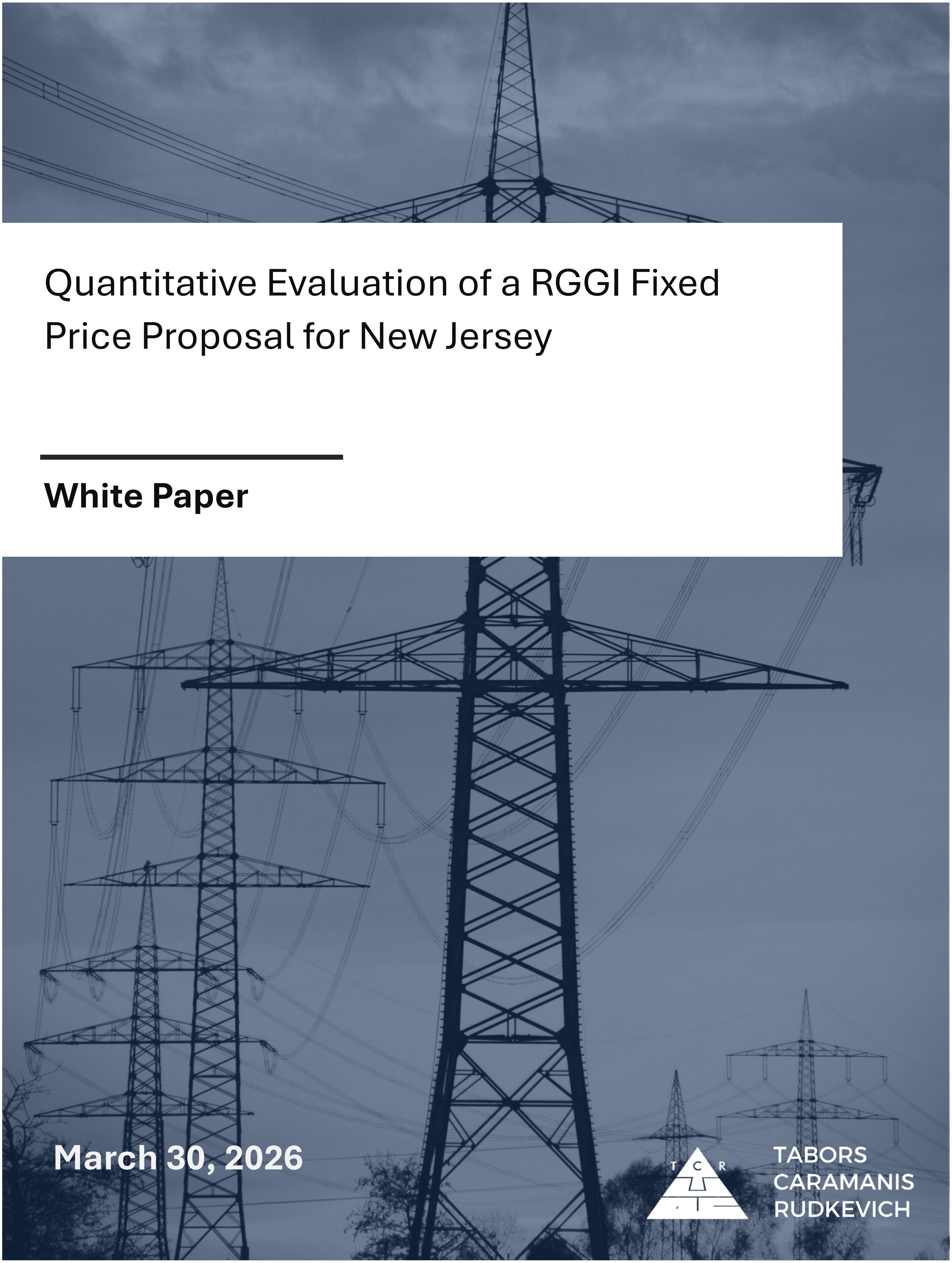

Quantitative Evaluation of a RGGI Fixed Price Proposal for New Jersey

White Paper

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Abstract

The objective of this white paper is to provide a detailed analysis of the environmental and economic impacts of a proposal to set the price of Regional Greenhouse Gas Initiative (RGGI) allowances at $7 per short ton for all compliance entities operating within the state of New Jersey. We consider current state-level participation in RGGI and a sensitivity analysis in which Virginia re-joins RGGI in 2028. The paper begins with a short summary of the history and impact of RGGI since its inception, specifically with regard to the PJM market. Next, we present the results of a quantitative analysis exploring the impact of setting the RGGI allowance price to $7 per short ton for compliance entities in New Jersey. The results of the analysis indicate that the proposal would lower the cost of energy to consumers and also reduce carbon emissions relative to a base case scenario in which the cost of allowances is set to the Cost Containment Reserve (CCR) Tier 2 Trigger Price.

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Executive Summary

This paper briefly summarizes the history of the Regional Greenhouse Gas Initiative (RGGI) and quantitatively evaluates a proposal to set the price of RGGI allowances to $7 per short ton for all compliance entities operating within the state of New Jersey (the “NJ $7 Proposal”).[1]

The three PJM states that participate in RGGI – Delaware, Maryland, and New Jersey – have collectively reduced their carbon dioxide (CO_2) emissions from 44.8 million short tons in 2009 to 23.6 million short tons in 2024, a net reduction of 21.2 million short tons. Over the same time period, total CO_2 emissions across the RGGI footprint have decreased by 41.2 million short tons. Despite this past success, rising RGGI allowance prices are threatening the ability of RGGI to continue to deliver emissions reductions because of a market phenomenon known as “emissions leakage”.[2]

The quantitative evaluation of the NJ $7 Proposal is based on power market simulations performed by Tabors Caramanis Rudkevich Inc. (TCR) comparing a “Base Case” to a “Change Case” in which the only difference is the price of RGGI allowances for compliance entities in New Jersey. In the Base Case, the price of allowances is set to the Cost Containment Reserve (CCR) Tier 2 Trigger Price. This represents an upper bound on allowance prices that is consistent with the results of recent auctions.[3] In the Change Case, the price of allowances is set to $7 per short ton for compliance entities in New Jersey (and the CCR Tier 2 Trigger Price elsewhere.) The impact of the NJ $7 Proposal can be derived by comparing these two cases. Our primary analysis assumes that the PJM RGGI states are Delaware, Maryland, and New Jersey, and we evaluate the study period 2027-2030. The results of the quantitative analysis indicate that the NJ $7 Proposal would lower the cost of energy to consumers and also reduce CO_2 emissions across PJM.

[1] A compliance entity is an owner or operator of a facility that is a CO_2 budget source pursuant to state regulation in one or more of the RGGI-participating states. *See* https://www.rggi.org/sites/default/files/Uploads/Auction-Materials/48/FAQs_Apr_7_2020.pdf. In general, compliance entities are fossil fuel-fired power plants with capacity 25 megawatts or greater and located within a RGGI-participating state.

[2] Emissions leakage occurs when efforts to reduce CO_2 emissions in one geographic area unintentionally causes emissions to increase in another geographic area. In this case, because some PJM states do not participate in RGGI, some less efficient and higher emitting generating units in western PJM that are not subject to the RGGI cost adder are dispatched ahead of more efficient combined-cycle units located in New Jersey and other RGGI states, thereby increasing overall emissions and costs in PJM.

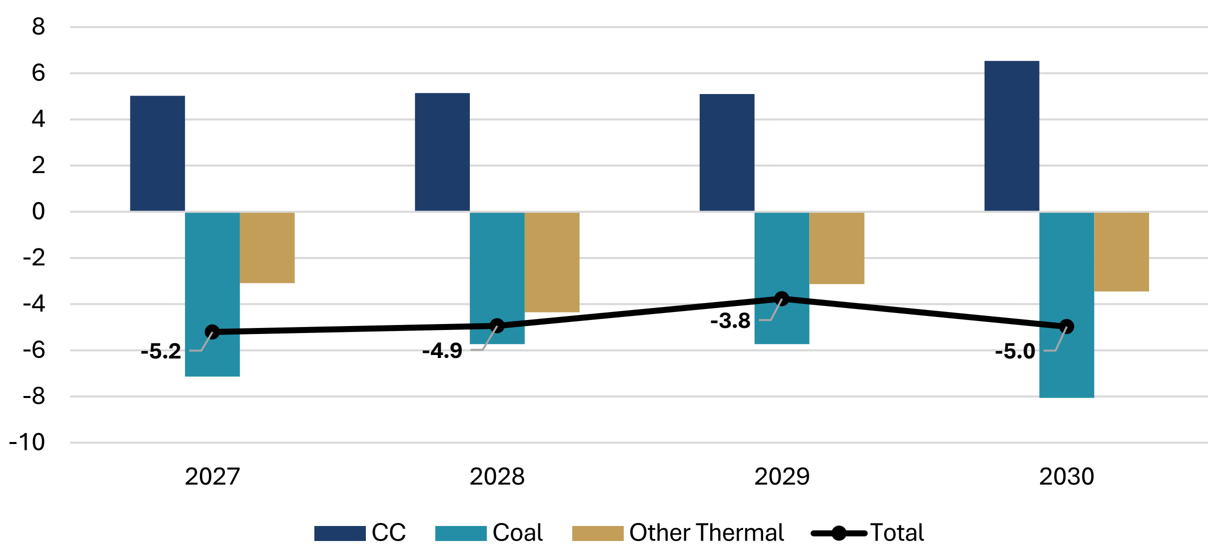
[3] The CCR Tier 2 Trigger Price for 2027 is $29.25. The clearing prices resulting from the three most recent auctions (Auction 68-70) were $19.63, $22.25, and $26.73, respectively. https://www.rggi.org/auctions/auction-results

Our analysis shows that adopting the NJ $7 Proposal would provide the following key benefits to New Jersey:

- **Economic Benefits to Consumers**:
  - The NJ $7 Proposal would lower the annual average LMP across all New Jersey zones by $2.26-$3.96/MWh in the day-head market and by $2.06-$3.99/MWh in the real-time market, with the biggest impact coming in the near-term years.
  - As a result of the lower LMPs, consumers in New Jersey would save an average of $274 million per year on wholesale energy costs over the study period.
- **Environmental Benefits**:
  - The NJ $7 Proposal would reduce PJM-wide CO_2 emissions by an average of 4.7 million short tons per year by enabling efficient New Jersey-based gas-fired combined-cycle generation to displace higher-emitting coal-fired and other thermal generation located in western PJM, as shown in Figure 1.

FIGURE 1

Impact of NJ $7 Proposal on PJM-Wide CO2 Emissions, by Type (Million Short Tons)



Notes: Value shown is the increase (decrease) in CO2 emissions between the Base Case and the Change Case. A negative value indicates that emissions decrease as a result of the NJ $7 Proposal. Other Thermal includes IC/GT, gas- and oil-fired steam, and fuel cell.

We also conduct a sensitivity analysis in which Virginia re-joins RGGI in 2028.[4] We find that our key conclusions – that adopting the NJ $7 Proposal would lower the cost of energy to consumers and also reduce CO_2 emissions across PJM – hold irrespective of whether Virginia participates in

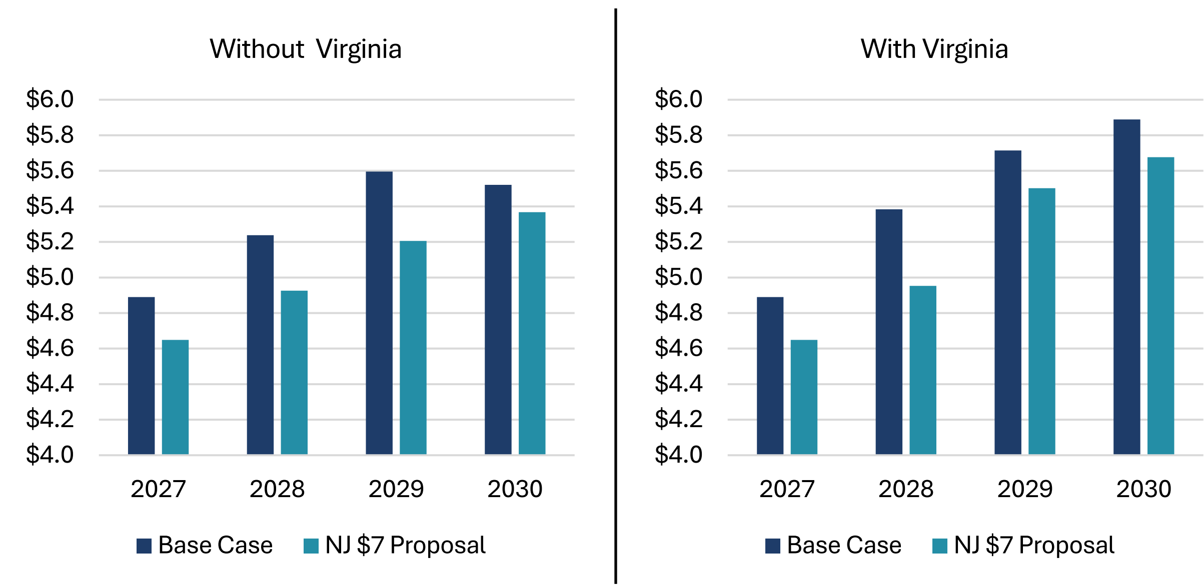
[4] On November 4, 2025, Abigail Spanberger, a Democrat, was elected governor of Virginia. Governor Spanberger has publicly stated her commitment to re-joining RGGI. *See* https://www.governor.virginia.gov/newsroom/news-releases/2026/january-releases/name-1111414-en.html

RGGI. Detailed results of the sensitivity analysis are presented in Section 3.2. As shown in Figure 2, we find that baseline levels of costs to New Jersey consumers and PJM-wide CO_2 emissions are lower when Virginia does not participate in RGGI. The impact on the cost to serve load in New Jersey is materially the same between the two scenarios, while the emissions reductions resulting from the NJ $7 Proposal are greater when Virginia does not participate in RGGI.

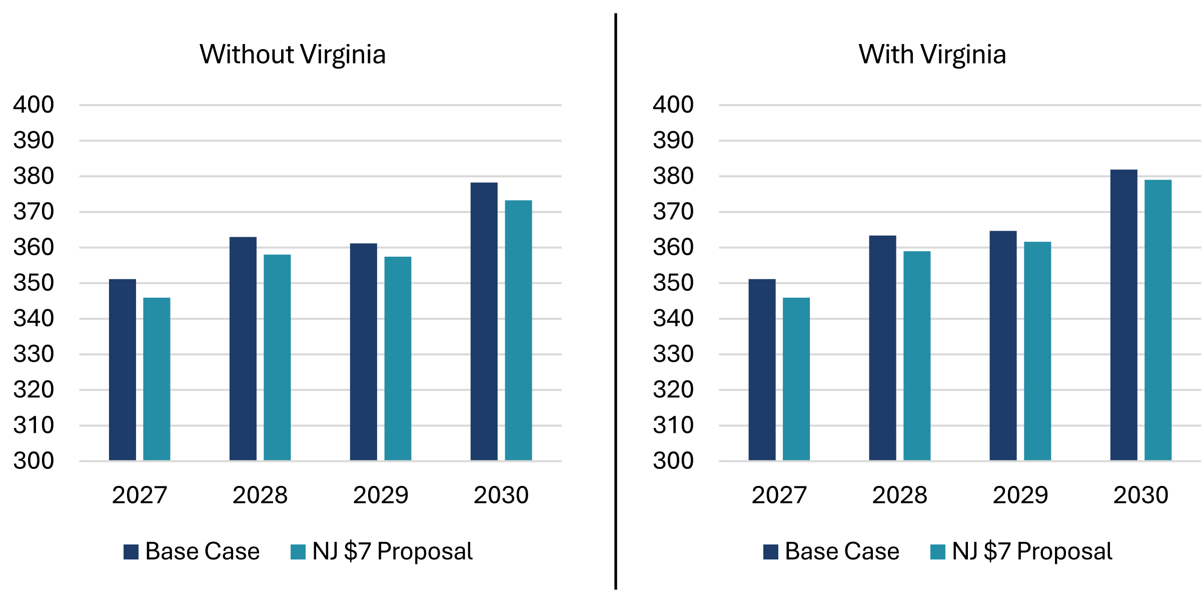
FIGURE 2

Key Results from the Sensitivity Analysis

a. Cost to Serve Load in New Jersey ($B)



b. PJM-Wide CO2 Emissions (Million Short Tons)



Under the NJ $7 Proposal, the emissions from compliance entities in New Jersey exceeds New Jersey's total allocation of RGGI allowances. For this reason, we also model two additional scenarios, or variations of the proposal, which differ from the NJ $7 Proposal in the amount of $7 allowances available and the eligible compliance entities, as outlined in Table 1. In the two new scenarios, the $7 allowances are available only to New Jersey compliance entities with a CO_2 emission rate less than or equal to 1,000 lbs/MWh,[5] and the availability of $7 allowances is capped at 50% and 100%, respectively, of New Jersey's share of RGGI allowances. We find that both cost to serve New Jersey load and PJM-wide CO_2 emissions are lowest under the NJ$7 Proposal, followed by the 100% Limited $7 Allowances scenario, followed by the 50% Limited $7 Allowances scenario. Detailed results from the additional scenarios are presented in Appendix A.

NJ $7 Proposal (original proposal variation)	RGGI allowances are set to $7 per allowance for all compliance entities in New Jersey and there is no limit on the availability of $7 allowances
50% Limited $7 Allowances	The availability of $7 allowances is capped at 50% of New Jersey's share of RGGI allowances and these allowances are available only to New Jersey compliance entities with a CO_2 emissions rate less than or equal to 1,000 lb/MWh
100% Limited $7 Allowances	The availability of $7 allowances is capped at 100% of New Jersey's share of RGGI allowances and these allowances are available only to New Jersey compliance entities with a CO_2 emissions rate less than or equal to 1,000 lb/MWh

Table 1. Overview of Additional Scenarios

[5] The qualifying compliance entities are Bergen Generating Station, Lakewood Cogeneration, Linden Generating Station, Newark Energy Center, Red Oak Power, Sewaren 7 Combined Cycle Power Plant, West Deptford Power Station, and Woodbridge Energy Center. The CO_2 emissions rate (in pounds per megawatt-hour, or lbs/MWh) was calculated by dividing the total short tons of CO_2 emitted by a facility over a defined period by the total net electricity generated (in megawatt-hours) during that same period, and then multiplying by 2,000 to convert short tons to pounds. The emissions and generation data used in this calculation were sourced from the U.S. Environmental Protection Agency's Emissions & Generation Resource Integrated Database (eGRID) for calendar year 2023. The eGRID database provides plant-level emissions and generation data for U.S. electric power plants and is publicly available at: https://www.epa.gov/egrid. For example, a facility emitting 500,000 short tons of CO_2 while generating 1,000,000 MWh would have an emissions rate of 1,000 lbs/MWh.

1. Background on RGGI and PJM State Participation

The Regional Greenhouse Gas Initiative (RGGI) was the first mandatory, market-based greenhouse gas emissions market in the United States. The initiative began in 2005, when a memorandum of understanding (MOU) initiated by then-governor of New York, George Pataki, was signed by seven states: Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont. In 2007, Massachusetts, Maryland, and Rhode Island joined the MOU. The first RGGI auction took place in September 2008, and the program became effective on January 1, 2009. From 2009-2011, the ten states listed above comprised a ten-state RGGI region referred to as RGGI 10. From 2012-2019, New Jersey did not participate in RGGI. During this period, RGGI was comprised of nine states and referred to as RGGI 9. Beginning in 2020, New Jersey again became a RGGI-participating state. From 2021-2023, Virginia also participated in RGGI and later stopped participating prior to the 2024 compliance year.[6]

The goal of RGGI is to reduce carbon dioxide (CO2) emissions from the power sector through a cap-and-trade market. RGGI sets an annual regional cap on emissions that is applied across all power plants with a capacity of 25 megawatts or greater located within the participating states.[7] Generators are then required to procure tradable CO2 allowances to cover their emissions. An allowance permits its holder to emit one short ton of CO2.

RGGI emission allowances are sold at auction on a quarterly basis to any qualified buyer. The RGGI program includes a Cost Containment Reserve, which is a quantity of extra allowances in addition to the cap that are held in reserve and sold only if the allowance price exceeds predefined threshold levels. The CCR has a two-tier structure; the first tranche of extra allowances is sold if the auction clearing price reaches the Tier 1 Trigger Price. If the auction clearing price reaches the higher Tier 2 Trigger Price, then an additional tranche of allowances is released. The CCR Tier 1 and Tier 2 Trigger Prices for 2027 are $19.50 and $29.25, respectively, and will increase by 7% annually thereafter.

In addition, there is a highly active secondary market for RGGI allowances. The gross trading in secondary allowances is frequently a multiplier of 1.2 to 1.4 or higher as a function of the

[6] Pennsylvania formally joined RGGI in April 2022, however, the state never fully implemented the program due to legal challenges. In November 2025, the state legislature passed a budget deal to withdraw, officially ending its participation in RGGI.

[7] Compliance entities in New York are facilities with a capacity of 15 MW or greater.

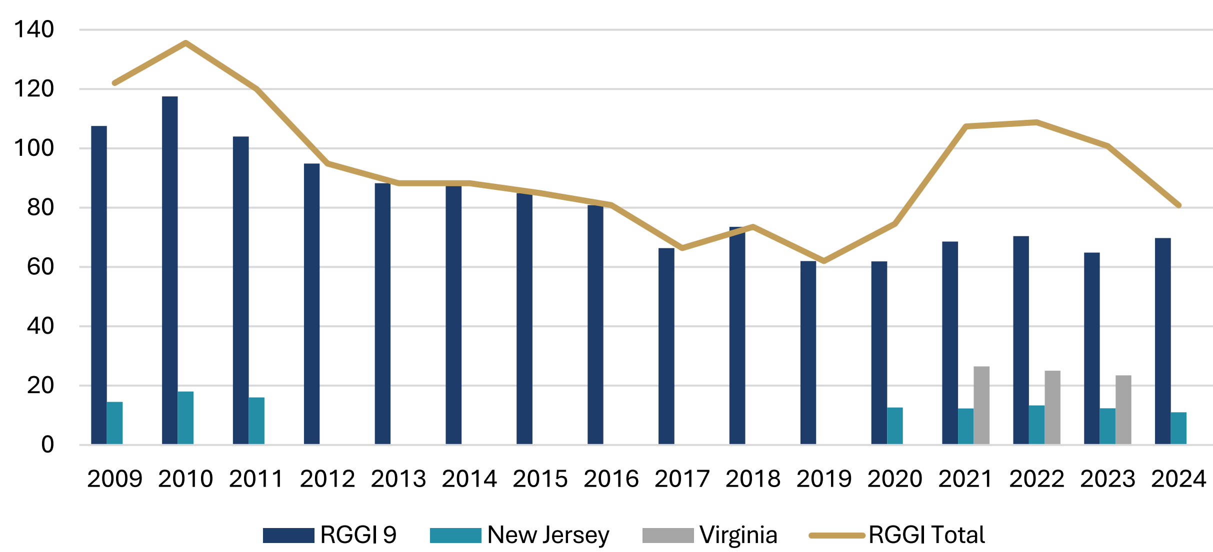
uncertainty in multiple elements of the electricity market. The secondary market serves several purposes. For example, it provides a source of allowances during periods between auctions; it provides a mechanism for hedging the cost of allowances; additionally, the forward market provides economic signals for generator offers into the energy markets and for potential investment.

As shown in Figure 3, the RGGI 10 states collectively reduced their CO2 emissions from 122 million short tons in 2009 to 80.8 million short tons in 2024,[8] a net reduction of 41.2 million short tons. From 2009 through 2024, the three PJM states of Delaware, Maryland, and New Jersey collectively reduced their CO2 emissions by 21.2 million short tons or roughly 47%, as shown in Figure 4. RGGI reports that total revenue from the sale of emission allowances through 70 auctions was $10,125,338,671, which was returned proportionately to the participating states where it was then applied broadly to electric sector programs that ranged from load management to other programs for emissions reductions.

Having achieved its goal of emissions reductions, there can be no doubt that RGGI has been successful. However, much has changed since RGGI's inception in 2005. The generation fleet has transformed from a fleet largely reliant on thermal generation to one with meaningful renewable capacity (thanks, in part, to RGGI-driven coal retirements), and the RGGI allowance auction clearing price has risen to record levels. Therefore, it is important to analyze whether RGGI, as it exists currently, can continue to deliver emissions reductions or whether an alternative implementation of the program would be more effective at achieving this goal.

FIGURE 3

CO2 Emissions in RGGI States, 2009 to 2024 (Million Short Tons)

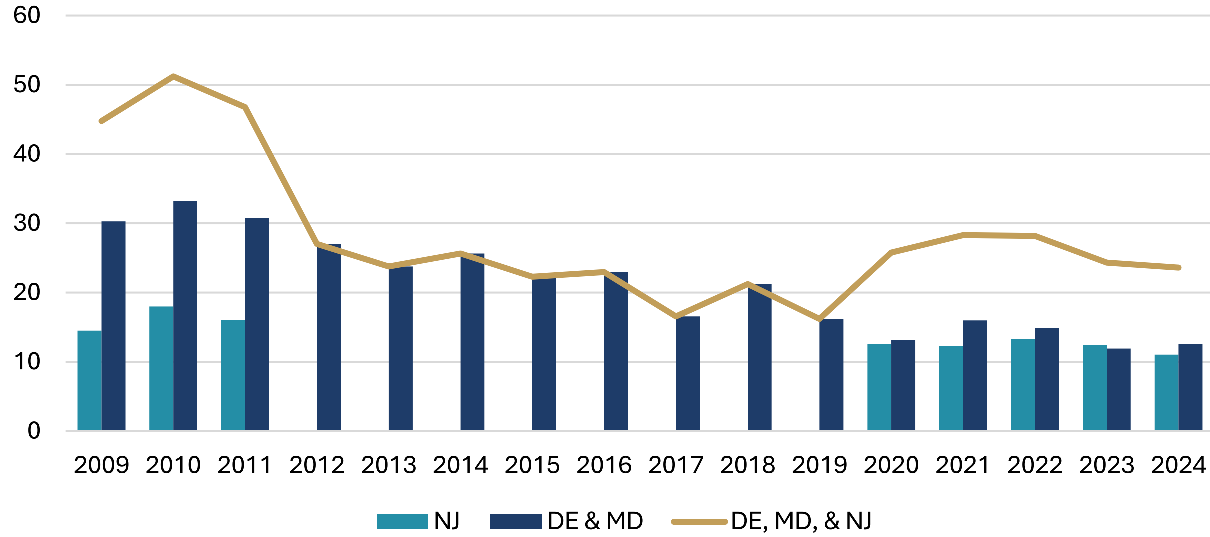


[8] 2024 is the most current year for which data is available as of the date of this white paper.

Notes: Since the first compliance period in 2009, New Jersey participated in RGGI from 2009 through 2011 and again from 2020 to the present. RGGI reports statistics as "RGGI 10" when including New Jersey and as "RGGI 9" when excluding New Jersey. Virginia participated in RGGI from 2021 through 2023. RGGI reports statistics as "RGGI 11" when Virginia is included.

FIGURE 4

CO2 Emissions in Delaware, Maryland, & New Jersey, 2009 to 2024 (Million Short Tons)



Notes: Since the first compliance period in 2009, New Jersey participated in RGGI from 2009 through 2011 and again from 2020 to the present. RGGI reports statistics as "RGGI 10" when including New Jersey and as "RGGI 9" when excluding New Jersey.

2. Methodology for Quantitative Analysis

The quantitative analysis is based on power market simulations performed by TCR using the ENELYTIX® modeling platform and the PJM model dataset maintained by TCR and dated 2026Q1.

2.1. The Base Case and the Change Case

For the purpose of this study, TCR developed two simulation scenarios. In the first scenario (the "Base Case"), the RGGI allowance price was set to the CCR Tier 2 Trigger Price. This represents an upper bound on allowance prices that is consistent with the results of recent auctions.[9] In the second scenario (the "Change Case"), the RGGI allowance price was set to $7 per short ton for compliance entities in New Jersey (and the CCR Tier 2 Trigger Price for compliance entities located elsewhere).[10] Both scenarios were evaluated over the four-year period 2027-2030. For the primary analysis, the RGGI region was assumed to be the RGGI 10 region, with the PJM states being Delaware, Maryland, and New Jersey. A sensitivity analysis was performed to evaluate the impact of Virginia re-joining RGGI in 2028.[11]

The Change Case deviates from the Base Case in one and only one assumption - the price of RGGI allowances for compliance entities located in New Jersey. In both cases, the PJM system was dispatched using Security Constrained Unit Commitment and Economic Dispatch simulating the day-ahead and real-time markets at an hourly resolution. TCR then compared the results of these two simulations, focusing on the differences in Locational Marginal Prices (LMPs), wholesale load payments, generation levels, generator revenues, and CO2 emissions by technology type and PJM zone. These results are presented in Chapter 3.

[9] The CCR Tier 2 Trigger Price for 2027 is $29.25. The clearing prices resulting from the three most recent auctions (Auction 68-70) were $19.63, $22.25, and $26.73, respectively. https://www.rggi.org/auctions/auction-results

[10] A compliance entity is an owner or operator of a facility that is a CO2 budget source pursuant to state regulation in one or more of the RGGI-participating states. *See* https://www.rggi.org/sites/default/files/Uploads/Auction-Materials/48/FAQs_Apr_7_2020.pdf. In general, compliance entities are fossil fuel-fired power plants with capacity 25 megawatts or greater and located within a RGGI-participating state.

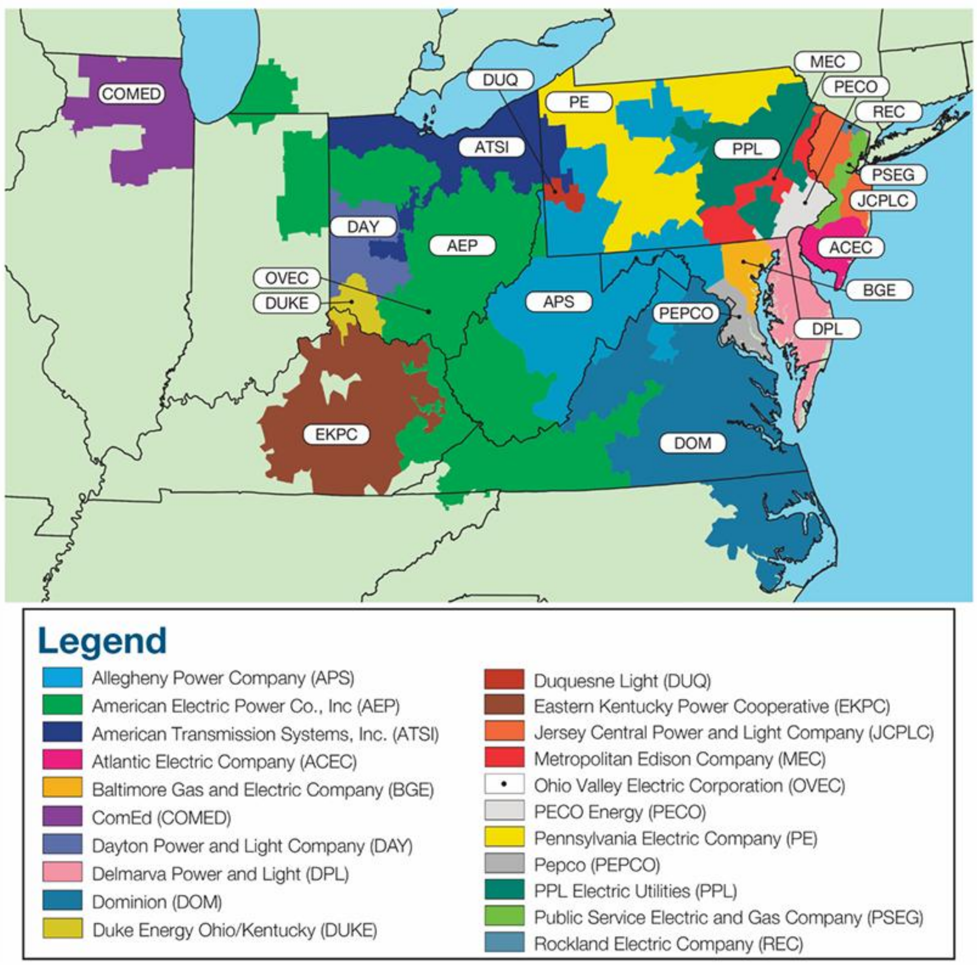
[11] On November 4, 2025, Abigail Spanberger, a Democrat, was elected governor of Virginia. Governor Spanberger has publicly stated her commitment to re-joining RGGI. *See* https://www.governor.virginia.gov/newsroom/news-releases/2026/january-releases/name-1111414-en.html

2.2. The Model Footprint

The geographic footprint modeled in this analysis includes all PJM market zones shown in Figure 5. Interchange between PJM and its neighboring systems is modeled as fixed flow schedules based on 2023 historical hourly net interchange flow data obtained from PJM.[12] The ENELYTIX model includes the physical representation of the electrical network of PJM and its neighboring systems. The system includes an engineering economic model of power generating units, electricity demand, and their respective locations on the PJM network. The key engineering and economic parameters of these supply, demand, and transmission objects are defined within the dataset TCR maintains for all project studies the company undertakes.

FIGURE 5

PJM Footprint and Control Areas



Source: Monitoring Analytics

[12] PJM Data Miner. Real-Time Scheduled Interchange. https://dataminer2.pjm.com/feed/rt_scheduled_interchange

2.3. Key Model Inputs

TCR's PJM model is updated regularly to reflect changing market conditions and new information related to categories such as:

- changes in the generation fleet (new additions, plants under construction, generator retirement or repowering decisions);
- transmission topology;
- electricity demand forecasts; and
- market outlook for fuel prices.

TCR uses S&P Capital IQ, PJM's Interconnection Planning Queue,[13] and Generation Deactivations[14] databases to create a list of operating assets, new additions, and retirements in PJM to capture changes in PJM's generation mix. The generator dataset used for this study was updated as of December 19, 2025.

This analysis utilizes the 2024 series Multiregional Modeling Working Group (MMWG) base case summer peak power flow cases. The MMWG 2026 power flow case is used for study period years 2027-2028 and the MMWG 2029 power flow case is used for study period years 2029-2030. The later power flow reflects a system with transmission upgrades.

This analysis utilizes PJM's 2025 Load Forecast, released on January 24, 2025.[15] Because of the uncertainty in data center load growth, TCR assumes that only a portion of the data center load projected in PJM's 2025 Load Forecast will be realized every year, as shown in Table 2. As a result, the annual energy requirements and peak demand forecasts in this analysis are slightly lower than those published in PJM's 2025 Load Forecast.

[13] PJM Serial Service Request Status as of 12/19/2025. PJM. https://www.pjm.com/planning/service-requests/serial-service-request-status

[14] PJM Generator Deactivations as of 12/19/2025. PJM. https://www.pjm.com/planning/service-requests/gen-deactivations

[15] PJM Long-Term Load Forecast Report. January 24, 2025. https://www.pjm.com/-/media/DotCom/library/reports-notices/load-forecast/2025-load-report.pdf. PJM released its 2026 Load Forecast on January 14, 2026. Compared to the 2025 Load Forecast, PJM slightly revised down its peak load and energy requirements forecasts by an annual average of 2.1% and 2.6%, respectively, for the study period years 2027-2030. We would, therefore, expect no material change in the results were the assumptions to be updated.

Year	Data Center Load Fulfillment (%)
2026	100
2027	85
2028	78
2029	74
2030	72

Table 2. Data Center Load Fulfillment Assumptions

The monthly spot natural gas price forecasts used in this analysis were sourced from OTC Global Holdings Natural Gas forwards published on September 30, 2025. TCR develops plant-level coal price assumptions using S&P Global's power plant operations database. TCR derives coal cost in $/MMBtu by dividing S&P Global reported annual cost of coal delivered ($/ton) by the annual average heat content of coal burned (Btu/lbs). Based on this method, TCR calculates the exact cost of coal for plants where data is available. For plants without sufficient data, TCR assumes the average cost from other coal plants located in the same county or state. The coal costs used in this analysis were developed using historical plant-level data from the year 2024.

Finally, this analysis uses an assumed RGGI allowance price equal to the CCR Tier 2 Trigger Price, as listed in Table 3.[16]

Year	CCR Tier 2 Trigger Price $/short ton (nominal)
2027	$29.25
2028	$31.30
2029	$33.49
2030	$35.83

Table 3. CCR Tier 2 Trigger Price

As stated above, the only difference between the Base Case and the Change Case is the RGGI allowance price applied to thermal generators in New Jersey.[17] The key effect of this change is to alter the dispatch cost of affected units. The change in dispatch cost is calculated internally by the Power System Optimizer (PSO), the market simulation engine within ENELYTIX.[18] For each affected generating unit, that change equals the product of the incremental emission rate of the unit at the specific operating point and the change in the carbon price.[19] For example, consider

[16] https://www.rggi.org/program-overview-and-design/program-review

[17] Physical location is established in accordance with the EIA Form 860 data.

[18] See Appendix B for more detail.

[19] TCR obtains generator unit level emission rates from three sources: S&P Global's historic unit emissions database, S&P Global's simulated Generator Supply Curve (GSC) database, and EIA's generic future unit characteristics. For existing thermal units, TCR uses S&P Global's historic emission rates. For existing units without historical data, TCR

a typical gas-fired combined-cycle power plant in New Jersey with an emission rate of 0.45 short tons-CO_2 per MWh. A decrease in the RGGI allowance price from $29.25 per short ton to $7 per short ton would result in a decrease in dispatch cost of $10.01/MWh.

The change in dispatch cost of affected power plants will change their position in the dispatch merit order and result in different generation, power flow, and price patterns within the PJM system.

uses GSC emission rates. Finally, for existing units without historical and GSC data, and for future additions not yet operating, TCR uses EIA's generic rate.

3. Modeling Results

This chapter presents the results of a quantitative analysis of the environmental and economic impacts of a policy proposal to set the price of Regional Greenhouse Gas Initiative (RGGI) allowances at $7 per short ton for all compliance entities operating within the state of New Jersey (the "NJ $7 Proposal"). All prices presented in this section are in real 2026 dollars.

3.1. Status Quo RGGI States (Primary Analysis)

In the primary analysis, we assume that the PJM RGGI states are Delaware, Maryland, and New Jersey.

3.1.1. Impact on LMPs and Load Payments

Figures 6 and 7 show the change in the annual average day-ahead LMP and the change in the annual average real-time LMP, respectively, by PJM zone for the study years 2027-2030. The NJ $7 Proposal causes wholesale energy prices to decrease throughout PJM, with some exceptions in the Mid-Atlantic and Western zones where small increases are seen in 2027-2028. The change in MMWG power flow (transmission model) that occurs in 2029 allows lower cost New Jersey CC generation to reach these previously constrained areas, driving down LMPs in 2029-2030.[20] Over the study period, the average decrease in annual average day-ahead LMP across all PJM zones ranges from $1.35-$2.21/MWh. In New Jersey, the average decrease in annual average day-ahead LMP ranges from $2.26-$3.96/MWh, with the biggest impact coming in the near-term years.[21] The average decrease in annual average real-time LMP ranges from $1.12-$2.90/MWh across PJM and from $2.06-$3.99/MWh in New Jersey.

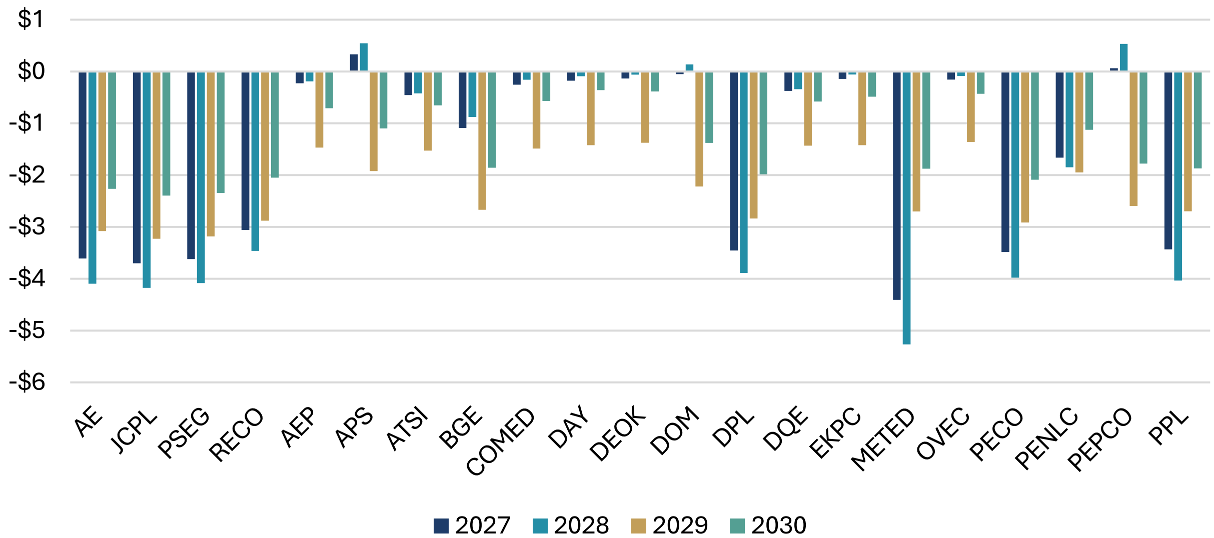
The impact to LMPs ultimately translates into costs payable by PJM consumers, which is shown graphically in Figure 8. The total savings are greatest in New Jersey and neighboring zones, and in high-load zones in western PJM (*e.g.* AEP, COMED, DOM). As a result of the NJ $7 Proposal, consumers in New Jersey are expected to save an average of $274 million per year over the study period. The total cost to all PJM consumers is estimated to decrease by an average of $1.3 billion per year over the study period, with the annual savings ranging from $451 million in 2027 to $3 billion in 2029.

[20] See Section 2.3. Key Model Inputs.

[21] Metrics for New Jersey reflect an average across the zones AE, JCPL, PSEG, and RECO.

FIGURE 6 | Primary Analysis

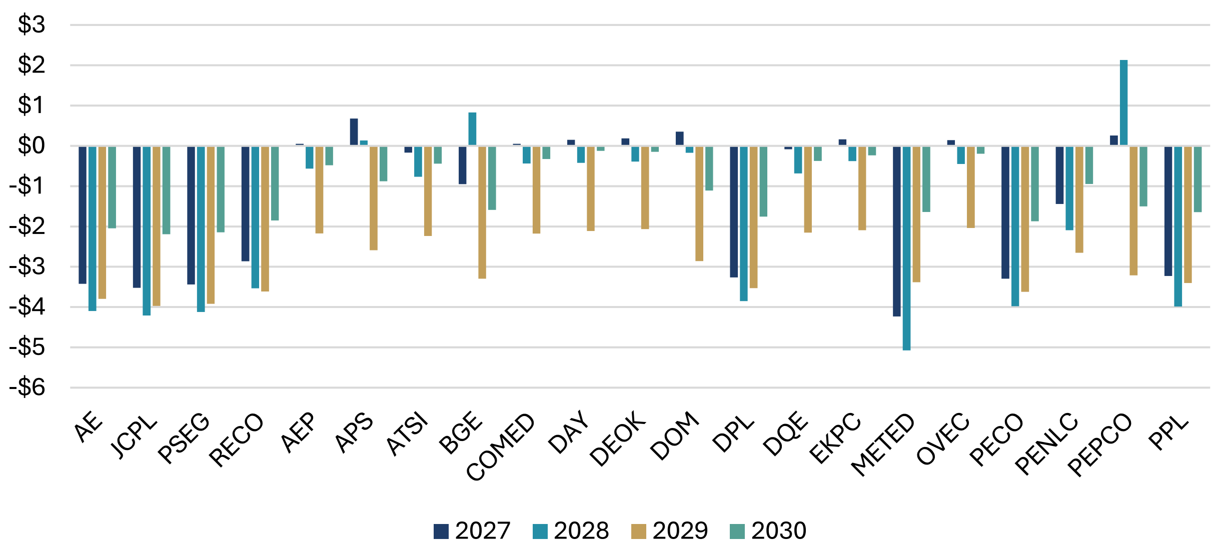
Impact of NJ $7 Proposal on Day-Ahead Load LMPs, by Zone ($/MWh)



Notes: Value shown is the increase (decrease) in LMP between the Base Case and the Change Case. A negative value indicates that the LMP decreases as a result of the NJ $7 Proposal.

FIGURE 7 | Primary Analysis

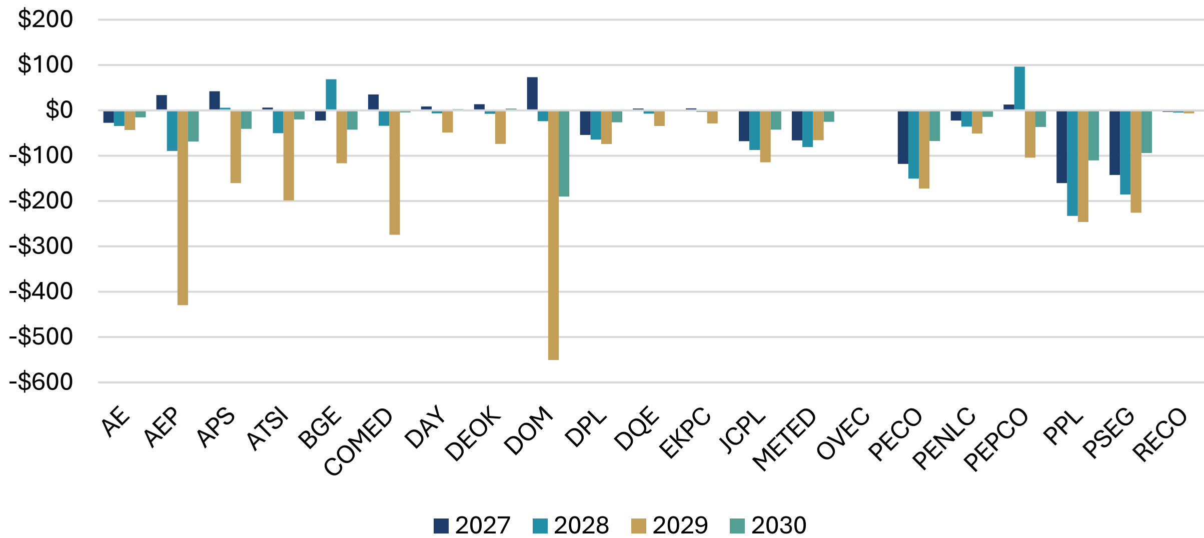
Impact of NJ $7 Proposal on Real-Time Load LMPs, by Zone ($/MWh)



Notes: Value shown is the increase (decrease) in LMP between the Base Case and the Change Case. A negative value indicates that the LMP decreases as a result of the NJ $7 Proposal.

FIGURE 8 | Primary Analysis

Impact of NJ $7 Proposal on Cost to Serve Load, by Zone ($M)



Notes: Value shown is the increase (decrease) in Cost to Serve Load between the Base Case and the Change Case. A negative value indicates that the Cost to Serve Load decreases as a result of the NJ $7 Proposal.

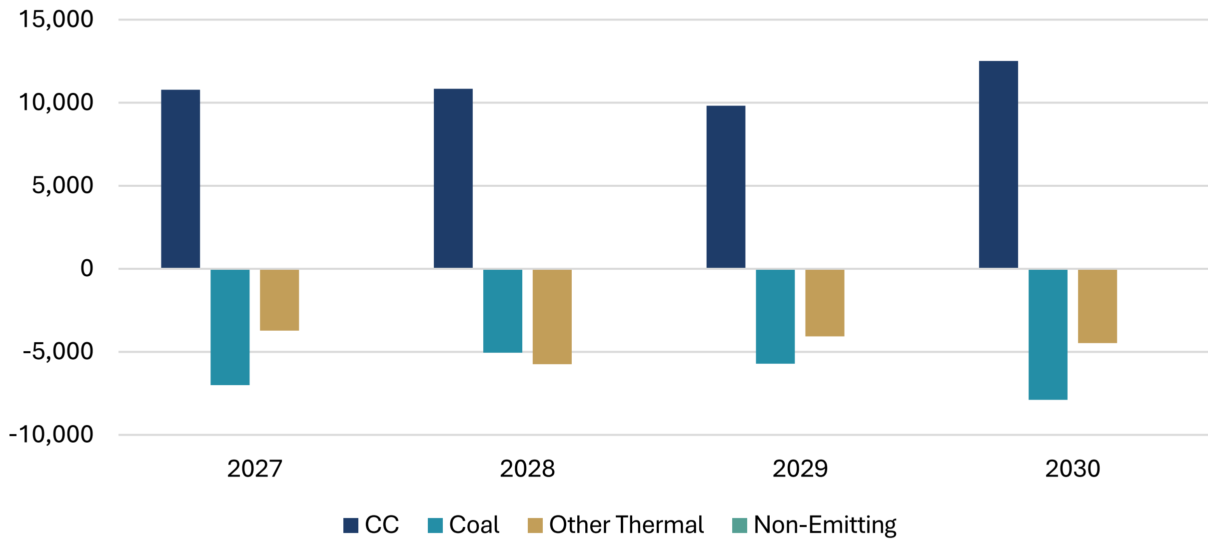
3.1.2. Impact on Generation

Participation in RGGI predominantly affects the merit order and dispatch patterns of four generating technologies: gas-fired combined cycle units ("CC"), coal-fired steam turbine units ("Coal"), gas- and oil-fired steam turbine units, and gas- and oil-fired internal combustion or gas turbine units (collectively, along with fuel cells, "Other Thermal"). Figure 9 shows the net impact on generation by technology type for each year in the study period. As a result of the NJ $7 Proposal, annual generation from CC units increases by an average of 10,988 GWh over the study period, while annual generation from Coal and Other Thermal units decreases by an average of 6,415 GWh and 4,503 GWh, respectively.

The immediate effect of the NJ $7 Proposal is to reduce the dispatch cost of emitting units in New Jersey, which then move up the dispatch merit order and replace more expensive generation located elsewhere. This effect is visible in Figure 10, which shows the impact of the NJ $7 Proposal on total generation by PJM zone for each year in the study period. Total generation increases in the New Jersey zones of AE, PSEG, and JCPL, while decreasing elsewhere throughout PJM.

FIGURE 9 | Primary Analysis

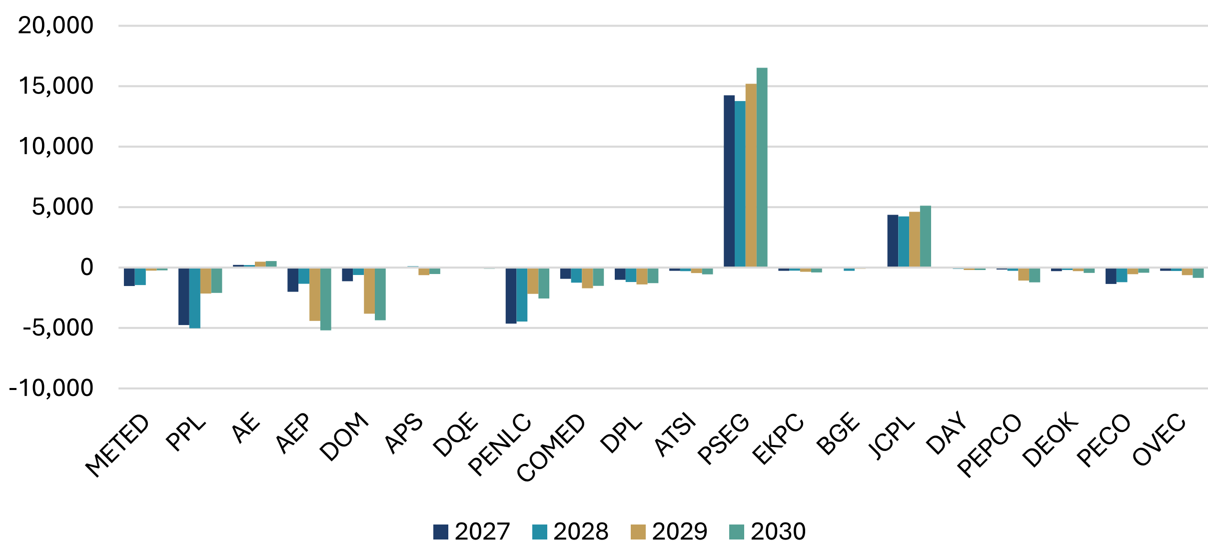
Impact of NJ $7 Proposal on PJM-Wide Generation, by Type (GWh)



Notes: Value shown is the increase (decrease) in generation between the Base Case and the Change Case. A positive value indicates that generation increases as a result of the NJ $7 Proposal. Other Thermal includes IC/GT, gas- and oil-fired steam, and fuel cell.

FIGURE 10 | Primary Analysis

Impact of NJ $7 Proposal on Generation, by Zone (GWh)



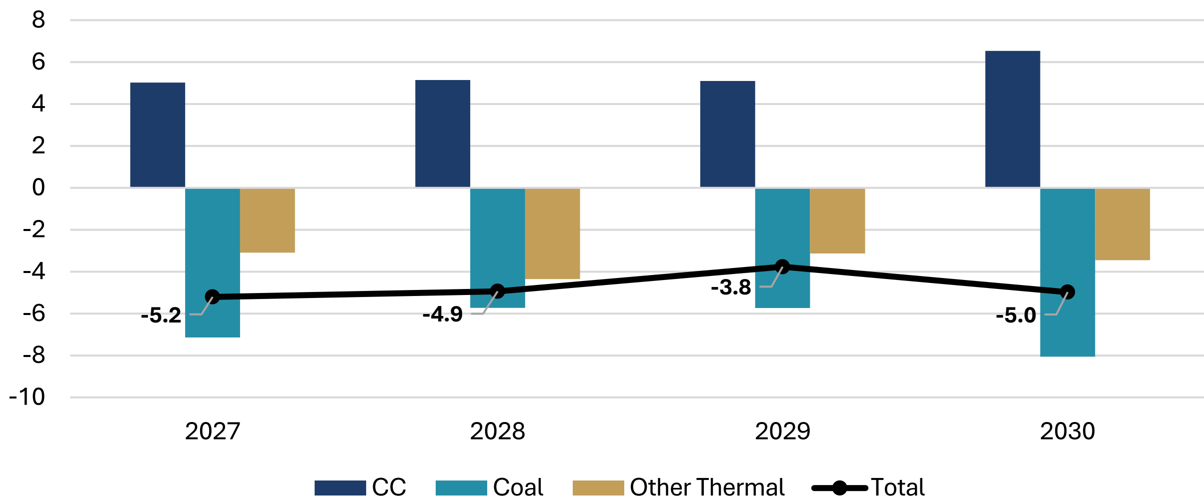
Notes: Value shown is the increase (decrease) in generation between the Base Case and the Change Case. A positive value indicates that generation increases as a result of the NJ $7 Proposal.

3.1.3. Impact on CO2 Emissions

The change in generation depicted in Figure 9 results in a change in CO2 emissions. As shown in Figure 11, our analysis indicates that PJM-wide CO2 emissions would decrease by an average of 4.7 million short tons per year as a result of the NJ $7 Proposal. This decrease in total CO2 emissions is derived from an increase in generation from gas-fired CC units in New Jersey and a corresponding decrease in generation from higher-emitting coal-fired and Other Thermal generation located in western PJM (Figure 12).

FIGURE 11 | Primary Analysis

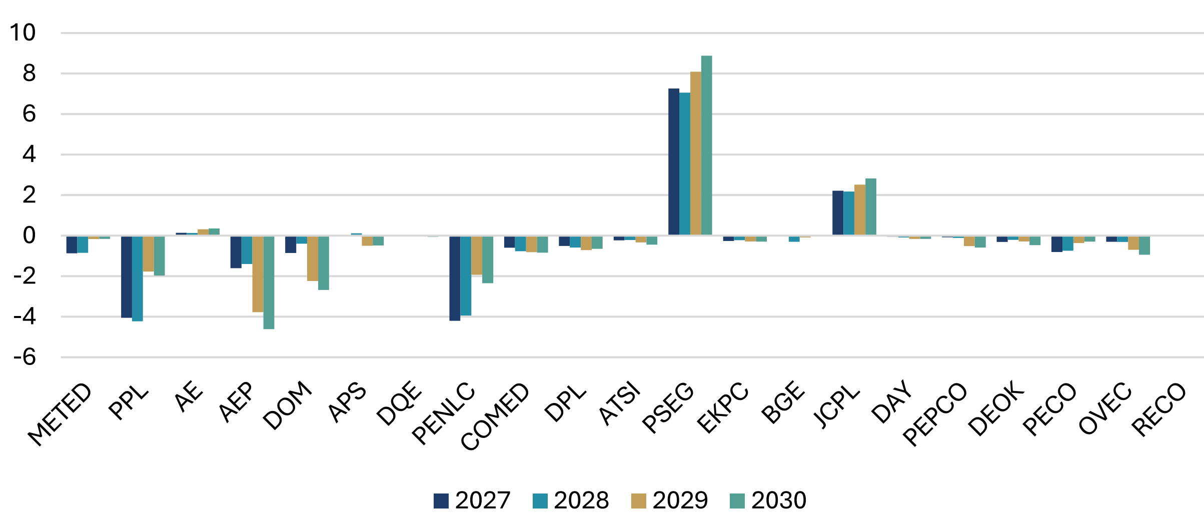
Impact of NJ $7 Proposal on PJM-Wide CO2 Emissions, by Type (Million Short Tons)



Notes: Value shown is the increase (decrease) in CO2 emissions between the Base Case and the Change Case. A negative value indicates that emissions decrease as a result of the NJ $7 Proposal. Other Thermal includes IC/GT, gas- and oil-fired steam, and fuel cell.

FIGURE 12 | Primary Analysis

Impact of NJ $7 Proposal on CO2 Emissions, by Zone (Million Short Tons)



Notes: Value shown is the increase (decrease) in CO2 emissions between the Base Case and the Change Case. A negative value indicates that emissions decrease as a result of the NJ $7 Proposal.

3.2. Virginia Rejoins RGGI in 2028 (Sensitivity Analysis)

This section presents the results of a sensitivity analysis to evaluate the impact to the results of Virginia re-joining RGGI in 2028. In this sensitivity analysis, the PJM RGGI states are assumed to be Delaware, Maryland, New Jersey, and Virginia. We find that baseline levels of costs to New Jersey consumers and PJM-wide CO2 emissions are lower when Virginia does not participate in RGGI (see Figure 2). The impact of the NJ $7 Proposal on the cost to serve load in New Jersey is materially the same between the primary analysis and the sensitivity analysis, while the emissions reductions resulting from the NJ $7 Proposal are greater when Virginia does not participate in RGGI.

3.2.1. Impact on LMPs and Load Payments

Figures 13 and 14 show the change in the annual average day-ahead LMP and the change in the annual average real-time LMP, respectively, by PJM zone for the study years 2028-2030. The NJ $7 Proposal causes wholesale energy prices to decrease throughout PJM, with the impact being greatest in New Jersey and neighboring zones. Over the study period, the average decrease in annual average day-ahead LMP across all PJM zones ranges from $1.52-$2.47/MWh. In New Jersey, the average decrease in annual average day-ahead LMP ranges from $2.35-$5.00/MWh, with the biggest impact coming in 2028.[22] The average decrease in annual average real-time LMP ranges from $1.60-$2.50/MWh across PJM and from $2.50-$4.98/MWh in New Jersey.

The impact to LMPs ultimately translates into costs payable by PJM consumers, which is shown graphically in Figure 15. The total savings are greatest in New Jersey and neighboring zones, and in high-load zones in western PJM (*e.g.* AEP, DOM). As a result of the NJ $7 Proposal, consumers in New Jersey are expected to save an average of $285 million per year over the study period, while the total cost to all PJM consumers is estimated to decrease by an average of $1.6 billion per year over the study period.

[22] Metrics for New Jersey reflect an average across the zones AE, JCPL, PSEG, and RECO.

FIGURE 13 | Sensitivity Analysis

Impact of NJ $7 Proposal on Day-Ahead Load LMPs, by Zone ($/MWh)

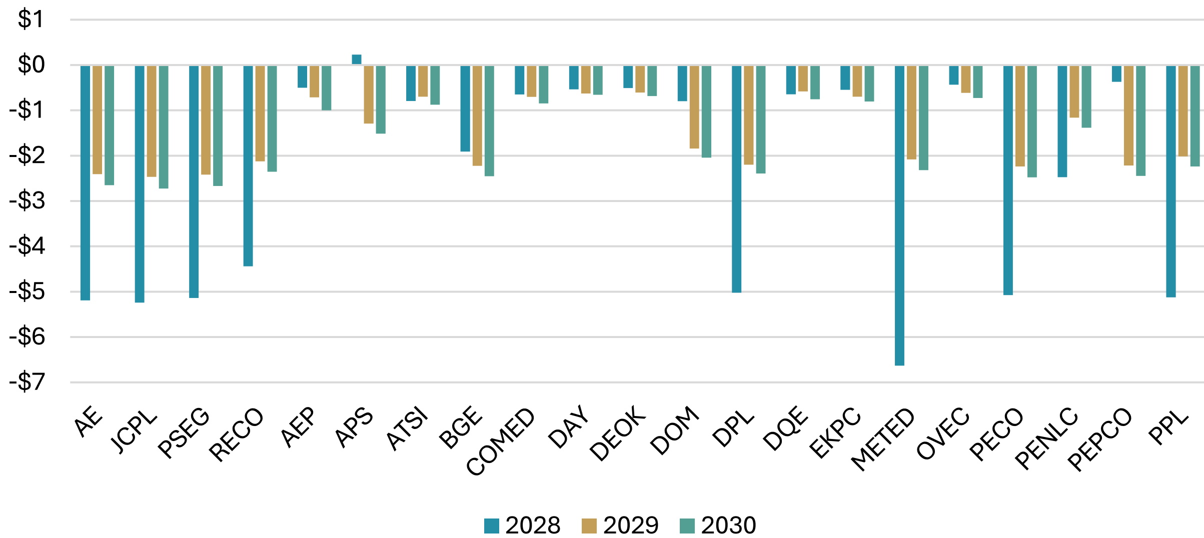


FIGURE 14 | Sensitivity Analysis

Impact of NJ $7 Proposal on Real-Time Load LMPs, by Zone ($/MWh)

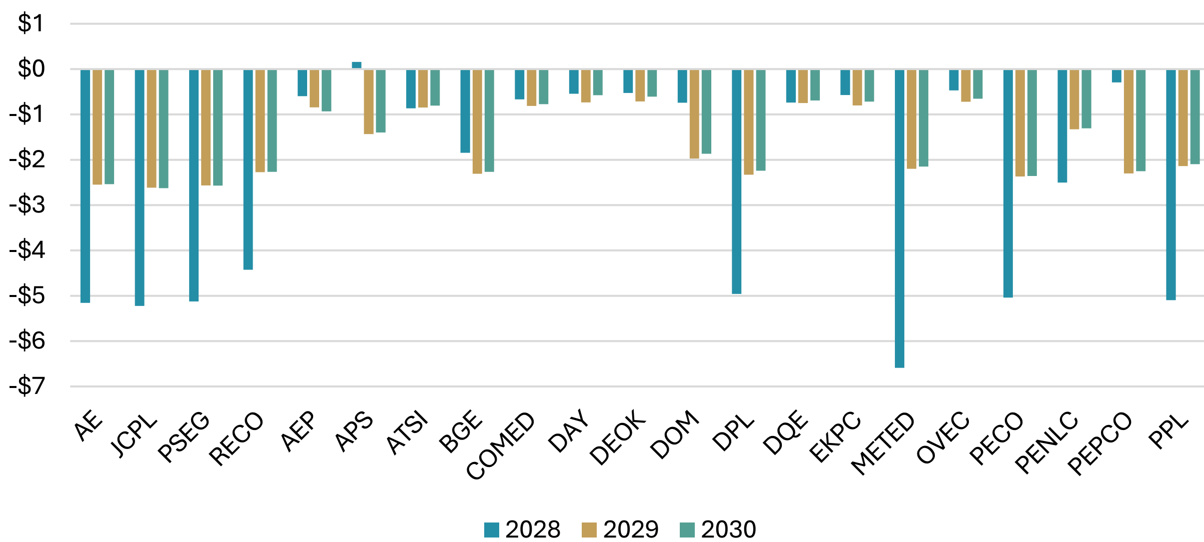
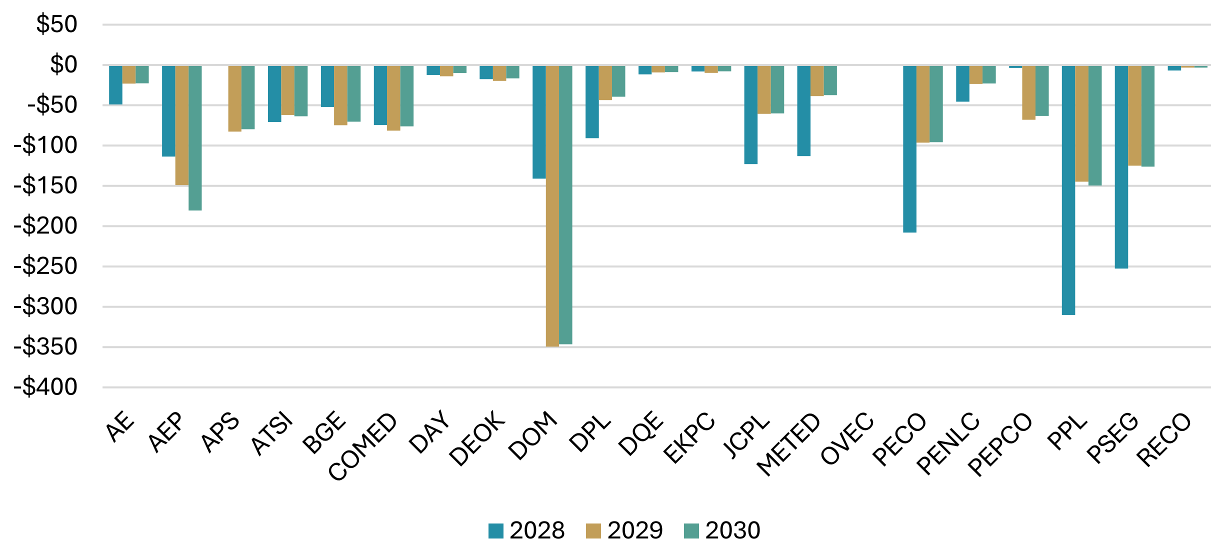


FIGURE 15 | Sensitivity Analysis
Impact of NJ $7 Proposal on Cost to Serve Load, by Zone ($M)



3.2.2. Impact on Generation

Figure 16 shows the net impact on generation by technology type for each year in the study period. As a result of the NJ $7 Proposal, annual generation from CC units increases by an average of 8,206 GWh over the study period, while annual generation from Coal and Other Thermal units decreases by an average of 4,958 GWh and 3,108 GWh, respectively.

Figure 17 shows the impact of the NJ $7 Proposal on total generation by PJM zone for each year in the study period. Total generation increases in the New Jersey zones of AE, PSEG, and JCPL, while decreasing elsewhere throughout PJM.

FIGURE 16 | Sensitivity Analysis

Impact of NJ $7 Proposal on PJM-Wide Generation, by Type (GWh)

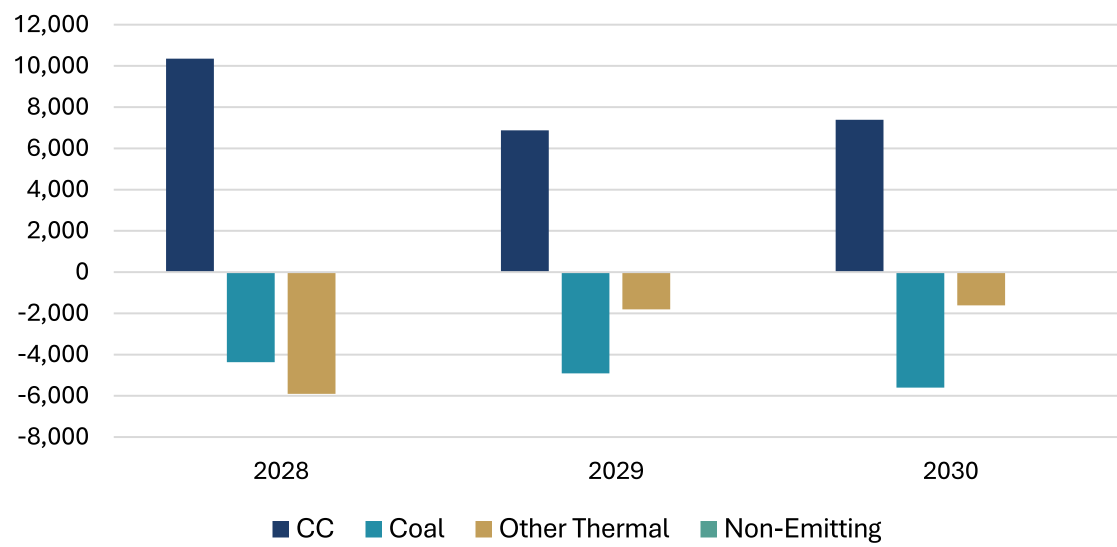
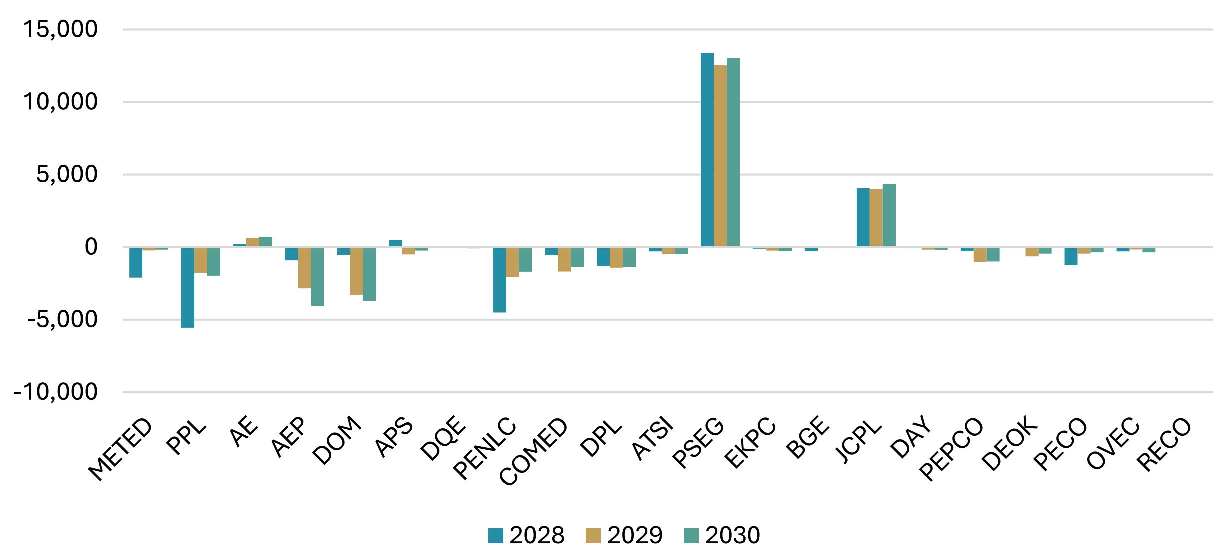


FIGURE 17 | Sensitivity Analysis

Impact of NJ $7 Proposal on Generation, by Zone (GWh)



3.2.3. Impact on CO2 Emissions

The change in generation results in a change in CO2 emissions. As shown in Figure 18, our analysis indicates that PJM-wide CO2 emissions would decrease by an average of 3.5 million short tons per year as a result of the NJ $7 Proposal. This decrease in total CO2 emissions is derived from an increase in generation from gas-fired CC units in New Jersey and a corresponding decrease in generation from higher-emitting coal-fired and Other Thermal generation located in western PJM (Figure 19).

FIGURE 18 | Sensitivity Analysis

Impact of NJ $7 Proposal on CO2 Emissions in PJM (Million Short Tons)

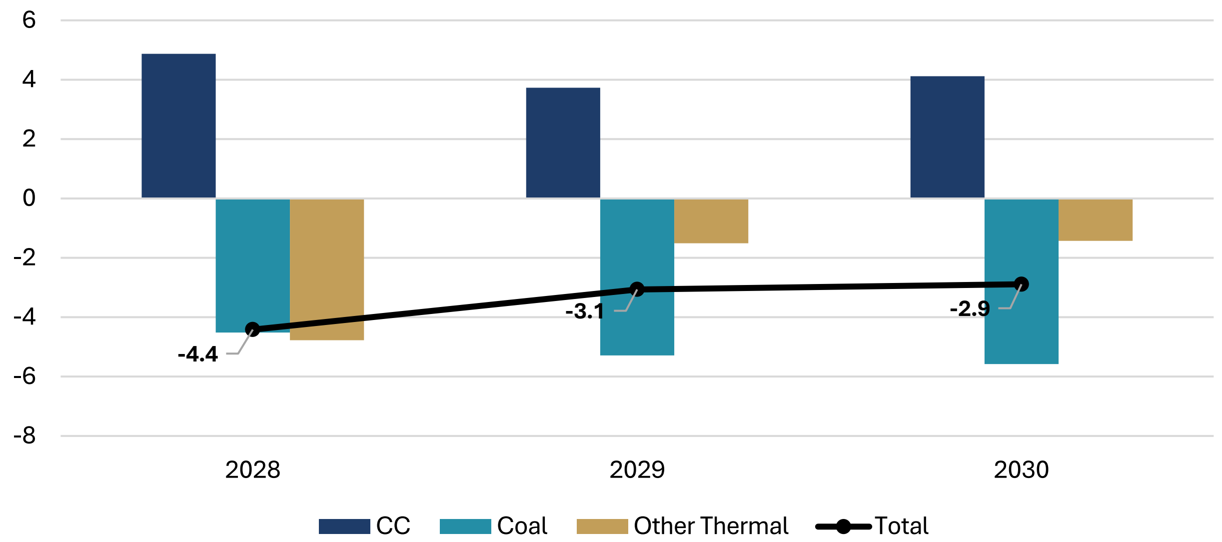
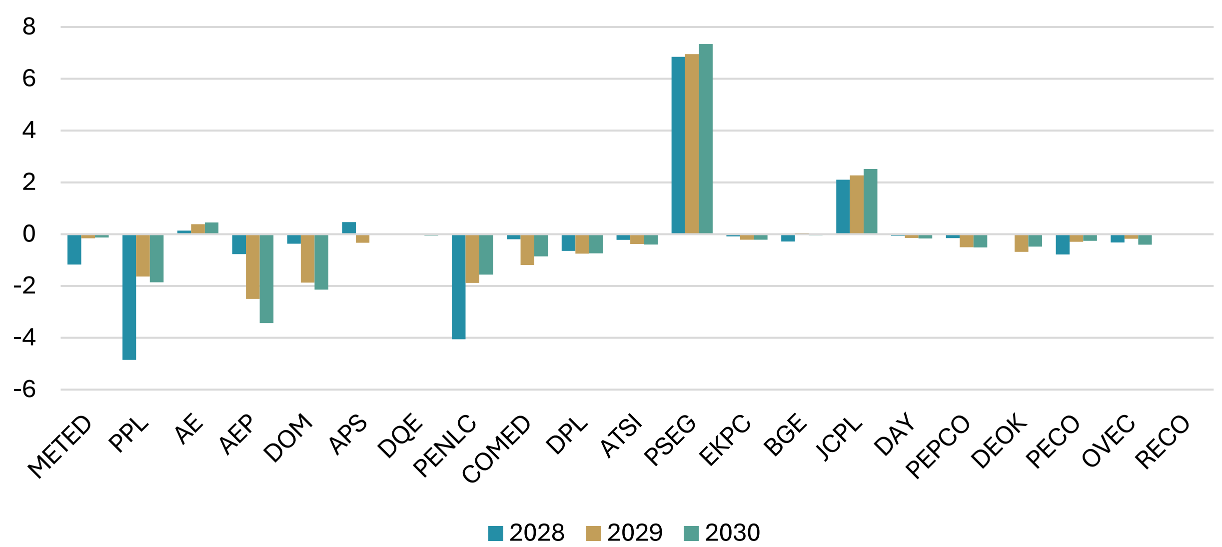


FIGURE 19 | Sensitivity Analysis

Impact of NJ $7 Proposal on CO2 Emissions, by Zone (Million Short Tons)



3.3. Discussion

The results of this study demonstrate that, although the goal of RGGI is to reduce CO2 emissions, its current implementation actually leads to greater emissions (and greater costs to consumers) than the alternative implementation we analyzed. This occurs because some states in the PJM electricity market do not participate in the RGGI emissions market. As a result of the carbon price imposed by RGGI, lower-emitting units that would otherwise be dispatched by PJM are disadvantaged in the energy market and higher-emitting units are dispatched in their place. In the past, the RGGI allowance price was low enough that efficient generation in RGGI states could still effectively compete with generation in non-RGGI states. However, as the RGGI allowance price has risen, this market distortion has rendered RGGI ineffective at achieving its goal of emissions reductions, leading to the results presented in the preceding sections: consumers are *paying more* for *worse* environmental benefits. Our analysis indicates that an alternative implementation of RGGI in which the price of RGGI allowances is set to $7 per short ton for compliance entities in New Jersey would lower both costs to consumers and PJM-wide CO2 emissions.

Appendix A: Additional Proposal Variations

A1. Overview

This appendix presents the results of two additional scenarios that differ from the NJ $7 Proposal in the amount of $7 allowances available and the eligible compliance entities, as detailed in Table 4. In the two new scenarios, the $7 allowances are available only to New Jersey compliance entities with a CO_2 emission rate less than or equal to 1,000 lbs/MWh; these units are listed in Table 5 and referred to in the text as "CC List".[23]

NJ $7 Proposal (original proposal variation)	RGGI allowances are set to $7 per allowance for all compliance entities in New Jersey and there is no limit on the availability of $7 allowances
50% Limited $7 Allowances	The availability of $7 allowances is capped at 50% of New Jersey's share of RGGI allowances and these allowances are available only to New Jersey compliance entities with a CO_2 emissions rate less than or equal to 1,000 lb/MWh
100% Limited $7 Allowances	The availability of $7 allowances is capped at 100% of New Jersey's share of RGGI allowances and these allowances are available only to New Jersey compliance entities with a CO_2 emissions rate less than or equal to 1,000 lb/MWh

Table 4. Overview of Additional Scenarios

[23] The CO_2 emissions rate (in pounds per megawatt-hour, or lbs/MWh) was calculated by dividing the total short tons of CO_2 emitted by a facility over a defined period by the total net electricity generated (in megawatt-hours) during that same period, and then multiplying by 2,000 to convert short tons to pounds. The emissions and generation data used in this calculation were sourced from the U.S. Environmental Protection Agency's Emissions & Generation Resource Integrated Database (eGRID) for calendar year 2023. The eGRID database provides plant-level emissions and generation data for U.S. electric power plants and is publicly available at: https://www.epa.gov/egrid. For example, a facility emitting 500,000 short tons of CO_2 while generating 1,000,000 MWh would have an emissions rate of 1,000 lbs/MWh.

Unit	Zone
Bergen Generating Station	PSEG
Lakewood Cogeneration	JCPL
Linden Generating Station	PSEG
Newark Energy Center	PSEG
Red Oak Power	JCPL
Sewaren 7 Combined Cycle Power Plant	PSEG
West Deptford Power Station	PSEG
Woodbridge Energy Center	PSEG

Table 5. New Jersey Compliance Entities Eligible for $7 Allowances

Both scenarios incorporate a limit on the availability of $7 allowances. Specifically, the availability of $7 allowances is capped at 50% and 100%, respectively, of New Jersey's share of RGGI allowances, as listed in Table 6. We use the allowance budget numbers from the Third Program Review and assume that New Jersey's share of the RGGI-wide total budget is approximately 18.8%.[24]

Year	NJ Base Budget	NJ CCR Tier 1	NJ CCR Tier 2	NJ Total Allocation
2027	13,109,924	2,205,997	2,205,997	17,521,918
2028	11,461,686	2,204,171	2,204,171	15,870,027
2029	9,815,508	2,202,198	2,202,198	14,219,903
2030	8,171,648	2,200,059	2,200,059	12,571,766

Table 6. New Jersey's RGGI Allowance Allocation

To enforce the limit in the model, we utilized a two-step modeling approach whereby, in the first step, a long-term model was used to identify the optimal usage of limited allowances across the year (to minimize total system costs). In the second step, the optimal daily usage was applied as a soft constraint in the hourly day-ahead SCUC/SCED simulation. In other words, the CC List units could violate the soft constraint by paying a penalty cost equal to the difference between the full price allowances and the $7 allowances. This process is depicted schematically in Figure 20, while Figure 21 shows the model-determined optimal usage of $7 allowances for the year 2027, as an example.

[24] https://www.rggi.org/program-overview-and-design/program-review

FIGURE 20

Modeling Approach Used in Allowance Limited Scenarios

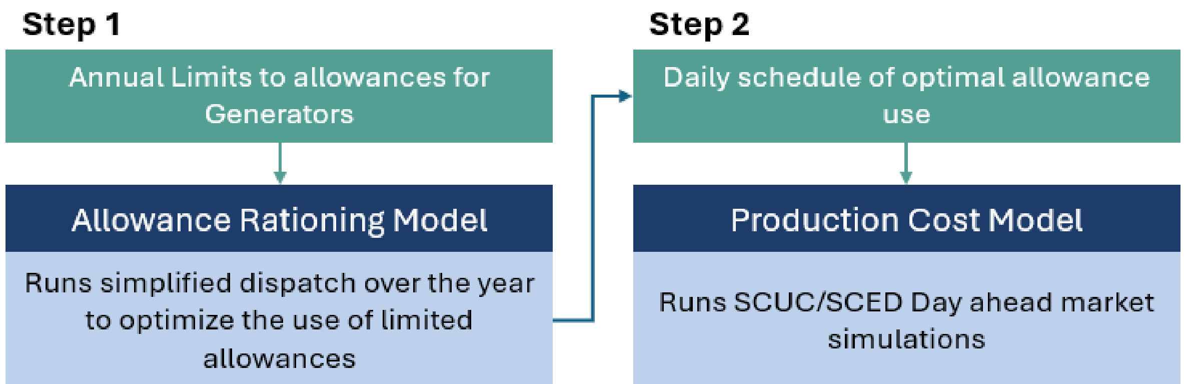


FIGURE 21

Optimized Daily Usage of $7 Allowances by Scenario, 2027

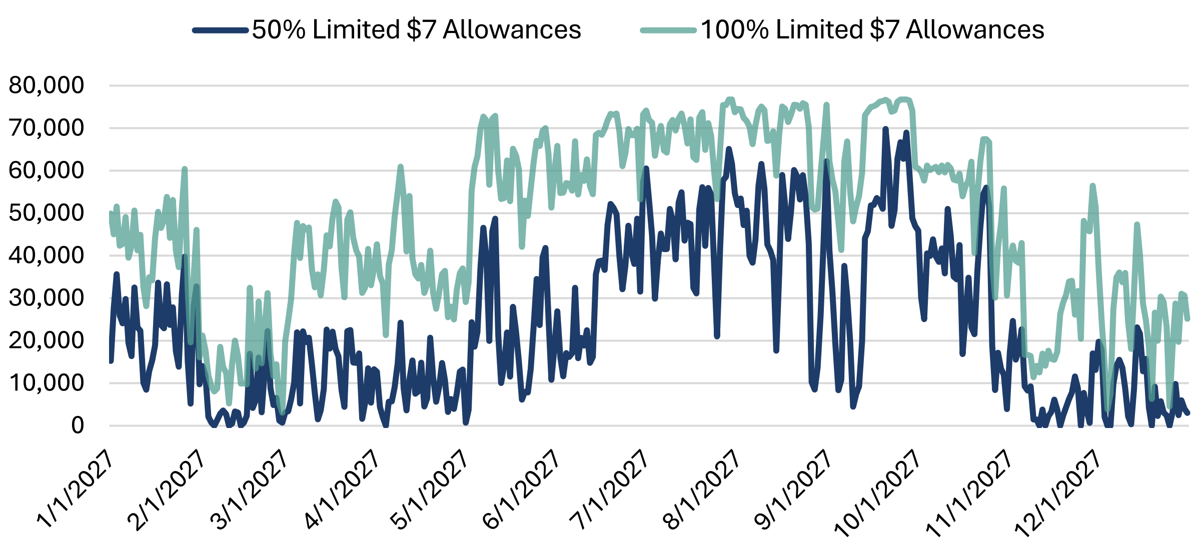


Figure 22 shows a simple average of the capacity factor of each CC List unit for each year in the study period. As expected, the results show that the CC List units operate more in the 100% Limited $7 Allowances scenario compared to the 50% Limited $7 Allowances scenario; and also operate more when Virginia participates in RGGI. This is because the RGGI cost adder increases the marginal cost of emitting units in Virginia, which pushes them further down the dispatch merit order to the benefit of CC List units.

FIGURE 22
Average Capacity Factor of CC List Units

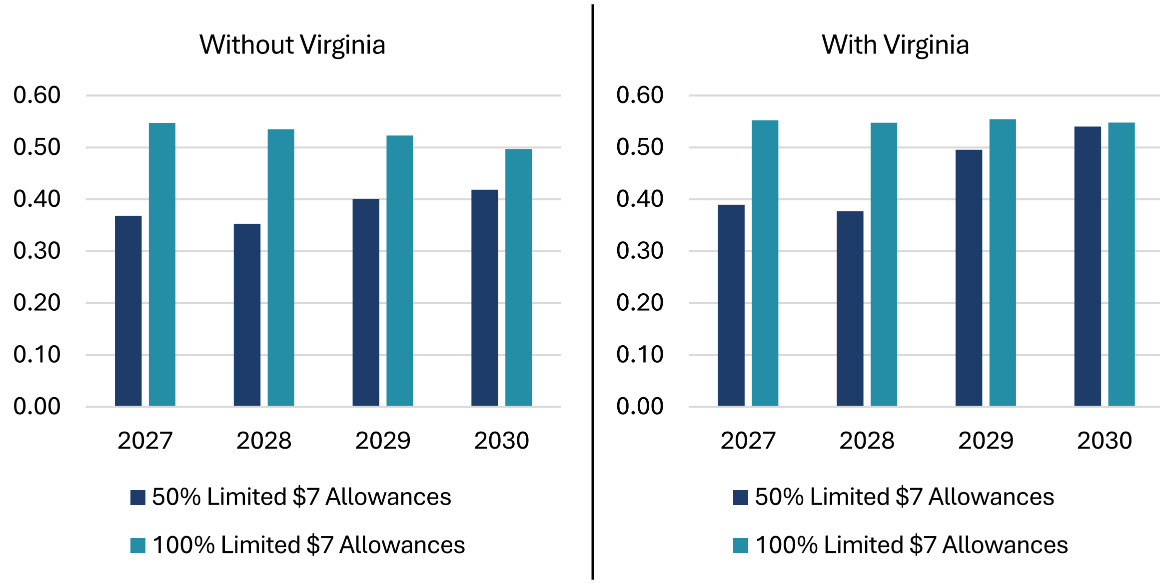
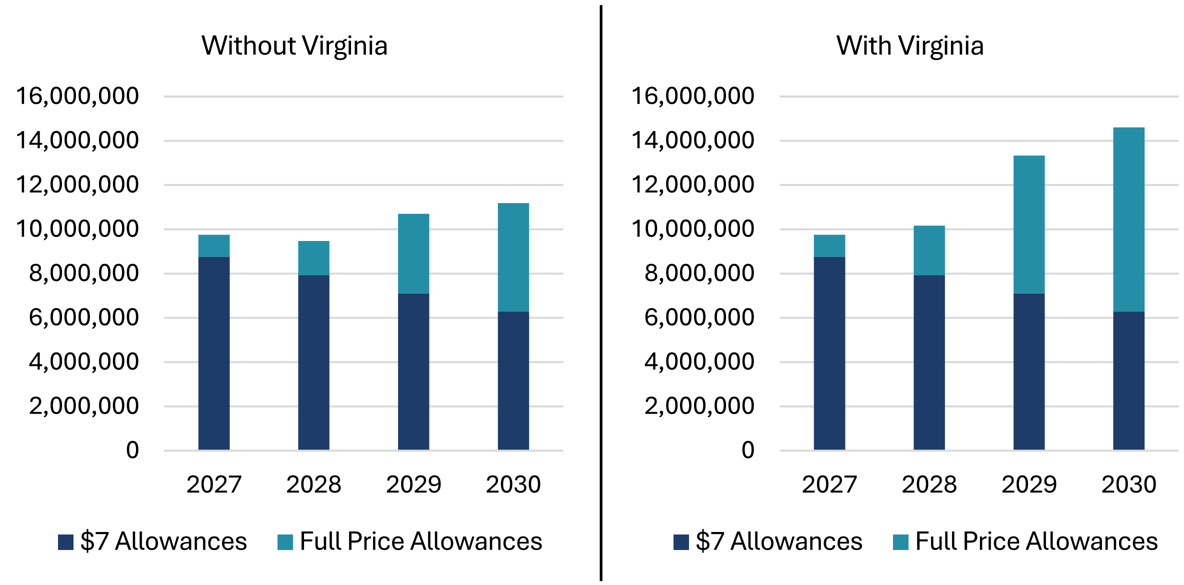


Figure 23 shows the total emissions from the units that qualify for the $7 allowances. In the 50% Limited $7 Allowances scenario, the qualifying units exhaust the availability of $7 allowances in all years and must purchase additional allowances at the CCR Tier 2 price to cover their total emissions. In the 100% Limited $7 Allowances scenario, the need to purchase additional allowances at the CCR Tier 2 price is significantly lower. When Virginia does not participate in RGGI, the higher-priced allowances are only needed in 2030; when Virginia participates in RGGI, the higher-priced allowances are needed in 2029 and 2030. In both scenarios, generation and, therefore, CO_2 emissions from the qualifying units are greater when Virginia participates in RGGI.

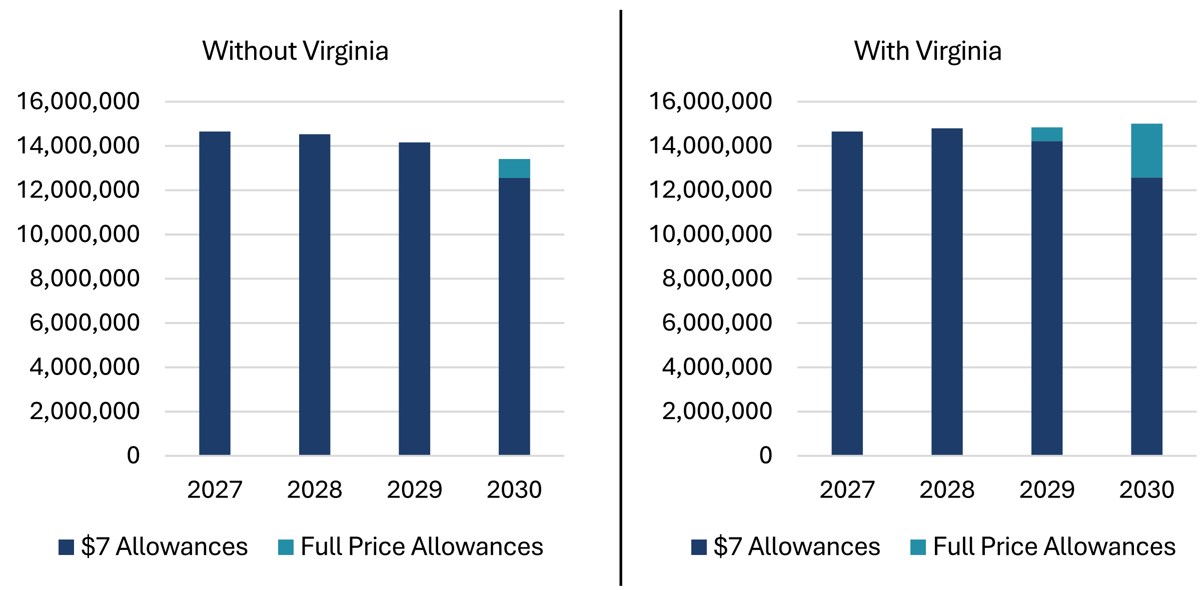
FIGURE 23

CC List Usage of $7 Allowances

a. 50% Limited $7 Allowances



b. 100% Limited $7 Allowances



A2. Modeling Results[25]

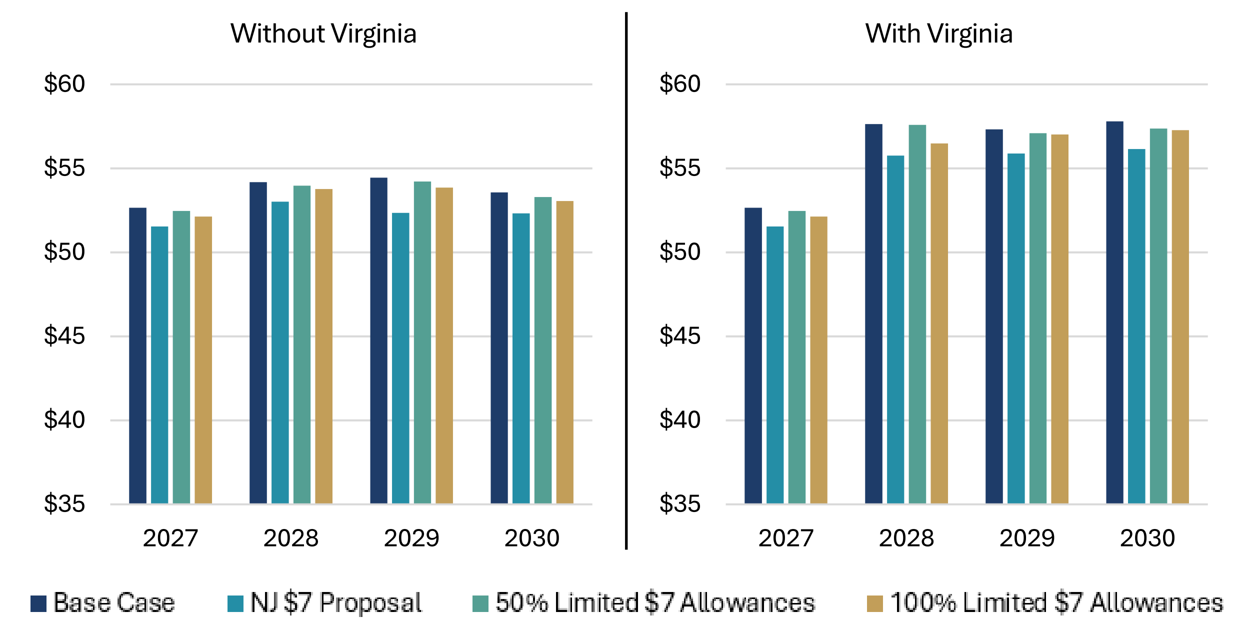
A2.1. LMPs and Load Payments

Figure 24 shows the annual average day-ahead LMP for the Base Case, in which RGGI allowances are priced at the CCR Tier 2 trigger price, and the three Change Case scenarios for both the primary analysis (status quo RGGI states, left) and the Virginia sensitivity analysis (Virginia rejoins RGGI in 2028, right). As in the NJ $7 Proposal, both allowance-limited scenarios cause wholesale energy prices to decrease in New Jersey and throughout PJM relative to the Base Case. The reduction in LMPs results from lower allowance costs for qualifying combined-cycle units in New Jersey, which reduces their dispatch costs and moves them higher in the dispatch merit order, enabling them to displace higher-cost generation elsewhere in PJM. As shown in Figure 25, because the $7 allowance price applies only to units with a CO_2 emissions rate at or below 1,000 lb/MWh and is subject to caps on allowance availability, the magnitude of the LMP reductions is smaller than in the NJ $7 Proposal. The 100% Limited $7 Allowances scenario, in which a larger pool of $7 allowances is available, produces greater LMP reductions than the 50% Limited $7 Allowances scenario. As illustrated in Figure 23, the need to purchase additional allowances at the higher price drives up marginal costs in the 50% Limited $7 Allowances scenario, resulting in lesser LMP reductions.

FIGURE 24

Day-Ahead Load LMPs ($/MWh)

a. PJM-Wide Annual Average Price



[25] The results presented in this appendix represent outputs from the model's day-ahead cycle, while the results in the main body of the white paper represent outputs from the real-time cycle. Reported metrics may differ between cycles as a result of differences in dispatch.

b. New Jersey Annual Average Price[26]

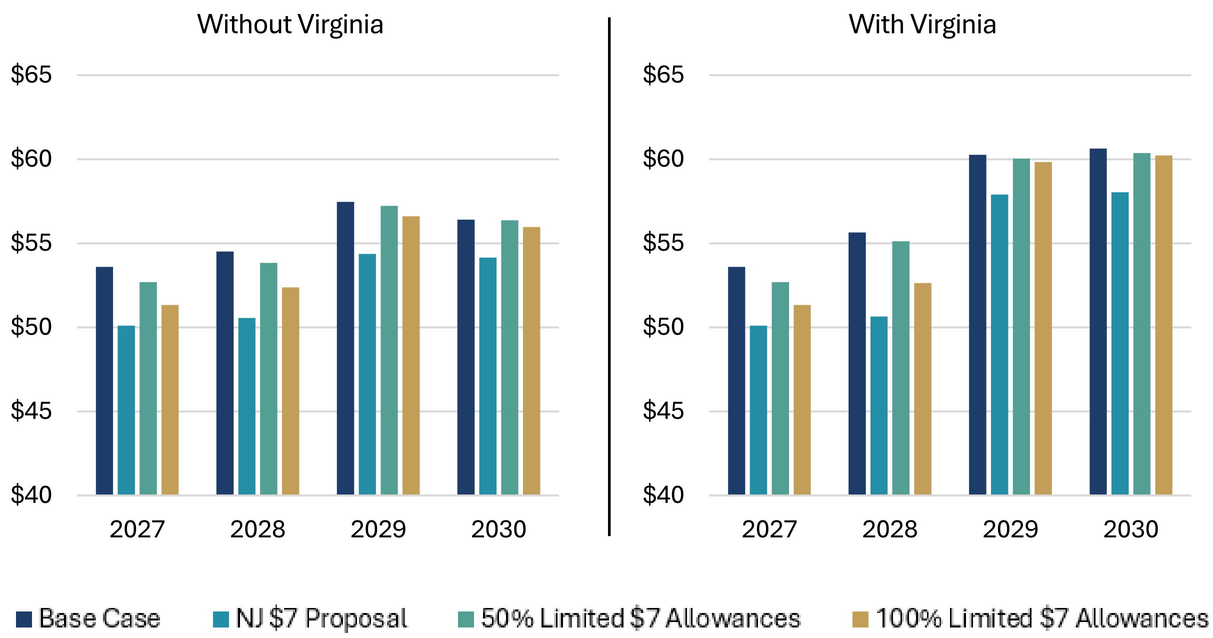
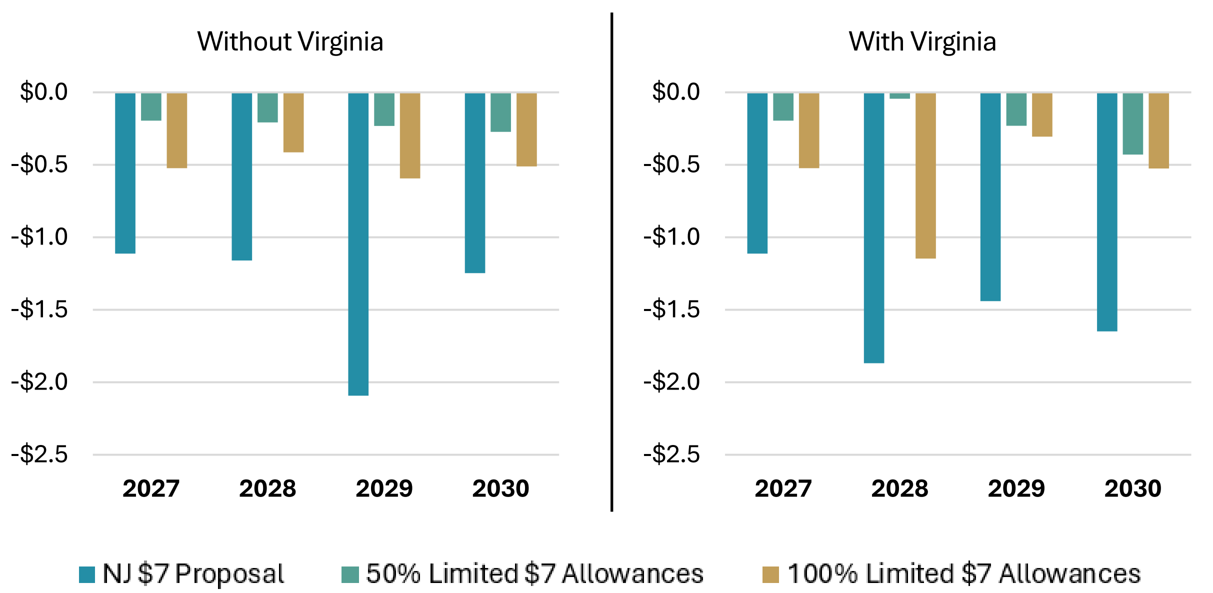


FIGURE 25

Change in Day-Ahead Load LMPs Relative to Base Case ($/MWh)

a. Change in PJM-Wide Annual Average Price



[26] Reflects zones AE, JCPL, PSEG, and RECO.

b. Change in New Jersey Annual Average Price[27]

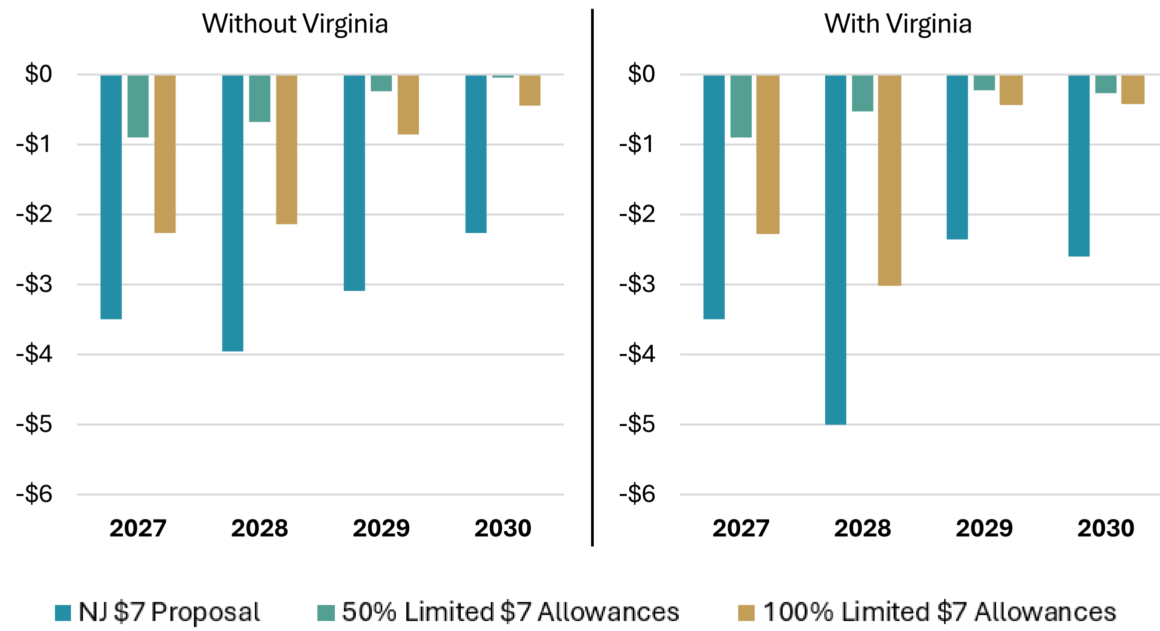
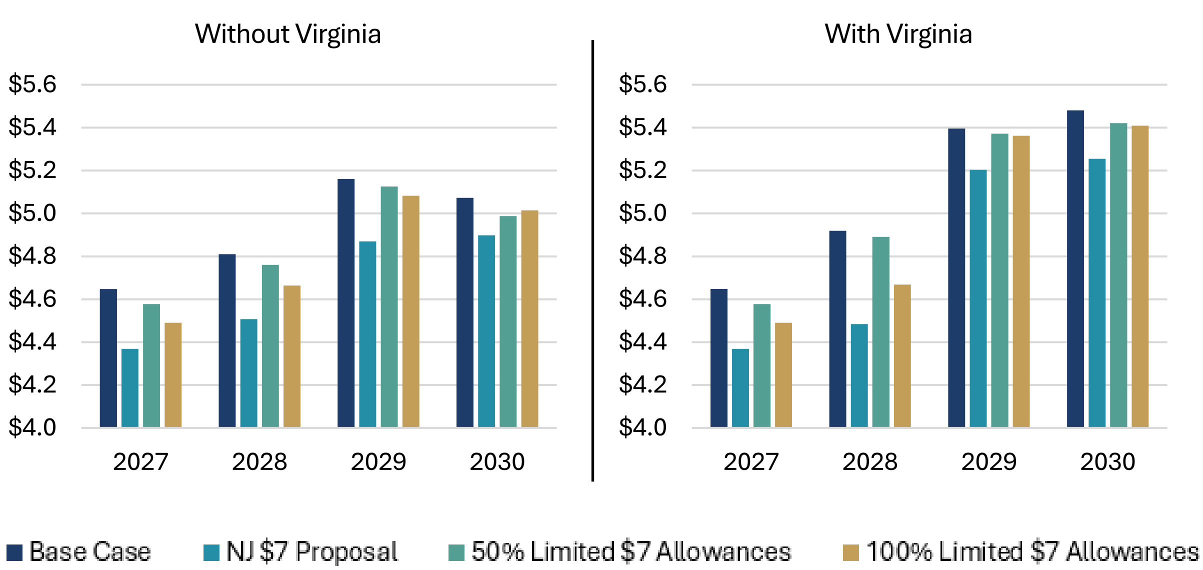


Figure 26 shows the corresponding cost to serve New Jersey load for each scenario, illustrating the consumer savings that result from lower wholesale energy prices in each case. Figure 27 shows the change in cost to serve New Jersey load relative to the Base Case scenario.

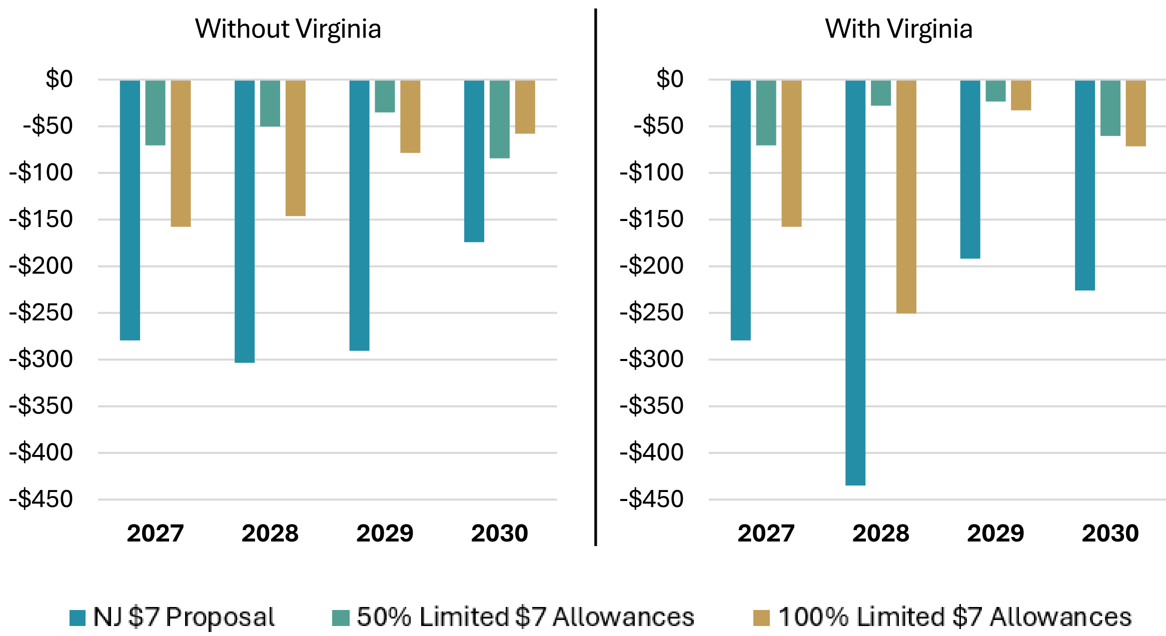
FIGURE 26
Cost of Wholesale Energy to Serve New Jersey Load ($B)



[27] Reflects zones AE, JCPL, PSEG, and RECO.

FIGURE 27

Change in Cost of Wholesale Energy to Serve New Jersey Load Relative to Base Case ($M)



A2.2. CO_2 Emissions

Figures 28 and 29 show PJM-wide CO_2 emissions and the change in PJM-wide CO_2 emissions relative to the Base Case, respectively, for each scenario. As shown in Figure 28, all three Change Case scenarios result in lower CO_2 emissions than the Base Case. These reductions are driven by an increase in generation from gas-fired combined-cycle units in New Jersey and a corresponding decrease in generation from higher-emitting coal-fired and other thermal generation located in western PJM. The NJ $7 Proposal achieves the greatest emissions reductions due to the greater availability of $7 allowances and the wider pool of eligible compliance entities. The allowance-limited scenarios produce smaller reductions due to the more restricted availability of $7 allowances and the narrower set of eligible compliance entities. As shown in Figure 29, the 100% Limited $7 Allowances scenario results in much greater emissions reductions than the 50% Limited $7 Allowances scenario in each year of the study period. The annual emissions reductions are greatest in the first two years of the study period as the availability of $7 allowances decreases over time while load is increasing. Table 7 (Without Virginia) and Table 8 (With Virginia) reproduce the emissions reduction data from Figure 29 in tabular format.

FIGURE 28

PJM-Wide CO2 Emissions (Million Short Tons)

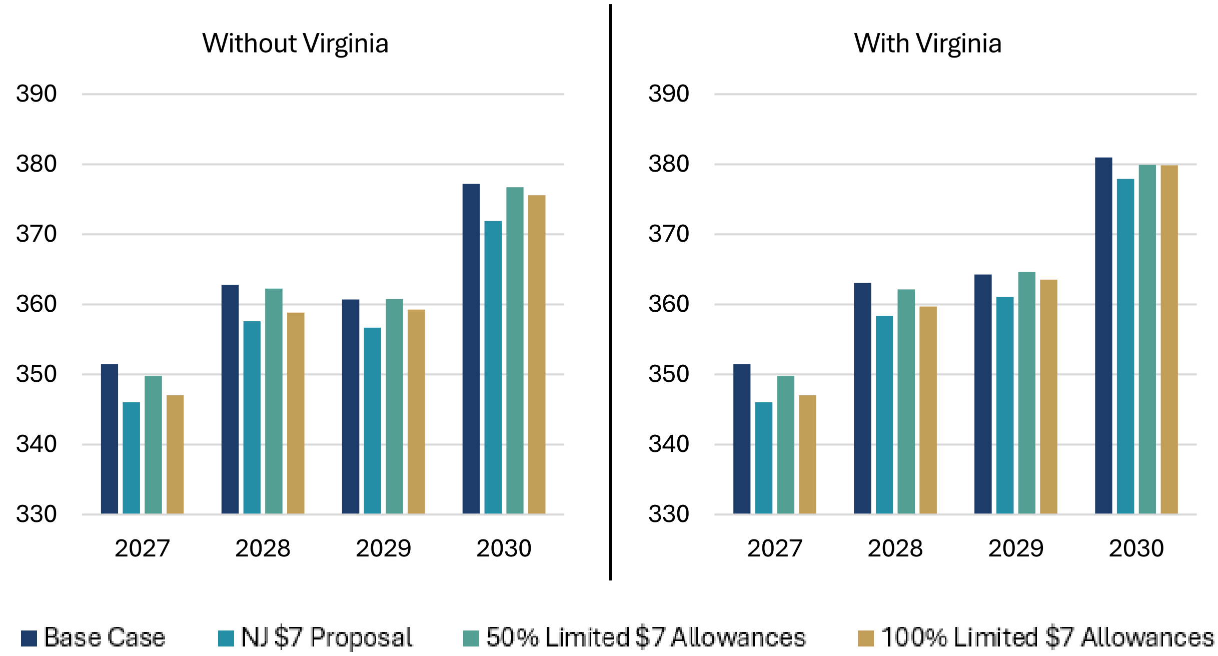
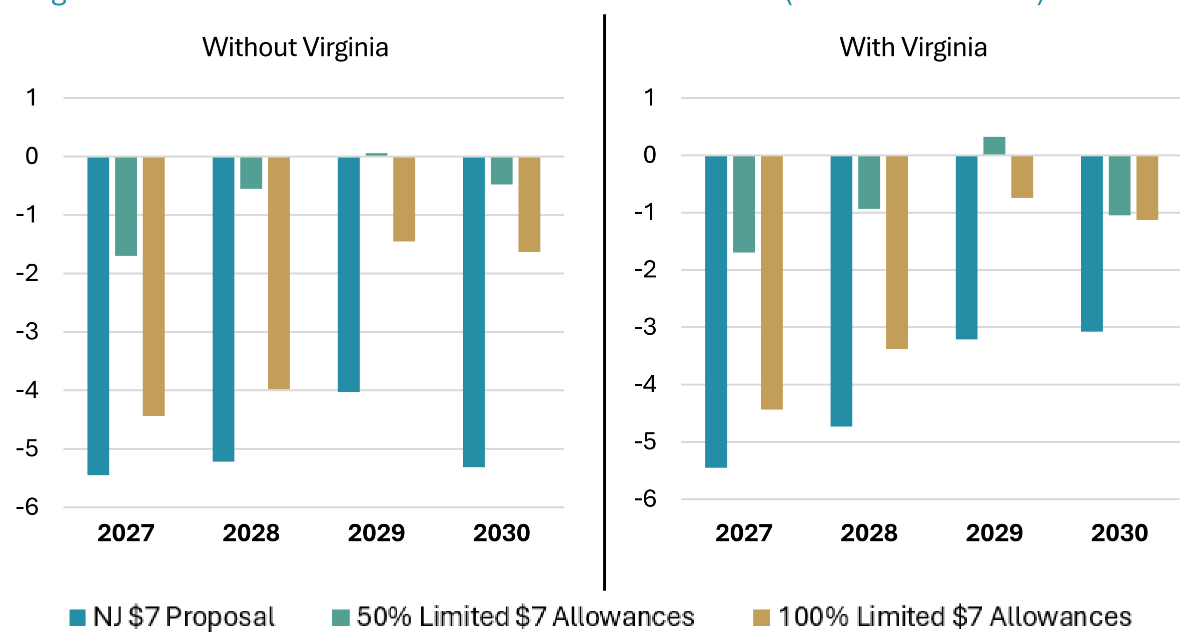


FIGURE 29

Change in PJM-Wide CO2 Emissions Relative to Base Case (Million Short Tons)



Year	NJ $7 Proposal (Million Short Tons)	100% Limited $7 Allowances (Million Short Tons)	50% Limited $7 Allowances (Million Short Tons)
2027	-5.45	-4.44	-1.70
2028	-5.22	-3.98	-0.55
2029	-4.03	-1.45	0.06
2030	-5.31	-1.63	-0.48
2027-2030 Average	**-5.00**	**-2.88**	**-0.67**

Table 7. Change in PJM-Wide CO_2 Emissions Relative to Base Case, Without Virginia

Year	NJ $7 Proposal (Million Short Tons)	100% Limited $7 Allowances (Million Short Tons)	50% Limited $7 Allowances (Million Short Tons)
2027	-5.45	-4.44	-1.70
2028	-4.73	-3.38	-0.94
2029	-3.21	-0.74	0.32
2030	-3.08	-1.13	-1.05
2027-2030 Average	**-4.12**	**-2.42**	**-0.84**

Table 8. Change in PJM-Wide CO_2 Emissions Relative to Base Case, With Virginia

A2.3. State Revenues

New Jersey will continue to collect RGGI revenues under the new proposals, albeit at a lesser level.[28] Table 9 shows the estimated 2027 financial benefits from RGGI for each scenario. In each scenario, we assume that the number of allowances sold by New Jersey is equal to the total emissions from New Jersey compliance entities.[29] The combination of annual ratepayer savings and revenues from the sale of allowances exceeds the $270M in total RGGI revenues raised in 2025 in all scenarios except the 50% Limited $7 Allowances scenario.

Metric	NJ $7 Proposal	100% Limited $7 Allowances	50% Limited $7 Allowances
NJ Emissions / Allowance Need	19,260,707	16,249,144	11,559,437
Allowances Sold	19,260,707	16,249,144	11,559,437
$7 Allowances	19,260,707	16,249,144	8,760,959
Full Price Allowances	0	0	2,798,478
Revenue from Sale of Allowances ($M)	$135	$114	$143
Annual Ratepayer Savings Relative to Base Case ($M)	$279	$158	$70
Total ($M)	$414	$271	$214

Table 9. Estimated New Jersey State Revenues for 2027

[28] In 2025, New Jersey sold 12,375,668 allowances for total revenue of $269,780,768.

[29] We note that, in the case of the NJ $7 Proposal, the total emissions from New Jersey compliance entities exceeds New Jersey's allowance allocation of 17,521,918 in 2027.

Appendix B: ENELYTIX® Powered by PSO

ENELYTIX® is a Software as a Service (SaaS) energy market simulation environment implemented on Amazon EC2, a commercial cloud computing platform.[30]

A central element of ENELYTIX is the Power System Optimizer (PSO), an advanced power markets simulator.[31] PSO provides ENELYTIX the capability to accurately model the decision processes used in a wide range of power planning and market structures including long-term system expansion, capacity markets, Day-Ahead (DA) energy markets, and Real-Time (RT) energy markets. ENELYTIX has this capability because it can configure PSO to determine the optimum solution to each market structure.

As a system expansion optimization model, PSO integrates resource adequacy requirements and the specific design of the capacity market with environmental compliance policies, such as state-level and regional Renewable Portfolio Standards (RPS) and emission constraints.

As a production cost model, PSO is built on a Mixed Integer Programming (MIP) unit commitment and economic dispatch structure that simulates the operation of the electric power system. PSO determines the security-constrained commitment and dispatch of each modeled generating unit, the loading of each element of the transmission system, and the locational marginal price (LMP) for each generator and load area. PSO supports both hourly and sub-hourly timescales.

For this analysis, PSO was set up to model unit commitment (DA market) and economic dispatch (RT market). In the commitment process, generating units in a region are turned on or kept on in order for the system to have enough generating capacity available to meet the expected next-day peak load and operating reserve requirements. PSO then uses the set of committed units to dispatch the system on an hourly real-time basis, whereby committed units throughout the modeled footprint are operated between their minimum and maximum operating points to minimize total production costs. The unit commitment in PSO is formulated as a mixed integer

[30] ENELYTIX® is a registered trademark of Newton Energy Group, LLC.

[31] PSO is a product of Polaris System Optimization, Inc.

linear programming optimization problem, which is solved to the true optima using the commercial CPLEX solver.[32]

The ENELYTIX/PSO modeling environment provides a realistic, objective, and highly defendable analysis of the physical and financial performance of power systems, in particular power systems integrating variable renewable resources. The critical advantage of ENELYTIX/PSO over traditional production costing modeling tools is its ability to model the concurrent dynamics of:

1. uncertainty of future conditions of the power system;
2. the scope, physical capabilities, and economics of options available to the system operator to respond to these uncertain conditions;
3. the timing and optionality or irreversibility of the operator's decisions to exercise these options.

By capturing these concurrent dynamics, ENELYTIX/PSO avoids the generally recognized inability of traditional simulation tools to reflect the effect of operational decisions on the physics of the power system, price formation, and financial performance of physical and financial assets.

For additional information about ENELYTIX powered by PSO, visit https://enelytix.com.

[32] CPLEX is a product of IBM Corporation.