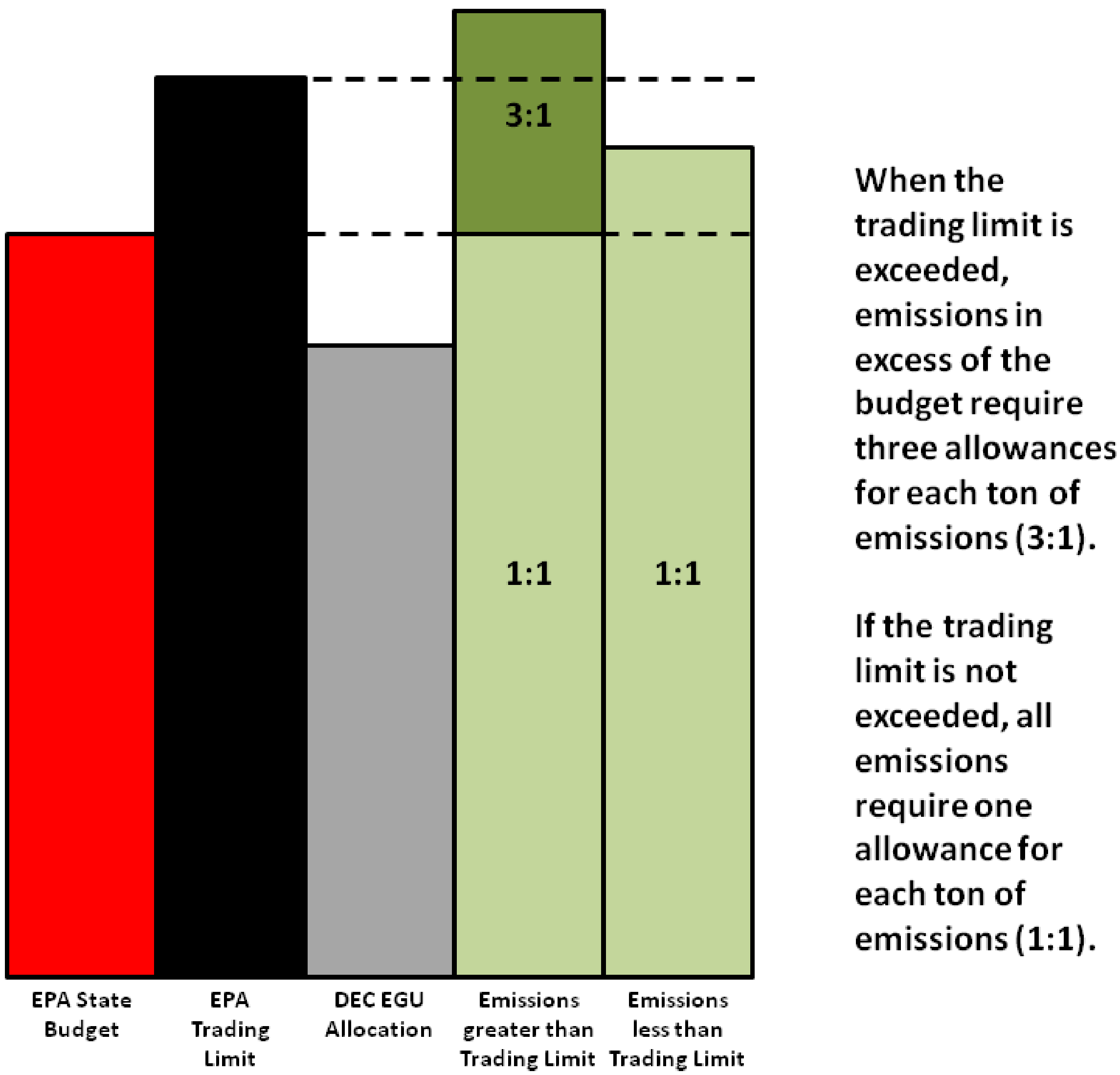


Figure 1-7 CSAPR Phase 2 Excess Emissions Provisions

[21] The ozone season is the period from May 1 to September 30.
[22] 81 Fed. Reg. 74509.

In a separate action, the New York State DEC petitioned the EPA for the authority to distribute CSAPR program allowances, which was approved by the EPA and codified in Parts 243, 244, and 245 of Title 6 of the New York Code of Rules and Regulations (NYCRR).[23] These rules and the CSAPR Update Rule would become effective in 2017, concurrent with CSAPR Phase 2. New York State will hold various accounts for allowances including for new units, retired units, and Energy Efficiency and Renewable Energy Technology, reducing the EGU allocation below the state budget, as shown in Figure 1-7.

It should be noted here that the 2015 Ozone NAAQS of 70 ppb, published in the Federal Register on October 26, 2015,[24] may drive another round of required reductions from power plants in the early 2020's. However, given the uncertainty regarding these requirements, the assessment assumed no additional NO_X reductions beyond those in the final CSAPR Update.

1.2.2. Operational Parameters

Operational parameters for this assessment were classified into two categories—environmental permit limitations and generator prime mover characteristics. The former are regulatory conditions applicable by way of their inclusion in air and water permits or other regulatory limitations, while the latter are physical limits imposed by the characteristics of the generators themselves.

Permits for fossil fuel-fired generators in New York contain numerous conditions. Some permits limit the quantities of various fuels that can be consumed, while other permits limit the quantity of emissions or the duration of operations in a specific time period. The production simulations were modeled to reflect these limits.

1.2.3. Economics

The GridView production cost simulation model considers electric system constraints, unit efficiencies, unit costs, and other generating unit characteristics as inputs and reports system-wide production costs, load payments, congestion costs, losses, and emissions. Generator retirements and additions are also expected. The location and size of transmission and generator additions are beyond the scope of this study. Accordingly, the costs associated with transmission reinforcements and generator additions are beyond the scope of this assessment and are not included in the economic analysis.

1.3. Other NYISO Studies

1.3.1. NYISO CARIS Study

The NYISO Congestion Assessment and Resource Integration Study (CARIS) reports on historic and forecasted congestion on the New York State bulk power transmission system and

[23] http://www.dec.ny.gov/regulations/103194.html
[24] 80 Fed. Reg. 65292.

provides an analysis of potential costs and benefits of relieving that congestion.[25] The database established for the CARIS study has been subject to extensive review by and input from the NYISO stakeholders and therefore provides a credible starting point for this assessment. The database contains detailed information on plant operating characteristics and costs, as well as, a detailed electrical representation of the New York transmission grid.

1.3.2. NYISO RNA Study

The NYISO performs a Reliability Needs Assessment (RNA) biennially to evaluate electric system reliability for both resource adequacy and transmission security over a ten-year planning horizon.[26] The assessment compares forecasted performance of the grid and compares that performance to Reliability Criteria for Bulk Power Transmission Facilities (BPTF). The most recent assessment was approved by the NYISO Board of Directors on October 18, 2016. The 2016 RNA was used in this assessment to evaluate the impact of changes to the NYCA fleet that incorporate potential losses of nuclear capacity and additions of various combinations of new renewable resources.

1.3.3. NYISO Wind Study

The NYISO 2010 Wind Study, *Growing Wind*, determined that, with increases in bulk power system regulation service, up to 8,000 MW of wind could be added to the NYCA system.[27] The results showed, in the higher wind penetration cases, curtailments of wind generation could be reduced with appropriately planned transmission system upgrades. This assessment captures the wind modeling work from the Wind Study.

1.3.4. NYISO Solar Study

The NYISO 2016 Solar Study, *Solar Impact on Grid Operations - An Initial Assessment*, determined that with appropriate increases in bulk power system regulation service, up to 9,000 MW of photovoltaic (PV) and 4,500 MW of wind capacity can be accommodated.[28] This assessment captures the solar modeling work from the Solar Study.

The resource assumptions on location and output variability of renewable resources contained within the NYISO Wind Study and Solar Study provided the basis for the new renewable generation assumptions in this assessment.

---

[25] http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Planning_Studies/Economic_Planning_Studies_(CARIS)/CARIS_Final_Reports/2015_CARIS_Report_FINAL.pdf

[26] http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Planning_Studies/Reliability_Planning_Studies/Reliability_Assessment_Documents/2016RNA_Final_Oct18_2016.pdf

[27] *See* NYISO, *Growing Wind: Final Report of the NYISO 2010 Wind Generation Study*, *available at* http://www.nyiso.com/public/webdocs/media_room/press_releases/2010/Child_New_York_Grid_Ready_for_More_Wind_093010/GROWING_WIND_-_Final_Report_of_the_NYISO_2010_Wind_Generation_Study.pdf (September 30, 2010).

[28] *See* NYISO, *Solar Impacts on Grid Operations – An Initial Assessment*, *available at* http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Special_Studies/Special_Studies_Documents/Solar%20Integration%20Study%20Report%20Final%20063016.pdf (June 30, 2016).

2. Methodology

2.1. Development of Operational Limitations

In order to assess key parameters required by regulatory programs, various databases were assembled at the unit-level. Five years of data from prior Gold Books were used to build the base unit list. Parameters for each generator were aggregated to the Gold Book PTID and the modeled units in GridView.

EPA Air Market Program Data (AMPD) was obtained at the EPA ID level[29] aggregated to annual and ozone season values for 2012-2015. AMPD data consists of gross generation (MWh), heat input (mmBtu), CO_2, NO_x, and SO_2 emissions (tons), hours of operation, and regulatory program registrations for the CPP, RGGI, and the CSAPR Update Rule.

A database containing unit specific information and permitted limitations was developed to approximate thermal unit operations of 136 NYCA generators[30] representing 31 GW of summer capability and 108 terawatt-hours (TWh)[31] of generation in 2015 (approximately 80% and 76% of NYCA totals, respectively). The remainder of the 2015 NYCA generation was composed of 25 TWh hydroelectric energy and 7 TWh other renewable energy. Information was compiled from environmental permits[32] and regulations,[33] site visits, generator-provided information, and analysis of EPA AMPD hourly datasets. The NYISO assessed permitted oil use, emissions, load/capacity factor, fuel/heat input, water/thermal, and other limits with the potential to restrict generator's operations. The most restrictive set of limitations was imported into this assessment's database for comparison to the production cost simulation output. Generally, these are annual NO_X and fuel use limitations imposed within the Title V air permits issued by DEC.

In addition, the NYSIO assessed the unit level impacts of the CPP, RGGI, and CSAPR ozone season NO_x programs for inclusion in its operational database. The NYISO assigned EGUs external to NYCA to regulatory programs based upon satisfaction of specific criteria—whether they have greater than 25 MW in capacity and have applicable generator type, vintage, and fuel use. Modeling of these program assignment criteria was fine tuned by comparing them to the NYCA generators' actual unit level program assignments.

29 Unique combination of Facility ID (ORISPL) and Unit ID as reported by EPA AMPD.
30 Several generators listed in the Gold Book may be combined and modeled as a single "generator" in the environmental limits database.
31 A terawatt-hour or TWh is equivalent to one million MWh.
32 The environmental permits included: Title V and State Facility DEC Air Permits, State Pollutant Discharge Elimination System (SPDES) Permits, and Nuclear Regulatory Commission Operation Licenses.
33 The NYISO considered the EPA's Mercury and Air Toxics Standards (MATS) limits to oil- and coal-fired generators (*i.e.*, 10% or 8% capacity factor limits on oil firing), as well as the 15% capacity factor limits from the Clean Water Act 316(b) Intake Structures Rule found in SPDES permits, effective over the five-year permit term.

2.2. Update 2015 CARIS Study

The starting point for this assessment was the 2015 CARIS Phase 1 study. The assumptions and data were reviewed and revised to reflect new resource additions, retirements, load forecasts, fuel forecasts, emission price forecasts, and transmission reinforcements.

2.2.1. Fuel Forecast

This assessment used an updated fuel price forecast that included regional long-term forecasts of natural gas, fuel oil, coal, and nuclear fuel prices for New York and neighboring control areas. The CARIS study developed a fuel price forecast methodology that has been vetted with NYISO stakeholders and market participants. The methodology is based upon the United States Energy Information Administration (EIA) yearly national delivered long-term fuel price forecasts and adjusted to reflect both local constraints as well as historic volatility patterns. In essence, regional basis and seasonal factors based on analysis of historical spot prices from selected hubs are used to forecast prices over the study horizon. Weekly fuel prices were developed using the CARIS methodology, which is assessed annually and updated regularly to reflect the most recent information available. The weekly oil and natural gas fuel price forecasts used for this assessment are shown in Figure 2-1 and Figure 2-2. The oil prices are relatively flat throughout the year—approximating $25/mmBtu for distillate fuel oil (DFO) and $15/mmBtu for residual fuel oil (RFO)—although there is some variation across the year and oil trading hubs.[34] Natural gas prices are expected to remain at or near historic lows on average. However, winter spikes, which may be driven by insufficient gas system capability, are expected to continue without new gas transmission capacity reinforcements.

An additional natural gas price ("TCM3-Leidy") was applied to specific generators in central Pennsylvania that are located behind constrained pipeline corridors. This price forecast was based upon analysis of the Leidy and Transco price histories.

[34] Unless otherwise stated, all dollar values presented in this Report are in nominal dollars.

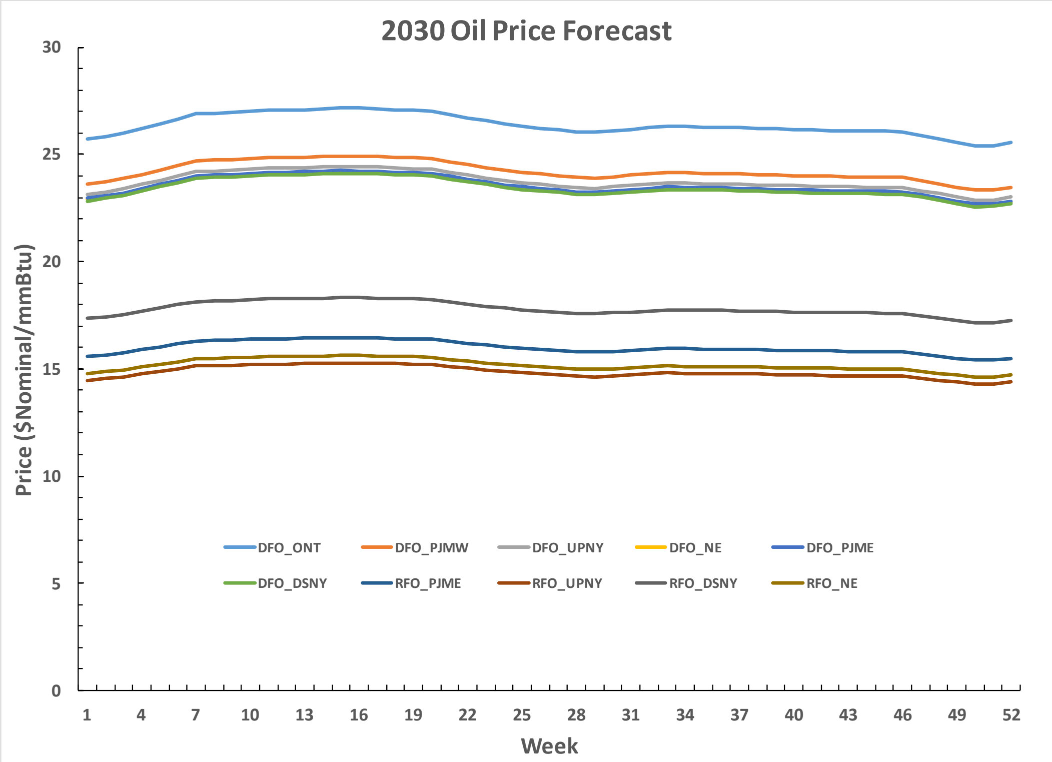


Figure 2-1 CPP Assessment Oil Price Forecast

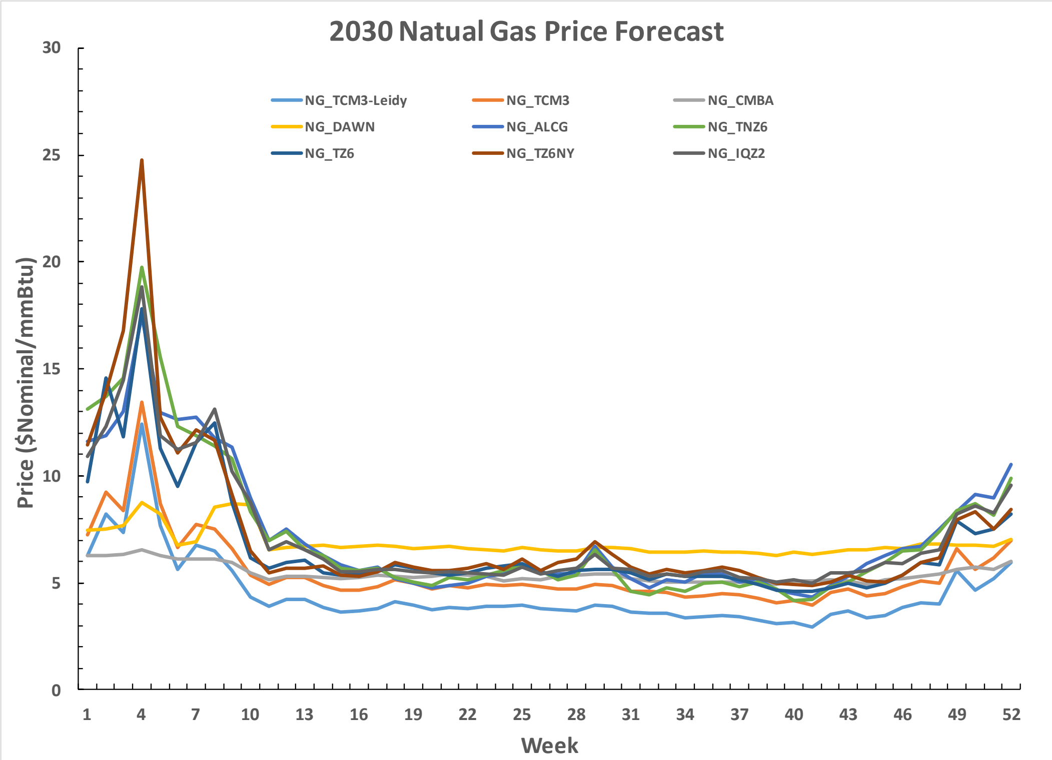


Figure 2-2 CPP Assessment Natural Gas Price Forecast

2.2.2. Resource Changes

This assessment started with the 2015 CARIS Phase 1 base case[35] and integrated resource additions and retirements to reflect those changes in the ongoing 2016 CARIS 2 database development efforts. Supplemental additions were performed to align the CARIS model with incremental modeling assumptions that did not meet the inclusion rules for CARIS.

Resource Additions

The 2015 CARIS Phase 1 base case was updated to reflect all unit additions in the NYCA and in neighboring external control areas. Across NYISO, PJM, ISO-NE, and IESO, a total of 15.5 GW of capacity was added between the 2015 CARIS Phase 1 base case and this assessment's business as usual case.

The NYISO resource additions were based on the 2016 Gold Book Addition list subject to the RNA inclusion rules.[36] Generation additions in PJM were based on the latest generation interconnection queue.[37] This assessment used the latest ISO-NE 2019-2020 Forward Capacity Market (FCM) cleared unit list to add resources for ISO-NE.[38] The NYISO used IESO's latest 18 Month Outlook Report as the data source to build additions in IESO.[39]

This assessment added 12.7 GW of thermal units as of summer 2020; a sizable majority being combined cycle units. Control area thermal additions for this assessment are summarized in Table 2-1.

Table 2-1 Thermal Additions by Control Area

Unit Type	Summer Capacity as of 2020 (MW)				
	NYISO	PJM	ISO-NE	IESO	Total
CC-Gas	678	9,213	-	-	9,891
CC-O/G	-	-	2,146	-	2,146
CT-Gas	-	-	93	-	93
CT-O/G	-	-	263	-	263
IC	-	96	-	-	96
ST	-	228	-	-	228
Total	678	9,537	2,502	-	12,717

As of summer 2020, the assessment added 2.8 GW of renewable resources, most of which represented wind units, with some solar unit additions. Control area renewable resource additions for the assessment are summarized in Table 2-2.

[35] 2015 Congestion Assessment and Resource Integration Study(CARIS) Phase 1 Final Report, *available at* http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Planning_Studies/Economic_Planning_Studies_(CARIS)/CARIS_Final_Reports/2015_CARIS_Report_FINAL.pdf (November 17, 2015).
[36] The RNA inclusion rules are contained in Section 3.1 of the Reliability Planning Process Manual, *available at* http://www.nyiso.com/public/webdocs/markets_operations/documents/Manuals_and_Guides/Manuals/Planning/rpp_mnl.pdf.
[37] http://www.pjm.com/planning/generation-interconnection/generation-queue-active.aspx
[38] http://www.iso-ne.com/markets-operations/markets/forward-capacity-market
[39] http://www.ieso.ca/Pages/Participate/Reliability-Requirements/Forecasts-&-18-Month-Outlooks.aspx

Table 2-2 Renewable Resource Additions by Control Area

Unit Type	Summer Capacity as of 2020 (MW)				
	NYISO	PJM	ISO-NE	IESO	Total
Wind	93	1,480	-	833	2,406
Solar	-	280	-	140	420
Total	93	1,760	-	973	2,826

Transmission

Generally, this assessment used the NYCA transmission system model.[40] Figure 2-3, below, displays a simplified representation of the NYCA bulk power system. This transmission model generally consists of facilities 230 kV and above. However, the transmission model also includes certain 138 kV and 115 kV facilities as set forth in the NYISO's tariffs and manuals. In addition, Figure 2-3 shows key transmission interfaces.

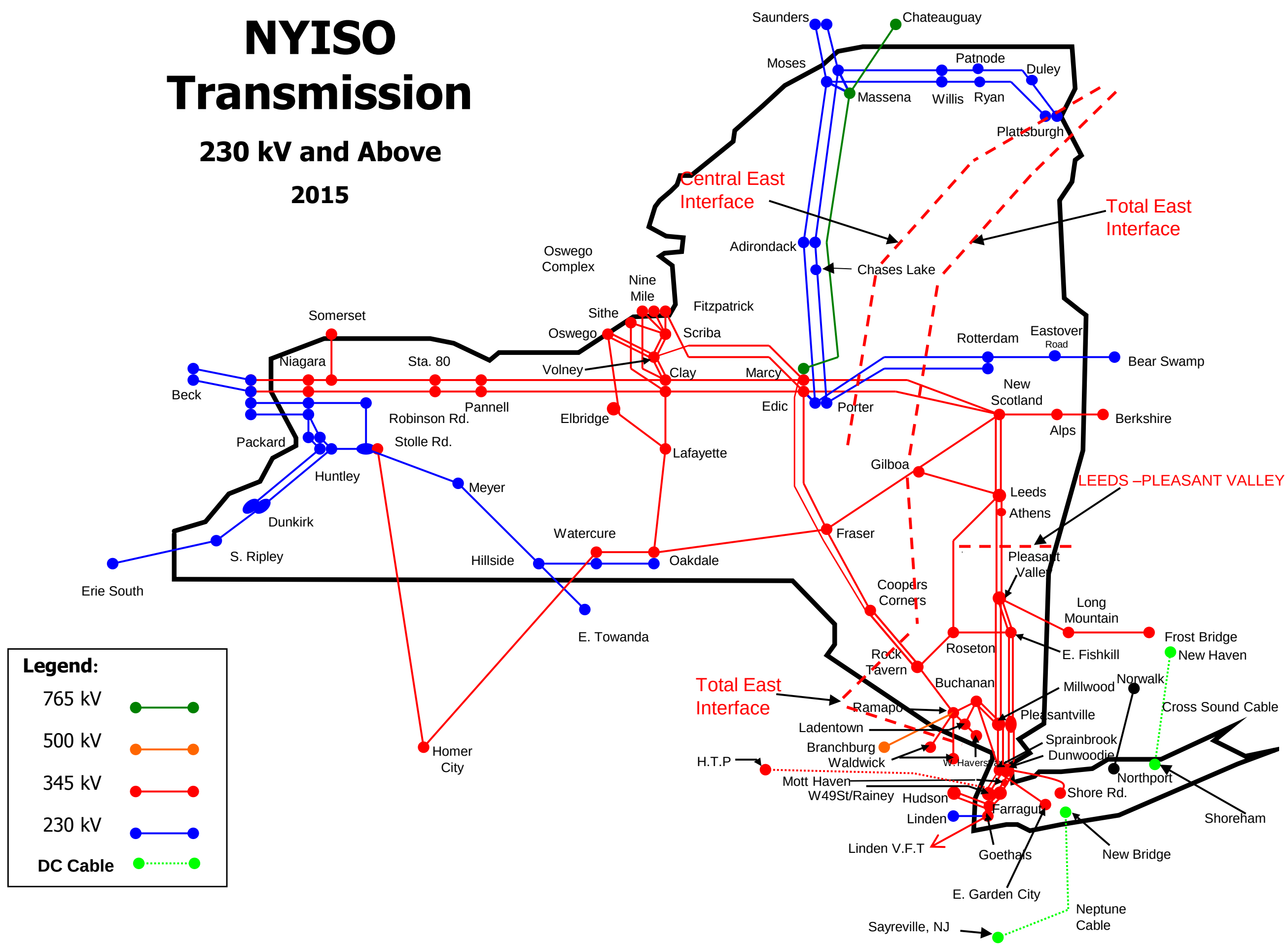


Figure 2-3 NYISO 230 kV and above Transmission Map

[40] 2015 CARIS – Phase 1 Appendices B-J

This assessment also included incremental transmission changes to the 2015 CARIS Phase 1 base case including:

- Staten Island Un-bottling Project Phase 2 was removed pursuant to a New York State Public Service Commission order modifying the Transmission Owner Transmission Solution projects,
- The Packard Sawyer 77 and 78 1.5% series reactor was added,
- Station 122 and Station 80 upgrade - Ginna Retirement Transmission Alternative was added, and
- Leeds Hurley 21% series compensation was added.

External Area Model

The external areas immediately adjacent to the NYCA, namely ISO-NE, IESO and PJM, were represented in the assessment's model. Since Hydro Quebec (HQ) is asynchronously tied to the NYCA's bulk electric system, proxy buses representing the direct ties from HQ to NYISO, HQ to IESO, and HQ to ISO-NE were modeled.

Retirements

The assessment also updated the model to reflect announced generator retirements in the NYCA and in neighboring control areas. The NYCA announced retirements were based on the 2016 Gold Book,[41] subject to the latest 2016 RNA modeling assumptions. Generation retirements in PJM were based on the latest Future PJM Deactivation list.[42] The NYISO modeled ISO-NE retirements using the Status of Non-Price Retirement Requests unit lists.[43] IESO's latest 18-Month Outlook was used to model retirements in IESO.[44]

Across NYISO, PJM, ISO-NE, and IESO, a total of 4.8 GW of capacity retired between the 2015 CARIS Phase 1 Study and this assessment's business as usual case, including 3.7 GW of coal and nuclear units. Control area thermal retirements for this assessment are summarized in Table 2-3, below.

[41] *See* Section IV of the 2016 Gold Book, *available at* http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2016_Load__Capacity_Data_Report.pdf (April 2016).
[42] http://www.pjm.com/planning/generation-deactivation.aspx
[43] http://www.iso-ne.com/system-planning/resource-planning/nonprice-retirement
[44] http://www.ieso.ca/Pages/Participate/Reliability-Requirements/Forecasts-&-18-Month-Outlooks.aspx

Table 2-3 Retirements by Control Area

Unit Type	Summer Capacity as of 2020 (MW)				
	NYISO	PJM	ISO-NE	IESO	Total
CT-O/G	26	-	-	-	26
CT-OIL	118	-	-	-	118
ST-GAS	435	-	-	-	435
ST-O/G	-	443	-	-	443
ST-BIO	43	-	-	-	43
NUC	1,210	614	702	-	2,526
COAL	1,062	135	-	-	1,197
Total	2,894	1,192	702	-	4,788

2.2.3. Load Forecast

This assessment uses a load shape model that is based on historical load data. Load peak and energy is summarized as follows:

- The NYISO load forecast is based on the 2016 Gold Book Baseline Forecast of Annual Energy and Non-Coincident Peak Demand, including the impacts of Energy Saving Programs & Non-Solar Behind-the-Meter Generation.[45]
- The PJM load forecast is based on posted 2016 Load Forecast of Annual Energy and Non-Coincident Peak Demand.[46]
- The ISO-NE load forecast is based on 2016 Capacity, Energy, Load, and Transmission (CELT) Report Sub-area Load Forecast of Annual Energy and Non-Coincident Peak Demand prior to the impact of BTM solar PV and passive demand resources.[47]
- The IESO load forecast is from IESO Planning Group's 2015 Q2 Long Term Zonal Outlook Annual Energy and Non-Coincident Peak Demand prior to the impact of Net Conservation and Embedded Generation.

2.2.4. Behind-the-Meter Photovoltaic Forecast

The NYISO's Behind-the-meter (BTM) PV forecast incorporated into the CARIS process was developed using an adoption-model approach. The forecast assumes that, over the forecast period, the cumulative NYCA capacity approaches the NY-Sun Initiative (NY-Sun) goal of around 3,200 MW DC, or approximately 2,500 MW AC, of BTM PV, as shown in Table 2-5, below.[48]

Typically, BTM PV hourly generation is apportioned from zonal totals to load buses by the annual load shares of each load bus to the total zonal load. In this assessment, in order to develop an equitable and reasonable modeling of BTM PV across Zone J (New York City) territory, the NYISO developed an updated methodology to apportion the forecasted PV by

[45] *See* 2016 Gold Book.
[46] http://www.pjm.com/planning/resource-adequacy-planning/load-forecast-dev-process.aspx
[47] http://www.iso-ne.com/system-planning/system-plans-studies/celt
[48] Additional information on the NY-Sun is available at http://www.nyserda.ny.gov/All-Programs/Programs/NY-Sun.

load bus. This methodology provides that the geographic distribution of PV in the model reflects the share of forecasted installed capacity.

The NYISO's methodology involves the following:

- Determine the NYISO county-level forecasts of PV capacity,
- Map Zone J load buses to the territory's counties, and
- Assign the shares of Zone J's coincident Summer Peak load by load bus from the Power Flow model used in the NYISO's planning analyses.

Using Queens County for example, the forecasted PV capacity for a given year was allocated across that county's load buses based on the shares implied by the Power Flow. While the load bus shares are not constant over time, the differences across years were negligible at these adoption rates.

The PV shapes and forecasts were obtained from the CARIS study and augmented with BTM PV generation from the NYISO Solar Study.

2.2.5. Emission Price Forecast

The NYISO updated the CARIS 2015 emission price forecast for this assessment. Table 2-4 sets forth the emission allowance prices. In cases where emissions exceeded the RGGI-wide program cap, the RGGI CO_2 emission prices were increased until approximate compliance levels were achieved. Prices were developed by examination of various historic emission allowance indexes and allowance auction clearing prices and forecasts. During the ozone season, the price of the sum of the ozone season (OS) and Annual NO_X allowances were applied as the NO_X emission price.

Table 2-4 CPP Assessment Emission Price Forecast

Emission Price Forecast (Nominal$/ton)				
Year	Annual CO_2	OS NO_X	Annual NO_X	Annual SO_2
2024	$ 18.41	$ 232.50	$ 45.00	$ 5.00
2030	$ 24.14	$ 202.50	$ 15.00	$ 5.00

2.3. Assessment Cases

This assessment examined years 2024 and 2030. The mid-term 2024 date was selected to examine compliance with the CPP during the Interim Step 1 compliance period (*i.e.*, 2022-2024), while the 2030 horizon year aligns with the first year of the final CPP compliance obligation. This Final Report focuses on 2030 CPP horizon year. Further discussion of assumptions for 2024 cases can be found in the *Clean Power Plan Assessment - Interim Report*.[49]

The five cases studied for 2030 were:

Business As Usual ("BAU"): Ginna and Nine Mile Point 1 (NMP1) nuclear units were designated as out-of-service in 2030 as their current NRC Operating Licenses expire prior to that date;[50] CO_2 allowance price is zero for non-RGGI states; RGGI CO_2 Cap is kept flat post-2020 at 78.175 million tons.

Flat Cap ("FlatCap"): Ginna, NMP1, and FitzPatrick nuclear units are designated as out-of-service in 2030; CPP is a constraining factor in non-RGGI states; RGGI CO_2 Cap is kept flat post-2020 at 78.175 million tons.

Declining Cap ("DecCap"): Ginna, NMP1, and FitzPatrick nuclear units are designated as out-of-service in 2030; 6,649 MW of wind generators located in upstate New York as identified in the NYISO Wind Study, and 1,400 MW offshore wind off Long Island, 1,000 MW PV distributed to all zones in New York; CPP is a constraining factor in non-RGGI states; RGGI CO_2 emissions are capped by a 2.5% annual reduction post-2020, *i.e.*, 58.631 million tons in 2030.

High Renewable Energy ("HiRE"): Ginna, FitzPatrick, NMP1, and Indian Point nuclear units are designated as out-of-service in 2030; CPP is a constraining factor in non-RGGI states; RGGI CO_2 emissions are kept flat post-2020 at 78.175 million tons; Nuclear capacity and energy are replaced by 1,400 MW Gas Turbine units located at Indian Point, 6,791 MW of wind generators located in upstate New York as identified in the NYISO Wind Study, and 1,400 MW offshore wind off Long Island, 1,000 MW PV distributed to all zones in New York.

High Gas Turbine ("HiGT"): Ginna, FitzPatrick, NMP1, and Indian Point nuclear units out-of-service in 2030; CPP is a constraining factor in non-RGGI states; RGGI CO_2 emissions are kept flat post-2020 at 78.175 million tons; Nuclear capacity and energy are replaced by 2,500 MW GT units at Indian Point plant location, 4,250 MW of wind generators in upstate New York as identified in the NYISO Wind study, and 750 MW PV distributed to all zones in New York.

The NYISO selected combinations of resources to replace retiring nuclear facilities in the HiRE and HiGT cases to approximate replacement capacity and annual energy production. In all cases studied in this Report, CPV Valley is assumed to be in service and the NY-Sun goal of over 3,000 MW DC BTM PV is assumed to have been reached by 2024, as reflected in Table 2-5 below. In the 2030 cases, the NYISO assumes all remaining NYCA coal generators are retired. In addition, Nine Mile Point 2 was in service in all cases, while Ginna and Nine Mile Point 1 were out-of-service in all cases. Wind and solar resources in the BAU, FlatCap, and

[49] http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Special_Studies/Special_Studies_Documents/Clean_Power_Plan_Assessment-Interim_Report-July_2016.pdf

[50] The NRC operating license for Ginna expires October 17, 2029 and for Nine Mile Point 1 expires August, 22, 2029. Nine Mile Point 2 was retained in the model as its license does not expire until after the 2030 Study horizon year.

DecCap cases were derived from the most recent CARIS Phase 1 Study, while the HiRE and HiGT cases assume wind and solar based upon the NYISO Wind and Solar Studies.

RGGI CO_2 prices, as shown in Table 2-5, were determined by maintaining RGGI-wide compliance with the nine-state program cap for each case as outlined at the bottom of Table 2-5. To meet the RGGI cap, CO_2 allowance prices were increased for all RGGI states until the cap limits were achieved. As shown in Table 2-5, increases in RGGI CO_2 prices are required in all cases except the BAU case. Emissions associated with new CC generators assumed in the assessment are counted towards the CPP CO_2 emission totals within the RGGI states. As described more fully in Section 2.5, additional resources beyond those considered in this assessment will be necessary to satisfy resource adequacy criteria. Some portion of those resources will likely be fossil fuel-fired. Neither the cost of operation of these additional resources nor the related emissions have been evaluated in this assessment. Conversely, for non-RGGI states, new CC plants will not be included in the CPP emission totals.

Table 2-5 Scenario Details for 2030 Cases

2030 Assumption	BAU	FlatCap	DecCap	HiRE	HiGT
FitzPatrick	In	Out	Out	Out	Out
Indian Point 2 and 3	In	In	In	Out	Out
RGGI CO_2 Price ($/ton)	24.14	36.21	60.00	36.21	40.00
Ontario CO_2 Price ($/ton)	48.28	48.28	48.28	48.28	48.28
Non-RGGI CO_2 Price ($/ton)	-	24.14	24.14	24.14	24.14
Wind (MW)	1,820	1,820	8,049	8,192	4,619
PV (MW)	2,538	2,538	3,538	3,538	3,288
Replacement GT (MW)	-	-	-	1,400	2,500
RGGI Wide CO_2 Target (mmtons)	78.18	78.18	58.63	78.18	78.18

The Province of Ontario has announced plans to establish an economy-wide CO_2 emissions cap program that will be linked with Quebec and California. Estimates for allowance prices in California have been used as a proxy for Ontario. More recently the Prime Minister of Canada announced plans for a national carbon pricing scheme to be implemented by the provinces increasing from C$10/tonne[51] in 2018 to C$50/tonne in 2022.[52] It was assumed within non-RGGI states, in all cases except the BAU, that emitting generators are exposed to the BAU RGGI allowance price. In this assessment, as in the CARIS Study, non-RGGI states were exposed to the BAU RGGI CO_2 price to represent implementation of a federal CO_2 emission reduction program similar to RGGI.

2.4. CARIS Metrics

This assessment employed GridView for each case to simulate hourly production in the NYCA and the surrounding control areas—ISO-NE, PJM, and IESO.[53] The model respects the system constraints and is driven by unit-specific inputs, such as: fuel costs, heat rates, start

[51] C$/tonne being Canadian dollars per tonne. A tonne, or metric ton, is 1.10231 tons.
[52] http://pm.gc.ca/eng/news/2016/10/03/prime-minister-trudeau-delivers-speech-pricing-carbon-pollution
[53] HQ is asynchronously tied to the NYISO's bulk electric system and, therefore, represented by proxy buses directly tied between HQ and other regions.

costs, ramp rates, emission rates, and emission allowance costs. For this assessment, the GridView results are reported for CARIS metrics (*e.g.*, production cost, load payment, and emissions) and are augmented to provide regulatory program emissions.

The reported operations were compared to limits for each unit and to the operational limit database. Emission results were further compared to statewide-emission limits for the CPP, RGGI, and CSAPR Update Rule.

2.5. Resource Adequacy

As a starting point, this assessment used the RNA base cases and extended them to the 2030 CPP horizon year. The NYISO RNA is a biennial study that examines the resource adequacy and transmission system adequacy and security of the New York State BPTF over a ten-year study period. The RNA for the study years 2016 to 2025 was recently approved by the NYISO Board of Directors.

Resource Adequacy Assessment Scope

This analysis provides a limited assessment of the resource adequacy of the NYCA to determine whether the assumed changes in the composition of the NYCA fleet in the year 2030 may result in the NYCA meeting its reliability measure, which is the Loss of Load Expectation (LOLE). The criterion is a probabilistic approach designed to provide adequate supply resources to reliably meet customer demand. The criterion requires an LOLE of less than or equal to 0.1 day per year, which was applied for the cases below. This resource criterion requires planners of the BPTF to procure through their markets sufficient capacity resources such that the probability of an unplanned loss of load is no greater than one occurrence in 10 years. The generation and transmission assumptions from the 2016 RNA were updated in this assessment to be consistent with the production cost modeling case assumptions in Section 2.3 of this Report. The GE MARS model was used to evaluate resource adequacy.

a) CPP RA 2030 Preliminary Base Case (PBC)

- The base case was developed from the Final 2016 RNA base case
- The 2030 load forecast was created by extending the load forecast developed for the 2016 Gold Book
- The base case maintains the generation profile from the RNA base case for 2025
- The base case maintains the topology network and limits from the RNA base case for 2025
- The external LOLEs were set consistent with the 2016 RNA base case assumptions

b) CPP RA Base Case (BAU)

- The NYCA thermal generation from the PBC base case was updated based on input from CPP BAU production simulation
- The base case was updated to make the renewable forecast consistent with the renewable resources included in the CARIS model

- The external LOLEs were set consistent with 2016 RNA base case assumptions

c) CPP RA High Renewable Case (HiRE)

- This case assumes that all NY Nuclear generation except Nine Mile 2 retires by 2030
- The renewable forecast was updated consistent with the NYISO Wind/PV studies
- The external LOLEs were set consistent with 2016 RNA base case assumptions

Assessments:

- All three cases were tested to determine if the system meets the LOLE criterion
- For CPP RA Base Case and CPP RA High Renewable Case:
    - If LOLE criterion is not met, the run analysis determines if there is a resource or transmission inadequacy
    - If there is a resource inadequacy, compensatory resources are added to deficient zones until the LOLE criterion is met, revealing the resource deficiency in MW
    - If transmission is inadequate, the assessment determines how much the interface ratings have to increase to meet the LOLE criterion

Consistent with the assessment scope, no analysis was performed to determine the impact of intermittent resources on Installed Reserve Margin (IRM) and Locational Capacity Requirement (LCR) levels in future capability years as part of this study.

3. Results

3.1. Environmental Limitations

Local, state, and federal regulatory air programs constrain the operation of conventional EGUs. The focus of this assessment is on the federal and (multi-)state air regulations impacting the power sector. Particular attention is paid to CO_2 and ozone season NO_X as one represents the largest long-term power sector pollutant and the other the most-pressing, near-term health concern considered in pending regulations, respectively.

Compliance with the CPP, RGGI, and CSAPR ozone season NO_x limits were assessed at the state level for those states regulated by each program and the program cap was compared to the aggregate emissions among the affected states.

Table 3-1 through Table 3-3 display environmental program compliance metrics for each regulatory program examined. Table 3-2 and Table 3-3 display this information as the compliance margin in units of the standard and then as a percentage relative to the standard itself. Positive values for compliance margins indicate compliance with the corresponding regulatory program for each case, while negative values indicate a need to obtain allowances or clean energy attributes from outside New York to cover excess emissions. In scenarios with increasing amounts of renewable resources, rate-based approaches to CPP compliance consistently provide greater compliance margins.

Table 3-1 Environmental Program Case Results

Environmental Program Metrics	BAU	FlatCap	DecCap	HiRE	HiGT
NY CPP CO_2 (mmtons)	26.89	31.18	23.03	29.88	31.66
NY CPP Rate ($lbCO_2$/MWh)	986	964	764	770	837
NY RGGI CO_2 (mmtons)	27.21	31.54	23.29	30.26	32.14
NY CSAPR OS NO_x (tons)	4,527	5,391	3,579	5,247	5,526

Table 3-2 Environmental Program Compliance Margin Case Results

Environmental Program Margins	BAU	FlatCap	DecCap	HiRE	HiGT
NY CPP CO_2 (mmtons)	4.83	0.54	8.69	1.84	0.06
NY CPP Rate ($lbCO_2$/MWh)	-68	-46	154	148	82
NY RGGI CO_2 (mmtons)	3.22	-1.11	-0.47	0.18	-1.70
NY CSAPR OS NO_x Budget (tons)	608	-256	1,556	-112	-391
NY CSAPR OS NO_x Trading Limit (tons)	1,686	822	2,634	966	687

Table 3-3 Environmental Program Compliance Margin Percentage Case Results

Environmental Program Margins	BAU	FlatCap	DecCap	HiRE	HiGT
NY CPP CO_2 (mmtons)	15%	2%	27%	6%	0.2%
NY CPP Rate ($lbCO_2$/MWh)	-7%	-5%	17%	16%	9%
NY RGGI CO_2 (mmtons)	11%	-4%	-2%	1%	-6%
NY CSAPR OS NO_x Budget (tons)	12%	-5%	30%	-2%	-8%
NY CSAPR OS NO_x Trading Limit (tons)	27%	13%	42%	16%	11%

3.1.1. EPA CPP

Affected EGU emissions and generation were aggregated in each state and compared to the state mass- and rate-based goals provided in the CPP. The comparison of the CPP mass-based goals in this assessment uses the New + Existing[54] goal in the eight affected RGGI member states and the Existing Only goals in the remaining modeled states.

Figure 3-1, below, shows the CPP compliance comparisons in each state and in each case for both state mass- and rate-based approaches. The top panel displays the CO_2 emissions relative to the final annualized mass-based goals.[55] The corresponding state emission rates and rate-based goals are shown in the bottom panel. The states' average emission rate may be reduced by lower emissions from existing sources and by new qualifying renewable energy (RE) resources. The reductions in emission rate associated with the quantities of qualifying RE are included in the bottom panel of Figure 3-1. In New York, the forecasted operations are within the final mass-based limits set in the CPP for all scenarios. The EGU fleet can achieve rate-based compliance by utilizing additional ERCs available from eligible RE generation resources in the DecCap, HiRE, and HiGT cases.

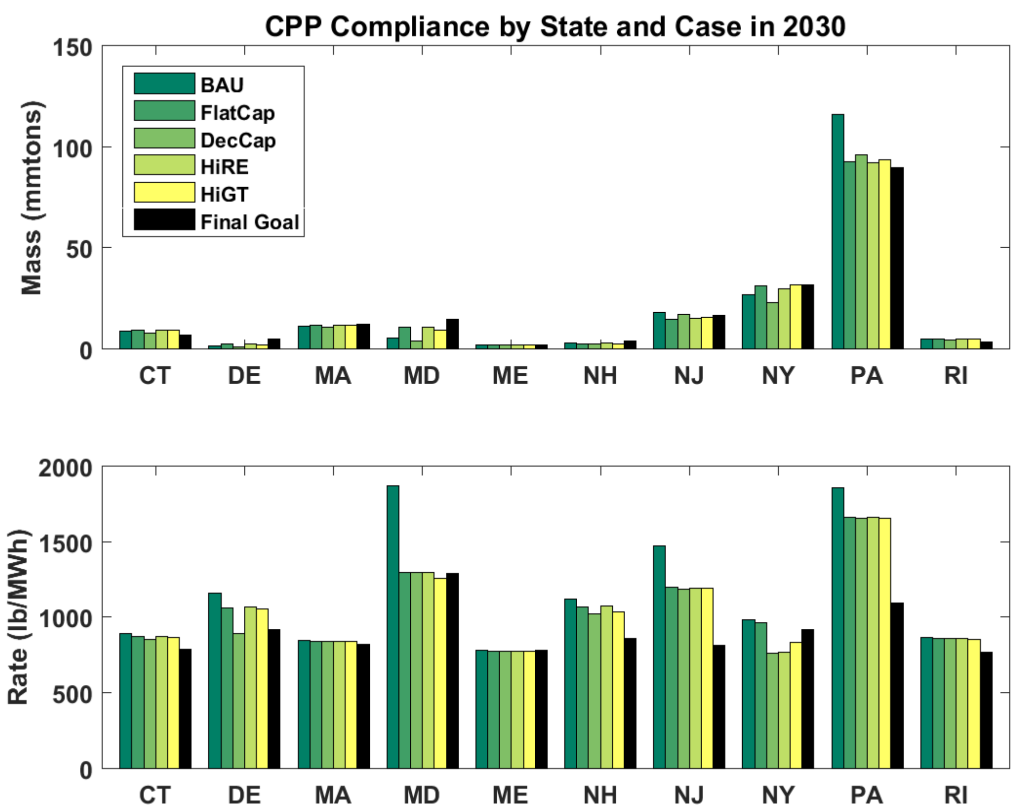


Figure 3-1 Clean Power Plan Mass and Rate Compliance Comparison

[54] The CPP does not regulate emissions from "New Sources" under the same rule as existing sources, unless a state chooses to treat new and existing sources under the same rule in its implementation plan. In contrast, the RGGI program regulates both new and existing sources under the same rule.
[55] In this Study, RGGI state CPP mass-based goals are presented as New+Existing generators while non-RGGI states mass-based goals are for existing units only. New EGU emissions and generation are not included in the calculated state rates.

The compliance margin for each state and case was computed as the difference between the goal and the emissions and rates shown in Figure 3-1. Positive compliance margins shown in Figure 3-2 indicate that the state is in compliance with the CPP, while negative margins indicate a need for out-of-state trading to achieve compliance. As modeled, New York is compliant with the Final CPP mass goals in all cases studied. In the alternative, the results are varied when emission rates are compared to the CPP performance standard. Cases that add increasing quantities of renewable resources can offset the tendency of increased emissions when increasing numbers of nuclear units are retired.

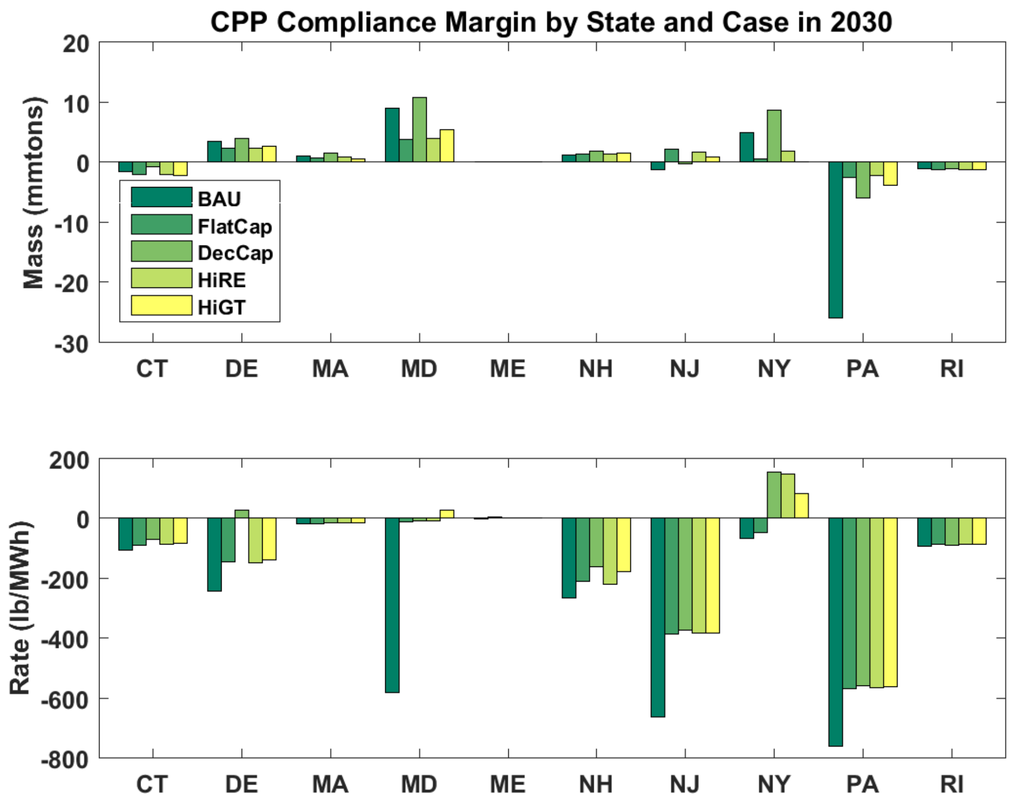


Figure 3-2 Clean Power Plan Mass and Rate Compliance Margin Comparison

ERC-eligible renewable generation is only a portion of the total renewable generation. For the states plotted in Figure 3-1, the total and ERC-eligible (potential) generation is shown in Figure 3-3. The darkened portions of the bar indicate the amount of the total renewable generation eligible for ERC production.

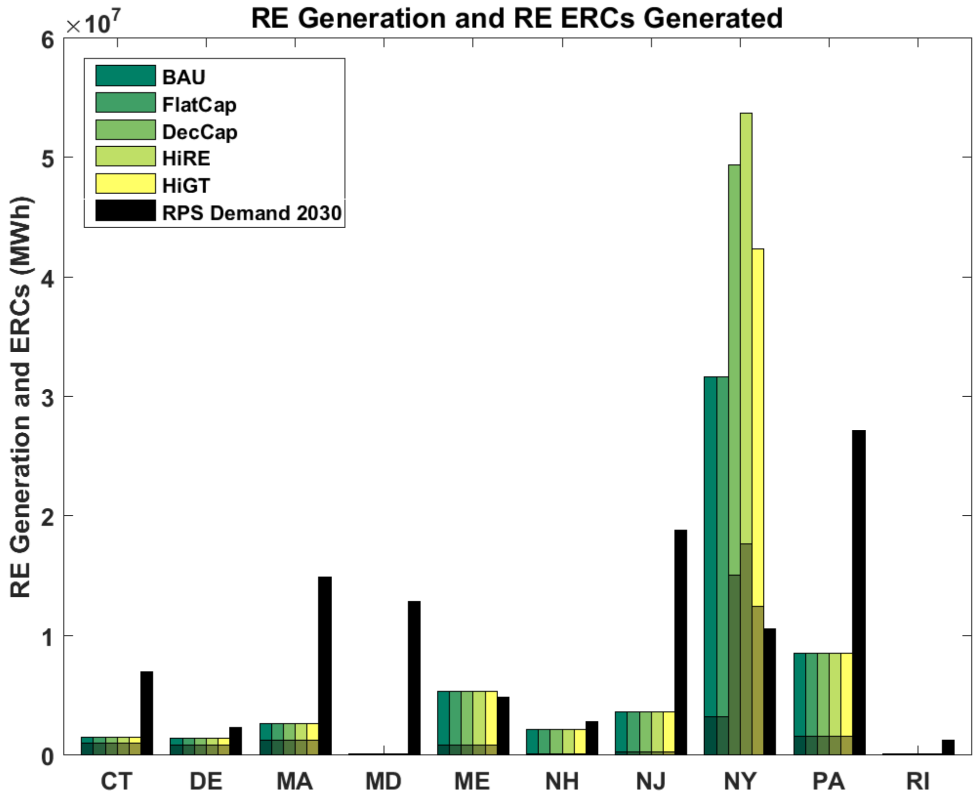


Figure 3-3 Total Renewable and ERC Generation Potential

The projected demand in 2030 for existing RPS programs in these states is shown for comparison in Figure 3-3, above.[56] The New York RPS demand of 10.4 million MWh represents the original RPS Main- and Customer-Sited Tier targets for 2015. Based upon the most recent progress report, as of 2015, attainment of this goal was approximately 60% and 24% of New York generation was from renewable energy sources.[57] For comparison, the largest quantity of eligible ERCs is represented in the HiRE case (17.7 million MWh). New renewable generation embedded within the CELT forecast for ISO-NE was assumed to generate ERCs and was included.

3.1.2. RGGI Program

The CO_2 emissions for RGGI states (excluding Vermont)[58] are shown in Figure 3-4 across the study cases for the RGGI affected fleets. The RGGI limits are also shown for comparison with the case results. The difference between RGGI and CPP emissions in a given case reflects the difference in the group of regulated or affected units in each program. Generally, due to the state caps and the list of affected units, RGGI is more stringent than the CPP for the RGGI

[56] Found at https://emp.lbl.gov/projects/renewables-portfolio using values from https://emp.lbl.gov/sites/all/files/RPS%20Demand%20Projections_March%202016.xlsx

[57] http://www.nyserda.ny.gov/-/media/Files/Publications/Energy-Analysis/RPS/2016-RPS-Annual-Report.pdf

[58] Vermont participates in the sale of RGGI CO_2 allowances but does not have any affected generators. Vermont is also not subject to the CPP.

member states. This result is consistent with analysis by the EIA of the CPP on the RGGI states.[59] The program limits applicable to New York are shown in Figure 1-5.

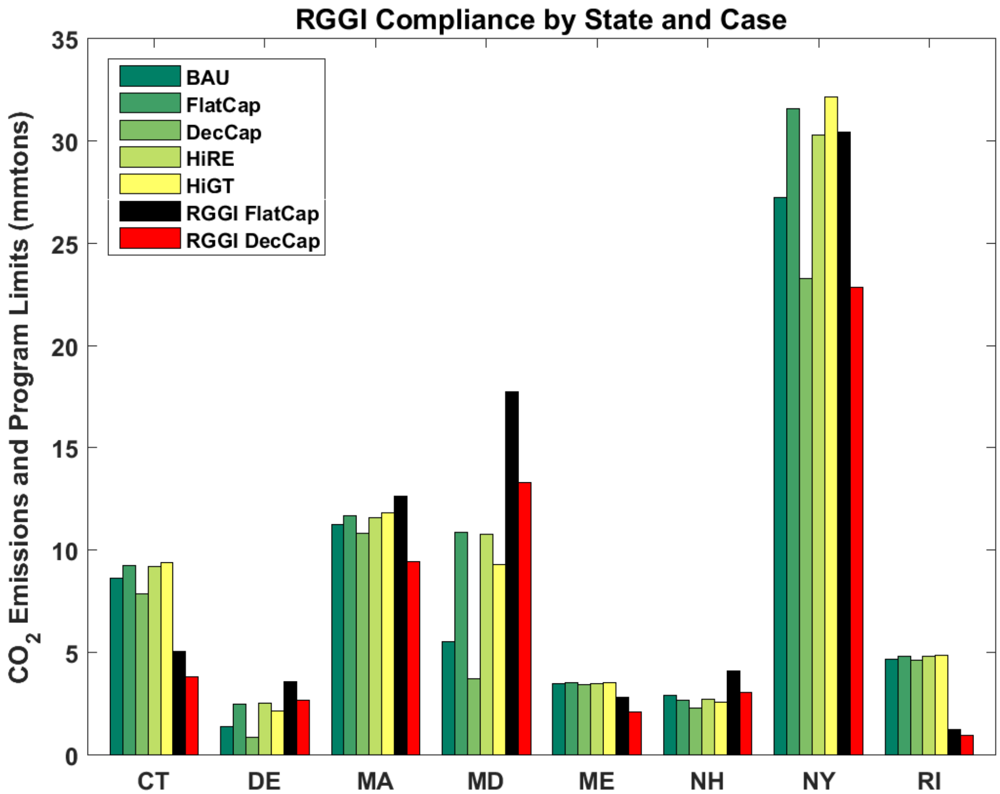


Figure 3-4 Regional Greenhouse Gas Initiative Compliance Comparison

Figure 3-5, below, shows the compliance margin (*i.e.*, computed as the applicable limit minus the program emissions) or excess allowances that a state would have based upon projected operations. For the FlatCap, DecCap, and HiGT cases, RGGI compliance for New York will depend upon a supply of surplus allowances available from other RGGI states.

[59] https://www.eia.gov/forecasts/aeo/cpp.cfm

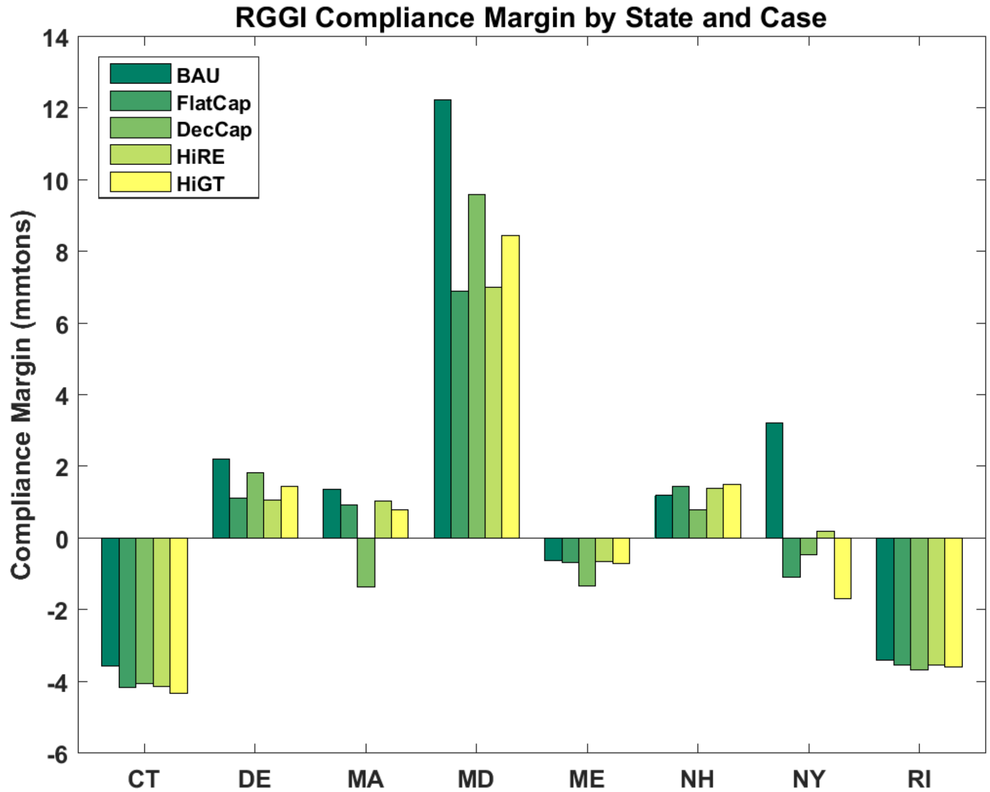


Figure 3-5 Regional Greenhouse Gas Initiative Compliance Margin Comparison

3.1.3. EPA CSAPR Update Ozone Season Phase 2

NO_X emissions in New York and neighboring affected states were examined during the ozone season for comparison with the limits published in the CSAPR Update Rule. A detailed review of the results for New York is shown in Figure 3-6, below. The bars show either ozone season emissions or limits in tons of NO_X. Historic emissions in the past three ozone seasons were well below the CSAPR 2015-2016 ozone season NO_X budget of 10,369 tons, but above the final CSAPR Update Rule budget of 5,135 tons. The budget level in the final CSAPR Update Rule represents a 50% reduction from the 2017 budget in the current rule. The 2016 ozone season NO_X emissions exceeded the new final trading limit of 6,213 tons (21% above the budget) by 5%. In addition, examination across the assessment cases shows that NO_X emissions in the BAU and DecCap cases were within the ozone season NO_X emissions budget and that NO_X emissions in all the cases were within the trading limit, as illustrated in Figure 3-6.

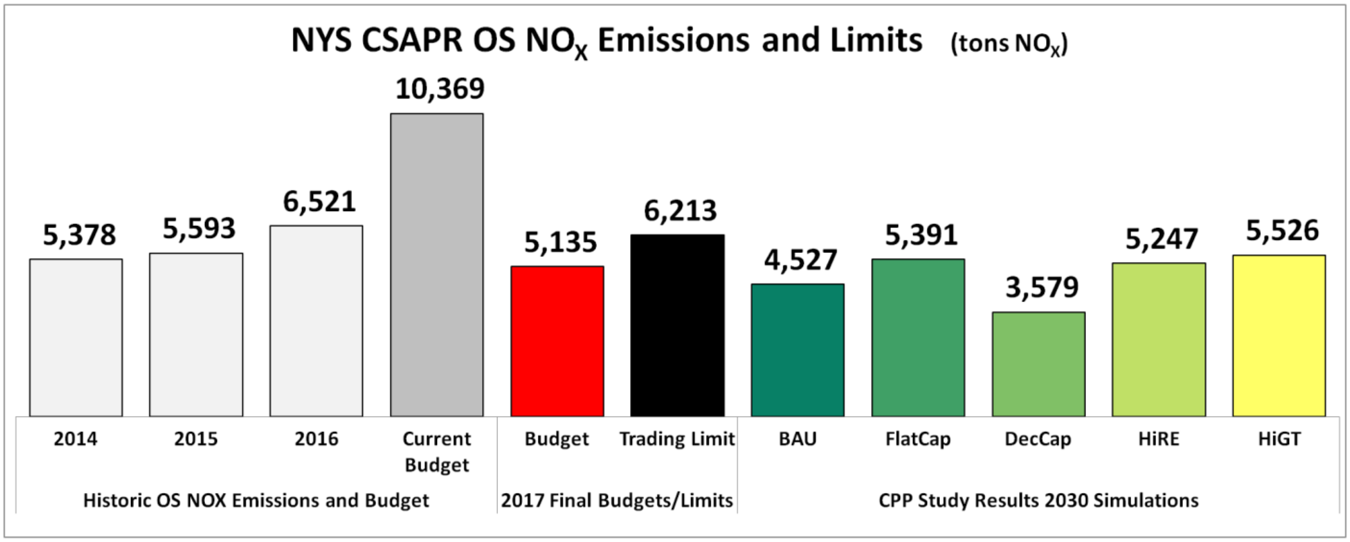


Figure 3-6 New York CSAPR Ozone Season NO_x Emissions and Limits

Ozone season NO_X emissions within Maryland, New Jersey, New York, and Pennsylvania are shown in Figure 3-7, below, relative to their respective statewide budgets and trading limits. The CSAPR Update Rule does not affect the New England states or Delaware. However, significant reductions create an additional compliance requirement beginning in May 2017 that will affect New York, as well as Pennsylvania and New Jersey—both of which are facing emission reductions of similar stringency as New York from their current Phase 2 limits. The constrained limits would likely increase the need for interstate trading and flexibility in the supply of allowances among New York and its neighbors.

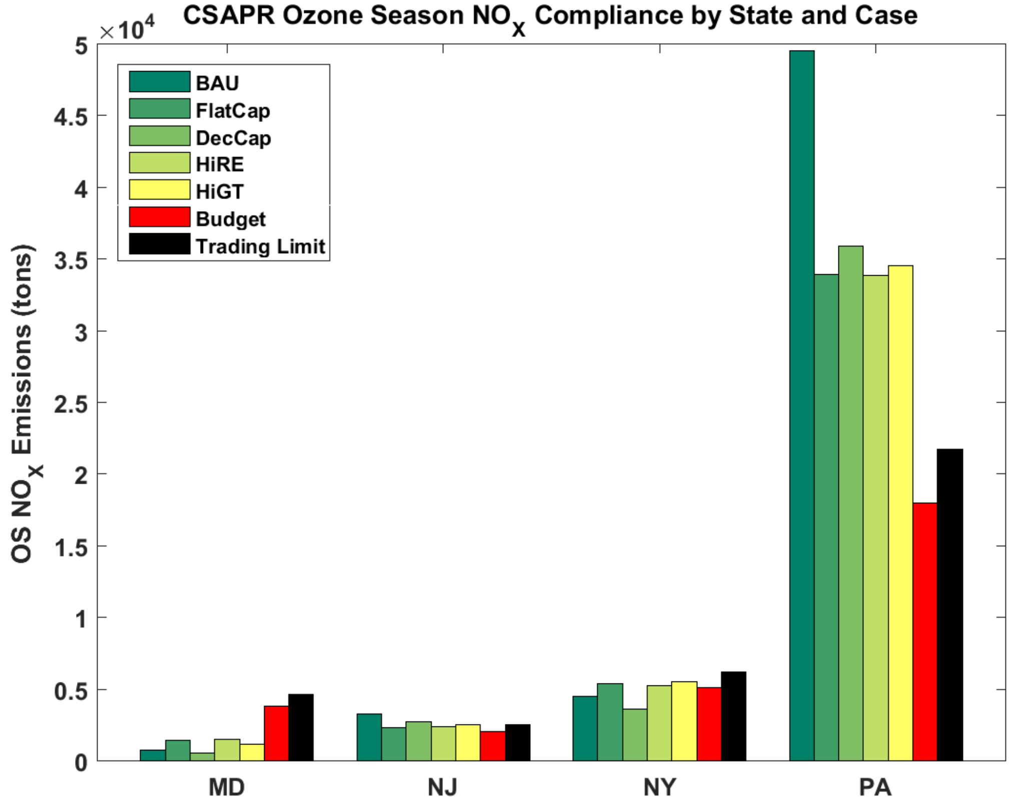


Figure 3-7 CSAPR Ozone Season NO_X Comparison

3.2. Production Cost Simulations

In addition to the standard metrics typically generated by the CARIS study and other power sector models, a more detailed analysis was employed to examine the load served by NYCA generation. Within each hour, the portion of load served by different fuels was calculated, as presented in Figure 3-8 for the BAU case and Figure 3-9 for the HiRE case for the week of the NYCA peak load. This assessment used CO_2 emission rates based upon the ratio of heat input to CO_2 emissions for the purpose of determining hourly fuel type assignments to determine both the associated generation and fuel consumption. The white area between the red line and the NYCA generation represents the load met by imports from outside of the NYISO.

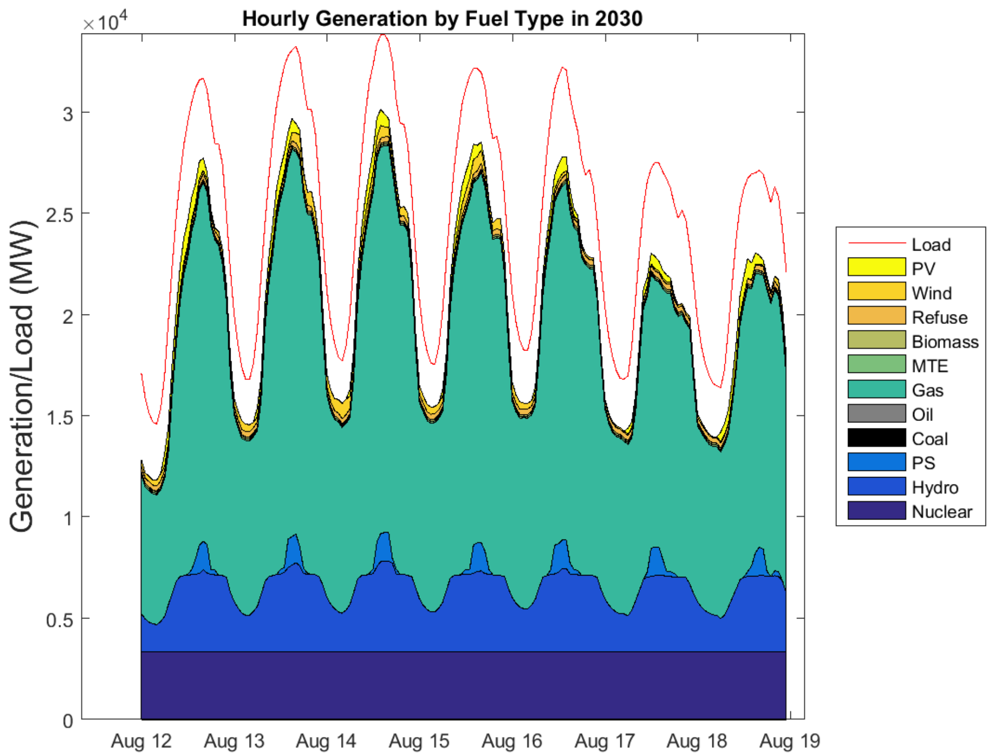


Figure 3-8 Hourly Generation by Fuel Type from BAU Case

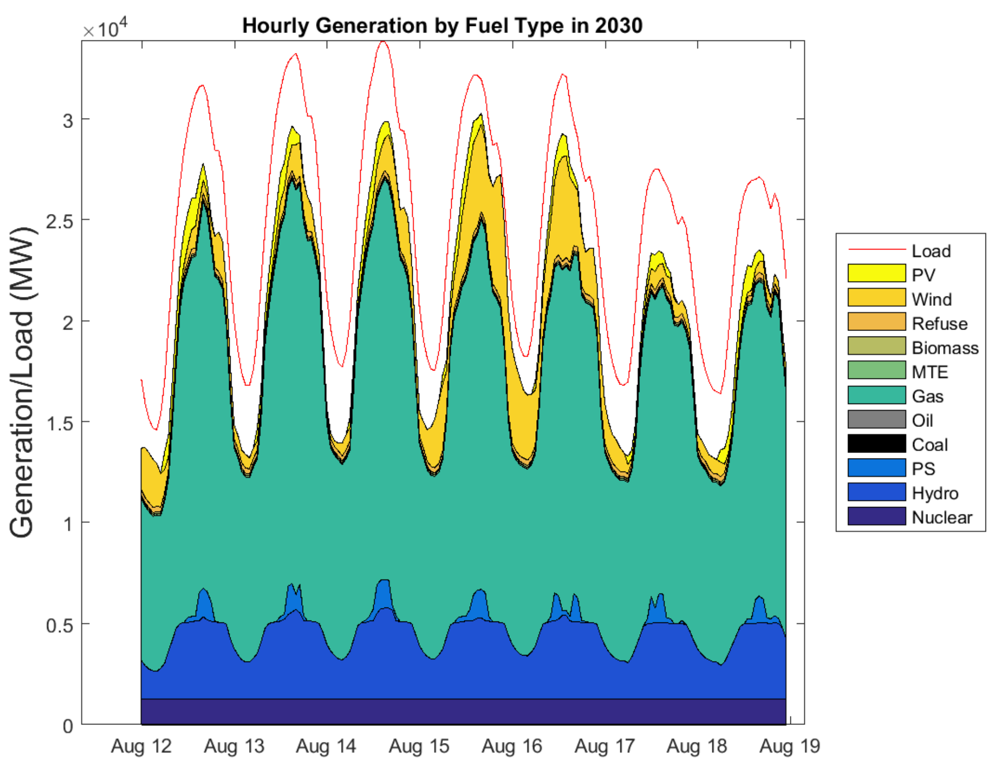


Figure 3-9 Hourly Generation by Fuel Type from HiRE Case

Annual totals for several segments of the generation fleet are shown in Table 3-4. The HiRE case had the highest RE penetration in NYCA representing above 40% of the annual energy generation, while nearly a third of that energy was eligible to receive ERCs to be used to reduce the CPP compliance obligation of conventional generators. Also shown in Table 3-4, the generation from the simple cycle GT, nuclear, and gas generation are included for comparison with the RE generation. The summation of the RE, nuclear, and gas generation is relatively constant across the five cases examined, as these are the units most often on the margin in New York. The gas generation and associated estimated gas consumption across the fleet are also reported in Table 3-4. For comparison, all time peak gas demand in New York State was 6.6 BCF/D and occurred February 13, 2016 driven by winter residential heating demand. In this assessment, the power sector peak day gas usage was 3.5 BCF/D in the BAU and FlatCap cases and occurred during the summer due to peak electricity demand.

Table 3-4 Energy Generation Case Results

Energy Generation Metrics	BAU	FlatCap	DecCap	HiRE	HiGT
Total RE Generation (GWh)	31,661	31,657	49,392	53,670	42,372
ERC Eligible Generation (GWh)	3,174	3,174	15,021	17,652	12,435
RE Generation Penetration (%)	25%	25%	39%	42%	35%
ERC Generation Ratio (%)	10%	10%	30%	33%	29%
Simple Cycle GT Generation (GWh)	1,093	841	1,033	916	1,224
Nuclear Generation (GWh)	33,805	27,215	27,215	10,337	10,337
NYCA Gas Generation (GWh)	56,280	65,318	49,022	62,786	67,094
RE + Nuke + Gas (GWh)	121,746	124,191	125,629	126,794	119,804
NYCA Annual Gas Consumption (BCF)	470	535	408	514	549
NYCA Annual Average Gas Consumption (BCF/D)	1.29	1.46	1.12	1.41	1.50
NYCA Electricity Peak Day Gas Consumption (BCF/D)	3.47	3.49	2.85	3.24	3.37

The production cost modeling results showed that fossil units remain on the margin for a significant majority of the time across the cases studied here, as reported in Table 3-5. Results are displayed as both the number of hours and as a fraction of the 8,760 hours in a year. Fossil units were the marginal unit in approximately 90% of the hours in the 2030 simulation results, excluding the DecCap case, where about three quarters of the hours saw gas/oil on the margin. The remainder was made up of a mix of imports and wind units. In the HiRE case wind was on the margin for 5% of the hours, while imports were on the margin 22% of the hours in the DecCap case.

Table 3-5 Marginal Resource Case Results

Marginal Units in NYISO (hours)	BAU	FlatCap	DecCap	HiRE	HiGT
Gas/oil on the margin	7,760	8,211	6,704	8,117	7,904
Wind on the margin	3	64	110	469	245
Nuclear unit operating at LMP below its cost	1	28	15	25	14
Imports	996	457	1,931	149	597
Marginal Units in NYISO (%)	**BAU**	**FlatCap**	**DecCap**	**HiRE**	**HiGT**
Gas/oil on the margin	89%	94%	77%	93%	90%
Wind on the margin	0.0%	1%	1%	5%	3%
Nuclear unit operating at LMP below its cost	0.0%	0.3%	0.2%	0.3%	0.2%
Imports	11%	5%	22%	2%	7%

3.3. Resource Adequacy

The first step in the resource adequacy analysis was to update the RNA case to reflect the known resource changes and to extend the study horizon to 2030. The results of the assessment of the three cases are shown below in Table 3-6. The PBC LOLE in NYCA is below the 0.1 days per year criterion, showing no violation. The BAU and HiRE cases exhibit an LOLE greater than 0.1 days per year, which is a criterion violation. These cases were then adjusted to reflect improvements to the LOLEs in the neighboring control areas, and are referred to as the external adjustment (Ext. Adj.) cases. The adjustments are consistent with the 2016 RNA base case assumptions and methodology, and reduce the magnitude of the LOLE violations as shown.

Table 3-6 Case LOLE Values

CPP Assessment LOLE					
Pool	PBC	BAU	BAU Ext. Adj.	HiRE	HiRE Ext. Adj.
NYCA	0.06	0.15	0.13	0.28	0.26
PJM	0.12	0.13	0.11	0.15	0.13
ISONE	0.13	0.19	0.13	0.24	0.19
IESO	0.13	0.19	0.11	0.21	0.14
HQ	0.13	0.13	0.13	0.13	0.13

Transmission interfaces were then relaxed and the case was reanalyzed to determine if transmission system limitations are the determining factor for the violation. This series of analyses are referred to as free flow cases. The results for these cases are shown in Table 3-7. The results for the free flow cases show that the criterion for the BAU Ext. Adj. case is satisfied, whereas, the HiRE case reveals that additional resources are required to satisfy the criterion.

Table 3-7 Results of Free Flow

NYCA LOLE		
Case	Ext. Adj.	Free Flow
BAU	0.13	0.08
HiRE	0.26	0.16

The next step in the analysis restores the transmission system limitations and then adds capacity in the form of MW of resources within NYCA zones. The process is iterated until the resource adequacy criterion is satisfied. The results shown in Table 3-8 indicate that adding 250 MW of capacity to Zone K satisfies the criterion for the BAU Ext. Adj. case, while 1,700 MW of capacity dispersed across NYCA is required for the HiRE case. Resource MW additions represent perfect capacity (*i.e.*, there is no equivalent forced outage rate demand (EFORd) associated with the unit modeled). This assumed perfect capacity, presumed always to be available, is referred to as compensatory MWs.

Table 3-8 Results of Capacity Additions

NYCA LOLE								
Case	Ext. Adj.	Capacity Addition (Compensatory MW)						Cap Added
		Zone B	Zone C	Zone E	Zone H	Zone J	Zone K	
BAU	0.13	-	-	-	-	-	250	0.10
HiRE	0.26	200	200	200	200	400	500	0.10

The BAU case results indicate that either resource additions or transfer limit increases would be effective in removing the resource adequacy violation. Since the HiRE case continued to exhibit resource adequacy violations after the free flow test, only addition of compensatory MW resource addition was examined. In sum, New York State would need 1,700 MW of compensatory MWs of capacity to maintain resource adequacy while integrating high levels of renewable resources and considering the nuclear retirements assumed in the HiRE case. The impact of emissions from some portion of this 1,700 MW of capacity, which would likely take the form of natural gas combustion turbines, was not examined to determine its impact on New York's ability to achieve the EPA CPP CO_2 emission targets.

For the BAU case, the free flow case exhibits an LOLE of 0.08, indicating that transmission upgrades could effectively remove the LOLE violation. As an intermediate step to the free flow conditions, the incremental transfer limits associated with achieving the goals of two ongoing Public Policy Transmission Planning Process projects, one for Western New York and the other for AC Transmission in the Mohawk and Hudson Valleys, were included to assess whether those transfer capability increases were sufficient to remove the resource adequacy violation. For AC Transmission (ACT Update), the increase for UPNY/SENY transfer capability was approximately 1,000 MW and the increase for Central East was approximately 300 MW. For Western New York (WNY Update), the increase to the export limits associated with Zone A to New York State regions to the east was approximately 600 MW. As can be seen in Table 3-9, these increases were not enough to resolve the resource adequacy need because NYCA LOLE remains above 0.1.

Table 3-9 Results of Transmission Additions

NYCA LOLE					
Case	Ext. Adj.	Free Flow	ACT Update	WNY Update	Add LI import
BAU	0.13	0.08	0.13	0.13	0.10

The remaining resource adequacy violation is driven by the import limit onto Long Island. An increase of the import limit onto Long Island of approximately 500 MW would be sufficient to relieve the resource adequacy need.

3.4. Results Analysis

Based on the modeling assumptions and results in this assessment, it appears that compliance with the CPP goals can be achieved for the scenarios studied through the use of either a mass- or rate-based State Plan in New York.

For the FlatCap, DecCap, and HiGT cases, RGGI compliance for New York will depend upon a supply of allowances available from other RGGI states. On the other hand, the BAU and HiRE cases project compliance based upon the quantity of allowances available within New York.

Compliance with the proposed CSAPR Update Rule ozone season NO_x limits will depend upon a supply of surplus allowances from outside New York for the FlatCap, HiRE, and HiGT cases. The trading limit may be exceeded in which case emissions in excess of the budget will need to be offset at a ratio of three allowances for every ton of emissions (3:1). The relationship between the budget, trading limit, and emissions that must be covered at a penalty is shown in Figure 1-7. The relatively short duration of the ozone season coupled with the delays in compliance demonstration prescribed in rules could create uncertainty in the market as to the correct emission cost component of production costs for affected fossil fuel-fired units. The probabilistic expectation of the change in compliance obligation from one allowance per ton emitted to three allowances per ton emitted when the trading limit is exceeded would be reflected in the offers provided by generators and other resources. However, the determination of whether the trading cap has been exceeded will not be known for several months after the ozone season has concluded. Further, the 3:1 requirement is designed to apply to all emissions above the budget. Consequently, generators will be exposed to increased emission allowance cost uncertainty and, by their offer behavior, electric consumers will be exposed to increased costs as well.

The generation and summer capacity of the operating fleet in 2014 was compared to results for each case by aggregating based upon the generators' unit fuel types. Figure 3-10 displays the generation on the left with the corresponding capacity on the right. As nuclear units and other conventional generation retire, renewable resources (*i.e.*, wind and solar) and new gas CC and GT generators were assumed for replacement resources. As observed, the total installed capacity level increases with increasing renewable energy resource penetration. Intermittent renewable resources generally have lower capacity factors than the resources they are replacing.

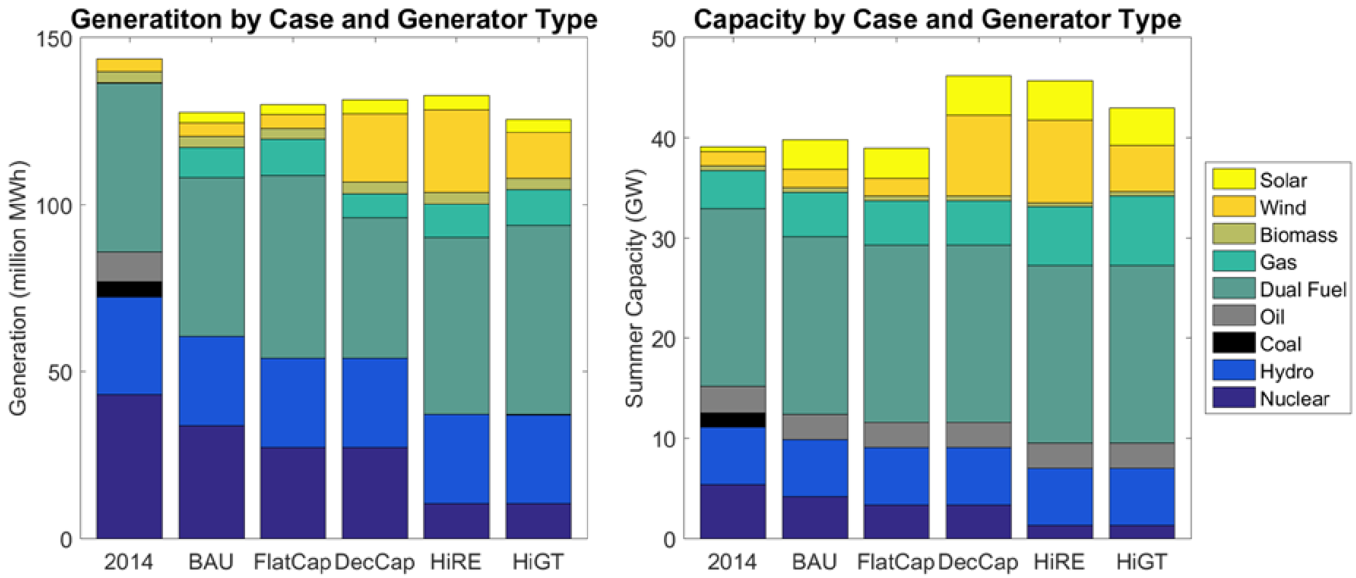


Figure 3-10 Historic Generation and Capacity by Unit Fuel Type of Operating Fleet compared to Modeled Fleet in each of the 2030 CPP Assessment cases

3.4.1. CARIS Metrics

The CARIS metrics reported in this assessment include: production cost, load payment, generator payment, imports, generation, and emissions. In addition, Table 3-1 reports regulatory program CO_2 emissions (and rates) for the CPP, RGGI, and ozone season NO_x emissions for the CSAPR Update.

Table 3-10 CARIS Metrics Case Results

2030 CARIS Metrics	BAU	FlatCap	DecCap	HiRE	HiGT
Generation (GWh)	**124,199**	**126,659**	**128,288**	**129,180**	**122,235**
Total Net Imports (GWh)	**35,837**	**33,135**	**32,060**	**31,636**	**38,166**
ProductionCost (mm$)	**4,658**	**5,591**	**4,915**	**5,221**	**5,715**
Generation Payment (mm$)	**7,928**	**9,261**	**9,624**	**9,004**	**9,057**
Load Payment (mm$)	**10,601**	**12,108**	**12,454**	**11,768**	**12,417**
Load Weighted LMP ($/MWh)	**61.04**	**70.69**	**72.04**	**67.46**	**71.45**

Results and costs could vary significantly based upon the modeling assumptions employed across and between cases. A high-level analysis of the CO_2 emission costs is provided in Table 3-10, below. While higher load and generator payments are the result of the modeling assumptions, one third to one half of the added generation cost can be attributed to the higher CO_2 prices necessary to produce results where the annual net imports are proximate to recent patterns after adjusting for the retired nuclear facilities. These assumptions were selected to focus the assessment on changes that may happen in New York with limited consideration for changes that could occur within the region that includes the NYISO's neighboring control areas. Model inputs will change in further work when the New York State CPP Initial Submittal is available.

Table 3-11 Cost Accounting Case Results

Cost Accounting	BAU	FlatCap	DecCap	HiRE	HiGT
RGGI CO_2 Price ($/ton)	24.14	36.21	60.00	36.21	40.00
CO_2 CPP Costs (mm$)	649	1,129	1,382	1,082	1,266
CO_2 CPP Costs Delta off BAU (mm$)	-	480	733	433	617
CO_2 RGGI Costs (mm$)	657	1,142	1,398	1,096	1,285
CO_2 RGGI Costs Delta off BAU (mm$)	-	485	741	439	628

3.4.2. Carbon Dioxide Emissions

Figure 3-11, below, builds upon the concepts introduced in Figure 1-4. Here, the mass- and rate-based compliance results for New York from Figure 3-1 and Table 3-1 have been plotted as symbols. The mass emissions from new and existing affected EGUs (□) should be compared to the mass-based goal (light blue dashed lines from 35.5 to 31.1 million tons). The CPP emission rate (○) includes the emissions and generation of affected EGUs and new RE ERCs. The CPP state rate goal in New York decreases from 1,095 to 918 lb/MWh between 2022 and 2030. Costs vary greatly among these cases and depend strongly on the State Plan design selected by the states.

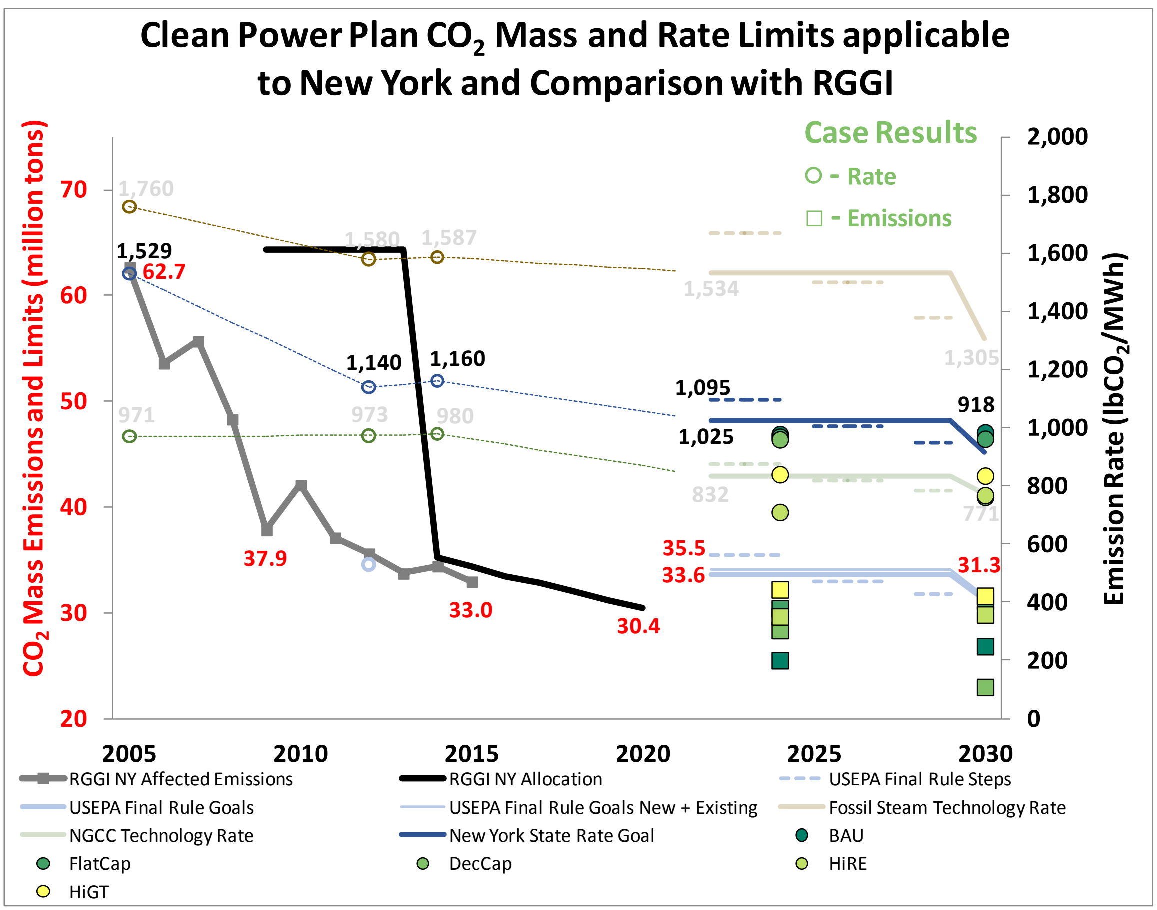


Figure 3-11 Comparison of CPP and RGGI Goals to Case Results

New York's generation fleet has already made very significant emission reductions, as shown in Figure 3-11. Currently, New York ranks as the state with the 7th least carbon intensive fleet-wide emission rate, 521 lb/MWh, according to the most recent data reported to the EIA.[60] The rankings are shown in Figure 3-12. The RGGI states are shown in yellow, with New York highlighted in red. Based on the relatively clean operation of the NYCA, consideration should be given to seeking additional reductions that may be available elsewhere and could be economically attractive. Therefore, trading either tons or clean MWh, should be given serious consideration in any State Plan that New York may ultimately submit to the EPA for approval.

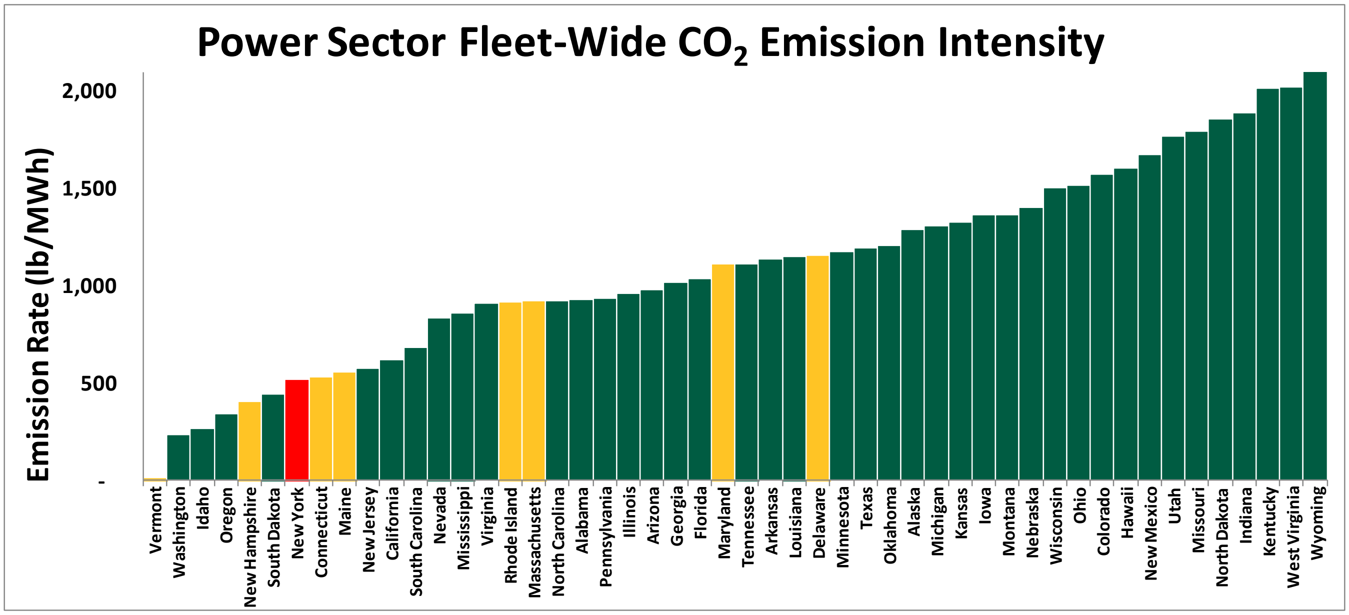


Figure 3-12 State-Level Power Sector 2015 CO_2 Emission Intensity as Reported by EIA

[60] EIA 2016 Annual Energy Outlook; Table 3.7 Net Generation and Table 9.5 Emissions by State.

4. Discussion

Based upon the modeling results and analysis presented, this Report offers the following points for discussion and input into the design of these regulatory programs in New York.

- Compliance with the CPP in 2030 can likely be achieved with either mass- or rate-based approaches.
- Compliance with the RGGI FlatCap, DecCap, and the HiGT cases will depend on a sufficient quantity of allowances from other RGGI states that can be made available to New York. Under the conditions studied here, such a surplus is projected.
- Compliance with CSAPR Update Phase 2 ozone season NO_x budget will depend upon whether there is a sufficient quantity of surplus allowances that will be available to New York from other CSAPR OS NO_x states.
- Increasing deployment of renewable resources increases New York's CPP compliance margin.
- Peak day gas consumption for electric generation is not projected to increase beyond the business as usual case.
- Achieving compliance with the CPP, RGGI, and CSAPR Update Rule in 2030 will require additional capacity resources and transmission reinforcements beyond those examined in this assessment. Resources in excess of 1,700 MW of perfect capacity (no EFORd associated with the unit modeled) beyond that studied here would be necessary.

This report did not analyze the impact of emissions from additional resources needed to maintain resource adequacy on the achievement of the CPP emission limits. Future analyses can be considered when the judicial review of the CPP and the RGGI program review are completed.